



MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEMS

ARINC CHARACTERISTIC 781-8

PUBLISHED: September 10, 2019

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Prepared by the Airlines Electronic Engineering Committee (AEEC)
Adopted by the AEEC Executive Committee

	Adoption Date	Published Date
Characteristic 781	October 4, 2005	November 22, 2005
	Supplements to this ARINC Standard	
Characteristic 781-1	October 11, 2006	November 22, 2006
Characteristic 781-2	September 26, 2007	November 15, 2007
Characteristic 781-3	October 22, 2008	February 9, 2009
Characteristic 781-4	March 31, 2010	May 19, 2010
Characteristic 781-5	May 2, 2012	June 15, 2012
Characteristic 781-6	October 4, 2012	December 5, 2012
Characteristic 781-7	May 2, 2017	August 9, 2017
Characteristic 781-8	April 30, 2019	September 10, 2019

A summary of the changes introduced by each supplement is included at the end of this document.

FOREWORD

The AEEC, SAE ITC, and ARINC Standards

ARINC Industry Activities, an SAE ITC program, organizes aviation industry committees and participates in related industry activities that benefit aviation at large by providing technical leadership and guidance. These activities directly support aviation industry goals: promote safety, efficiency, regularity, and cost-effectiveness in aircraft operations.

ARINC Industry Activities organizes and provides the secretariat for international aviation organizations (AEEC, AMC, FSEMC) which coordinate the work of aviation industry technical professionals and lead the development of technical standards for airborne electronic equipment, aircraft maintenance equipment and practices, and flight simulator equipment used in commercial, military, and business aviation. The AEEC, AMC, and FSEMC develop consensus-based, voluntary standards that are published by SAE ITC and are known as ARINC Standards. The use of ARINC Standards results in substantial technical and economic benefit to the aviation industry.

There are three classes of ARINC Standards:

- a) ARINC Characteristics – Define the form, fit, function, and interfaces of avionics and other airline electronic equipment. ARINC Characteristics indicate to prospective manufacturers of airline electronic equipment the considered and coordinated opinion of the airline technical community concerning the requisites of new equipment including standardized physical and electrical characteristics to foster interchangeability and competition.
- b) ARINC Specifications – Are principally used to define either the physical packaging or mounting of avionics equipment, data communication standards, or a high-level computer language.
- c) ARINC Reports – Provide guidelines or general information found by the airlines to be good practices, often related to avionics maintenance and support.

The release of an ARINC Standard does not obligate any organization to purchase equipment so described, nor does it establish or indicate recognition or the existence of an operational requirement for such equipment, nor does it constitute endorsement of any manufacturer's product designed or built to meet the ARINC Standard.

In order to facilitate the continuous product improvement of this ARINC Standard, two items are included in the back of this document:

An Errata Report solicits any corrections to existing text or diagrams that may be included in a future Supplement to this ARINC Standard.

An ARINC IA Project Initiation/Modification (APIM) form solicits any proposals for the addition of technical material to this ARINC Standard.

ARINC CHARACTERISTIC 781
TABLE OF CONTENTS

1.0	INTRODUCTION AND DESCRIPTION	1
1.1	Purpose of this Characteristic.....	1
1.2	Referenced ARINC Standards and Industry Documents	1
1.3	Inmarsat System Description.....	3
1.4	Function of Equipment.....	5
1.5	Airborne Avionics Configurations	6
1.6	Unit Description	6
1.6.1	Satellite Data Unit (SDU)	6
1.6.2	SDU Configuration Module (SCM).....	7
1.6.3	High-Power Amplifier (HPA)	7
1.6.4	Diplexer/Low-Noise Amplifier (DLNA).....	7
1.6.5	HPA LNA Diplexer (HLD).....	7
1.6.6	Enhanced Low Gain Antenna (ELGA)	7
1.6.7	Intermediate Gain Antenna (IGA)	7
1.6.8	High Gain Antenna (HGA)	7
1.7	System Performance	8
1.7.1	Transmitter Equipment Performance.....	8
1.7.2	Receiver Equipment Performance	8
1.8	Interchangeability	9
1.9	Regulatory Approval	9
2.0	INTERCHANGEABILITY STANDARDS.....	11
2.1	Introduction.....	11
2.2	Form Factors, Connectors, and Index Pin Coding	11
2.2.1	Satellite Data Unit (SDU)	11
2.2.1.1	SDU Size.....	11
2.2.1.2	Connectors.....	11
2.2.1.3	Form Factor.....	12
2.2.1.4	RF Characteristics for SDU with Integrated HPA.....	12
2.2.1.4.1	Frequency Range	12
2.2.1.4.2	RF Output Power.....	12
2.2.1.4.3	Back-off Range, Step Size, and Accuracy	12
2.2.1.4.4	Stability	12
2.2.1.4.4.1	RF Output Power Stability	12
2.2.1.4.4.2	AM/PM Conversion.....	13
2.2.1.4.5	Linearity.....	13
2.2.1.4.5.1	Intermodulation Products.....	13
2.2.1.4.5.2	Error Vector Magnitude (EVM) ²	14
2.2.1.4.5.3	Spectral Regrowth	14
2.2.1.4.6	Harmonics, Discrete Spurious Emissions and Noise	15
2.2.1.4.7	Receiver Noise Figure.....	15
2.2.1.4.8	Muting and Carrier Off.....	15
2.2.1.4.9	Voltage Standing Wave Ratio (VSWR)	16
2.2.1.5	RF Characteristics for SDU with External HPA.....	16
2.2.2	External Flange-mounted High-Power Amplifier (HPA).....	16
2.2.2.1	General	16
2.2.2.2	Small Form Factor External HPA.....	17
2.2.2.3	Large Form Factor External HPA.....	17
2.2.3	SDU Configuration Module	18
2.2.3.1	SCM Form Factor.....	18
2.2.3.2	Connectors.....	18
2.2.3.3	USIMs	18

**ARINC CHARACTERISTIC 781
TABLE OF CONTENTS**

2.2.4	Diplexer/Low-Noise Amplifier (DLNA).....	18
2.2.4.1	DLNA VSWR.....	20
2.2.4.2	Noise Figure/Gain	20
2.2.4.3	Insertion Loss and Rejection.....	20
2.2.4.3.1	Antenna Port to Receive Port (DLNA Output)	20
2.2.4.3.2	Transmit Port to Antenna Port.....	20
2.2.4.3.2.1	Type D – Transmit Port to Antenna Port.....	20
2.2.4.3.2.2	Type F – Transmit Port to Antenna Port.....	21
2.2.4.3.3	Transmit Port to Receive Port (DLNA Output)	22
2.2.4.3.3.1	Type D – Transmit Port to Receive Port (DLNA Output)	22
2.2.4.3.3.2	Type F – Transmit Port to Receive Port (DLNA Output).....	22
2.2.4.4	DLNA Output Power.....	22
2.2.4.5	DLNA Intermodulation.....	23
2.2.4.5.1	Type F – DLNA Intermodulation Products in Satcom Receive Band	23
2.2.4.5.2	Type F – DLNA Intermodulation Products in GNSS Band	23
2.2.4.6	DLNA Connectors	23
2.2.4.7	DLNA Form Factor	24
2.2.4.8	DLNA On/Off Control	24
2.2.4.9	DLNA BITE.....	24
2.3	Antenna Specification.....	24
2.3.1	Antenna Coverage Volume.....	24
2.3.1.1	Ideal Antenna Coverage Volume	24
2.3.1.2	Achieved Antenna Coverage Volume	25
2.3.1.3	Antenna Measurement Ground Plane.....	25
2.3.2	High Gain Antenna (HGA)	25
2.3.2.1	High Gain Antenna Size.....	25
2.3.2.2	High Gain Antenna Connectors	25
2.3.2.3	High Gain Antenna Form Factor	25
2.3.2.4	High Gain Antenna Grounding and Bonding.....	25
2.3.2.5	High Gain Antenna (HGA) Receive System.....	26
2.3.2.5.1	Frequency of Operation.....	26
2.3.2.5.2	Polarization.....	26
2.3.2.5.3	Axial Ratio	26
2.3.2.5.4	Receive System Figure of Merit (G/T)	26
2.3.2.5.5	Steering Angle.....	26
2.3.2.5.6	Steering Control	26
2.3.2.5.7	Overload Capability	27
2.3.2.5.8	Receive Antenna VSWR	27
2.3.2.5.9	Satellite Discrimination	27
2.3.2.5.10	Phase Discontinuity	27
2.3.2.5.11	Carrier-to-Multipath (C/M) Discrimination	28
2.3.2.6	High Gain Antenna Transmit System.....	28
2.3.2.6.1	Frequency of Operation.....	28
2.3.2.6.2	Polarization.....	28
2.3.2.6.3	Axial Ratio	28
2.3.2.6.4	Gain.....	28
2.3.2.6.5	Steering Angle.....	28
2.3.2.6.6	Steering Control	28
2.3.2.6.7	Transmit Antenna VSWR	28
2.3.2.6.8	Output Power Capability.....	28
2.3.2.6.9	Satellite Discrimination	29
2.3.2.6.10	Phase Discontinuity	29

**ARINC CHARACTERISTIC 781
TABLE OF CONTENTS**

2.3.2.6.11	Carrier-to-Multipath (C/M) Discrimination	29
2.3.2.6.12	L-band System Isolation	29
2.3.2.6.13	Antenna Intermodulation	30
2.3.2.6.13.1	Antenna Intermodulation Products in Satcom Receive Band	30
2.3.2.6.13.2	Antenna Intermodulation Products in GNSS Band	31
2.3.3	Intermediate Gain Antenna (IGA)	31
2.3.3.1	Intermediate Gain Antenna Size	31
2.3.3.2	Intermediate Gain Antenna Connectors	31
2.3.3.3	Intermediate Gain Antenna Form Factor	31
2.3.3.4	Intermediate Gain Antenna Grounding and Bonding	32
2.3.3.5	Intermediate Gain Antenna Receive System	32
2.3.3.5.1	Frequency of Operation	32
2.3.3.5.2	Polarization	32
2.3.3.5.3	Axial Ratio	32
2.3.3.5.4	Receive System Figure of Merit (G/T)	32
2.3.3.5.5	Steering Angle	33
2.3.3.5.6	Steering Control	33
2.3.3.5.7	Overload Capability	33
2.3.3.5.7.1	Receive Antenna VSWR	33
2.3.3.5.8	Discrimination	33
2.3.3.5.9	Phase Discontinuity	33
2.3.3.6	Intermediate Gain Transmit System	34
2.3.3.6.1	Frequency of Operation	34
2.3.3.6.2	Polarization	34
2.3.3.6.3	Axial Ratio	34
2.3.3.6.4	Gain	34
2.3.3.6.5	Steering Angle	34
2.3.3.6.6	Steering Control	34
2.3.3.6.7	Transmit Antenna VSWR	34
2.3.3.6.8	Output Power Capability	34
2.3.3.6.9	Discrimination	34
2.3.3.6.10	Phase Discontinuity	35
2.3.3.6.11	L-band System Isolation	35
2.3.3.6.12	Antenna Intermodulation	35
2.3.3.6.12.1	Antenna Intermodulation Products in Satcom Receive Band	35
2.3.3.6.12.2	Antenna Intermodulation Products in GNSS Band	36
2.3.4	Enhanced Low Gain Antenna (ELGA)	36
2.3.5	Coaxial Cables	36
2.3.5.1	Loss Between SDU and External HPA	36
2.3.5.2	DLNA to Antenna Cable	36
2.3.5.3	Total Transmit Loss between SDU or HPA and Antenna	37
2.3.5.4	Loss between LNA and SDU	37
2.3.6	RF installation issues	37
2.4	Standard Interwiring	39
2.5	Power Circuitry	39
2.5.1	Primary Power Input	39
2.5.2	Power Control Circuitry	40
2.6	System Functions and Signal Characteristics	40
2.7	Environmental Conditions	40
2.8	Cooling	40
2.8.1	SDU	41
2.8.2	Flange Mounted HPA	41

**ARINC CHARACTERISTIC 781
TABLE OF CONTENTS**

2.9	Grounding and Bonding.....	42
2.10	System ATE and BITE Design	42
2.10.1	General	42
2.10.2	Unit Identification	42
2.10.3	Built-In Test Equipment (BITE).....	42
2.10.3.1	BITE Display	43
2.10.3.2	Fault Monitor	43
2.10.3.3	Self-Test Initiation	44
2.10.3.4	Monitor Memory Output	44
2.10.4	Use of Automatic Test Equipment	44
3.0	SATCOM FUNCTIONS	46
3.1	Inmarsat Radio	46
3.1.1	Inmarsat Services	46
3.1.1.1	General	46
3.1.1.2	Classic Aero	46
3.1.1.3	Swift64	47
3.1.1.4	SwiftBroadband.....	48
3.1.2	Management of Radio Interface	52
3.1.2.1	RF Power	52
3.1.2.2	Antenna.....	53
3.1.2.3	SwiftBroadband Transmit Burst timing.....	53
3.1.2.4	GNSS Interference Prevention.....	54
3.1.2.4.1	Background	54
3.1.2.4.2	Frequency Allocations by Ground Stations	54
3.1.2.4.3	GNSS Frequency Management in the AES	55
3.1.2.4.4	Recommended Frequency Check Algorithm In SDU	55
3.1.2.5	Mapping User Interfaces to Radio Interfaces.....	56
3.1.2.6	Selection of Inmarsat Services, Satellites, and Ground Stations	57
3.2	User Interfaces	58
3.2.1	Pilot System Interfaces for Voice Communication.....	58
3.2.1.1	Introduction	58
3.2.1.2	Call Control	58
3.2.1.2.1	MCDU.....	58
3.2.1.2.2	ACP	59
3.2.1.2.3	AMS.....	60
3.2.1.3	Call Annunciation	61
3.2.1.4	Call Priority.....	61
3.2.1.5	Call Routing.....	62
3.2.1.6	SAT Phone Using Classic Aero Services.....	62
3.2.1.6.1	General.....	62
3.2.1.6.2	Air-To-Ground Call	63
3.2.1.6.3	Ground-To-Air Call	64
3.2.1.7	SAT Phone using SwiftBroadband.....	64
3.2.1.8	SAT Radio.....	65
3.2.1.9	Williamsburg SDU Controller	67
3.2.2	Cockpit ACARS Data	67
3.2.2.1	SDU to ACARS MU/CMU Join/Leave	67
3.2.3	ISDN Interface	68
3.2.4	Ethernet	68
3.2.4.1	Purpose and Requirements of the Interface	68
3.2.4.2	Interface Components.....	69
3.2.4.3	Interface Fundamentals	70

**ARINC CHARACTERISTIC 781
TABLE OF CONTENTS**

3.2.4.4	Multiple Ethernet Interfaces	71
3.2.5	CEPT-E1	71
3.2.6	POTS	71
3.3	Software Data Loader Interfaces	71
3.4	Miscellaneous	71
3.4.1	Dual Satcom Installation	71
3.4.1.1	Dual Satcom Configurations	71
3.4.1.2	Physical Interfaces for Dual Satcom	73
3.4.1.2.1	Dual Crosstalk Buses	73
3.4.1.2.2	System Select and Disable Discrete Signals	73
3.4.1.2.3	SDU Number Configuration Pin	74
3.4.1.3	Standard Warm Standby Operation and Protocol	74
3.4.1.3.1	General Dual Operating Principles	74
3.4.1.3.2	ORT Items for Dual Satcom	75
3.4.1.3.3	Power-up Sequence for Dual Satcom	76
3.4.1.3.4	Satcom Select "Auto" Mode	77
3.4.1.3.5	MCDU Menus	78
3.4.1.3.6	Crosstalk Protocol	78
3.4.1.3.7	Crosstalk Label 273 Definition	79
3.4.1.4	Interference between Terminals	81
3.4.2	Configuration and Identification Data	81
3.4.2.1	ORT	81
3.4.2.1.1	General	81
3.4.2.1.2	ORT Synchronization	82
3.4.2.1.3	ORT Contents	83
3.4.2.2	System Configuration Pins	96
3.4.2.3	AES ID	96
3.4.2.4	Forward/Return ID (Swift64)	96
3.4.2.5	IMSI and IMEI(SV) (SwiftBroadband)	97
3.4.2.6	Addressing for SwiftBroadband Safety Services	97
3.4.2.7	Aircraft Type	97
3.4.3	Security	97
3.5	Priority, Precedence, Preemption, and Preference	99
3.6	Future Growth	99
3.6.1	ARINC 664 Deterministic Ethernet	99
3.6.2	Fiber Optic	100
3.6.3	FANS/ATS over SwiftBroadband	100
3.6.4	Multi-Frequency Band	100
3.7	Passive Intermodulation Built-In Test (PIMBIT)	100
3.7.1	Introduction	100
3.7.2	Technical Background	101
3.7.3	SDU Functionality	101
3.7.3.1	Frequencies Reserved for PIMBIT	101
3.7.3.2	Transmit Test Signal Levels (EIRP)	102
3.7.3.3	Constant EIRP versus Constant Power to the Antenna	102
3.7.3.4	ORT Parameters	102
3.7.3.5	IM Product Order to be Tested	102
3.7.3.6	Transmit Signal Off/On Sequence for Receive Signal Monitoring	102
3.7.3.7	Antenna Beam Pointing Angles to be Tested	103
3.7.3.8	PIMBIT Assessment Parameter	103
3.7.3.9	Stabilization and Measurement Times	103
3.7.3.10	Measurement Discard Ratio	104

**ARINC CHARACTERISTIC 781
TABLE OF CONTENTS**

3.7.3.11	Measurement of Additional IM Product Orders	104
3.7.3.11.1	PIMBIT Results Display/Storage and Immediate Clearing of any “Failure” ..	104
3.7.4	Operational Considerations	104
3.7.4.1	Prerequisite Conditions	104
3.7.4.2	Aircraft Orientation	105
3.7.4.3	Test Initiation.....	105
3.7.4.4	Action Following Test Failure	105
3.7.4.5	Interpreting Results of the PIMBIT	105
3.7.4.6	AMM Recommendations	106

ATTACHMENTS

ATTACHMENT 1	STANDARD INTERFACES	107
ATTACHMENT 2	ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM	152
ATTACHMENT 2A	ANTENNA CONFIGURATION DATA REPORTING	167
ATTACHMENT 2B	BIT-ORIENTED FAULT REPORTING PROTOCOL	174
ATTACHMENT 3	COCKPIT VOICE – SAT PHONE STATE MACHINE FOR NORMAL OPERATION.....	185
ATTACHMENT 4A	ARINC 781 SDU FUNCTIONS MATRIX	186
ATTACHMENT 4B	ARINC 781 SDU INTERFACES MATRIX	188
ATTACHMENT 5	ETHERNET INTERFACE	189
ATTACHMENT 6	ARINC 781 OUTPUT POWER USE CASES.....	248
ATTACHMENT 7	COMPACT SATCOM SYSTEMS	251
ATTACHMENT 8	NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES	270
ATTACHMENT 9	ATCT AND LTE RESILIENT DLNA.....	299
ATTACHMENT 10	ATTACHMENT REFERENCE GUIDE.....	323

APPENDICES

APPENDIX A	ACRONYMS	324
APPENDIX B	SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE.....	332

1.0 INTRODUCTION AND DESCRIPTION

1.0 INTRODUCTION AND DESCRIPTION

1.1 Purpose of this Characteristic

This document sets forth the desired characteristics of an aviation satellite communication (satcom) system intended for installation in all types of commercial transport and business aircraft. The intent of this document is to provide general and specific guidance on the form factor and pin assignments for the installation of the avionics primarily for airline use. It also describes the desired operational capability of the equipment to provide data and voice communications, as well as additional standards necessary to ensure interchangeability.

This characteristic specifies equipment using Inmarsat satellites operating in L-band. Ku-band and Ka-band equipment is specified in ARINC Characteristic 791 [and ARINC Characteristic 792](#).

1.2 Referenced ARINC Standards and Industry Documents

The Aviation Satellite Communication (satcom) System will present standard interfaces to a number of other aircraft systems. These include legacy ARINC 429 based systems along with newer ARINC 664 deterministic Ethernet network systems. Cockpit-based systems (Aircraft Communications Addressing and Reporting System (ACARS), Multi-Purpose Control and Display Unit (MCDU), Centralized Fault Display System (CFDS), etc.) are progressing towards communicating via ARINC 664 instead of ARINC 429 interfaces, especially for new aircraft programs. Cabin-based systems are moving towards switched Ethernet systems performing the functions of onboard networks such as those described in ARINC Characteristic 763.

ARINC Specification 404A: *Air Transport Equipment Cases and Racking*

ARINC Report 413A: *Guidance for Aircraft Electrical Power Utilization and Transient Protection*

ARINC Specification 429: *Digital Information Transfer System*

ARINC Specification 600: *Air Transport Avionics Equipment Interfaces*

ARINC Report 604: *Guidance for Design and Use of Built-In Test Equipment*

ARINC Specification 608A: *Design Guidance for Avionics Test Equipment*

ARINC Report 615: *Airborne Computer High Speed Data Loader*

ARINC Report 615A: *Software Data Loader Using Ethernet Interface*

ARINC Specification 618: *Air/Ground Character-Oriented Protocol Specification*

ARINC Specification 619: *ACARS Protocols for Avionic End Systems*

ARINC Specification 620: *Data Link Ground System Standard and Interface Specification (DGSS/IS)*

ARINC Specification 623: *Character-Oriented Air Traffic Services (ATS) Applications*

ARINC Report 624: *Design Guidance for Onboard Maintenance System*

ARINC Specification 626: *Standard ATLAS Language for Modular Test*

ARINC Report 627: *Programmers Guide to SMART™ Systems Using ARINC 626 ATLAS*

1.0 INTRODUCTION AND DESCRIPTION

ARINC Specification 653: *Avionics Application Software Standard Interface*

ARINC Specification 664: *Aircraft Data Network, Part 2, Ethernet Physical and Data Link Layer Specification*

ARINC Specification 664: *Aircraft Data Network, Part 7, Avionics Full Duplex Switched Ethernet Network*

ARINC Report 665: *Loadable Software Standards*

ARINC Characteristic 716: *Airborne VHF Communications Transceiver*

ARINC Characteristic 724B: *Aircraft Communications Addressing and Reporting System (ACARS)*

ARINC Characteristic 739: *Multi-Purpose Control and Display Unit*

ARINC Characteristic 739A: *Multi-Purpose Control and Display Unit*

ARINC Characteristic 741: *Aviation Satellite Communication System, Part 1, Aircraft Installation Provisions*

ARINC Characteristic 743A: *GNSS Sensor*

ARINC Characteristic 746: *Cabin Communications Systems (CCS)*

ARINC Characteristic 758: *Communications Management Unit (CMU) Mark 2*

ARINC Characteristic 761: *Second Generation Aviation Satellite Communication System, Aircraft Installation Provisions*

ARINC Characteristic 763: *Network Server Systems*

ARINC Characteristic 771: *Low-Earth Orbiting Aviation Satellite Communication System*

ARINC Characteristic 791: *Mark I Aviation Ku-Band and Ka-Band Satellite Communication System, Part 1, Physical Installation and Aircraft Interfaces*

ARINC Characteristic 792: *Second-Generation Ku-Band and Ka-Band Satellite Communication System*

ARINC Specification 801: *Fiber Optic Connectors*

ARINC Specification 802: *Fiber Optic Cables*

ARINC Report 803: *Fiber Optic System Design Guidelines*

ARINC Report 804: *Fiber Optic Active Device Specification*

ARINC Report 805: *Fiber Optic Test Procedures*

ARINC Report 806: *Fiber Optic Installation and Maintenance*

ARINC Specification 808: *3GCN – Cabin Distribution System*

ARINC Report 811: *Commercial Aircraft Information Security Concepts of Operation and Process Framework*

ARINC Specification 823: *Data Link Security, Part 1, ACARS Message Security*

ARINC Report 842: *Guidance for Usage of Digital Certificates*

ATA 42: *Aviation Industry Standards for Digital Information Security*

1.0 INTRODUCTION AND DESCRIPTION

EUROCAE ED-12/RTCA DO-178: *Software Considerations in Airborne Systems and Equipment Certification*

EUROCAE ED-14/RTCA DO-160: *Environmental Conditions and Test Procedures for Airborne Equipment*

EUROCAE ED-202/RTCA DO-326: *Airworthiness Security Process Specification*

FAA Advisory Circular 20-150: *Satellite Voice Equipment*

FAA Advisory Circular 20-173: *Installation of Electronic Flight Bag (EFB) Components*

Inmarsat Aeronautical System Definition Manual (Classic Aero)

Inmarsat Broadband Global Area Network (BGAN) System Definition Manual

ITU-R Recommendation 573: *Radio Communication Vocabulary*

ITU-T Recommendation G.703: *Transmission Systems and Media, Digital Systems and Networks, Digital Terminal Equipments – General*

ITU-T Recommendation G.704: *Transmission Systems and Media, Digital Systems and Networks, Digital – Terminal Equipments – General*

ITU-T Recommendation Q.850: *Digital Subscriber Signalling System No. 1 – General; Usage of cause and location in the Digital Subscriber Signalling System No. 1 and the Signalling System No. 7 ISDN User Part*

RTCA DO-210: *Minimum Operational Performance Standards (MOPS) for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS) Avionics (up to and including Change 3)*

RTCA DO-229: *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment*

RTCA DO-254: *Design Assurance Guidance for Airborne Electronic Hardware*

RTCA DO-262: *Minimum Operational Performance Standards for Avionics Supporting Next Generation Satellite Systems (NGSS)*

RTCA DO-270: *Minimum Aviation System Performance Standards (MASPS) for the Aeronautical Mobile-Satellite (R) Service – AMS(R)S*

RTCA DO-343: *Minimum Aviation System Performance Standard for AMS(R)S Data and Voice Communications Supporting Required Communications Performance (RCP) and Required Surveillance Performance (RSP) In Procedural Airspace*

SAE ARP4754: *Guidelines for Development of Civil Aircraft and Systems*

1.3 Inmarsat System Description

Inmarsat supports three distinct types of L-band aeronautical services, known as Classic Aero, Swift64, and SwiftBroadband (SBB). All of these services support different types of voice, fax, and data communications to and from an aircraft. An ARINC 781-compliant Aircraft Earth Station (AES) is intended to support one or more of these Inmarsat aeronautical services for cockpit and/or cabin use.

The Inmarsat L-band network consists of: a space segment formed by the Inmarsat-3 (I-3), Inmarsat-4 (I-4), and Alphasat geostationary satellites; a terrestrial ground infrastructure formed by the Ground Earth Stations (GESs) for Classic Aero, Land Earth Stations (LESs) for Swift64, and Satellite Access Stations (SASs) for

1.0 INTRODUCTION AND DESCRIPTION

SwiftBroadband; terrestrial interconnect networks; the AESs; a network control center; and a Business Support System (BSS). The user links are in L-band (1.5/1.6 GHz). In addition to supporting services to aeronautical users, the Inmarsat network also supports communications with land and maritime users.

The latest L-band satellites are the I-4s and Alphasat which support higher data rate services through the use of a 9-meter (I-4) or 12-meter (Alphasat) satellite antenna and digital beam forming. The coverage area of the satellites is formed through the use of a global beam (all satellites), regional beams (I-3 and I-4) and narrow spot beams (I-4 and Alphasat only). The Inmarsat Classic Aero service is supported through all generations of Inmarsat satellites; the Swift64 service is supported through the I-3 and I-4 satellites, and the SwiftBroadband service is supported through I-4 and Alphasat satellites.

The Inmarsat Classic Aero service supports multiple simultaneous voice channels, 4.8 kbps fax, packet-mode data at a channel-rate of up to 10.5 kbps, and real-time two-way circuit-mode data at up to 9.6 kbps. The service interfaces with the international X.25 and public switched telephone and data networks. Furthermore, it is compliant with the AMSS Standards and Recommended Practices (SARPs) published by International Civil Aviation Organization (ICAO) to support air traffic control and distress communications via voice and datalink.

The Inmarsat Swift64 service supports two types of data communications: Mobile ISDN and an Internet Protocol (IP)-based Mobile Packet Data Service (MPDS). A single Integrated Services Digital Network (ISDN) channel is a dedicated 64 kbps circuit-switched connection that may be bonded or multilinked together with other ISDN channels to support higher data rates. MPDS is a shared 64 kbps connection.

The SwiftBroadband service is designed to deliver cabin and cockpit services for pilots and cabin crew, together with in-flight Internet access for passengers. The data rates available on SwiftBroadband are significantly greater than those offered by Swift64 or Classic Aero. SwiftBroadband supports IP services as well as traditional circuit-switched voice. The Standard IP data service offers variable data rates up to 432 kbps (subject to aeronautical terminal capability, link availability, signaling, and contention). A Streaming IP data service is also available that offers guaranteed bandwidth-on-demand communications. Typical applications for SwiftBroadband include:

- Traditional telephony services
- Internet access, e.g.,
 - Web browsing
 - E-mail
 - File transfer
 - Video conferencing
 - Intranet access (i.e., corporate WAN access via secure Virtual Private Network (VPN) connection)
- ACARS-based and voice Future Air Navigation System (FANS) Air Traffic Services (ATS)

There are four user terminal types defined for the SwiftBroadband service. They are referred to as Class 6 (High Gain Antenna), Class 7 (Intermediate Gain Antenna), Class 15 (Low Gain Antenna), and Class 4 (Enhanced Low Gain Antenna) user

1.0 INTRODUCTION AND DESCRIPTION

terminal (UTs). An aircraft UT supports one transmit and one return RF channel. An ARINC 781 AES can contain one or more SwiftBroadband UTs.

COMMENTARY

At WRC-03, additional spectrum, known as Extended L-band, was allocated for Mobile Satellite Service. The Alphasat satellite is the first Inmarsat satellite to use this spectrum. Terminals with this capability are known as Extended L-band or XL capable. It is expected that, over time, equipment manufacturers will incorporate the additional tuning range into their equipment. Before equipment is designed for Extended L-band capability, the relevant sections of this characteristic should be updated.

Table 1-1 – Tuning Range for Standard and Extended L-band Terminals

Terminal Type	Receive (MHz)	Transmit (MHz)
Standard	1525 to 1559	1626.5 to 1660.5
Extended L-band	1518 to 1559	1626.5 to 1660.5 and 1668 to 1675

1.4 Function of Equipment

The function of this equipment is the transmission, reception and processing of signals via a satellite providing aeronautical services in the L-band (1518 to 1559 MHz for receive, and 1626.5 to 1660.5 and 1668 to 1675 MHz for transmit). The system should provide a capability for aeronautical satellite communications requirements external to the aircraft.

The equipment should provide one or more of the following classes of communication services:

- Air Traffic Services (ATS)
- Aeronautical Operational Control (AOC)
- Airline Administrative Communications (AAC)
- Aeronautical Passenger Communications (APC)

The equipment is designed to provide one or more of the following Inmarsat services:

- Classic Aero (e.g., Aero H, Aero H+, Aero I)
- Swift64
- SwiftBroadband

The exact services to be provided together with the associated numbers of channels per service are not described in this document and are determined by the individual manufacturers based on their response to market needs.

In addition, the supported interfaces, features (including High Power Amplifier (HPA) size and power), and functions that a specific satcom system supports are determined by the individual manufacturers based on their response to market needs. Hence, the airframe manufacturers, airlines, and operators need to specify the exact configuration of the desired ARINC 781 product – the tables in Attachments 4A and 4B are intended to facilitate this process.

1.0 INTRODUCTION AND DESCRIPTION

The equipment is optimized to operate with the I-4 series satellites, but for certain services will also operate with earlier Inmarsat satellites plus similar satellite services offered by other operators such as Multifunctional Transport Satellite (MTSAT).

COMMENTARY

Inmarsat requires that an AES be able to tune over the full allocated band for SwiftBroadband and that channels anywhere in the band may be allocated. Users are cautioned not to incorporate filters that protect other installed satcom equipment such as Iridium, since such filters would typically block access to the full band.

1.5 Airborne Avionics Configurations

The general configuration of the satellite avionics and related systems is shown in Attachment 1, Section 1.1. A more detailed block diagram (including alternate configurations) is shown in Attachment 1, Section 1.2. The typical configuration of equipment consists of an ARINC 781 Satellite Data Unit (SDU) (which normally contains an integrated High-Power Amplifier (HPA)), its associated SDU Configuration Module (SCM), plus a Diplexer/Low-Noise Amplifier (DLNA), and an ARINC 781 antenna (which contains an integrated beam steering function). The SDU is also designed to interface with an external HPA when, for example, the cable run and hence cable loss from the SDU to the DLNA is excessive. The SDU is also designed to interface with legacy top and side mounted ARINC 741 antenna subsystems, to allow a simple upgrade path to new satcom services for aircraft that are already equipped with ARINC 741 equipment.

High Gain Antennas (HGAs), Intermediate Gain Antennas (IGAs), and Enhanced Low Gain Antennas (ELGAs) are defined in this characteristic.

The SDU is capable of sending and receiving various data rates. The rate is dynamically selected by the individual applications and by pragmatic assessment of current operating conditions. The signals are transmitted via geostationary satellite transponders to/from designated supporting earth stations.

1.6 Unit Description

1.6.1 Satellite Data Unit (SDU)

The signal-in-space parameters are determined by the SDU in relation to modulation/demodulation, error correction, coding, interleaving, and data rates associated with the communication channel(s). This unit contains circuits for conversion of digital and/or analog inputs/outputs to/from Radio Frequency (RF), and typically contains an HPA module. The SDU interfaces at L-band with the DLNA. The SDU provides a number of user interfaces including:

- Cockpit 4-wire analog voice
- Cockpit data (e.g., via an ARINC 724B ACARS Management Unit or an ARINC 758 Communications Management Unit)
- Cockpit Ethernet
- Cabin voice and data via CEPT E1
- Cabin voice via 2-wire analog audio
- Cabin Ethernet, which may support data services as well as voice via picocells

1.0 INTRODUCTION AND DESCRIPTION

- The SDU is defined in two form factors: 6 MCU and 2 MCU. The 2 MCU form factor is known as a Compact SDU (CSDU) and is defined in Attachment 7.

1.6.2 SDU Configuration Module (SCM)

The SCM provides a location for retaining SDU configuration information, the Universal Mobile Telecommunications Service (UMTS) Subscriber Identity Modules (USIM), and the Security Smart Card (for Enhanced ACARS **and Enhanced Voice over IP (VoIP)**). The SCM remains with the aircraft whenever the SDU is changed and facilitates the swapping of an SDU without the need to reload Owner Requirements Tables (ORT) (if stored in the SCM) or to swap USIMs.

1.6.3 High-Power Amplifier (HPA)

The HPA is an optional external amplifier unit that provides an adequate RF power level, by automatic control, to the antenna in order to maintain the aircraft Effective Radiated Isotropic Power (EIRP) within required limits. The HPA may be used in installations where the expected cable loss between the SDU power amplifier output and antenna input is greater than the allowable cable loss. The HPA may be located near the respective antenna to assure minimum loss of energy at the RF operating frequency and to avoid excessive thermal dissipation in the HPA.

1.6.4 Diplexer/Low-Noise Amplifier (DLNA)

The Diplexer/Low-Noise Amplifier (DLNA) are combined into one unit for ease of installation. The Diplexer couples transmit signals from the SDU (or external HPA) to the antenna, and couples receive signals from the antenna to the LNA while isolating transmit frequencies from receive frequencies. The DLNA also filters both the transmit and receive signals.

The LNA amplifies the very low-level L-band receive signal from the antenna and compensates for RF losses in the coaxial cabling to the SDU.

1.6.5 HPA LNA Diplexer (HLD)

The High-Power Amplifier/Low-Noise Amplifier/Diplexer (HLD) is a combined HPA and DLNA unit in a compact physical outline for single channel operation. The HLD is installed near the antenna and accommodates large cable losses between the SDU and the HLD. The HLD is defined in Attachment 7.

1.6.6 Enhanced Low Gain Antenna (ELGA)

The ELGA provides a nominal gain of 3 dBic above 20 degrees elevation, and 2 dBic between 5 and 20 degrees elevation, and supports a single channel. The ELGA may optionally contain the HPA and DLNA function. The ELGA is defined in Attachment 7.

1.6.7 Intermediate Gain Antenna (IGA)

The IGA provides a nominal gain of 6 dBic. An ARINC 781 IGA is normally top-mounted and contains an integrated beam steering function (as opposed to an ARINC 761 IGA).

1.6.8 High Gain Antenna (HGA)

The HGA provides a nominal gain of 12 dBic. The HGA is normally top-mounted and contains an integrated beam steering function, which in ARINC Characteristic 741, requires a separate Line Replaceable Unit (LRU).

1.0 INTRODUCTION AND DESCRIPTION

1.7 System Performance

1.7.1 Transmitter Equipment Performance

Table 1-2 provides an indication of EIRP required per RF carrier to support various Inmarsat services.

Table 1-2 – Aircraft EIRP (dBW)

Service/Configuration		Inmarsat 3 Satellite		Inmarsat 4 Satellite		
		Global beam	Spot beam	Global beam	Regional beam ¹	Spot beam
1200	R, T	9.1	-	9.1	-	-
10500	R, T	20.4	-	20.4	-	-
8400	C initial	18.5	14.5 ²	18.5	-	-
21000	C initial	19.5	-	19.5	-	-
Swift64		-	22.5	-	-	-
SwiftBroadband	ELGA	-	-	-	-	10
SwiftBroadband	IGA	-	-	-	-	15.1
SwiftBroadband	HGA	-	-	-	-	20.0

Notes:

1. The regional beams are not currently used on the I-4 satellites for Classic Aero.
2. Inmarsat does not currently offer C-channels (other than C8400 Aero I) or 10500 R/T-channels in the I-3 spot or I-4 regional beams.

The transmit system is equipped to adjust the EIRP according to commands from the earth station.

The transmit gain of an HGA or an IGA may vary as its beam position is changed while tracking a satellite from an aircraft in motion. To maintain a more constant EIRP as the antenna's beam position is changed, the antenna provides transmit gain for the current beam position on its ARINC 429 bus (in the antenna status word) to the SDU. The antenna should report its gain in the direction currently pointed with a resolution of 0.5 dB. The SDU should make appropriate HPA adjustments to maintain a given EIRP whenever an antenna gain change is reported. The SDU should also monitor HPA output power when one data channel is active or under other determined signal conditions and make appropriate HPA adjustments to maintain the EIRP to compensate for drifts in the HPA output power.

The antenna beam steering interface from the SDU to the antenna should be an ARINC 429 bus.

The antenna beam steering function should be capable of maintaining the transmitted beam performance with aircraft attitude rates of change of up to 7.5 degrees per second.

1.7.2 Receiver Equipment Performance

The receiver system performance is determined by the characteristics of the antenna subsystem, the DLNA or HLD, the SDU and the interconnecting RF cables. This includes all of the satcom equipment's RF systems and circuits from the antenna to the demodulated baseband output. The design parameters of each of these system elements have been described to achieve the following receiver figure of merit (gain-to-noise temperature ratio or G/T) values. For a switched beam antenna, this example corresponds to the main beam for any pointing angle.

1.0 INTRODUCTION AND DESCRIPTION

	IGA	HGA	ELGA
G/T	-19 dB/K	-13 dB/K	-21 dB/K

The above values for G/T should be achieved under the conditions in Section 2.3.2.5.4. Under the operational RF environment, e.g., when the receive antenna is illuminated in its operating bandwidth (34 MHz) by a total RF flux density of -100 dBW/m², the receiver system performance is intended to provide a bit error rate (BER) of 1×10^{-5} or better for classic Aero packet-mode data and 1×10^{-3} or better for Classic Aero circuit-mode voice.

The receiver system performance is intended to provide a Packet Error Rate (PER) of 1×10^{-3} or better for SwiftBroadband packet-switched services and 1×10^{-2} or better for SwiftBroadband circuit-switched voice.

1.8 Interchangeability

ARINC Characteristic 781: *Mark 3 Aviation Satellite Communication Systems* comprises two major subsystems and a number of individual units. System interchangeability is desired for each of the major subsystems, and unit interchangeability is desired for the individual units. The first major subsystem comprises the SDU and the SCM. The second is the antenna subsystem, comprising two LRUs: the antenna with its integrated beam steering function, and the DLNA. Interchangeability is also desired for the external flange-mounted HPAs.

There are two instances whereby individual units are defined to be functional doublets. This means that the interwiring and pin-out definitions are interchangeable; but due to unique protocol implementations, the supply and acquisition of these units are manufacturer specific. Functional Doublets are different from Matched Pairs in that each unit of the Functional Doublet may fail and be changed independently; whereas, in Matched Pairs, both units must be changed regardless of which unit has failed.

Functional Doublet #1: SDU and SCM.

Functional Doublet #2: SDU and External Flange Mounted HPA or Optional ARINC 741 HPA.

Additional interchangeability standards may be found in Section 2.0 of this characteristic.

COMMENTARY

Even though the overall satellite system avionics suite comprises subsystems made up of multiple LRUs, each LRU must be designed to be autonomous for installation purposes. The airlines will not accept “matched pairs” of units or similar “unbreakable bonds,” which necessitate changing more than the LRU whose failure actually causes a subsystem malfunction.

1.9 Regulatory Approval

The equipment should meet all applicable aviation and telecommunication regulatory requirements. This document does not and cannot set forth the specific requirements that such equipment must meet to be assured of approval. Such information must be obtained from the regulatory agencies themselves. Reference RTCA MOPS, RTCA MASPS, ICAO SARPs, and telecommunications regulations.

1.0 INTRODUCTION AND DESCRIPTION

COMMENTARY

Minimum Operational Performance Standards (MOPS) are prepared by Special Committees of RTCA. MOPS define the performance required of equipment certified by the FAA. Performance above and beyond that specified in MOPS may be required for certification.

Minimum Aviation System Performance Standards (MASPS) are also prepared by Special Committees of RTCA. MASPS document end-to-end system performance requirements including terrestrial elements where required.

Standards and Recommended Practices (SARPs) are prepared by the International Civil Aviation Organization (ICAO). SARPs define system-level interoperability requirements for safety services (ATS and AOC).

COMMENTARY

This document does not define service levels provided (i.e., safety versus non-safety) by any particular system or avionics implementation.

2.0 INTERCHANGEABILITY STANDARDS

2.0 INTERCHANGEABILITY STANDARDS

2.1 Introduction

This section sets forth the specific form factors, mounting provisions, interwiring, input and output interfaces, and power supply characteristics desired for the satellite avionics equipment. These standards should permit the parallel, but independent design of compatible equipment and airframe installations. Refer to **ARINC Specification 600: *Air Transport Avionics Equipment Interfaces*** for detailed information on selected form factors, connectors, etc. ARINC 600 standards with respect to mass, racking attachments, front and rear projections, and cooling apply.

Manufacturers should note that although this characteristic does not preclude the use of standards different from those set forth herein, the practical problems of redesigning a standard airframe installation to accommodate special equipment could very well make the use of that equipment prohibitively expensive for the customer. They should recognize, therefore, the practical advantages of developing equipment in accordance with the standards set forth in this document.

Interchangeability standards for the CSDU, ELGA, and HLD are defined in Attachment 7.

2.2 Form Factors, Connectors, and Index Pin Coding

This document defines two distinct form factors of equipment. The original definition is based on a 6 MCU SDU, an SCM, an optional flange-mount HPA, a DLNA, and a HGA or IGA that typically supports multi-channel/multi-service (e.g., Classic Aero and SwiftBroadband) operation. More recently, a compact version of equipment was defined, based on a 2 MCU SDU – known as a Compact SDU (CSDU), an SCM, a small form factor antenna – known as an Enhanced Low Gain Antenna (ELGA), and an optional DLNA or HLD (where the HLD is a combined HPA/DLNA) that supports the SB200 single channel SwiftBroadband service (either safety or non-safety). This compact version is defined in Attachment 7.

2.2.1 Satellite Data Unit (SDU)

2.2.1.1 SDU Size

The SDU should comply with the dimensional standards in ARINC Specification 600 for the 6 MCU size.

2.2.1.2 Connectors

The SDU should be provided with a low insertion force, size 2 shell receptacle in accordance with ARINC 600, Attachment 19 (see Attachment 1, Section 1.5 of this standard). This connector should accommodate coaxial and signal interconnections in the Top Plug (TP) insert, Quadrax and signal interconnections in the Middle Plug (MP) insert, and coaxial, fiber, and power interconnections in the Bottom Plug (BP) insert.

The contact arrangements should be as follows:

- Insert arrangement 08 receptacles in accordance with ARINC Specification 600, Attachment 11, for the top insert (Size 1 coax cavity and Size 22 sockets).

2.0 INTERCHANGEABILITY STANDARDS

- Insert arrangement 120Q2 receptacle in accordance with ARINC Specification 600, Attachment 20, Figure 20-6.5.5, for the middle insert (Size 8 Quadrax cavities for pin components and Size 22 sockets).
- Insert arrangement 12F5C2 receptacle in accordance with ARINC Specification 600, Attachment 19, Figure 19-49.19, for the bottom insert (Size 12 pins, Size 16 pin, Size 5 coax cavities, and Size 16 optical cavities).
- Index pin code 081 in accordance with ARINC Specification 600, Attachment 18, should be used on both the SDU and the aircraft rack connectors.

Note: Supplement 20 to ARINC Specification 600 revised arrangements 06 and 08 in Attachment 11.

2.2.1.3 Form Factor

See Attachment 1, Section 1.5.

2.2.1.4 RF Characteristics for SDU with Integrated HPA

2.2.1.4.1 Frequency Range

The SDU should operate over the frequency range of 1525.0 to 1559.0 MHz (receive) and 1626.5 to 1660.5 MHz (transmit).

2.2.1.4.2 RF Output Power

The SDU output power should be capable of delivering the satellite services for which the SDU is designed (see Attachment 6, Case 1 and 2). The SDU maximum total RF output power should be no more than 80 W (average, not peak envelope) when operating with an HGA and 40 W when operating with an IGA.

Note: The purpose of the output power limit is to protect the antenna subsystem including RF cable power handling capability.

2.2.1.4.3 Back-off Range, Step Size, and Accuracy

The back-off range, step size, and accuracy of the SDU should be compatible with the Inmarsat satellite services being provided and should also take into account variations in antenna gains.

2.2.1.4.4 Stability

2.2.1.4.4.1 RF Output Power Stability

SwiftBroadband

The output power stability should be within ± 0.5 dB of the latest setting change for a period of 1000 bursts, ignoring the first burst.

Note: The first burst transmitted after a period of non-transmission exceeding 2 seconds should be considered to be a first burst. The first burst is also after a retune outside the 200 kHz sub-band. All other bursts are to be included in RF output power stability requirements.

2.0 INTERCHANGEABILITY STANDARDS

Existing Classic Aero services and Swift64

Output power stability should be within ± 2 dB.

Note: Stability includes the effect of temperature and frequency.

2.2.1.4.4.2 AM/PM Conversion

The SDU output should not vary by more than $2^\circ/\text{dB}$ and at a rate not exceeding $30^\circ/2$ ms when the output level is adjusted by up to 4 dB in any 80 ms period.

Note: This applies to Classic Aero and Swift64 services.

2.2.1.4.5 Linearity**2.2.1.4.5.1 Intermodulation Products****Table 2-1 – Intermodulation Products**

Intermodulation Products	Classic and Swift64 Services ¹		SwiftBroadband Services ²	
	Spacing of Carriers	Intermod Levels	Spacing of Carriers	Intermod Levels
(3rd Order)	5 kHz to 17 MHz (e.g., 10 kHz, 100 kHz, 1 MHz, 14 MHz)	-25 dBc	34 MHz (e.g., 200 kHz, 1 MHz, 10 MHz, 34 MHz)	-29.5 dBc
(5th Order)	<13.5 MHz (e.g., 10 kHz, 100 kHz, 1 MHz, 13 MHz)	-25 dBc	34 MHz (e.g., 200 kHz, 1 MHz, 10 MHz, 34 MHz)	-29.5 dBc
(7th Order)	13.5 MHz to 14.5 MHz (e.g., 14 MHz)	-30 dBc	34 MHz (e.g., 200 kHz, 1 MHz, 10 MHz, 34 MHz)	-35 dBc
(7th Order)	<13.5 MHz (e.g., 10 kHz, 100 kHz, 1 MHz, 13 MHz)	-33 dBc		
(Greater than 7th Order, <12 GHz band)	<13.5 MHz (e.g., 10 kHz, 100 kHz, 1 MHz, 13 MHz)	-35 dBc	34 MHz (e.g., 200 kHz, 1 MHz, 10 MHz, 34 MHz)	-35 dBc
(Greater than 7th Order, 12 to 18 GHz band)		-70 dBc		-70 dBc

Notes:

1. This performance applies when the SDU is transmitting two unmodulated carriers each at a power level of half the rated output power measured at the SDU output connector.
2. This performance applies when the SDU is driven by two unmodulated carriers each at a power level necessary to provide the EIRP given in Table 1-2 for the SwiftBroadband services provided by the SDU. The SDU output power should be calculated from the EIRP based on a 12 dBic HGA or 6 dBic IGA and a loss from the SDU output to the antenna input of 2.5 dB. As an alternative test condition, modulated carriers may be used. The required test levels for modulated carriers are specified in the Inmarsat Broadband Global Area Network (BGAN) System Definition Manual (SDM).

2.0 INTERCHANGEABILITY STANDARDS

2.2.1.4.5.2 Error Vector Magnitude (EVM)²

The mean EVM² should be no more than 0.01 while transmitting a SwiftBroadband carrier at the power level necessary to support the EIRP of the service being provided – as defined in Table 1-2.

Note: This applies to SwiftBroadband services. Error Vector Magnitude is a measure of the difference between the (ideal) waveform and the measured waveform. The difference is called the error vector, usually referred to with regard to M-ary I/Q modulation schemes like Quadrature Phase Shift Keying (QPSK), and shown on an I/Q (in-phase and quadrature) constellation plot of the demodulated symbols. Modulation characteristics and EVM are further defined in the Inmarsat BGAN SDM.

2.2.1.4.5.3 Spectral Regrowth

While transmitting with either an IGA or HGA and using either a $\pi/4$ QPSK or 16 Quadrature Amplitude Modulation (QAM) modulated bearer at the required output power level, the SDU should comply with the spectral masks defined below.

Note: This applies to SwiftBroadband services.

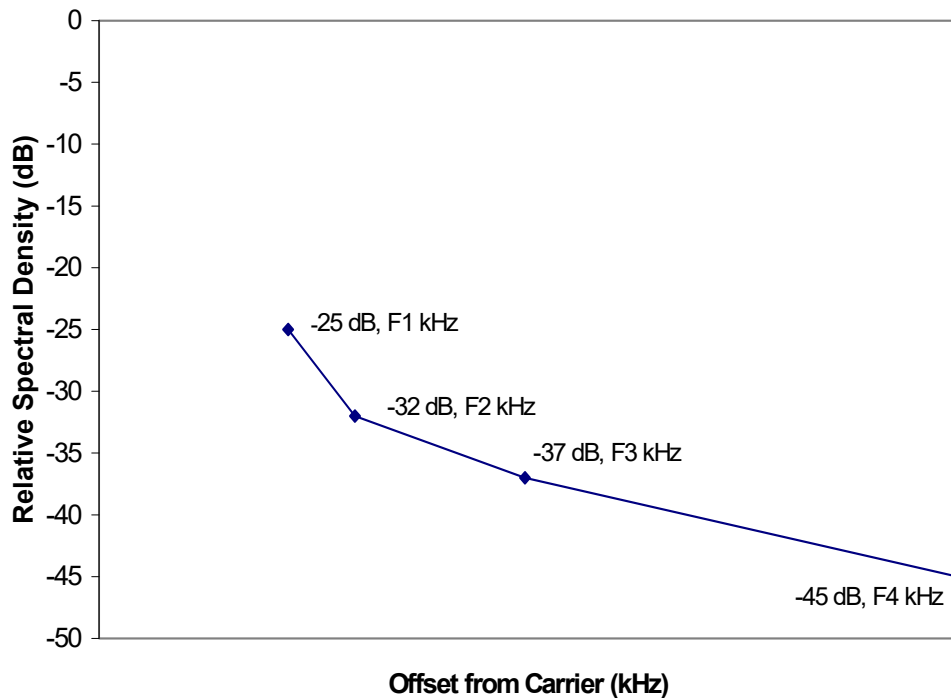


Figure 2-1 – Spectral Regrowth Envelope

2.0 INTERCHANGEABILITY STANDARDS

Table 2-2 – Spectral Regrowth

Fx	Relative Spectral Density	Offset from Carrier (kHz) for Different Channel Types			
		T0.5 Data rate 16.8 kSym/s	T1.0 Data rate 33.6 kSym/s	T2 Data rate 67.2 kSym/s	T4.5 Data rate 151.2 kSym/s
	dB	Offset (kHz)	Offset (kHz)	Offset (kHz)	Offset (kHz)
F1	-25	11.0	22.0	44.0	99.0
F2	-32	14.9	29.8	59.6	134.1
F3	-37	24.8	49.6	99.2	223.2
F4	-45	50.0	100.0	200.0	450.0

Note: T0.5, T1.0, etc., are Inmarsat designators of SwiftBroadband channel types.

2.2.1.4.6 Harmonics, Discrete Spurious Emissions and Noise

The SDU, when connected to a DLNA, should comply with the emission limits defined in RTCA DO-210 MOPS, RTCA DO-262 MOPS, and other regulatory documents.

2.2.1.4.7 Receiver Noise Figure

The receive path noise figure for the SDU should not exceed 10 dB under conditions equivalent to a wide-band input signal level of -50 dBm at the SDU input. For conditions equivalent to larger input levels, the noise figure (in dB) may increase in proportion to the signal level (in dBm).

COMMENTARY

This SDU noise figure should allow the system installer a maximum loss as specified in Section 2.3.5 between the DLNA receive output port and the SDU. This noise figure and a maximum loss of 25 dB between the SDU and the DLNA adds 0.05 dB to the satcom receiver noise figure.

Interfering RF energy can exist in frequency bands adjacent to the AES receive band, such as radiation from a mobile system used in Japan operating in the 1513 to 1525 MHz band. The diplexer rejection specified in Section 2.2.4 does not provide specific protection against interference from RF energy in such a closely-spaced frequency band. Noise figure which is increased by an Automatic Gain Control (AGC) function reacting to interfering RF energy can degrade a desired channel's carrier-to-noise density ratio (C/No), thereby causing an apparent degradation of the receiver system performance.

2.2.1.4.8 Muting and Carrier Off

When the SDU is muted by signals from ARINC 741 side-mount antennas, from maximum rated output power, the SDU RF output level should be at or less than -10 dBW within 1 ms after receiving the mute command (see Attachment 1, Section 1.4, Note 32).

When the SDU is muted by the Tx Mute discrete, the SDU RF output level should be at or less than -40 dBW within one second.

2.0 INTERCHANGEABILITY STANDARDS

In a Carrier(s) Off state, the SDU RF output should comply with the Carriers Off limits defined in RTCA DO-210D MOPS and other regulatory documents.

2.2.1.4.9 Voltage Standing Wave Ratio (VSWR)

The SDU output port VSWR (i.e., the VSWR measured looking into the SDU output port) should not exceed 1.5:1. The SDU should be capable of operating into a load VSWR of 2.0:1 maximum at any phase angle.

Note: Safety circuitry should be provided to protect the transmitter output stage in the event of an accidental short or open circuit at its output.

2.2.1.5 RF Characteristics for SDU with External HPA

COMMENTARY

Although the SDU and external flange mounted HPA are defined as a functional doublet, it is recommended that the SDU RF output power is nominally +23 dBm (when the HPA is delivering full power) with a maximum value of +28 dBm. The SDU RF characteristics should be such that when driving the external HPA, the HPA meets the requirements defined in Section 2.2.1.4.

2.2.2 External Flange-mounted High-Power Amplifier (HPA)

2.2.2.1 General

The purpose of this amplifier is to provide a solution to overcome the cable loss issues associated with the HPA located internal to the SDU on installations where the SDU is, in general, greater than 1.4 dB (approximately 35 feet) away from the DLNA. The design of this HPA should be a functional doublet with the SDU as the gain stages of the HPA internal to the SDU and the flange-mounted HPA are manufacturer-specific.

Two external HPA form factors are described in this document; a small form factor external HPA suitable for installation in locations where space is more restricted, e.g., on short-range/narrow-body aircraft and a large form factor suitable for installation on larger aircraft, typically long-range/wide-body aircraft.

COMMENTARY

It is anticipated that equipment manufacturers will develop external HPAs with differing RF output power capabilities. The objective of the output power ranges specified herein is to encourage manufacturers to maximize RF output power with the available power and cooling inputs.

COMMENTARY

Although the SDU and external flange mounted HPA are defined as a functional doublet, it is recommended that the HPA RF input power is nominally +5 dBm to +15 dBm (when the HPA is delivering full power) with a maximum value of +20 dBm. The HPA RF characteristics should be such that when driven by the SDU, the HPA meets the requirements defined in Section 2.2.1.4.

2.0 INTERCHANGEABILITY STANDARDS

The form factor and connector pin-out arrangement are shown in Attachment 1m Sections 1.7A through 1.7C. The connector and pin-out arrangement is common to both the large and small form factor external HPAs.

The communication protocol between the SDU and the external Flange Mounted HPA is manufacturer specific. However, the SDU to HPA communications use the same multi-control bus to the antenna. Some labels are reserved for SDU to antenna communications and should not be used for the SDU to HPA communications. Other labels defined in ARINC Specification 429 are broadcast on this multi-control bus by the SDU and should not be used for any other purpose by the HPA. The list of these labels is available in Attachment 2.

COMMENTARY

The external flange-mounted HPA is not intended to be a substitute for the internal HPA within the SDU for installations not truly requiring an external HPA. In most installations, this device is not needed, as the maximum allowed cable loss between the SDU (with internal HPA) and antenna subsystem can be met.

2.2.2.2 Small Form Factor External HPA

The output power of the small form factor external HPA should be between 22 W and 35 W to ensure that the form factor can be met with minimal weight (see Attachment 6, Case 3, 4, and 5).

The small form factor external HPA design includes an internal plenum to allow for a flexible hose attachment for additional cooling purposes. Attachment 1, Section 1.7A depicts the size and arrangement of this connection.

Continuous operation within the output power range is expected when cooling is provided. Continuous operation is not expected (but is desirable) in the absence of cooling.

2.2.2.3 Large Form Factor External HPA

The output power of the large form factor external HPA should be between 30 W and 60 W to ensure that the form factor can be met with minimal weight (see Attachment 6, Case 6 and 8).

The large form factor flange-mounted HPA design includes an internal plenum to allow for a flexible hose attachment for additional cooling purposes. Attachment 1, Section 1.7B depicts the size and arrangement of this connection.

When cooling air is available, the unit will operate in an actively-cooled manner; but when cooling is lost the unit will revert to a passively-cooled operation but at a reduced services mode of a minimum of 9 W and will inform the SDU of it being in such a mode (See Attachment 6, Case 7). A minimum clearance of one inch beyond the envelope defined in Attachment 1, Sections 1.7A and 1.7B should be provided to facilitate the passively cooled nature of this design when in "loss of cooling mode."

The specific design of each installation should be discussed with the installer to ensure adequate natural cooling around the device.

Continuous operation within the output power range is expected when cooling is provided. An acceptable duty cycle restriction could then be applied as necessary and could consist of the SDU restricting services to match the HPA

2.0 INTERCHANGEABILITY STANDARDS

capability to retain cockpit functions in instances where the ambient temperature is at an extreme.

2.2.3 SDU Configuration Module

2.2.3.1 SCM Form Factor

The SCM form factor should comply with Attachment 1, Section 1.6.

2.2.3.2 Connectors

The SCM should include a 15-pin D-type male connector and locking screws. The connector layout is defined in Attachment 1, Section 1.6A.

2.2.3.3 USIMs

The SCM should be able to accommodate at least 4 USIMs as well as a Security Smartcard if SSB Enhanced ACARS is supported.

2.2.4 Diplexer/Low-Noise Amplifier (DLNA)

The following characteristics apply to both the Type D and to the Type F DLNA unless otherwise stated.

COMMENTARY

There is a threat of interference from Long Term Evolution (LTE) and Ancillary Terrestrial Component (ATCt). New DLNAs to suppress this interference are defined in Attachment 9.

COMMENTARY

Please note that the Type D DLNA is not suitable for SwiftBroadband since its passband does not extend down to 1626.5 MHz. The Type D DLNA has been retained in ARINC Characteristic 781 since a few units have been built and installed on aircraft for use with Classic Aero and Swift64 services.

2.0 INTERCHANGEABILITY STANDARDS

COMMENTARY

HISTORICAL DEVELOPMENT OF THE DLNA

The DLNA's main purpose is to provide filtering of the transmit and receive signals, and amplification of the receive signal. DLNA specifications are found in ARINC Characteristic 741, ARINC Characteristic 761, and ARINC Characteristic 781 (Section 2.2.4 and Attachment 9).

Different DLNAs have been specified and designed over the years, depending on the transmit and receive frequency ranges, which systems require protection from the AES, and which systems can interfere with the AES (and hence drive filter requirements on the DLNA). The former corresponds to which Inmarsat service the DLNAs support (Classic Aero or SwiftBroadband (SBB)).

The original DLNA design was the Type A and it offered sufficient protection only for GPS. Its receive band is 1530 to 1559 MHz.

The Modified Type A DLNA design was subsequently developed to give more protection to GLONASS as well as protecting GPS. It also extended the receive band to 1525 MHz.

The Type B, C, and G DLNA characteristics were developed by the AGCS but not published.

The Type D DLNA was a retuned version of the Modified Type A, which provided protection to Iridium services, but at the expense of cutting of the Inmarsat band below 1629.5 MHz.

The Type E DLNA is used for a non-Inmarsat system.

The Type F DLNA supported the full Inmarsat transmit band whilst providing 10 dB protection to Iridium services at 1625.5 MHz.

The Type A-LTE, Modified Type A-LTE, and Type F-LTE DLNAs provide rejection of LTE signals in the band immediately below 1518 MHz and are based on the corresponding non-LTE DLNAs.

The Type H DLNA provides rejection against LTE and ATCt signals as proposed by Ligado but its passband starts at 1538 MHz and is thus suitable for Classic Aero, but not SBB.

Type I nomenclature was not used to avoid confusion with 'one'.

The Type J DLNA provides rejection against LTE and ATCt signals and supports the full Inmarsat passband. It includes a switchable filter.

As of December 2018, only the Type A, Modified Type A, Type D, and Type F have been produced and fitted to aircraft in production volumes.

2.0 INTERCHANGEABILITY STANDARDS

The table below summarizes the capabilities of the various DLNAs.

DLNA Type	Supports Classic Aero	Supports SBB	Tx Filter			Rx Filter	
			GPS	GLONASS	Iridium	LTE	ATCt
A	X		X				
Mod A	X	X	X	X			
D	X		X	X	X		
F	X	X	X	X	X		
A-LTE	X		X			X	
Mod A-LTE	X	X	X	X		X	
F-LTE	X	X	X	X	X	X	
H	X		X	X	X	X	X
J	X	X	X	X	X	X	X

2.2.4.1 DLNA VSWR

The VSWR of the DLNAs antenna-port and transmit-port (Tx) should be 1.3:1 maximum. The DLNAs receive port (Rx) VSWR should be 1.5:1 maximum.

Note: In all DLNA performance measurements, any unused port should be terminated with its characteristic impedance.

2.2.4.2 Noise Figure/Gain

The DLNA noise figure should be less than 1.2 dB at temperatures below 25 °C. The noise figure may increase with temperature to a maximum of 1.6 dB at the maximum operating temperature (70 °C). The gain should be between 53 and 60 dB under all operating conditions.

2.2.4.3 Insertion Loss and Rejection

2.2.4.3.1 Antenna Port to Receive Port (DLNA Output)

The rejection from the antenna-port to the receive port (DLNA output) relative to the 1525 to 1559 MHz passband level should be:

Frequency (MHz)			Rejection
0.0	to	1450.0	> 75 dB
1626.5	to	1660.5	> 120 dB
1660.5	to	18000.0	> 75 dB

2.2.4.3.2 Transmit Port to Antenna Port

2.2.4.3.2.1 Type D – Transmit Port to Antenna Port

The path from the transmit port to the antenna port should have the following characteristics:

Frequency (MHz)			Rejection
0.0	to	1525.0	> 80 dB
1525.0	to	1559.0	> 120 dB
1559.0	to	1585.0	> 111 dB
1585.0	to	1605.0	> 95 dB
1605.0	to	1610.0	> 62 dB
1610.0	to	1614.0	> 40 dB
1614.0	to	1620.0	> 20 dB

2.0 INTERCHANGEABILITY STANDARDS

Frequency (MHz)			Rejection
1620.0	to	1625.5	> 10 dB
1625.5	to	1629.5	Decreases
1629.5	to	1633.0	Insertion loss < 1.3 dB
1633.0	to	1660.5	Insertion loss < 0.8 dB
1660.5	to	1735.0	Increases
1735.0	to	12000.0	> 50 dB
12000.0	to	18000.0	> 15 dB

The above should be met over the DLNAs operating temperature range.

In addition, the path from the transmit port to the antenna port should have the following characteristics at ambient and cold temperatures:

Frequency (MHz)			Insertion loss
1628.7	to	1629.1	< 1.8 dB
1629.1	to	1629.5	< 1.3 dB

2.2.4.3.2.2 Type F – Transmit Port to Antenna Port

The path from the transmit port to the antenna port should have the following characteristics:

Frequency (MHz)			Rejection
0.0	to	1525.0	> 80 dB
1525.0	to	1559.0	> 120 dB
1559.0	to	1585.0	> 111 dB
1585.0	to	1605.0	> 95 dB
1605.0	to	1610.0	> 62 dB
1610.0	to	1614.0	> 40 dB
1614.0	to	1620.0	> 30 dB
1620.0	to	1624.5	> 20 dB
1624.5	to	1625.5	> 10 dB
1625.5	to	1626.5	Decreases
1626.5	to	1633.0	Insertion loss < 1.3 dB
1633.0	to	1660.5	Insertion loss < 0.8 dB
1660.5	to	1735.0	Increases
1735.0	to	1865.0	> 50 dB
1865.0	to	3250.0	> 20 dB
3250.0	to	3330.0	> 50 dB
3330.0	to	4000.0	> 40 dB
4000.0	to	12000.0	> 50 dB
12000.0	to	18000.0	> 15 dB

The above should be met over -55 °C to +55 °C.

Between +55 °C to +70 °C, the characteristics above may be degraded as follows:

Frequency (MHz)			Rejection
1625.0	to	1625.5	> 2.5 dB

2.0 INTERCHANGEABILITY STANDARDS

2.2.4.3.3 Transmit Port to Receive Port (DLNA Output)

2.2.4.3.3.1 Type D – Transmit Port to Receive Port (DLNA Output)

The rejection from the transmit port to the receive port (DLNA output) relative to the passband level from the antenna port to the receive port should be as follows:

Frequency (MHz)			Rejection
0.0	to	1350.0	> 100 dB
1350.0	to	1525.0	> 80 dB
1525.0	to	1559.0	> 120 dB
1559.0	to	1565.0	> 80 dB
1565.0	to	1585.0	> 100 dB
1585.0	to	1626.5	> 40 dB
1626.5	to	1660.5	> 120 dB
1660.5	to	2000.0	> 80 dB
2000.0	to	18000.0	> 50 dB

2.2.4.3.3.2 Type F – Transmit Port to Receive Port (DLNA Output)

The rejection from the transmit port to the receive port (DLNA output) relative to the passband level from the antenna port to the receive port should be as follows:

Frequency (MHz)			Rejection
0.0	to	1515.0	> 135 dB
1515.0	to	1580.0	> 125 dB
1580.0	to	2000.0	> 135 dB
2000.0	to	18000.0	> 50 dB

2.2.4.4 DLNA Output Power

The output power capability of the DLNA receive output port should be 10 dBm minimum at the 1 dB gain compression point. This set of parameters establishes the linearity for the receive system and is directly related to its two-tone intermodulation performance.

COMMENTARY

This LNA output should allow the system installer a maximum loss between the LNA and the SDU as described in Section 2.3.5.3.

Interfering RF energy can exist in frequency bands adjacent to the AES receive band, such as radiation from a mobile system used in Japan operating in the 1513 to 1525 MHz band. The DLNA rejection specified in Section 2.2.4.3 does not provide specific protection against interference from RF energy in such a closely-spaced frequency band. Interfering signals exceeding the output capability of the LNA may cause suppression of desired weak signals and, thereby, cause an apparent degradation of the receiver system performance.

2.0 INTERCHANGEABILITY STANDARDS

2.2.4.5 DLNA Intermodulation

COMMENTARY

DLNA intermodulation is only specified for the Type F DLNA.

2.2.4.5.1 Type F – DLNA Intermodulation Products in Satcom Receive Band

With two Continuous Waveform (CW) carriers, each of power 10.2 dBW anywhere in the band 1626.5 to 1660.5 MHz, the 7th and higher intermodulation product should be less than -133 dBm in the band 1525 to 1559 MHz as measured at the receive port, but with the power level referenced to the antenna port.

COMMENTARY

The test carrier levels are based on the carrier power level for the IGA antenna spec level (Section 2.3.3.6.12.1) but increased by 0.8 dB for the DLNA insertion loss and increased by 0.3 dB for the DLNA to antenna cable loss.

The required intermodulation level to protect the satcom receive band are based on a degradation of 6% to the system noise figure (i.e., $\Delta T/T=6\%$) which is equivalent to 0.25 dB. An interference bandwidth of 170 kHz is assumed, which is equivalent to a seventh order intermodulation product formed by SwiftBroadband (151.2 kSym/s) and Classic (10.5 kSym/s) bearers.

2.2.4.5.2 Type F – DLNA Intermodulation Products in GNSS Band

With two CW carriers, each of power 10.2 dBW anywhere in the band 1626.5 to 1660.5 MHz, the 5th and higher intermodulation products should each be less than -100 dBm in the band 1555 to 1595.42 MHz as measured at the antenna port.

COMMENTARY

The test carrier levels are the same as those used for the intermodulation products into the satcom receive band.

The intermodulation level is based on the IGA/HGA intermodulation level at the GPS carrier frequency (1575.42 MHz) but reduced by 40 dB to reflect the satcom to GNSS antenna isolation and reduced by approximately an additional 12 dB to partition the intermodulation budget between the various system components (antenna, cable, and DLNA). To ease DLNA test, the intermodulation level is not a function of frequency.

2.2.4.6 DLNA Connectors

The DLNA should use the following connectors for its RF ports:

Port	Connector Type
Transmit Port (SDU or HPA)	N Jack (Female)
Receive Port (SDU)	TNC Jack (Female)
Antenna Port	TNC Jack (Female)

The DLNA should use a MIL-C-26482 Series 2 type connector for control and power interconnections.

2.0 INTERCHANGEABILITY STANDARDS

Shell size and insert arrangement as per Attachment 1, Section 1.8.

2.2.4.7 DLNA Form Factor

See Attachment 1, Section 1.8 for the form factor of the DLNAs.

Note: The form factor of the two DLNAs are slightly different – principally in the position of the transmit connector. The mounting hole locations are the same.

2.2.4.8 DLNA On/Off Control

Provisions are needed to switch the LNA on and off. Note 6 to the Standard Interwiring in Attachment 1, Section 1.4 of this characteristic describes the switching signal.

2.2.4.9 DLNA BITE

Provisions are needed for the DLNA to provide BITE to the antenna. Note 5 to the Standard Interwiring in Attachment 1, Section 1.4 of this characteristic describes the switching signal.

2.3 Antenna Specification

This section sets forth the antenna characteristics and the need for physical isolation between L-band antennas. The antenna system radiates and receives radio frequency signals between the aircraft and the satellite to enable communications to and from the aircraft.

Various types of antenna configurations can be utilized as follows:

- An HGA as defined in this document, mounted on top of the fuselage that is electrically steerable. Top-mount HGAs are mounted on an adapter plate, which is generally customized for each aircraft type. The adapter plate should provide a mechanical interface to the aircraft and facilitate using the same antenna part number across a number of aircraft types of various fuselage curvatures.
- HGA systems as defined in ARINC Characteristic 741.
- An IGA as defined in this document, mounted on top of the fuselage that is electrically steerable. Top-mount IGAs are mounted on an adapter plate, which is generally customized for each aircraft type. The adapter plate should provide a mechanical interface to the aircraft and facilitate using the same antenna part number across a number of aircraft types of various fuselage curvatures.
- An LGA as defined in this document, mounted on top of the fuselage, providing hemispherical coverage.

This characteristic does not describe the form factor of mechanically steered antennas. Providers of mechanically steered antennas should comply with the performance characteristics, the ARINC 429 control and BITE interface and electrical interfaces as defined in this characteristic.

2.3.1 Antenna Coverage Volume

2.3.1.1 Ideal Antenna Coverage Volume

The antennas should achieve the desired performance over an ideal coverage volume (relative to the aircraft's horizontal line of flight) defined by an elevation

2.0 INTERCHANGEABILITY STANDARDS

range of 5° to 90° and an azimuth range of 360°. This ideal coverage volume is illustrated in Attachment 1, Section 1.9.

2.3.1.2 Achieved Antenna Coverage Volume

The achieved coverage volume over which all the performance characteristics are satisfied may be less than the ideal antenna coverage volume. As a minimum, an LGA or subsystem (Class 4) should achieve the required performance over at least 98%, IGA over at least 85%, and an HGA over at least 75%, of the ideal coverage volume. Antenna manufacturers are encouraged to exceed this minimum specification to enhance communications performance and availability.

2.3.1.3 Antenna Measurement Ground Plane

An antenna ground plane should be used to simulate the conductive mounting surface on the intended aircraft. The ground plane size should be 94.5 inches [2.4 m] (L) x 65 inches [1.65 m] (W) $\pm 5\%$. In addition, the active portion of the antenna under test should be mounted in the center of the ground plane. The ground plane should be curved to simulate the radius of curvature of the aircraft on which it is intended to mount the antenna. This radius should be 120 inches [3.05 m] $\pm 5\%$. Where the antenna is to be installed on an aircraft with a radius of curvature which differs by more than 20% from that used in the antenna tests, validity of the results should be justified by analysis and/or measurement.

2.3.2 High Gain Antenna (HGA)

2.3.2.1 High Gain Antenna Size

The top mounted HGA footprint should be a maximum of 43 inches [1092 mm] long and 14.4 inches [366 mm] wide.

2.3.2.2 High Gain Antenna Connectors

The HGA Control connector should conform to Mil Spec part number MIL-C-38999 Series III or equivalent, with pin layout as shown in Attachment 1, Section 1.12.

The HGA RF connector on the antenna should be a TNC jack (female).

2.3.2.3 High Gain Antenna Form Factor

The leading edge of the antenna should be tapered, the height of the antenna should be minimized (within the constraints of required RF performance) and the overall shape should be designed to minimize aerodynamic drag. The antenna should be designed to minimize weight.

The maximum allowable HGA footprint dimensions are presented in Attachment 1, Section 1.10.

2.3.2.4 High Gain Antenna Grounding and Bonding

The attention of equipment and airframe manufacturers is drawn to the guidance material in Section 6.0 and Appendix 2 of ARINC Specification 404A on the subject of equipment and radio rack grounding and bonding. Particular attention should be given to bonding and grounding requirements of the antenna system, especially components mounted outside the airframe.

2.0 INTERCHANGEABILITY STANDARDS

2.3.2.5 High Gain Antenna (HGA) Receive System

2.3.2.5.1 Frequency of Operation

The HGA receive antenna system should operate on any frequency within the band 1525 to 1559 MHz.

2.3.2.5.2 Polarization

The polarization should be right-hand circular. The definition of ITU-R Recommendation 573 applies.

2.3.2.5.3 Axial Ratio

The axial ratio should be less than 6.0 dB for all steering angles and frequencies of operation. Axial ratio values greater than 6 dB need to be compensated by additional G/T margin. A value of 2.5 dB should be assumed for the satellite antenna axial ratio, with the polarization ellipse major axes orthogonal.

2.3.2.5.4 Receive System Figure of Merit (G/T)

The receive antenna should perform such that an overall receive system figure of merit of at least -13 dB/K is achieved under the following conditions:

- Clear sky climatic conditions.
- Satellite elevation angles greater than or equal to 5 degrees within the coverage volume of the antenna.
- With residual antenna pointing errors (including effects of errors introduced by the antenna beam steering system).
- With a DLNA noise figure and gain as described in Section 2.2.4.2 at a temperature of 290 K.
- With a receiver having a noise figure described in Section 2.2.1.4.7 at the SDU interface at a temperature of 290 K.
- With coaxial cable losses as described in Section 2.3.5 at a temperature of 290K.
- With the transmitter power of 60 watts (17.8 dBW) at the HGA antenna connector.
- With noise contribution from passive and active intermodulation effects and spurious signals associated with multi-carrier operation.
- Including the loss and noise contribution of a radome where a radome is fitted.

2.3.2.5.5 Steering Angle

The main beam of the antenna should be steerable in accordance with the coverage specifications.

2.3.2.5.6 Steering Control

The antenna receive beam performance specifications should be maintained on a wanted satellite that is within the antenna coverage volume described in Section 2.3.1.1 for aircraft motions that do not cause the aircraft itself to obstruct the beam. The antenna should point to the commanded direction to within 0.5 dB of its final gain value within 3 seconds from any initial condition. For switched beam systems, the signal should not be interrupted by more than 50 microseconds when switching beams.

2.0 INTERCHANGEABILITY STANDARDS

The HGA should position beams in accordance with the azimuth and elevation positions given in the ARINC Specification 429 Open Loop Steering Word. If the antenna is mounted offset the top centerline of the aircraft, the SDU should adjust the azimuth and elevation to account for the offset.

A current beam is one assigned to optimally point to the chosen satellite for a given aircraft attitude/heading. When the azimuth and/or elevation angles to the satellite change to the extent that one or more phase shifters change state, the new beam is defined as an adjacent beam.

COMMENTARY

Inmarsat Classic Aero SDM (Module 2, Paragraph 3.4.6) specifies a 3-second acquisition time for open-loop steering.

2.3.2.5.7 Overload Capability

The receive antenna system should be able to survive power in the receive band of 0 dBm at the antenna port.

2.3.2.5.8 Receive Antenna VSWR

The antenna VSWR measured at the single antenna input/output port should be less than 1.5:1 (with respect to a 50 ohm characteristic impedance) for all antenna beam positioning angles over the receive frequency band (see Section 2.3.2.5.1).

2.3.2.5.9 Satellite Discrimination

The radiation pattern should discriminate by not less than 13 dB between wanted and unwanted satellite positions over the declared coverage volume and not less than 5 dB outside the declared coverage volume. This specification assumes that: (1) satellites are in geostationary orbit, (2) unwanted satellites are not less than 45 degrees longitude away from the wanted satellite, and (3) the aircraft is in a straight and level attitude.

Note: Adequate discrimination is vital to satellite L-band spectrum reuse. Testing should be conducted with a ground plane representative of the HGA installation on the aircraft.

2.3.2.5.10 Phase Discontinuity

When switching adjacent beams in a switched beam antenna, the signal phase over the receive frequency range should not change by more than:

1. Eight degrees for a minimum of 90% of all combinations of adjacent beams.
2. Twelve degrees for a minimum of 99% of all combinations of adjacent beams.

Note: Adjacent beams are defined as beams which have the minimum spatial separation in a given direction and whose corresponding phase shifter states differ for at least one element.

2.0 INTERCHANGEABILITY STANDARDS

2.3.2.5.11 Carrier-to-Multipath (C/M) Discrimination

The HGA should attenuate the reflected signal from a sea surface relative to the main signal in the direction of the satellite so as to achieve a minimum C/M of 10 dB at 5° elevation and 12 dB at 20° elevation.

2.3.2.6 High Gain Antenna Transmit System

2.3.2.6.1 Frequency of Operation

The antenna transmit subsystem should operate on any frequency within the band 1626.5 to 1660.5 MHz.

2.3.2.6.2 Polarization

The polarization should be right-hand circular. The definition of ITU-R Recommendation 573 applies.

2.3.2.6.3 Axial Ratio

The axial ratio should be less than 6.0 dB for all steering angles and frequencies of operation. For axial ratio values of greater than 6 dB, compensation in the form of additional gain is required. A satellite antenna axial ratio of 2.5 dB should be assumed with the polarization ellipse axes orthogonal.

2.3.2.6.4 Gain

The HGA should have a minimum gain of 12 dBic within the achieved antenna coverage volume.

The antenna reported gain sent from the antenna to the SDU shall be based on the minimum gain value of the antenna measured at ambient for the highest, lowest and central frequencies in the transmit band for that pointing angle. This value shall be rounded to the nearest 0.5 dB and have an accuracy (before rounding) of -0.5 to +0.5 dB (including gain variation with frequency and measurement accuracy). This accuracy is required over 80% of the declared coverage volume.

2.3.2.6.5 Steering Angle

The main beam of the antenna transmit subsystem should be steerable as necessary to fulfill coverage specifications.

2.3.2.6.6 Steering Control

See Section 2.3.2.5.6.

2.3.2.6.7 Transmit Antenna VSWR

The antenna VSWR measured at the single antenna input/output port should be less than 1.5:1 (with respect to a 50 ohm characteristic impedance) for all antenna beam pointing angles over the transmit frequency band.

2.3.2.6.8 Output Power Capability

The antenna system should be able to transmit a continuous single carrier of up to 60 W (i.e., 17.8 dBW) at the HGA input connector. Peak Envelope Power (PEP) may exceed 150 watts due to the presence of multiple carriers.

2.0 INTERCHANGEABILITY STANDARDS

2.3.2.6.9 Satellite Discrimination

The radiation pattern should discriminate by not less than 13 dB between wanted and unwanted satellite positions over the declared coverage volume and not less than 5 dB outside the declared coverage volume. This specification assumes that: (1) satellites are in geostationary orbit, (2) unwanted satellites are not less than 45 degrees longitude away from the wanted satellite, and (3) the aircraft is in a straight and level attitude.

Note: Testing should be conducted with a ground plane representative of the HGA installation on the aircraft.

2.3.2.6.10 Phase Discontinuity

When switching adjacent beams in a switched beam antenna, the signal phase, over the transmit frequency range should not change by more than:

1. Eight degrees for a minimum of 90% of all combinations of adjacent beams.
2. Twelve degrees for a minimum of 99% of all combinations of adjacent beams.

Note: Adjacent beams are defined as beams which have the minimum spatial separation in a given direction and whose corresponding phase shifter states differ for at least one element.

2.3.2.6.11 Carrier-to-Multipath (C/M) Discrimination

The HGA should attenuate the reflected signal from a sea surface relative to the main signal in the direction of the satellite so as to achieve a minimum C/M of 10 dB at 5° elevation and 12 dB at 20° elevation.

2.3.2.6.12 L-band System Isolation

The installation designer should be aware of the need for physical and electrical isolation between L-band antennas at the following frequencies:

1565 to 1616 MHz	GPS/Galileo/GLONASS (GNSS) band
1626.5 to 1660.5 MHz	Satcom band

Electrical Isolation - The electrical isolation at GNSS frequencies should be not less than 40 dB between the HGA and GNSS antenna ports with the HGA steered toward the GNSS antenna. This 40 dB of electrical isolation is equivalent to approximately 200 inches of physical isolation between the closest points of the HGA and other L-band antennas.

COMMENTARY

Prime consideration should be given to providing as much separation as possible between satcom and GNSS antennas. The electrical isolation specified above is the same value as in previous characteristics for satcom (ARINC Characteristics 741 and 761). This isolation, together with use of the Type D DLNA, provides protection to GPS and Galileo receivers against 5th and higher satcom intermodulation products.

Examples of measured electrical isolation versus physical separation of an HGA (12 dBi) and a GPS antenna mounted on

2.0 INTERCHANGEABILITY STANDARDS

top of the aircraft are shown below. It should be noted that these levels of isolation were for the worst case where the beam of the HGA was steered toward the GPS antenna.

Aircraft	Separation	Isolation
B777	970 inches	52 dB: Top HGA to GPS
B767	400 inches	46 dB: Top HGA to GPS

From the above it can be concluded that 200 inches provides 40 dB of isolation for a HGA (cutting the distance in half reduces the isolation by 6 dB). For systems with lower power and antennas with less gain the distance could be reduced further (e.g., Aero I with a 20 watt HPA and a 6 dBi IGA could achieve isolation sufficient to protect GPS with 100 inches of separation).

On-aircraft measurements have also shown that interfering in-band signals (intermodulation products from satcom) received at the GPS antenna that are on the order of -105 dBm can degrade the GPS C/N by approximately 6 dB. Signals at -116 dBm produced no degradation.

The legacy of 40 dB isolation from ARINC Characteristic 741 stems from the anticipated levels of intermodulation products from a high gain antenna, and the amount of isolation required to keep the signal received at the GPS antenna at an acceptable level.

2.3.2.6.13 Antenna Intermodulation

COMMENTARY

The inherent non-linearities associated with RF coaxial connectors play a significant role in the generation of intermodulation products. If the end user is not using coaxial cables and connectors which are specifically made or recommended by the equipment system supplier, the choice of coaxial cables and connectors should be made carefully. Studies have concluded that there are significant differences in the levels of nonlinear properties depending on the connector conductor materials used. More specifically, connectors which employ the use of ferromagnetic materials such as stainless steel and nickel-plated metal should be avoided. Instead, the use of non-ferromagnetic materials should be used (e.g., silver plated brass, etc.).

In addition, insulating layers from oxidation and dissimilar material migration at the connector interface further degrade linearity and increase with time. Therefore, connectors should be tightened to the connector manufacturer's recommended value and checked periodically.

2.3.2.6.13.1 Antenna Intermodulation Products in Satcom Receive Band

For multi-carrier operation, the receive system figure of merit (G/T) of Section 2.3.2.5.4 should include the effects of passive and active seventh and higher order intermodulation products generated when operating with two carriers, each with a power of 6.3 watts (8 dBW), anywhere between 1626.5 and 1660.5 MHz.

2.0 INTERCHANGEABILITY STANDARDS**COMMENTARY**

The effect of intermodulation products is an increase in the equivalent noise temperature in the receive band. This is usually determined based on measurements with unmodulated carriers and application of a spreading factor related to the modulation and the order of the intermodulation product. For intermodulation products produced from SwiftBroadband (at a symbol rate of 151.2 kSym/s) and a Classic Aero channel (at a symbol rate of 10.5 kSym/s) the spreading factor is 52.4 dB for seventh order products and 52.8 dB for ninth order products. 8 dBW is equivalent to 20 dBW EIRP and 12dBic antenna.

2.3.2.6.13.2 Antenna Intermodulation Products in GNSS Band

For multi-carrier operation, when operating two unmodulated carriers, each with a power of 8 dBW, anywhere between 1626.5 and 1660.5 MHz, the HGA should not generate intermodulation products with levels and frequencies as follows:

In the frequency range 1555 to 1575.92 MHz, the level of the intermodulation product should not exceed -158.5 dBW.

In the frequency range 1575.92 to 1595.42 MHz, the level of the intermodulation product may linearly increase with frequency from -158.5 dBW at 1575.92 MHz to -138.5 dBW at 1595.42 MHz.

Intermodulation levels should be referenced to the output port of an external 1/4-wave monopole GNSS antenna mounted on a common ground plane with the HGA under test. The isolation between the monopole and the HGA shall be 40 dB, or suitable compensation to the measurement shall be applied.

COMMENTARY

The antenna intermodulation requirements to protect GNSS are based on Figures C-1 and C-2 of RTCA DO-229C using the curve for “Terminal area, enroute and acquisition for all,” and assuming a safety margin of 6 dB and a multiple equipment margin of 6 dB. The satcom intermodulation assumes 20 dBW EIRP, 12 dBic antenna, and interference bandwidth between 100 kHz and 1 MHz.

2.3.3 Intermediate Gain Antenna (IGA)**2.3.3.1 Intermediate Gain Antenna Size**

The top mounted IGA footprint should be a maximum of 43 inches [1092 mm] long and 14.4 inches [366 mm] wide.

2.3.3.2 Intermediate Gain Antenna Connectors

The IGA Control connector should conform to Mil Spec part number MIL-C-38999 Series III or equivalent, as shown in Attachment 1, Section 1.12.

The IGA RF connector should be a TNC jack (female).

2.3.3.3 Intermediate Gain Antenna Form Factor

The leading edge of the antenna should be tapered, the height of the antenna should be minimized (within the constraints of required RF performance), and the

2.0 INTERCHANGEABILITY STANDARDS

overall shape should be designed to minimize aerodynamic drag. The antenna should be designed to minimize weight.

The maximum allowable IGA footprint dimensions are presented in Attachment 1, Section 1.10.

2.3.3.4 Intermediate Gain Antenna Grounding and Bonding

The attention of equipment and airframe manufacturers is drawn to the guidance material in Section 6.0 and Appendix 2 of ARINC Specification 404A on the subject of equipment and radio rack grounding and bonding. Particular attention should be given to bonding and grounding requirements of the antenna system especially components mounted outside the airframe.

2.3.3.5 Intermediate Gain Antenna Receive System

2.3.3.5.1 Frequency of Operation

The IGA receive antenna system should operate on any frequency within the band 1525 to 1559 MHz.

2.3.3.5.2 Polarization

The polarization should be right-hand circular. The definition of ITU-R Recommendation 573 applies.

2.3.3.5.3 Axial Ratio

The axial ratio should be less than 6.0 dB for all steering angles and frequencies of operation.

2.3.3.5.4 Receive System Figure of Merit (G/T)

The receive antenna should perform such that an overall receive system figure of merit of at least -19 dB/K is achieved under the following conditions:

- Clear sky climatic conditions.
- Satellite elevation angles greater than or equal to 5 degrees within the coverage volume of the antenna.
- With residual antenna pointing errors (including effects of errors introduced by the antenna beam steering system).
- With a DLNA noise figure and gain as described in Section 2.2.4.2 at a temperature of 290 K.
- With a receiver having a noise figure described in Section 2.2.1.4.7 at the SDU interface at a temperature of 290 K.
- With coaxial cable losses as described in Section 2.3.5 at a temperature of 290 K.
- With the transmitter power of 30 watts (14.8 dBW) at the HGA antenna connector.
- With noise contribution from passive and active intermodulation effects and spurious signals associated with multi-carrier operation.
- Including the loss and noise contribution of a radome where a radome is fitted.

2.0 INTERCHANGEABILITY STANDARDS**2.3.3.5.5 Steering Angle**

The main beam of the antenna should be steerable in accordance with the coverage specifications.

2.3.3.5.6 Steering Control

The antenna receive beam performance specifications should be maintained on a wanted satellite that is within the antenna coverage volume described in Section 2.3.1.1 for aircraft motions that do not cause the aircraft itself to obstruct the beam. The antenna should point to the commanded direction to within 0.5 dB of its final gain value within 3 seconds from any initial condition. For switched beam systems, the signal should not be interrupted by more than 50 microseconds when switching beams.

The IGA should position beams in accordance with the azimuth and elevation positions given in the ARINC 429 Open Loop Steering Word. If the antenna is mounted offset the top centerline of the aircraft, the SDU should adjust the azimuth and elevation to account for the offset.

A current beam is one assigned to optimally point to the chosen satellite for a given aircraft attitude/heading. When the azimuth and/or elevation angles to the satellite change to the extent that one or more phase shifters change state, the new beam is defined as an adjacent beam.

COMMENTARY

Inmarsat Classic Aero SDM (Module 2, Paragraph 3.4.6) specifies a three-second acquisition time for open-loop steering.

2.3.3.5.7 Overload Capability

The receive antenna system should be able to survive power in the receive band of 0 dBm at the antenna port.

2.3.3.5.7.1 Receive Antenna VSWR

The antenna VSWR measured at the single antenna input/output port should be less than 1.5:1 (with respect to a 50 ohm characteristic impedance) for all antenna beam positioning angles over the receive frequency band (see Section 2.3.3.5.1).

2.3.3.5.8 Discrimination

The radiation pattern should discriminate by not less than 7 dB between wanted and 85% of unwanted satellite positions for all antenna steering angles above 5 degrees elevation. This specification assumes that (1) satellites are in geostationary orbits, (2) unwanted satellites are not less than 80 degrees longitude away from the wanted satellite, and (3) the aircraft is in straight and level flight.

Note: Testing should be conducted with a ground plane representative of the IGA installation on the aircraft.

2.3.3.5.9 Phase Discontinuity

When switching adjacent beams in a switched beam antenna, the signal phase, of the receive frequency range, should not change by more than 30 degrees for a minimum of 99% of all combinations of adjacent beams.

2.0 INTERCHANGEABILITY STANDARDS

Note: Adjacent beams are defined as beams which have the minimum spatial separation in a given direction and whose corresponding phase shifter states differ for at least one element.

2.3.3.6 Intermediate Gain Transmit System

2.3.3.6.1 Frequency of Operation

The antenna transmit subsystem should operate on any frequency within the band 1626.5 to 1660.5 MHz.

2.3.3.6.2 Polarization

The polarization should be right-hand circular. The definition of ITU-R Recommendation 573 applies.

2.3.3.6.3 Axial Ratio

The axial ratio should be less than 6.0 dB for all steering angles and frequencies of operation.

2.3.3.6.4 Gain

The IGA transmit antenna should have a minimum gain of 6 dBic within the achieved antenna coverage volume.

The antenna reported gain sent from the antenna to the SDU shall be based on the minimum gain value of the antenna measured at ambient for the highest, lowest and central frequencies in the transmit band for that pointing angle. This value shall be rounded to the nearest 0.5 dB and have an accuracy (before rounding) of -0.5 to +0.5 dB (including gain variation with frequency and measurement accuracy). This accuracy is required over 80% of the declared coverage volume.

2.3.3.6.5 Steering Angle

The main beam of the antenna transmit subsystem should be steerable as necessary to fulfill coverage requirements.

2.3.3.6.6 Steering Control

See Section 2.3.3.5.6.

2.3.3.6.7 Transmit Antenna VSWR

The antenna VSWR measured at the single antenna input/output port should be less than 1.5:1 (with respect to a 50 ohm characteristic impedance) for all antenna beam pointing angles over the transmit frequency band.

2.3.3.6.8 Output Power Capability

The antenna system should be able to transmit a continuous single carrier of up to 30 W (i.e., 14.8 dBW). Peak Envelope Power (PEP) may exceed 75 watts due to the presence of multiple carriers.

2.3.3.6.9 Discrimination

The radiation pattern should discriminate by not less than 7 dB between wanted and 85% of unwanted satellite positions for all antenna steering angles above 5 degrees elevation. This specification assumes that (1) satellites are in geostationary orbits, (2) unwanted satellites are not less than 80 degrees

2.0 INTERCHANGEABILITY STANDARDS

longitude away from the wanted satellite, and (3) the aircraft is in straight and level flight.

Note: Testing should be conducted with a ground plane representative of the IGA installation on the aircraft.

2.3.3.6.10 Phase Discontinuity

When switching adjacent beams in a switched beam antenna, the signal phase, of the transmit frequency range, should not change by more than 30 degrees for a minimum of 99% of all combinations of adjacent beams.

Note: Adjacent beams are defined as beams which have the minimum spatial separation in a given direction and whose corresponding phase shifter states differ for at least one element.

2.3.3.6.11 L-band System Isolation

The installation designer should be aware of the need for physical and electrical isolation between L-band antennas at the following frequencies:

1565 to 1616 MHz	GPS/Galileo/GLONASS band
1626.5 to 1660.5 MHz	Satcom band

Electrical Isolation: The electrical isolation at GNSS frequencies should be not less than 40 dB between the IGA and GNSS antenna ports with the IGA steered toward the GNSS antenna. This 40 dB of electrical isolation is equivalent to approximately 100 inches of physical isolation between the closest points of the IGA and other L-band antennas.

Also refer to commentary in Section 2.3.2.6.12.

2.3.3.6.12 Antenna Intermodulation

2.3.3.6.12.1 Antenna Intermodulation Products in Satcom Receive Band

For multi-carrier operation, the receive system figure of merit (G/T) of Section 2.3.3.5.4 should include the effects of passive and active seventh and higher order intermodulation products generated when operating with two carriers, each with a power of 8.1 watts (9.1 dBW), anywhere between 1626.5 and 1660.5 MHz.

COMMENTARY

The effect of intermodulation products is an increase in the equivalent noise temperature in the receive band. This is usually determined based on measurements with unmodulated carriers and application of a spreading factor related to the modulation and the order of the intermodulation product. For intermodulation products produced from SwiftBroadband (at a symbol rate of 151.2 kSym/s) and a Classic aero channel (at a symbol rate of 10.5 kSym/s) the spreading factor is 52.4 dB for seventh order products and 52.8 dB for ninth order products. 9.1 dBW is equivalent to 15.1 dBW EIRP and 6 dBic antenna.

2.0 INTERCHANGEABILITY STANDARDS

2.3.3.6.12.2 Antenna Intermodulation Products in GNSS Band

For multi-carrier operation, when operating two unmodulated carriers, each with a power of 9.1 dBW, anywhere between 1626.5 and 1660.5 MHz, the IGA should not generate intermodulation products with levels and frequencies as follows:

In the frequency range 1555 to 1575.92 MHz, the level of the intermodulation product should not exceed -158.5 dBW.

In the frequency range 1575.92 to 1595.42 MHz, the level of the intermodulation product may linearly increase with frequency from -158.5 dBW at 1575.92 MHz to -138.5 dBW at 1595.42 MHz.

Intermodulation levels should be referenced to the output port of an external 1/4-wave monopole GNSS antenna mounted on a common ground plane with the IGA under test. The isolation between the monopole and the IGA shall be 40 dB, or suitable compensation to the measurement shall be applied.

COMMENTARY

The antenna intermodulation requirements to protect GNSS are based on Figures C-1 and C-2 of RTCA DO-229C using the curve for “Terminal area, enroute and acquisition for all,” and assuming a safety margin of 6 dB and a multiple equipment margin of 6 dB. The satcom intermodulation assumes 15.1 dBW EIRP, 6 dBic antenna and interference bandwidth between 100 kHz and 1 MHz.

2.3.4 Enhanced Low Gain Antenna (ELGA)

The ELGA characteristics are defined in Attachment 7.

2.3.5 Coaxial Cables

2.3.5.1 Loss Between SDU and External HPA

The loss between the SDU output and optional external HPA input should fall within the range 8 to 18 dB.

2.3.5.2 DLNA to Antenna Cable

The coaxial cable loss between the antenna system and the DLNA should not exceed 0.3 dB.

For multicarrier operation, when operating with two CW carriers, each of power 9.4 dBW anywhere in the band 1626.5 to 1660.5, the cable should not generate (1) fifth or higher intermodulation product greater than -100 dBm in the frequency range of 1555 to 1595.42 MHz and (2) seventh or higher intermodulation product greater than -133 dBm in the frequency range of 1525 to 1559 MHz.

COMMENTARY

The test power levels are based on the IGA intermodulation requirement (Section 2.3.3.6.12) adjusted by the cable loss.

The intermodulation levels are the same as those for the Type F DLNA (Section 2.2.4.5).

2.0 INTERCHANGEABILITY STANDARDS

2.3.5.3 Total Transmit Loss between SDU or HPA and Antenna

The maximum values of the transmit cable/insertion losses for the antenna systems are:

SDU or HPA to DLNA	less than 1.4 dB
DLNA Insertion Loss	less than 0.8 dB
DLNA to antenna	less than 0.3 dB

Therefore:

Total SDU or HPA to Antenna	less than 2.5 dB

Note: The DLNA insertion loss may be higher at the bottom of the transmit band by up to an additional 0.5 dB. There will be a consequent increase in the overall loss.

2.3.5.4 Loss between LNA and SDU

The total loss between the LNA output and the SDU input should fall within the range 6 to 25 dB, including the cable and connectors.

COMMENTARY

Interfering RF energy can exist in frequency bands adjacent to the AES receive band, such as radiation from a mobile system used in Japan operating in the 1513 to 1525 MHz band. The diplexer rejection specified in Section 2.2.4.3 does not provide specific protection against interference from RF energy in such a closely-spaced frequency band. Use of a low loss cable may increase the likelihood that strong interfering RF signals may have a degrading effect on the apparent receiver system performance.

2.3.6 RF installation issues

COMMENTARY

The intent of this characteristic is to define subsystem components which, when installed on an aircraft equipped with a multi-channel satcom system with at least one SwiftBroadband carrier, should provide satcom services in accordance with systems specifications. Specifically, the deployment of multi-channel SwiftBroadband requires more stringent control of intermodulation levels – both passive and active. The use of antennas, Diplexer/Low-Noise Amplifiers (DLNA), and DLNA to antenna RF cables specifically designed for SwiftBroadband operation are recommended and suitable requirements are found in other parts of this document (see Sections 2.3.2.6.13, 2.3.3.6.12, and 2.2.4.5). In addition, the installation of the DLNA, DLNA to antenna RF cable, and the antenna (including adaptor plate) may cause Passive Intermodulation (PIM) and this section presents some best practices to obtain a low PIM installation and general maintenance guidelines for aluminum aircraft fuselages. The installation best practices have not been specifically addressed in this section for composite fuselage due to the limited experience and proprietary technology used in the construction of composite fuselages. Section 3.7 discusses Passive Intermodulation Built-In

2.0 INTERCHANGEABILITY STANDARDS

Test (PIMBIT) and provides additional technical background into the sources of intermodulation.

The following items should be considered during installation of a SwiftBroadband satcom system:

- a. Antennas – The antenna should be located on the fuselage such that the distance between it and other potential intermodulation generators is assessed. Potential intermodulation generators include:
 1. Active ADF antenna (contains ferrites)
 2. Passive antennas
 3. Magnetic materials
 4. Semiconductors
- b. When RF currents radiating from the antenna flow through these materials' intermodulation products may be generated and be coupled back into the antenna. The resulting signals may interfere with the reception of the desired incoming signal.
- c. Adapter Plates – Adapter plates are often used to provide a mating interface between the curved aircraft fuselage and the flat mounting surface of an antenna. The interfaces between the adapter plate and the fuselage and between the adapter plate and the antenna should be free of metal particles. When using the adapter plate as a drilling fixture for “zero tolerance” installations, it is especially important to ensure all surfaces are clean and free of metal particles.
- d. DLNA-to-Antenna RF Cable – A single RF cable carries both the high power transmit signal and the low power received signal between the DLNA and the antenna. The potential for high intermodulation levels is great because the transmit power is high. The cable should use connectors that are non-magnetic and the cable construction should be designed for low PIM. Each RF cable should be production tested for low PIM. The minimum bend radius must be observed during cable installation and in its final configuration. If the minimum bend radius of the cable is violated, the cable may be damaged (i.e., inner core could be collapsed, outer shield cracked, etc.) and become a source of PIM.
- e. RF Connectors – The mating surfaces between the male and female connector represent a metal-to-metal contact that could result in PIM if the pressure between the mating surfaces is too low. It is recommended that the RF connectors be tightened using a torque wrench to torque values recommended in the installation manual. It is not recommended to only finger-tighten connectors. To prevent contamination, during storage, equipment that has RF connectors should have dust caps on. Prior to installation, the dust caps should be removed and the connector should be cleaned with an appropriate applicator and cleaning agent, such as isopropyl alcohol.

The following maintenance guidelines are recommended:

- a. If the antenna, DLNA or RF cable is modified (i.e., cables unfastened, antenna/adapter plate removed for aircraft repainting, etc.), it is recommended that a Passive Intermodulation Built-In Test (PIMBIT) test be executed to ensure proper operation of the satcom system.

2.0 INTERCHANGEABILITY STANDARDS

- b. The antenna radome should not be painted during aircraft re-painting, as the paint used on aircraft may contain metal particles that could cause PIM and affect the transmit/reception properties of the antenna. It is recommended that the antenna either be masked or removed from the aircraft during (re)painting. If there are small chips or scratches in the radome, the operator should consult the component maintenance manual for specific repair instructions.
- c. Steel wool should not be used for cleaning of the fuselage, adapter plate, or antenna. Small metal particulate can be difficult to remove and can cause high levels of PIM.

2.4 Standard Interwiring

The standard interwiring to be installed for the aeronautical satellite system avionics is set forth in Attachment 1, Section 1.3 with the applicable notes in Attachment 1, Section 1.4. This interwiring is designed to provide the degree of interchangeability specified for the system in Section 1.8 of this document. Manufacturers are cautioned not to rely on special wires, cabling, or shielding for use with particular units because they may not exist in a standard installation.

COMMENTARY

Why standardize interwiring?

The standardized interwiring is perhaps the heart of all ARINC Standards. It is this feature which allows the airline customer to complete his negotiation with the airframe manufacturer so that the latter can proceed with installation engineering and initial fabrication prior to airline commitment on a specific source of equipment. This provides the equipment manufacturer with many valuable months in which to put final “polish” on his equipment in development.

2.5 Power Circuitry

2.5.1 Primary Power Input

The aeronautical satellite system should be designed to use 115 V variable frequency single phase ac power. Aircraft power supply characteristics, utilization, equipment design limitations and general guidance material are set forth in **ARINC Report 413A: Guidance for Aircraft Electrical Power Utilization and Transient Protection**. The primary power input should be protected by circuit breakers of the size described in Attachment 1, Section 1.4.

2.0 INTERCHANGEABILITY STANDARDS

The equipment should have a power consumption less than or equal to that shown below.

Equipment	Normal Operation (Internal HPA)	Normal Operation (External HPA)	Loss of Cooling Mode (refer to Section 2.2.2.3)
SDU	255 VA max	150 VA max	180 VA max
Antenna/DLNA	60 VA max	60 VA max	60 VA max
Small Form Factor External HPA	Not Applicable	240 VA max	Not Applicable
Large Form Factor External HPA	Not Applicable	440 VA max	150 VA max

2.5.2 Power Control Circuitry

There should be no master on/off power switching within the avionics. Any user desiring on/off control should provide, through the medium of a switching function installed in the airframe, means of interrupting the primary power to the system. It is probable, however, that on/off switching will not be needed in most installations and that power will be wired to the system from the circuit breaker panel.

2.6 System Functions and Signal Characteristics

A list of the system functions and signal characteristics for the desired level of interchangeability for the subsystems comprising the aeronautical satellite system is set forth in Attachment 1, Section 1.4.

2.7 Environmental Conditions

The avionics should be specified environmentally in terms of the requirements of **EUROCAE ED-14E/RTCA DO-160E: *Environmental Conditions and Test Procedures for Airborne Equipment***, and additional airframe-manufacturer-specific requirements.

2.8 Cooling

COMMENTARY

Equipment failures in aircraft due to inadequate thermal management have plagued the airlines for many years. Section 3.5 of ARINC Specification 600 contains everything airframe and equipment manufacturers need to know to prevent such problems in the future. They regard this material as “required reading” for all potential suppliers of satellite communication equipment and aircraft installations.

Equipment manufacturers should note that airlines may retrofit satellite equipment into aircraft in which forced air cooling is not available. They should therefore design their equipment such that the thermal interface limits set forth in Section 3.5 of ARINC Specification 600 can be met without such forced cooling air being provided, or persuade their customers to accept the presence of a cooling fan inside the component.

For non-ARINC 600 devices such as the flange mounted HPA, the thermal design, temperature and testing requirements should comply with ARINC Specification 628, Part 7, Section 4.0 for

2.0 INTERCHANGEABILITY STANDARDS

Forced-Air Cooled and Stand-Alone Cooled Equipment, but with the local environment amended as described in Sections 2.2.2.2 and 2.2.2.3.

2.8.1 SDU

The SDU should be designed to accept, and airframe manufacturers should configure the installation to provide, forced air cooling as defined in Section 3.5 of ARINC Specification 600. The airflow rate provided to the SDU in the aircraft installation should be 50 kg/hr of 40 °C (max.) air, and the pressure drop through the SDU should be 5 ±3 mm of water at this rate. The SDU should be designed to dissipate less than 225 W and to expend this pressure drop to maximize the cooling effect. Adherence to the pressure drop standard is necessary to allow interchangeability of the equipment.

It should be noted that in emergency situations the cooling for the SDU may be lost. The SDU should be able to detect this situation (without an external input) and assume it is in “loss of cooling mode.” If required, the SDU should shut down lower priority communications so that service is still maintained for ATS and AOC. Information on detailed requirements such as the length of time over which service is required, and the service required in terms of number and type of communications, EIRP and duty cycles should be obtained from airframe manufacturers and regulatory authorities.

2.8.2 Flange Mounted HPA

The small and large form factor flange mounted HPAs should be designed to accept, and airframe manufacturers should configure the installation to provide, forced air-cooling.

The airflow rate provided to the small form factor flange mounted HPA in the aircraft installation should be 50 kg/hr of 60 °C (max) air (inlet temperature), and the pressure drop through the small form factor flange mounted HPA should be 51 ±5 mm of water at this rate. The small form factor flange mounted HPA should be designed to expend this pressure drop to maximize the cooling effect.

The airflow rate provided to the large form factor flange mounted HPA in the aircraft installation should be 72 kg/hr of 60 °C (max) air (inlet temperature), and the pressure drop through the large form factor flange mounted HPA should be 51 ±5 mm of water at this rate. The large form factor flange mounted HPA should be designed to expend this pressure drop to maximize the cooling effect.

Adherence to these pressure drop standards is necessary to allow interchangeability of the equipment.

It should be noted that some aircraft may operate with pressure drops other than 51mm. Installations in these aircraft must be discussed with the installer.

It should be noted that in emergency situations the cooling for the flange mounted HPAs may be lost. The large form factor flange mounted HPA should be able to detect this situation (without an external discrete input), inform the SDU and should assume that it is in a “loss of cooling mode.” If required, the large form factor flange mounted HPA should auto-bias itself to a lower rated output (minimum 9 W) to ensure that the heat dissipated can be passively cooled so that service is still maintained for cockpit and some basic cabin services. Information on detailed requirements such as the length of time over which

2.0 INTERCHANGEABILITY STANDARDS

service is required, and the service required in terms of number and type of communications, EIRP and duty cycles should be obtained from airframe manufacturers and regulatory authorities. The small form factor flange mounted HPA is not expected to operate in the absence of forced air-cooling.

In addition to the above requirements, the large form factor flange mounted HPA should be capable of minimum 9 W rated output operations at 35 °C ambient, with a pressure altitude of up to 25,000 ft. and no cooling air.

2.9 Grounding and Bonding

The attention of equipment and airframe manufacturers is drawn to the guidance material in Section 6 and Appendix 2 of ARINC Specification 404A on the subject of equipment and radio rack grounding and bonding. Particular attention should be given to bonding and grounding requirements of the antenna system especially components mounted outside the airframe.

2.10 System ATE and BITE Design

2.10.1 General

To enable Automatic Test Equipment (ATE) to be used in the bench maintenance of the SDU, those internal circuit functions not available at active interconnection pins and considered by the equipment manufacturer to be needed for automatic test purposes, should be brought to ATE Reserved pins on the upper insert (TP) of the connector (see Attachment 1, Section 1.3).

2.10.2 Unit Identification

The SDU, antenna, and optional HPA should report their equipment identification codes and serial numbers as defined in ARINC Specification 429 and ARINC Report 665. The SDU should also provide all satcom LRU software and hardware revision levels when requested by a centralized fault display unit on the aircraft or when queried by ATE in the shop.

2.10.3 Built-In Test Equipment (BITE)

The SDU described in this characteristic should contain Built-In Test Equipment (BITE) capable of detecting and annunciating a minimum of 95% of the faults or failures which can occur within the SDU and as many faults as possible associated with the HPA (if fitted), antenna, SCM (if fitted), and the DLNA.

BITE should operate continuously during flight. Monitoring of the results should be automatic. The BITE should automatically test, detect, isolate, and record intermittent and steady state failures. The BITE should display system condition and indicate any faulty LRUs upon activation of the self-test routine. In addition, BITE should display faults which have been detected during in-flight monitoring.

No failure occurring within the BITE subsystem should interfere with the normal operation of the SDU.

COMMENTARY

Sufficient margins should be used in choosing BITE parameters to preclude nuisance warnings. Discrepancies in SDU operation caused by power bus transients, EMI ground handling, servicing interference, abnormal accelerations, or turbulence should not be recorded as faults.

2.0 INTERCHANGEABILITY STANDARDS

The SDU should be designed to be compatible with a centralized fault display system as described in **ARINC Report 604: *Guidance for Design and Use of Built-In Test Equipment (BITE)***. The philosophy expressed in ARINC Report 604 is that on-board avionic systems such as satcom should provide an interactive, “user friendly,” aid to maintenance. The SDU should provide a listing of BITE options in menu format for operator selection. By menu selection, the operator should be capable of requesting fault status (current and previous), initiating self-tests and requesting detailed failure information for diagnostics.

2.10.3.1 BITE Display

BITE information should be made available on all applicable data buses for use in the centralized fault display as described in ARINC Report 604 and Attachment 2B (for the Boeing Label 35X fault bits). This data will be presented to the maintenance technician on the display contained within that system. As an option, the SDU could also have a System/LRU fault status display on the front panel. This option could be beneficial for local troubleshooting in the electronics equipment bay.

COMMENTARY

Most users desire an alpha-numeric display to present fault information to line maintenance personnel. The desire includes presentation of the information in the form of easily understandable text – not coded! The airlines do not want the maintenance personnel to be burdened with carrying a library of code translations. The airlines would like to have the fault analysis capability of BITE using the alpha-numeric display equal to or surpassing the capability currently realized with shop Automatic Test Equipment.

2.10.3.2 Fault Monitor

The results of in-flight or ground operations of BITE should be stored in non-volatile memory. The size of the memory should be sufficient to retain detected faults during the previous ten flight legs. The data in the memory should include flight leg identification, fault description, and faulty LRU identification.

The contents of the memory should be retrievable by BITE operation or by shop maintenance equipment. Refer to ARINC Report 604 for further guidance on fault recording.

ARINC Report 604 also specifies that fault data should be sent to the centralized fault display interface unit on an ARINC 429 data bus at regular intervals. The SDU should output BITE fault data on all applicable data buses.

COMMENTARY

The airlines have expressed an interest in having BITE data from as many as 64 previous flight legs available in memory.

A question which must be considered by the equipment designer is, “What is the scope/purpose of BITE?” It appears from the unconfirmed failure data that is available from repair shop operations, that there is merit in considering storage of data which

2.0 INTERCHANGEABILITY STANDARDS

will identify the Shop Replaceable Unit (SRU). BITE should be used to detect and isolate faults to the LRU level.

2.10.3.3 Self-Test Initiation

At the time of equipment turn-on, a power-up self-test should be initiated automatically as described in ARINC Report 604. In addition, the SDU should, where practical, provide self-test capability for troubleshooting and installation verification. The initiation of all test sequences should be possible from the control portion of the centralized fault display system.

As an aid to shop maintenance and local trouble-shooting on the line, a self-test mechanism should be provided on the SDU front panel. The momentary depression of the push button on the front panel of the LRU should initiate a unit/system self-test. The self-test routine should start with an indicator test in which all indicator elements are activated simultaneously. If the self-test routine detects a fault, the “all on” indication should be deactivated leaving the appropriate “fault” indication activated. If no fault is found, the contents of the intermittent fault memory should be reviewed. Only the four most recent flight legs should be considered. If no fault is recorded, the “all on” indication should be deactivated leaving the “normal” indication visible. If an occurrence of a fault on one of the four earlier flight legs is detected, the appropriate “fault” indication should be activated. The activated indications should remain visible until the line maintenance mechanic presses the self-test button a second time or a “time-out” period of approximately ten minutes expires. Selection of four as the number of flight legs, for which intermittent fault memory should be examined for the line maintenance BITE function, was made in the belief that it could be reduced as confidence in the BITE was built up. Manufacturers are urged to make this number easily alterable in their BITE implementation.

2.10.3.4 Monitor Memory Output

The BITE monitor memory output should consist of the following:

- An output on all low-speed ARINC 429 data buses to the centralized fault display interface unit, when so requested, as described in ARINC Report 604 using the format described therein.
- An output to the display (if provided) located on the SDU, indicating system and LRU status. An English language alpha-numeric display is preferred over Light-Emitting Diodes (LEDs) or coded messages.
- An output of undefined format which should be made available at the ATE reserved pins of the upper connector located on the SDU.

The monitor memory should be capable of being reset in order that stored faults will not be carried over once an LRU replacement or repair has been affected. The reset should be initiated only by shop maintenance.

2.10.4 Use of Automatic Test Equipment

Equipment manufacturers should note that the airlines desire to have maintenance procedures shop verified on automatic test equipment which conforms to **ARINC Specification 608: Standard Modular Avionics Repair and Test System**. The automatic test equipment is expected to execute software with maintenance procedures written in accordance with **ARINC Specification 626:**

2.0 INTERCHANGEABILITY STANDARDS

*Standard ATLAS Language for Modular Test and **ARINC Report 627:**
Programmers Guide for SMART™ Systems using ARINC 626 ATLAS.*

3.0 SATCOM FUNCTIONS

3.0 SATCOM FUNCTIONS

3.1 Inmarsat Radio

3.1.1 Inmarsat Services

3.1.1.1 General

The Inmarsat radio function consists of all the required means to transmit and receive over the Inmarsat satellites in accordance with the Inmarsat specifications defined in the Inmarsat System Definition Manuals for each of the services (Classic Aero, Swift64, and SwiftBroadband). The Inmarsat radio function includes antenna, antenna control, DLNA, RF circuitry, modulation and demodulation to/from baseband, protocol stacks, any required gateway functions, and the corresponding control and signaling.

The various services, and channels within services, are supported by some shared components (e.g., antenna) and by some dedicated components. In particular, “channel units” within the AES may be dedicated to a particular service or they could be generic and the different service implemented by different software running within the “channel units.”

The three services and their RF carriers are briefly described below.

3.1.1.2 Classic Aero

The service capability is described in Section 1.3.

Classic Aero is based around four channel types, each of which has a number of defined data rates:

P-Channel. A packet mode Time Division Multiplexed (TDM) channel used in the forward direction (Ground-To-Air) to carry signaling and packet-mode data. The transmission is continuous from each GES in the satellite network.

R-Channel. A random access (slotted Aloha) channel, used in the return direction (aircraft to ground) to carry signaling and packet mode data, specifically the initial signals of a transaction, typically request signals.

T-Channel. A reservation Time Division Multiple Access (TDMA) channel used in the return direction only. The receiving GES reserves times slots for transmissions requested by AESs according to length. The sending AES transmits the messages in the reserved time slots according to priority.

C-Channel. A circuit-mode Single Channel Per Carrier (SCPC), used in both forward and return directions to carry digital voice or data/facsimile traffic. The use of the channel is controlled by assignment and release signaling at the start and end of each call.

All channels are digital, use interleaving and forward error correction, and use either Aviation Binary Phased Shift Keying (ABPSK) modulation or Aviation Quadrature Phased Shift Keying (AQPSK) modulation.

A Classic Aero AES may use three types of antennas: LGA (nominally 0 dBic), IGA (nominally 6 dBic) and HGA (nominally 12 dBic), and these support the following sub-services.

3.0 SATCOM FUNCTIONS

Table 3-1 – Classic Aero AES Services

Service	Antenna	C-Channels Supported	P-Channels Supported	R-Channels Supported	T-Channels Supported
Aero L	LGA	None	600*, 1200	600*, 1200*	600#, 1200#
Aero H	HGA	21000	600*, 1200	600*, 1200*	600#, 1200#
Aero I	IGA	8400	600*, 1200	600*, 1200*	600#, 1200#
Aero H+	HGA	21000, 8400	600*, 1200, 10500	600*, 1200*, 10500	600#, 1200#, 10500

* = mandatory, # = mandatory if AES supports a packet data service.

An AES typically has a dedicated P-Channel, a channel that is switchable between R- and T-channels, and a C-Channel pair for each voice channel supported.

Voice is coded at either 9600 bits per second (21000 C-Channel) or 4800 bits per second (8400 C-Channel).

600 and 1200 channels operate in the global beams of the satellites, while other channels can operate in either global or spot beams depending on system settings.

Aero L and Aero H AESs operate in the global beam of the satellite. Aero I and Aero H+ AESs are spot beam (e.g., regional spot beam) capable.

P-, R-, and T-Channels operate at fixed power levels which depend on the channel data rate. C-Channels use power control in both the forward and return direction under the control of the GES, where the GES reduces the power when the link conditions are good (as determined by the link Bit Error Rate) and increase the power when the link conditions are poor. The C-Channel in the return direction is continuous for the duration of a call while in the forward direction, Discontinuous Transmission (DTX) is used (the carrier is not transmitted when the ground party is not speaking).

Priority and preemption are supported in both the AES and GES.

Two types of packet data service are supported: data 2, which operates over the ACARS ground network, and data 3, which operates over the X-25 network.

Channel frequencies are assigned to each GES in the network. Network Coordination Stations, whose function is to demand assign frequencies from a common pool, are not currently implemented.

The GESs are dedicated to the Classic Aero services.

3.1.1.3 Swift64

The Swift64 service capability is described in Section 1.3 and consists of a circuit-switched service known as Mobile ISDN and a Point-to-Point Protocol (PPP)-based service (over which IP can run) known as Mobile Packet Data Service (MPDS).

A Swift64 channel within an AES containing Swift64 functionality supports either MPDS or Mobile ISDN (i.e., not both simultaneously). The address for the Swift64 channel uses the same Forward and Return IDs for both services. A Swift64 channel implements one transmit RF carrier and one receive RF carrier. An AES can support one or more Swift64 channels.

Mobile ISDN and MPDS are operated through different ground infrastructure. The ground infrastructure of both mobile ISDN and MPDS is also used to support other Inmarsat markets (land and maritime).

3.0 SATCOM FUNCTIONS

Mobile ISDN uses M/B Land Earth Stations (LES) operated by Inmarsat LES Operators (LESOs) and there are a number of stations per ocean region. Network Coordination Station (NCS) control frequency assignments to the LES in real time to maximize spectrum efficiency.

MPDS is operated via Inmarsat operated Satellite Base Stations (SBSs) and there is one station per ocean region (plus a redundant station).

MPDS uses 33.6 kilo symbols per second (kSym/s) 16 QAM carriers for aeronautical users with a fixed coding rate in both forward and return directions. RF channels are multiplexed – that is they carry both signaling and traffic and are shared between users. MPDS uses power control of the RF carriers in the return direction (from aircraft) only.

Mobile ISDN uses 33.6 kSym/s 16 QAM carriers for traffic channels with a fixed coding rate in both forward and return directions. Traffic channels are allocated on a call by call basis to an individual terminal. Power control of the RF carriers for mobile ISDN is mandatory in the return direction and optional in the forward direction.

The mobile ISDN and MPDS ground networks do not (currently) support priority and preemption for aeronautical users.

3.1.1.4 SwiftBroadband

The SwiftBroadband service capability is described in Section 1.3 and summarized in Figure 3-1.

SwiftBroadband supports both safety and non-safety services and the expected use of the services to the classes of applications is shown below:

Service	APC	AAC	AOC	ATS
SBB Non-safety	✓	✓	✓	
SBB Safety			✓	✓

For non-safety services, multiple packet switched services and one circuit switched service are available at a time to a SBB channel in an AES. Circuit switched and streaming class services are delivered to a user via dedicated bandwidth (using Quality of Service (QoS) mechanisms in the network). The available streaming rates to a user depend on terminal class, elevation to satellite and link conditions. Offered streaming rates are 8, 16, 32, 64, 128 kbps, and X-Stream. The X-Stream mode of operation assigns a dedicated 200 kHz bearer to the requesting AES for its exclusive use.

SwiftBroadband safety service delivers ACARS, two voice channels, IP data, and a position reporting service on one 200 kHz AES channel. Two types of ACARS service are provided: Standard ACARS and Enhanced ACARS. An SDU should support only one of these. The key difference between them is that the Enhanced ACARS service uses an IPSEC Virtual Private Network (VPN) whilst the Standard ACARS service does not. The interface to the CMU is the same for both ACARS services. The ground network supports delivering the two ACARS services via two separate but similar types of gateway. The IPSEC VPN operates between the Air Security Gateway (ASGW) and the Ground Security Gateway (GSGW). The VPN provides service to the Air and Ground Datalink Gateways (ADGW and GDGW). For the Standard ACARS service, the ACARS Air Gateway (AAGW) and the ACARS Ground Gateway (AGGW) are used. All the Air Gateways are implemented in the SDU. The IPSEC VPN uses Public Key Infrastructure (PKI) for certificate

The detailed requirements and implementation of SwiftBroadband safety are not described in this document. Further details are described in RTCA DO-343. For the voice (both circuit-switched and VoIP-based) and ACARS safety service, the SDU presents



interfaces to the aircraft that are the same as for Classic Aero, and hence functions such as the ACARS Aircraft Gateway for Standard ACARS (AAGW), the Aircraft Security Gateway (ASGW) and the Aircraft Datalink Gateway (ADGW) for Enhanced ACARS, and the VoIP server are contained in the SDU. The VoIP server implements the RTP and SIP VoIP protocols to deliver voice over the PS domain, as well as handling priority and preemption.

3.0 SATCOM FUNCTIONS

COMMENTARY

The IP safety service interface is being developed.

The above **Standard PS Voice** may also be used for the cabin. In this case, priority and preemption is not provided, and the addressing does not use the 24-bit AES ID.

SwiftBroadband is a satellite component of the Third Generation International Mobile Telecommunications 2000 (IMT-2000)/Universal Mobile Telecommunications System (3G UMTS). SwiftBroadband is a UMTS Release 4 network just like any other with one key difference being: SwiftBroadband has a proprietary satellite radio interface (IAI-2) instead of the terrestrial Wide-band Code Division Multiple Access (WCDMA) radio interface. In addition, to support safety services, the SwiftBroadband ground network contains various gateway functions (specifically, an ACARS Ground Gateway (AGGW)).

SwiftBroadband shares the same ground infrastructure that is used to deliver similar services to other market segments (enterprise (also known as land portable), land mobile and maritime). The enterprise service is known as Broadband Global Area Network (BGAN), and this term is often used to describe the totality of the system across all market segments. Unlike Classic Aero and Swift64 Mobile ISDN, Inmarsat owns and operate the ground infrastructure which primarily consists of the Satellite Access Station (SAS), the Data Communication Network (DCN), the Business Support System (BSS), the Network Operations Center (NOC), the Satellite Control Center (SCC), the Telemetry Tracking and Control system (TT&C – not shown in figure below), and the Payload Control System (PCS) - not shown in Figure 3-2. The SAS contains the satellite dishes, up down conversion, the Radio Access Network (RAN) and the Core Network (CN). Inmarsat sells service on a wholesale basis to Distribution Partners (DPs) who then sell service to service providers or end users. Service providers sell service to end users.

The overall SwiftBroadband architecture is shown in Figure 3-2.

3.0 SATCOM FUNCTIONS

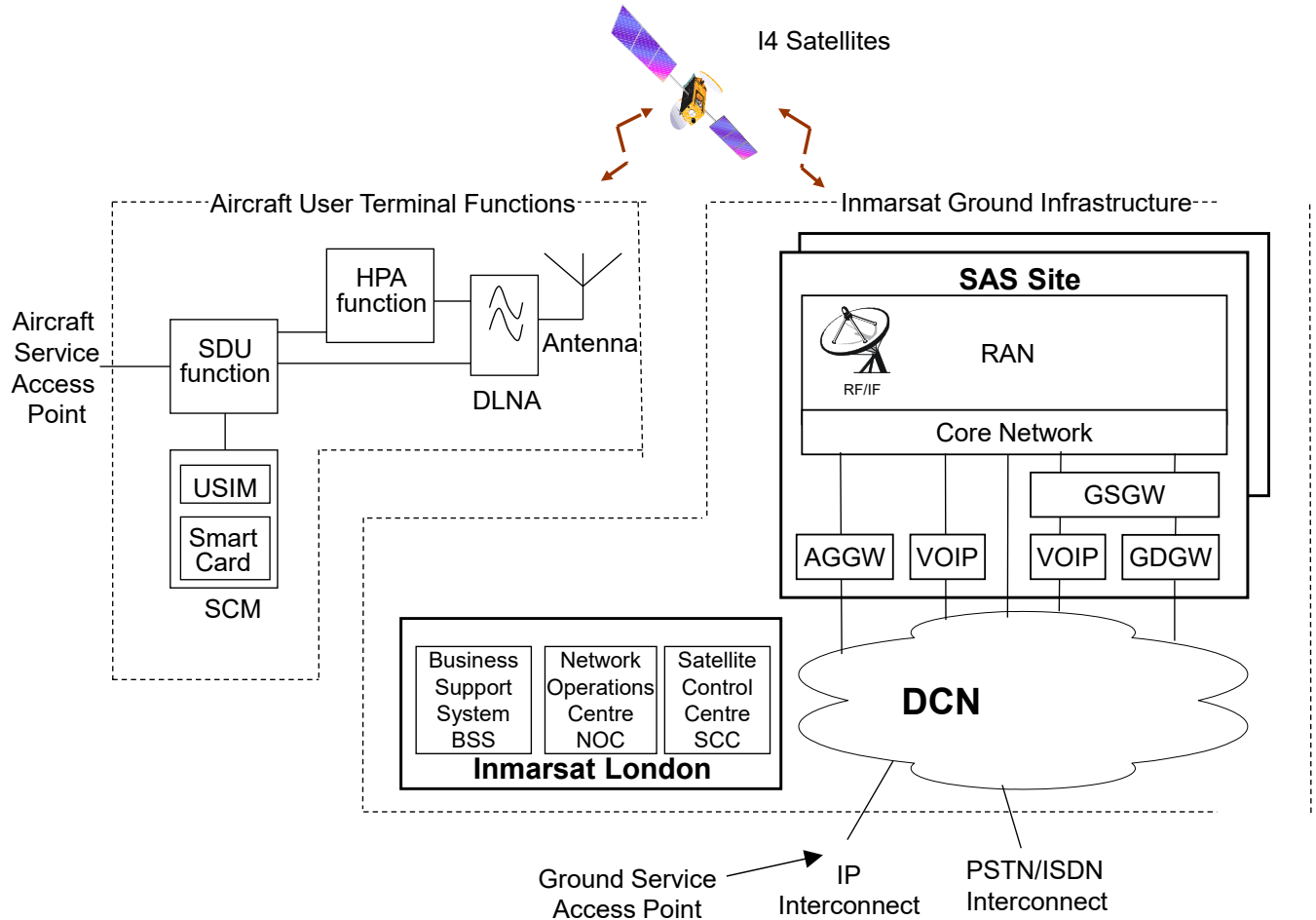


Figure 3-2 – Overall SwiftBroadband Architecture

The end to end SwiftBroadband architecture for enhanced ACARS is shown in Figure 3-3.

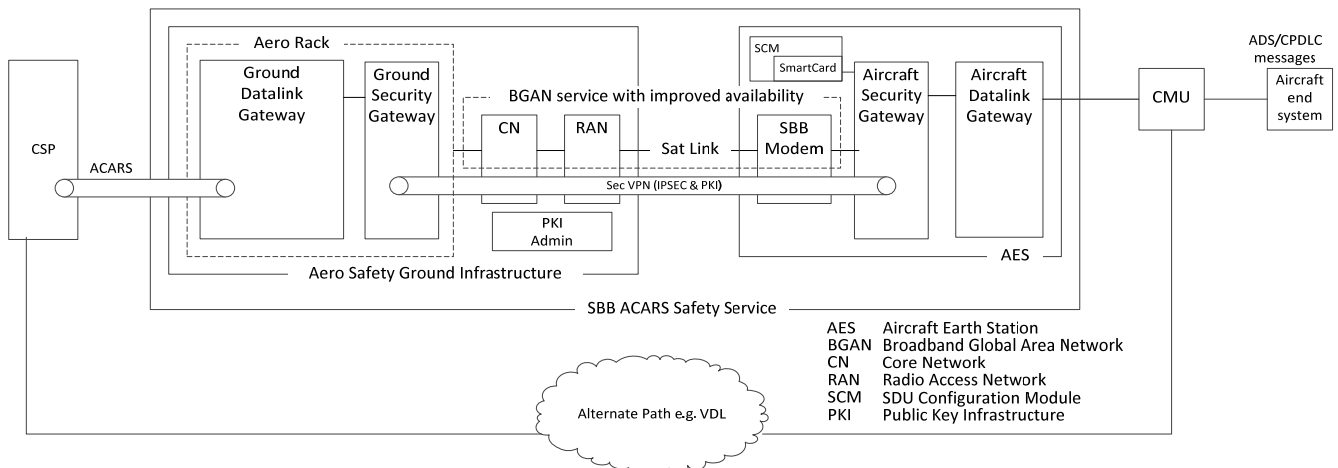


Figure 3-3 – Enhanced ACARS End to End Architecture

SwiftBroadband RF bearers in the forward (to aircraft) direction are a continuous transmission of Time Division Multiplexed (TDM) carriers shared between a number

3.0 SATCOM FUNCTIONS

of users. RF bearers in the return direction (from aircraft) are based on TDMA between a number of users.

Power efficient Quadrature Phase Shift Keying (QPSK) and bandwidth efficient 16 Quadrature Amplitude Modulation (QAM) modulation is used, together with a number of frame burst durations. Symbol rates between 8.4 kilo symbols per second (kSym/s) and 151.2 kSym/s are used with each symbol rate being a fraction or multiple of 33.6 kSym/s. A variable coding rate is used with rates corresponding to 1 dB changes in C/No. In the main the bearers operate at constant power and as the C/No varies the coding rate (and hence the user data rate) is adjusted accordingly. The forward and return bearer types are shown in Table 3-2.

Table 3-2 – Forward and Return Bearer Types

Symbol Rate/ 33.6 kSym/s	Forward		Return					
Modulation	QPSK	QAM	QPSK			QAM		
Frame Period	80 ms		5 ms	20 ms	80 ms	5 ms	20 ms	80 ms
Shared Access Bearers								
0.25	Y							
0.5				Y	Y			
1.0	Y	Y		Y	Y	Y	Y	
2.0			Y	Y		Y	Y	
4.5		Y	Y	Y		Y	Y	
Dedicated (High Data Rate) Bearers								
2.5		Y			Y			Y
5.0		Y			Y			Y

SwiftBroadband uses three types of satellite beam: global, regional, and narrow spot. The global beam is only used in the forward direction, while the regional and narrow beams are used in forward and return directions. User traffic is carried in the narrow beams, while the global and regional beams are used for log on and other signaling. Handover between beams within a satellite is supported.

The SwiftBroadband ground network supports priority and preemption for the SwiftBroadband safety services.

3.1.2 Management of Radio Interface

3.1.2.1 RF Power

The primary objectives of the SDU RF power management algorithm are to:

- Maintain the Aircraft EIRPs for established carriers.
- Determine the availability of RF power for additional RF carriers.
- Maintain the HPA within its operating limits (e.g., to satisfy intermodulation products requirements).
- Ensure reservation of power for on-demand transmissions, (e.g., Classic R or T channels).
- Prioritize the allocation of available RF power to multiple carriers, with regard to the priority of each related service.

The Aircraft EIRP is either the EIRP assigned by the ground station, or a value stored within the SDU.

3.0 SATCOM FUNCTIONS

The SDU should provide independent power adjustment for the EIRP of each RF carrier, plus optionally, overall power adjustment (e.g., by means of the HPA).

Calculation of the RF carrier adjustment should take into account factors such as:

- Power Control commands from the ground station (dynamically variable).
- Antenna transmit gain (dynamically variable).
- DLNA and RF cable losses (potentially frequency dependent).
- HPA (internal or external) gain variations or adjustments (dynamically variable).

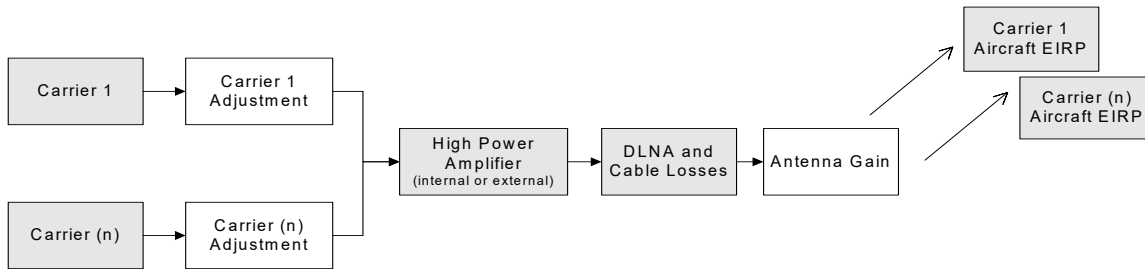


Figure 3-4 – RF Carrier Adjustment

3.1.2.2 Antenna

The SDU receives aircraft navigation data (position and attitude) and based on the satellite location, computes the required antenna elevation and azimuth. The azimuth and elevation data are then transmitted to the antenna.

3.1.2.3 SwiftBroadband Transmit Burst timing

The SwiftBroadband system requires that transmit bursts from AES are tightly synchronized in time and that they are received at the ground within $\pm 120 \mu\text{s}$ of the expected arrival time. This requires that the AES synchronizes its transmit timing based on the aircraft position, the received signal and knowledge of the satellite position which is broadcast by the ground.

The normal mode of operation is that the AES uses GPS derived 3D position and has a burst timing accuracy of $10 \mu\text{s}$ (include timing uncertainty in both receive and transmit chain).

A special timing mode may be used by AES where GPS derived position data is not available, but a position source with a slowly varying error is available (e.g., from an Inertial Reference System (IRS)). In this mode, transmit timing is controlled by a closed loop control system involving the Radio Access Network (RAN). This control system requires that the underlying 3D navigation data (1) has an error characteristic similar to that of an Inertial Reference System (error of no more than 2 nautical miles per hour and is slowly varying), (2) is updated frequently, e.g., at least once per second (3) has adequate relative accuracy and resolution and (4) is compatible with World Geodetic System 1984 (WGS-84).

It is recommended that if GPS is fitted to an aircraft, then GPS based position data is provided to the SDU.

3.0 SATCOM FUNCTIONS

3.1.2.4 GNSS Interference Prevention

3.1.2.4.1 Background

The AES operates in a frequency band such that combinations of transmit frequency assignments could result in intermodulation products falling into the GNSS band. If these intermodulation products are at a sufficient power level, they could interfere with a GNSS receiver on the same or nearby aircraft.

The mitigations against the above scenarios are:

1. The GNSS receiver is designed to operate in the interference environment as defined in the ICAO GNSS SARPs, RTCA GNSS MOPS, and ARINC Characteristic 743A.
2. Isolation is required on the aircraft between the satcom and GNSS antennas. The required isolation is defined in Sections 2.3.2.6.12 and 2.3.3.6.11.
3. The SDU, and external HPA if fitted, are specified to have low levels of intermodulation products.
4. The DLNA provides filtering against such intermodulation products.
5. The satcom antenna is specified to have low levels of passive intermodulation products in the GNSS band.
6. The Inmarsat channel assignments for certain services and combinations of services are frequency managed to ensure that 3rd and 5th order intermodulation products do not fall into the GNSS band.
7. The AES rejects combinations of frequency assignments that could result in harmful interference to the GNSS receiver. Such frequency checks are needed in case of erroneous ground station channel assignments.

The combination of items 1 through 5 above ensures that the 7th and higher order intermodulation products are at a sufficiently low level to not cause harmful interference to the GNSS receiver. Items 6 and 7 ensure that 3rd and 5th order intermodulation products are not in the GNSS band.

3.1.2.4.2 Frequency Allocations by Ground Stations

Classic Aero channel frequencies operate in the band 1545 to 1555 MHz and 1646.5 to 1656.5 MHz as allocated in ITU Radio Regulations for Aeronautical Mobile Satellite (Route) Service (AMS(R)S) services. Hence any combination of R-, T-, and C-channels do not produce 3rd and 5th order intermodulation products at frequencies below 1616 MHz.

SwiftBroadband channels are allocated any frequency in the assigned band.

Swift64 channels are allocated in two categories. The category is stored in the ground station's database and is entered into the database during the terminal registration process:

- Category A allocations and from 1 Jan 2009 Cat B allocations may be at any frequency in the band 1530 to 1559 MHz and 1631.5 to 1660.5 MHz, such that any combination of Swift64, R-, T-, and C-channels do not produce 3rd and 5th order intermodulation products at frequencies below 1585 MHz.
- Category B allocations until 1 Jan 2009 may be at any frequency in the band 1530 to 1559 MHz, and 1631.5 to 1660.5 MHz, such that any combination of Swift64, R-, T-, and C-channels do not produce 3rd and 5th order intermodulation products at frequencies below 1610 MHz.

3.0 SATCOM FUNCTIONS

3.1.2.4.3 GNSS Frequency Management in the AES

ORT item E5 or the configuration pins determines if the GNSS frequency management function is activated in the SDU and if so the value of f_{limit} .

The following guidance is provided so that the airframe manufacturer, installer, or aircraft operator can determine how to set the ORT item or configuration pin.

GNSS frequency management in the AES is only required if the 3rd and 5th order intermodulation products generated by the AES (as received at the GNSS receiver) are greater than the GNSS receiver susceptibility (plus safety margins).

The intermodulation products received at the GNSS receiver will be the sum (in dB) of the intermodulation products generated in the SDU (or external HPA), the filtering in the DLNA and the RF isolation between the satcom antenna and GNSS antenna. Hence, reducing the SDU (or external HPA) intermodulation products or increasing the DLNA rejection or increasing the RF antenna isolation could remove the necessity of GNSS frequency management checks in the SDU.

Single channel systems (e.g., one channel Swift64 only or one channel SwiftBroadband only) do not produce intermodulation products and hence frequency checks are not required for single channel systems.

Since SwiftBroadband channels are allocated anywhere in the band, installations with SwiftBroadband must have adequate RF performance and should not require any GNSS frequency checks. Adequate RF performance can be achieved with either a Type F DLNA or improved HPA intermodulation products or increasing the RF isolation between the satcom and GNSS antennas. Note that a Type D DLNA does not support the whole frequency band and hence is not suitable for SwiftBroadband.

For the recommended RF isolation between the GNSS and satcom antennas, and for GPS only installations:

1. If a Type D or Type F DLNA is fitted, then the GNSS frequency check is not required and should be deactivated.
2. For other DLNAs (e.g., Type A or Modified Type A), the GNSS frequency check is required (and f_{limit} should be set to 1585 MHz) if the HPA only meets the ARINC 741/ARINC 761/ARINC 781 intermodulation requirements.
3. For other DLNAs (e.g., Type A or Modified Type A), and with an HPA with improved intermodulation performance, then the GNSS frequency check is not required and should be deactivated. Please consult the HPA manufacturer on whether it's HPA has adequate performance.

For installations with GLONASS, consult the manufacturers of the avionics for guidance.

3.1.2.4.4 Recommended Frequency Check Algorithm In SDU

1. If no transmit channel is presently assigned, a new channel assignment is to be processed normally.
2. If one or more channels are already assigned, the SDU determines the highest and lowest frequency assignments of the existing and the “to be assigned” channels.

If $3F_L - 2FH > f_{limit}$, then the new frequency assignment is accepted by the SDU.

3.0 SATCOM FUNCTIONS

If $3F_L - 2F_H \leq f_{\text{limit}}$, then the SDU must not transmit on either the newly assigned frequency or a previously assigned frequency. In the latter case, the SDU must ensure that the channels remaining satisfy $3F_L - 2F_H > f_{\text{limit}}$. Note that no recovery mechanism is specified. F_H and F_L are the highest and lowest frequency assignments, respectively.

f_{limit} is 1605 MHz when GLONASS is fitted to the aircraft and 1585 MHz when GLONASS is not fitted to the aircraft.

The need for a frequency check algorithm and the value of f_{limit} is determined by ORT settings or the System Configuration pins (see Section 3.2.2.4.3).

3.1.2.5 Mapping User Interfaces to Radio Interfaces

The SDU should include a function to map user interfaces to Inmarsat Services.

The potential mapping of user interfaces to compatible Inmarsat Services is outlined in Table 3-3. This is a superset of interface capabilities and a specific SDU may have only a subset of these.

Table 3-3 – Potential Mapping of User Interfaces to Compatible Inmarsat Services

Inmarsat Service		SwiftBroadband				Swift64			Classic Aero	
User Interfaces		SBB CS Data	SBB CS Voice	SBB PS Data Streaming Class	SBB PS Data Background Class	M-ISDN CS Data	M-ISDN CS Voice	MPDS	Classic CS Voice (C-Channel)	Classic PS Data (P-/R-/T-Channel)
Non-ATC Cockpit Voice	4-wire Analog + discrete		Y ³	Y ^{1,3}	Y ^{5,3}				Y ^{2,3}	
ATC Cockpit Voice	4-wire Analog + discrete		Y ³	Y ^{1,3}	Y ^{5,3}				Y ^{2,3}	
Cabin Voice	2-wire Analog POTS/SLIC		Y	F ¹	F ⁵		Y		Y	
	CEPT-E1		Y	F ¹	F ⁵		Y		Y	
Non-ATC Cockpit Data	ARINC 429 ACARS				Y ³					Y ^{2,3}
	ARINC 429 Data-3									Y ³
	ARINC 664 Part 2 – Ethernet	Y		Y	Y	Y		Y		F
ATC Cockpit Data	ARINC 429 ACARS				Y ³					Y ^{2,3}
	ARINC 429 Data-3									
	ARINC 664 Part 2 – Ethernet	F		F	F					F
Cabin Data (incl. Fax, Modem and Packet Data)	CEPT-E1	Y		F	F	Y		F	Y	Y
	Ethernet	Y		Y ⁴	Y ⁴	Y		Y		
	2-wire Analog POTS/SLIC	Y				Y			Y	

Notes:

“Y” indicates that a particular service can be supported via a particular user interface.

3.0 SATCOM FUNCTIONS

“F” indicates potential Future Support pending definition or approval.

1. Requires Voice over IP (VoIP) conversion within the SDU.
2. Expected combination for cockpit Classic Aero system.
3. Expected combination for cockpit SBB and Classic Aero system.
4. Expected combination for (digital) cabin voice (e.g., Global System for Mobiles (GSM)) and data (wired or Wi-Fi).
5. For voice signaling.

Ethernet port are by default per ARINC 664, Part 2; it may be changed to ARINC 664, Part 7 by ORT.

3.1.2.6 Selection of Inmarsat Services, Satellites, and Ground Stations

The SDU should include a function to (1) select Inmarsat services, (2) select the satellites and (3) select the ground stations. This function should also manage handovers between satellites and ground stations.

This function should take into account priority, precedence and preference (see Section 3.5) for the following items:

- Service type: Classic, Swift64, SwiftBroadband
- Service sub-type:
 - For Classic Aero: Aero H, Aero H+, Aero I, Aero L
 - For Swift64: Modular Integrated Services Digital Network (M-ISDN), MPDS
 - For SwiftBroadband: Packet-switched, ISDN, other circuit-switched
 - Satellite beam: Global, I-3 spot, I-4 regional spot, I-4 narrow spot
- Service provider for Classic and Swift64 by choosing the appropriate GES/LES
- Application: Voice, fax, PC modem, ISDN audio, packet data
- Application/service variants:
 - Voice:
 - Classic: 9.6 kbps Aero H BTRL, 4.8 kbps Aero H+/I AMBE
 - SwiftBroadband: 64 kbps ISDN, 4 kbps AMBE+2, VoIP
 - Fax:
 - Classic: Group 3 TIF, Group 3 DIU
 - Swift64: Group 3, Group 4
 - PC modem data: Classic: TIF, DIU
 - Packet data:
 - Classic: 600 bps, 1200 bps, 10,500 bps
 - SwiftBroadband class: Conversation (currently not supported), Streaming, Interactive (currently not supported), Background
 - ISDN Multilink/Bonding: 1B, 2B, 3B, 4B, 1B and 3B, 2B and 2B
- Physical interface: Ethernet 1-12, POTS 1-2, Cabin CEPT-E1

3.0 SATCOM FUNCTIONS

- Duration (time since establishment) of circuit-mode call or packet-mode session
- Satellite type in use: I-3, I-4, Alphasat, MTSAT
- Ocean region location: Atlantic Ocean Region-West (AOR-W), Atlantic Ocean Region-East (AOR-E), Indian Ocean Region (IOR), Pacific Ocean Region (POR), Multi-function Transport MTSAT
- Called terminal ID
- IP address

A way to implement such NS/PC preferences may be to use ORT parameters.

3.2 User Interfaces

3.2.1 Pilot System Interfaces for Voice Communication

3.2.1.1 Introduction

The design of the installation (including equipment) for satellite voice services should consist of four major components to satisfy flight deck voice requirements.

Additionally, special consideration has been made to accommodate

FAA AC 20-150: *Satellite Voice Equipment as a Means for Air Traffic Services*. The four components are:

- Call Control
- Call Annunciation
- Call Priority
- Call Routing

Satcom voice operations use SAT Phone (Sections 3.2.1.6 and 3.2.1.7). These sections describe Satellite communications by way of a telephony service to AOC and ATS. The SDU should provide two channels of audio for pilot use plus appropriate control/signaling. Both audio channels (1 and 2) should be wired to the flight crew audio management system. Two types of audio services are defined in the following sections:

- SAT Phone using Inmarsat Aero H/H+/I services
- SAT Phone using Inmarsat SwiftBroadband services

The audio output levels provided should be consistent with those provided by VHF radio services such that minimal level adjustment is required by the flight crew (see Section 3.2.1.2.3).

3.2.1.2 Call Control

The call control components include interfaces between the satcom system, MCDU, Audio Control Panel (ACP) and Audio Management System (AMS). The MCDU provides the capability to place, receive, change priority, and access contact numbers. The ACP provides the capability to select the channel MIC and CALL controls. The AMS provides the capability to tie in the two cockpit channels to the flight deck audio.

3.2.1.2.1 MCDU

ARINC 739/739A-compatible MCDUs or Satcom Control/Display Units (SCDUs) are used for functions such as selection of the called party phone number. The menu

3.0 SATCOM FUNCTIONS

layouts as displayed on the MCDU are based on unique Human-Machine Interface (HMI) requirements from different airframe manufacturers.

COMMENTARY

It is suggested that each equipment supplier obtain the appropriate controlling specification from airframe manufacturers.

Specific menus are defined using the diagram below, whereby each airframe manufacturer identifies which pages are bound by the unique HMI requirements for fleet commonality and certification. All other menus may be described by the individual avionics equipment manufacturers.

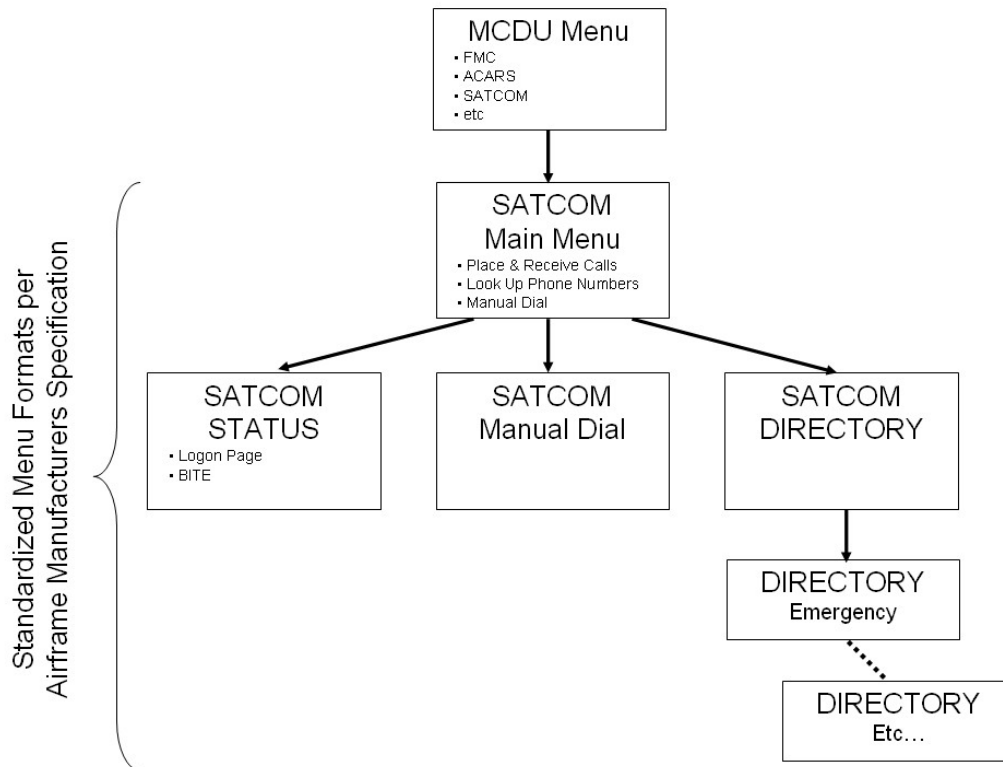


Figure 3-5 – Menus Expected to Have Airframe Manufacturer-Specific Definitions

3.2.1.2.2 ACP

The Audio Control Panel provides a CALL light indication when a Ground-To-Air (GTA) call is detected or an Air-To-Ground (ATG) call is in progress. The “MIC” light indication provides the indication to identify which channel the flight crew is communicating over. In some aircraft, pressing the “MIC” on light will answer and terminate the voice call.

The discrete signaling between the SDU and ACP consists of:

- Cockpit Voice mic-on Inputs #1 and #2 (i.e., one per audio channel). These inputs may be driven by latched mic-on or Push-To-Talk (PTT) signals (refer to ORT item D7).
- Cockpit Voice Call Light Output #1 and #2 (i.e., one per audio channel).

3.0 SATCOM FUNCTIONS

- Call Place/End Discrete Inputs #1 and #2 (i.e., one per audio channel).
- Cockpit Voice Chime Signal Contacts 1 and 2 (shared between audio channels).
- Cockpit Voice Go Ahead Chime Reset (an optional input shared between audio channels for silencing a multi-stroke chime without answering the annunciated call).

The electrical definition of the above (e.g., voltage, current, and impedance) is defined in Attachment 1, Section 1.4.

The Cockpit Voice mic-on inputs can operate in one of two modes as defined by ORT item D7 defined in Section 3.4.2.1.3. These modes are Latched ACP satcom mic switch and Switched PTT.

COMMENTARY

The use of discrete signaling is optional with the Williamsburg SDU Controller Interface (WSCI) described in Section 3.2.1.9 (WSCI is capable of handling all signaling on the ARINC Specification 429 signaling interface).

The use of ARINC Specification 429 signaling is to support more complex text or graphical user interaction (such as phone number selection) via ARINC 739 and 739A MCDUs/SCDUs or ARINC 741 Williamsburg SDU Controllers (WSCs). The latter use the Williamsburg SDU Controller Interface (WSCI) as described in Section 3.2.1.9.

3.2.1.2.3 AMS

The Audio Management System (AMS) is responsible for connecting the flight deck audio to each of the satcom voice channels.

The audio output from the SDU should:

1. Drive an analog balanced 600 ohms' circuit at a nominal output level of 10mW RMS for a digital voice level of -9.8 dBm0.
2. Be adjustable over at least the range 5 mW to 40 mW (-3 dB to +6 dB), via the ORT, for a digital voice level of -9.8 dBm0.
3. Be capable of driving an unbalanced load.

The input is a carbon microphone interface, which is the same as that of the VHF radio (see ARINC Characteristic 716, Section 3.7.4).

In order to assess headset audio levels during installation, the SDU should be able to, on demand via an MCDU or alternative HMI, generate a 1 kHz tone, at a level of at least between 5 mW to 40 mW, determined by the ORT (Cockpit Headset Audio Gain parameter).

The SDU should provide sidetone at a level dictated by the ORT. The maximum level should match that of the incoming audio and there should be a number of back-off levels, at multiples of 3 dB. There should also be a "Sidetone Off" setting to accommodate installations where sidetone is provided by the AMS.

3.0 SATCOM FUNCTIONS

COMMENTARY

Previous definitions of audio output level have referred to a nominal 10 mW RMS level. This is open to interpretation and has been clarified. Nominal operating level is the level applicable to typical operating conditions throughout the system (i.e., comfortable speech level and all controls in their usual operating positions). The digital voice level is the level within the terrestrial networks. Normalization of the SDU audio output levels with that from other services should be set via the ORT.

It should be noted that in order to present a sidetone level matching that of the incoming audio, significant amplification of the low-level carbon microphone signal is required.

A 1 kHz sine wave can be used to approximate the digital voice referenced in the text above.

The following table provides a set of A-law samples, sampling at 8 kHz, which represents a 1 kHz sine wave with a power level of -9.8 dBm0 into an A-law Pulse Code Modulation (PCM) decoder.

A-law Coded Binary	A-law Coded Hex
1001 0011	93
1000 1111	8F
1000 1111	8F
1001 0011	93
0001 0011	13
0000 1111	0F
0000 1111	0F
0001 0011	13

3.2.1.3 Call Annunciation

The satcom system should provide the ability for any aircraft to provide aural and visual indications to the flight crew during GTA and ATG satcom calls. Aircraft functions such as Engine Indication and Crew Alerting System (EICAS), Selective Calling (SELCAL), and chimes should be provided for. Call status information should be provided to the EICAS/ Electronic Centralized Aircraft Monitoring (ECAM)/Electronic Display Unit (EDU) or equivalent as described in ARINC Characteristic 741, Part 2, Section 4.7.3.1, in Label 270 content.

- Chime/SELCAL: Occurs whenever a GTA call is detected or when a flight deck call has been released from the camp on queue or when an ATG call is connected through to the ground.
- EICAS: For some airframe manufacturers, a Flight Deck Effect (FDE) "Comm" message should be displayed for the duration of the call.
- For SwiftBroadband safety, the satcom system shall additionally provide caller line identification to the pilot.

3.2.1.4 Call Priority

The satcom system should provide the means to change the priority prior to making the call. Four levels of priority (defined as 1 through 4 or Emergency, High, Low, Public, respectively) should be made available for the flight crew to select

3.0 SATCOM FUNCTIONS

(programmable via ORT item F3). The lowest priority means that the flight crew call is being placed at the same level of contention as cabin calls from aircraft in the same satellite beams. Selection of priorities above 4 or Public will allow for the flight deck call to preempt existing calls in the space segment that have a lower priority if satellite or AES or GES resource limits have been reached.

Preemption is also achieved within the aircraft due to a facility for the flight crew to terminate a cabin call or queue the flight deck call as desired for a given duration. This queuing facility is defined as camp-on. This action is achieved either manually or automatically.

3.2.1.5 Call Routing

The satcom system, by way of ORT item D4, provides the means to prevent Ground-To-Air Priority 4 or Public calls being routed to the cockpit. This advice is being made due to concerns about safety and access to the flight deck.

The satcom system, by way of ORT item D3, provides the means to route a Ground-To-Air call to either channel 1 or channel 2 reserved for the cockpit when the two channels are not already in use.

3.2.1.6 SAT Phone Using Classic Aero Services

3.2.1.6.1 General

This mode of operations has been previously defined as the traditional telephony service for cockpit voice. Currently, satellite telephony utilizes Inmarsat Aero H/H+/I services over the C-Channel protocol using either the 9.6 kbps or 4.8 kbps codecs. The definition below is based on ARINC Characteristic 741, but various options/functions from ARINC Characteristic 741 (Part 2, Section 4.4.4.3.2, and Attachment 2F-42) are not described in ARINC Characteristic 781. These not described options/functions are listed below. This does not preclude an avionics manufacturer to implement them in the SDU:

- Multi-stroke chime
- Flashing lights
- Call via ACP to a number stored in ATC call register
- Generation of in-band tones and/or speech messages
- Call light activation upon call initiation

The SDU implementation for normal operation is described below as a state machine, and this state machine is shown in Attachment 3. The SDU implements procedures for interworking between the Cockpit Lamp/Chime and Cockpit Voice mic-on Input control lines and the satellite network protocol for the provision of cockpit voice services.

COMMENTARY

Although the AES presents as much as possible the same man-machine interface as for HF and VHF radio, it nonetheless operates as an addressed, point-to-point telephony service.

Call progress and completion/failure annunciations should be displayed on the SCU.

3.0 SATCOM FUNCTIONS

3.2.1.6.2 Air-To-Ground Call

Call Initiation State

A call is initiated via the SCDU or via the Audio Control Panel (Cockpit Voice mic-on Discrete in ground state) after selection of the destination on the SCDU by means of user menus (Section 3.2.1.4). If two channels are available, the request should include the desired channel number.

Ground-To-Air Connected State

Upon receipt of the Call Attempt Result SU (S6D) or Connect SU (S6B) from the GES (whichever occurs first, but not both) the lamp is set steady and the chime is sounded once. At this point, Ground-To-Air voice is connected but Air-To-Ground voice is not connected.

Connected State

The SDU enters the connected state and voice is connected in both Ground-To-Air and Air-To-Ground when any of the following signals are received by the SDU:

1. An answer call line select key switch is activated on the SCDU (Case (c) is required for aircraft having no PTT or mic-on switch available for the SDU).
2. The Cockpit Voice mic-on Input (channel #1 or #2, as appropriate) makes a transition (the first one after the Lamp/Chime call annunciation) from an open circuit to a ground closure, provided that ORT item D7 (Section 3.4.2.1.3) is set to the Switched PTT option.
3. The Cockpit Voice mic-on Input (channel #1 or #2, as appropriate) has continuity to ground, provided ORT item D7 is set to the Latched ACP satcom mic switch option.

Air Initiated Clear

The call is cleared and the SDU transitions to the idle state when any of the following signals are received by the SDU:

- a. An End Call button selected on the SCDU, provided that ORT item D7, is set to the Switched PTT option.
- b. The Cockpit Voice mic-on Input (channel #1 or #2, as appropriate) is open circuit, provided that ORT item D7 is set to the Latched ACP satcom mic switch option.
- c. Activating the Place/End Call discrete (channel #1 or #2, as appropriate).

The chime is not used in an air initiated clear. The lamp is extinguished upon call termination.

Ground Initiated Clear

A channel Release signal unit from the satellite channel causes the SDU to disconnect the voice channel and transition to the idle state.

The chime is not used in a ground initiated clear. The lamp is extinguished upon call termination.

General

If the call cannot be connected, the lamp and chime are activated in the normal manner, and the SCDU/WSC displays a brief description of the reason; a manually selected option could be provided to automatically redial such a call until the

3.0 SATCOM FUNCTIONS

connection is made. If all available AES resources for making the call are busy, the call may automatically enter into a “camp-on” state (with the option of manually preempting or canceling the call), or it may simply immediately and automatically preempt an appropriate existing call.

3.2.1.6.3 Ground-To-Air Call

Ground-To-Air calls are handled largely by the ACP, with little involvement of the SCDU/WSC. However, the SDU may display call information on the SCDU/WSC; e.g., priority of the incoming call.

Incoming Call State

Receipt of the Call Announcement signal unit triggers the interworking process at the SDU. The SDU routes the call according to priority. Priority 1, 2, and 3 calls are routed to the cockpit.

Priority 4 calls are either rejected or routed to the cockpit AMS (using the preferred channel if available), analog cabin telephones, or digital cabin telephones, according to ORT item D4 (see Section 3.4.2.1.3).

The lamp is set steady and the chime is sounded once as soon as the satellite voice channel has been assigned and its continuity verified.

Note: Call priorities and associated Q precedence levels are defined in ARINC Characteristic 741, Part 2, Attachment 2F-42.

If available resources for a new ground-initiated call are all busy and the new call has a higher priority than an existing call, the new call is accommodated by preempting the lowest priority existing call. If the new call has the same or lower priority than all existing calls, the SDU indicates “busy” to the GES.

Connected State

The conditions to transition to the connected state, and the behavior of the lights, chime and voice circuits are the same as for an Air-To-Ground call.

Air and Ground Initiated Clearing

The conditions to clear the call and hence transition to the idle state, and the behavior of the lights, chime and voice circuits are the same as for an Air-To-Ground call.

3.2.1.7 SAT Phone using SwiftBroadband

SwiftBroadband offers **four** types of voice service:

1. The 4 kbps AMBE+2 codec for SwiftBroadband services running as non-safety. In this case, there is no priority and preemption capability, and Ground-To-Air call using the ICAO 24-bit address is not supported. A number of initial certifications of this functionality were made to provide AOC voice.
2. The 4 kbps AMBE+2 codec for SwiftBroadband services running as safety using the circuit switched air interface. Priority and preemption is supported, and Ground-To-Air call addressing uses the ICAO 24-bit address.
3. A G729 codec for SwiftBroadband services running as safety using the packet switched air interface. Priority and preemption is supported, and Ground-To-Air call addressing uses the ICAO 24-bit address. In this case, the SDU includes a VoIP server. On the ground side, the calls are converted

3.0 SATCOM FUNCTIONS

from VoIP to circuit switched and are delivered into the terrestrial networks as circuit switched. The SDU only uses this voice service when a second cockpit voice channel is required.

4. **As 3, but with the addition of a VPN to provide additional security on the packet switched air interface.**

The pilot input method for placing all **four** types of voice calls on SAT Phone from the MCDU should be no different to that when placing an Aero H+/H/I voice call.

3.2.1.8 SAT Radio

Note: At the time of this writing, SAT Radio has not been implemented within SwiftBroadband due to low customer demand. The text below has been retained for reference only.

This mode of operation is a newly defined concept by which satcom voice communications operates in a similar manner to a VHF Radio effectively a PTT radio service over a satellite link. This service is referred to as the Netted Voice feature described in the Inmarsat BGAN SDM. Candidates for the use of this service could be AOC Voice (to be used as private company voice use, airline oceanic/international fleet communications, etc.), Military command operations (Air/Ground/Sea) and possible ATS use. The use of SAT Radio can also be restricted to private and secured user groups. This service is not expected to be used for communications between aircraft since there is the issue of a double satellite latency hop making communications difficult to remain coherent.

The underlying technology is a combination of IP Multicast services for the forward link and a high priority VoIP service for the return link. Actual implementation of the SAT Radio service is still being defined with studies to determine the best tradeoff between the most efficient pilot HMI requirements and satellite resource usage. Some of the candidates for return link protocols could be Virtual Circuit, Packet Switched, and Dedicated Contention VoIP modes. Among the three modes are aspects of considerations for voice latencies, ability to preempt pilots, thus eliminating “Stuck MIC” situations. Other enhancements include minimization of bandwidth requirements, traffic loading, introduction of emergency pilot interrupts and preventing pilot to pilot “step-on” situations.

Figure 3-6 is a concept diagram of how the system could be implemented.

3.0 SATCOM FUNCTIONS

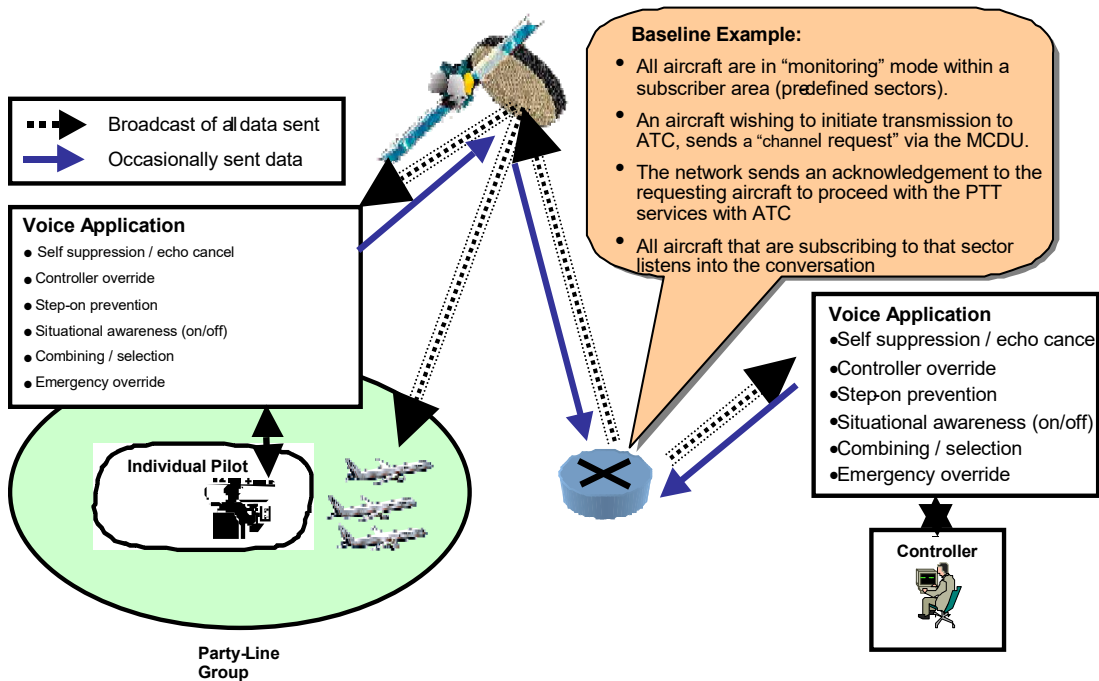


Figure 3-6 – Baseline Operational Concept for SAT Radio

For Air-To-Ground communications, one method of operation would be for a pilot to "tune" (via the SCDU/WSC) into the subscriber group that he/she is interested in (for possible ATS communications it could be the current FIR they are transiting like Shanwick-Center, in an AOC environment, their company's Maintenance Watch channel or for Military/Government use, their specific coded operations mission group). Once this subscriber group is selected and authentication is granted, any voice traffic is multicast to the cockpit. When the pilot wishes to speak, they could select a command on the SCDU/WSC that automatically assigns a forward link based on who else is in the queue requesting to talk. If no other aircraft is actively engaged in a conversation, then the pilot would get an indication to start transmitting, otherwise their request will be placed in a queue (controlled by the ground subscriber group) until the existing radio exchange is completed. This will prevent pilot to pilot step-on problems encountered in VHF radio communications. This method also allows the forward link satellite channel resources to be free and not used if there is no active transmission. Once radio conversation is completed, the person coordinating the ground subscriber group releases the aircraft and the next aircraft in the queue is automatically given the signal to start transmitting. For Ground-To-Air operations, the ground subscriber operator would broadcast any information (such as turbulence reports) and only aircraft that are already subscribed to that group will receive that information. The subscriber operator would have a list showing which aircraft are currently listening into that group. Since an aircraft usually has two cockpit voice channels, it is conceivable to have one channel listening into the AOC communication and the other channel listening into the ATS channel to aid in situational awareness.

As mentioned previously, the above example offers just one method or concept of operation. A full study is outside the scope of this standard.

3.0 SATCOM FUNCTIONS

3.2.1.9 Williamsburg SDU Controller

Pilot interaction with the satcom system is typically performed via one or more ARINC 739-compliant MCDUs/SCDUs. For aircraft without MCDUs/SCDUs, an alternative means of control/display is the Williamsburg SDU Controller Interface (WSCI), which may be used between the SDU and cockpit systems such as radio management panels or primary display systems with keypads and cursor control devices. The same physical ARINC Specification 429 ports are used on the SDU for either MCDUs/SCDUs or WSCs, with SDU configuration pin programming defined in Attachment 1, Section 1.4A or ORT items B11, B12, B13, and B14 determining which interface standard pertains for a given installation. The WSCI standard permits the human factors of the pilot interface (text, icons, colors, etc.) and the phone number data base to be completely independent from the SDU design, as it is based on the transfer of system control/status primitives (messages) using the ARINC Specification 429, Part 3, Version 1 (Williamsburg) file transfer protocol. The standard message suite may be expanded as necessary to meet new requirements. Reference ARINC Characteristic 741, Part 1, Attachment 2F-42.1 for details of this interface.

3.2.2 Cockpit ACARS Data

An ARINC 429 data bus provides communications between the satcom system and the ACARS MU/CMU system. ACARS data can be transmitted over either Classic Aero or SwiftBroadband.

For the description of the operation between the SDU and ACARS MU/CMU refer to ARINC Characteristic 741, Part 2, with the exception of the ARINC 429 Bus speed selection and Label 271 SDU to ACARS MU/CMU Join/Leave message. The ARINC 429 Speed selection parameter is set as ORT item B9 (Section 3.4.2.1.3) rather than configuration pin strapping. Label 271 is described below:

3.2.2.1 SDU to ACARS MU/CMU Join/Leave

The SDU should transmit a Label 271 Join/Leave message as defined below.

Bit(s)	Description
16-9	GES ID (per ARINC 741, Part 2, Attachment 2X Annex 1 Element 24 for classic aero and per BGAN SDM Volume 3, Chapter 3, Section A.3.1 for SBBSS)
22-17	Satellite ID (per ARINC 741, Part 2, Attachment 2X Annex 1 Element 51 for classic aero and per BGAN SDM Volume 3, Chapter 3, Section A.3.1 for SBBSS)
25-23	Aero service type currently being provided: 000: Aero-L 001: Aero-I 010: Aero-H 011: Aero-H+ 100: SwiftBroadBand (regardless of class) 101-111 Reserved for future use
28-26	Pad (zero)
29	Datalink via MU/CMU Not Available (identical to Bit 11 in ARINC 741, Part 2 Section 4.7.3.1)
31-30	SSM (per ARINC Specification 429 Sections 2.1.5 and 2.1.5.2)

COMMENTARY

Bit 29 indicates whether a datalink is Available (a Join message) or Not Available (a Leave message) from the AES to the GES which is

3.0 SATCOM FUNCTIONS

identified by the GES ID and Satellite ID fields. The CMU uses this information to initiate network-layer virtual circuits with available ground routers by determining the ground routers' DTE addresses from the provided GES identity. The GES and Satellite ID fields uniquely identify a GES. The Aero Service Type field may be used by the CMU to make routing decisions, e.g., if cost per bit is a routing/criterion.

3.2.3 ISDN Interface

This section was deleted by Supplement 7.

3.2.4 Ethernet

This section summarizes the way Ethernet ports can be used for SwiftBroadband and Swift64 services. A fully detailed interface description is available in Attachment 5.

COMMENTARY

The Ethernet interface defined in this section and in Attachment 5 was designed for non-safety applications. It has not yet been determined if this interface definition is suitable for the SBB Safety Priority IP service.

It is expected that this interface will be used by not only ARINC 781 SDUs but also non-ARINC 781 form factor LRUs that support SwiftBroadband.

Any reference to the Ethernet in the present document refers to Ethernet per ARINC Specification 664, Part 2.

3.2.4.1 Purpose and Requirements of the Interface

Depending on the functions supported, the SDU should interface directly to onboard communication networks using its Ethernet ports to access the following telecommunication services:

- SwiftBroadband Circuit Switched service.
- SwiftBroadband Packet Switched service.
- Swift64 Mobile ISDN service.
- Swift64 MPDS service.

The interface can also use be used to retrieve the status of the SDU and communication services/links.

The following requirements specify the proposed use of this interface:

- The interface needs to be scalable/extendable to architectures that include:
 - Commercial Off The Shelf (COTS) network client devices (Terminal Equipment (TE)) such as a Laptop.
 - Direct connection to the SDU for basic functionality.
 - Aeronautical Servers/Routers that host applications and services.
 - Services and connectivity to TEs that can run custom software to control one or many SDUs providing full functionality.
 - Aircraft that host one or many SDUs.

3.0 SATCOM FUNCTIONS

- SDUs that host one or many SwiftBroadband channels.
- A SwiftBroadband channel may support up to 11 simultaneous packet data services (Packet Data Protocol (PDP) Contexts) simultaneously:
 - Each PDP Context may be configured to operate with a specific traffic class (Streaming and Background are initially supported).
 - Quality of Service (QoS) properties for Streaming class PDP Contexts may be requested by an external device. QoS includes the guaranteed bit rates in the forward (to aircraft) and return (from aircraft) directions.
 - The QoS properties of each PDP context may be modified after the PDP Context has been established.
- The interface should have adequate security for the intended applications and aircraft environment.
- The interface should be suitable for Air Transport, Business, and Government aircraft.

Based on the above, the purpose of this interface can be summarized as:

- Set up, control, and transfer of packet data using SwiftBroadband packet data service. With control equating to set up, modify, and terminate primary contexts and set-up, modify, and terminate secondary contexts.
- Access the SwiftBroadband Circuit Switched service
- Obtain operational status of AES and communications link providing the above service.
- Be used (backwards compatible) for set up, termination, and transfer of packet data using Swift64 (packet and circuit switched services).
- Be suitable for use with communication networks containing unmodified COTS protocol stacks.

3.2.4.2 Interface Components

The proposed interface consists of:

1. Using Point-to-Point Protocol over Ethernet (PPPoE) to set up SwiftBroadband primary contexts and Swift64 packet data (packet switched services) by using pre-defined Access Concentrator (AC) service names in PPPoE frames (configurable through the SDU ORT Section C to define the type of service and associated QoS when applicable).

and/or

2. Using PPPoE to set up SwiftBroadband primary contexts using 3G/Inmarsat AT commands for AC Service names in PPPoE frames.

and (if there is a need to set-up secondary PDP context and modify established one)

3. An out of band control function using 3G/Inmarsat AT commands over Telnet/Transmission Control Protocol/Internet Protocol (TCP/IP)/Ethernet. Out of band means independent of the PPPoE session carrying the user data.

and/or

3.0 SATCOM FUNCTIONS

4. Providing an IP router interface with Network/Port address translation to route traffic to a SwiftBroadband primary context that is “always-on” subject to service availability. This is called “Routed Interface.”

and (if required)

5. Using PPPoE to set up Swift64 and SwiftBroadband Circuit Switched Unrestricted Data Interface (UDI) data calls by using service names in PPPoE frames.

and (if required)

6. Simple Network Management Protocol (SNMP) to retrieve SDU operational status of the AES and communication links.

3.2.4.3 Interface Fundamentals

Based on the above, the interface fundamentals are:

- For the “Routed Interface”:
 - Router functionality is limited to:
 - DHCP and NAT/PAT services to the TE.
 - Functionality is provided as a Primary PDP Background context.
 - When the SDU is successfully attached to the core network, it should activate the context associated to the Routed Interface and continue to re-connect in instances where service is lost due to aircraft maneuvering, etc.
- For PPPoE:
 - Each primary context is supported in a separate PPPoE session, and is allocated an IP address by either the Inmarsat ground network or the DP’s network. Secondary context traffic is supported via the PPPoE session of the parent primary and shares the parent’s IP address.

Note: SwiftBroadband supports up to 11 total contexts per channel (i.e., sum of the primary and secondary contexts.)

 - Error codes should be generated in the PPPoE error tags.
 - If primary PDP context is cleared, then SDU should initiate a PPPoE Active Discovery Termination (PADT).
- For the out of band control function:
 - Secondary contexts can only be set up (and controlled) via the out of band control function.
 - Traffic Flow Templates (TFTs) (based on 3G plus Inmarsat extensions) are a mechanism to specify the packet filter parameters between parent primary and its secondary PDP contexts.
 - Each control function equates to a single telnet session. There is no mandated pairing between PPPoE sessions/PDP contexts and control functions. The method for a control function to address a particular PDP context is a special AT command within a Telnet session.
 - The SDUs IP address can either be stored in the ORT (item C11) or can be dynamically assigned using DHCP.
 - The interface supports one to many and many to one (servers to SwiftBroadband channels) on one (or more) Ethernet interface.

3.0 SATCOM FUNCTIONS

3.2.4.4 Multiple Ethernet Interfaces

Further work is required to define how multiple Ethernet interfaces to an SDU operate on an aircraft in terms of how/if they can access a single RF channel. A key driver is security considerations.

3.2.5 CEPT-E1

For cabin communications services, the Cabin Communications System (CCS), described in ARINC Characteristic 746, is interconnected to the SDU by means of a CEPT E1 digital link. The E1 link is capable of supporting 30 PCM channels.

The SDU access protocol for call control of circuit-mode services to the CCS is the ITU-T Q.931/932 network layer protocol. The detailed implementation of this protocol for the SDU as well as the CCS is defined in ARINC Characteristic 746, Attachment 11.

3.2.6 POTS

The SDU should provide two 2-wire interfaces for connection to a Plain Old Telephone Service (POTS) standard telephone handset. A POTS interface is also known as a Subscriber Line Interface Circuit (SLIC). Each interface should support a Ringer Equivalent Number (REN) of 1. Further guidance on this interface can be found in international telecommunications standards such as the various pertinent ITU-T Recommendations and in the U.S. Code of Federal Regulations (CFR) Title 47 (Telecommunication) Volume 3, Chapter 1 (Federal Communications Commission (FCC)) Part 68 (Connection of Terminal Equipment to the Telephone Network).

3.3 Software Data Loader Interfaces

The SDU should be designed so that all embedded software components (operational software, User and Secure ORTs) can be loaded through industry standards ARINC 615 and ARINC 615A data loaders.

It should also be possible to download the ORTs from the SDU to a data loader.

SDU software files should be compliant with ARINC 665.

3.4 Miscellaneous

3.4.1 Dual Satcom Installation

3.4.1.1 Dual Satcom Configurations

Dual satcom is an optional configuration where two single satcom systems are installed aboard a single aircraft. Each system has all the equipment necessary to function without the other. The two systems may be similar or dissimilar, possibly using different networks.

Dual systems may provide backup redundancy for safety voice and data services or additional cabin channel capability, or both. The use of different satellite networks achieves not only redundancy of satcom avionics, but also of satellites and ground networks. Using two satellite networks may also provide superior total geographic coverage.

Due to the use of the ICAO 24-bit aircraft address for datalink layer addressing (AES ID), and due to the general restriction of assigning only one such ICAO 24-bit aircraft address per aircraft, a dual satcom installation has only one terminal providing cockpit data services at one time.

3.0 SATCOM FUNCTIONS

Dual satcom can be implemented in a variety of configurations as shown in the table below.

Table 3-1 – Various Dual Satcom Configurations

Generic Name	Key Characteristics	Notes
Dual – Independent	No or minimal interaction between the two systems. Two systems may have different functions and come from different suppliers.	Useful for cases where the two terminals provide services to the cockpit and cabin, respectively. Non-interference between the two systems has to be ensured.
Dual – Cold Standby	Standby system is powered off until needed. An external “control function” is required to power up the standby system.	Switching may be manual or under control of external equipment. Starting up the standby system may be slow, depending on the design.
Dual – Warm Standby	Standby system is powered on but typically not logged on to its network. The standby system should never interfere with the active system. A control function or mutual coordination mechanism is required to determine which system is active.	Can accommodate dissimilar terminals. A standard coordination mechanism is defined in subsections below.
Dual – Hot Standby	Standby system is powered on. The standby system should never interfere with the active system. The standby system is able to become active fast, e.g., by having frequency information or spot beam maps passed to it by the active system. A control function or mutual coordination is required to determine which system is active.	Suitable for two similar terminals. Typically, the two terminals are designed as a set, with proprietary communications between them.
Dual – Cooperative (Master/Slave)	There is no standby system since both systems are providing some functionality. Typically uses “Master-Slave” concept. Both systems are modulating and demodulating signals. The two systems are interacting, with coordination and some services provided by the Master unit to the Slave unit.	Example: Two Classic terminals where the Master provides the P-Channel receiver and R/T channel transmitter and some C-channels. The slave provides additional C-channels under control of the Master unit. Described in ARINC Characteristic 741. Typically, the two terminals are designed as a set.

In a dual satcom installation with dissimilar terminals, each terminal may provide cockpit services via Inmarsat Classic service, SwiftBroadband, Iridium Block1, or Iridium Certus. It is possible that further satellite networks or services will be added in the future.

The choice of which dual SDU mode to implement should be based on the expected use of the SDU (including redundancy considerations) on its target aircraft.

Key issues that determine the appropriate dual mode are:

- Interfaces to the avionics. To support two fully redundant satcom systems, the aircraft requires additional ports on the CMU, MCDUs, AMS, Central Maintenance Computer (CMC), EICAS, Data Loader, and possibly IP routers (see Attachment 1, Sections 1.1A and 1.1B). If these are not available, a Dual Cooperative configuration may be a solution, with only one SDU interfacing to the aircraft.
- Interference between the systems (see Section 3.4.1.4).

3.0 SATCOM FUNCTIONS

- Switchover time between the systems.
- Start-up behavior. It is desirable that a standby system is tested at start-up (e.g., by automatically logging on) so that failures may be detected before dispatch.

Of the dual satcom configurations listed in Table 3-4, the Dual Warm Standby configuration is considered to be the most attractive for coordinating dissimilar terminals and is encouraged for future systems. It allows conforming equipment from different manufacturers to cooperate in a dual satcom installation. A standard protocol for cooperation between SDUs in such a system is defined in Section 3.4.1.3.

Where the two terminals are provided by the same manufacturer, additional proprietary features may be supported by using proprietary protocols through the standard wiring provisions. This may be used for the implementation of Dual Hot Standby or Dual Cooperative configurations.

3.4.1.2 Physical Interfaces for Dual Satcom

The dual satcom installation is shown in Attachment 1, Section 1.1B. The two satcom systems are independently connected all the normal avionics functions. This requires that the aircraft architecture should therefore provide four additional ports on all avionics that interfaces to satcom.

For coordination between SDUs (in Cold/Warm/Hot Standby/Dual Cooperative implementations) specific signal pin definitions are provided for on the SDU connector. These signals are discussed in the subsections below.

These hardware interface definitions are the same as, or at least backward-compatible with, ARINC 741 and previous versions of ARINC 781. They have also been included in ARINC 771, allowing for cooperation between Inmarsat and Iridium systems.

3.4.1.2.1 Dual Crosstalk Buses

Each SDU supporting dual satcom operation installations should implement an ARINC 429 transmitter and receiver pair to handle dual crosstalk communications between the two SDUs (pins MP09C, MP09D and MP09G, and MP09H).

Through this interface, each terminal should provide an indication of its own status, modes, and health to the other terminal.

3.4.1.2.2 System Select and Disable Discrete Signals

The two discrete signals (pins MP09E and MP09F) should be cross-connected in the aircraft wiring, such that the System Select discrete pin of one system is wired to the System Disable discrete pin of the partner system.

The System Disable discrete is an input. The System Select discrete is a combination input and open-collector output. The high voltage level is nominally 28 Vdc, consistent with avionics high level discrete (for details, see Attachment 1, Section 1.3 and notes in Attachment 1, Section 1.4).

If one system determines that its partner system has failed and if it is not at fault and believes it can provide service, it holds its own System Select output (the partner system's System Disable input) low. While the input of a system is held low, this system should be inhibited from making any RF transmissions.

3.0 SATCOM FUNCTIONS

If the system select discrete is pulled low by an external source, it indicates that this system has been selected to be Active and should not attempt to utilize its partner system. In addition, if a system detects that its partner system has failed and if it is not at fault and believes it can provide service, it should pull its own System Select discrete low, declaring itself to be Active, and disabling the failed partner system.

This pair of discrete signals also allows for manual switching between the satcom systems, should this be desirable. This requires an additional switch to ground in the cockpit for each discrete line. It may additionally be possible to inhibit RF transmissions from both systems for special cases such as the proximity of maintenance or service personnel to the satcom antennas. However, manual switching should not be required if the SDUs implement their own coordination mechanism, e.g., the mechanism defined in Section 3.4.1.3.

When both systems are thus Disabled, they should both report their current status to the CMU.

3.4.1.2.3 SDU Number Configuration Pin

The SDU determines whether it is SDU1 or SDU2 by reading Configuration Pin 5 (TP04D). The interpretation of the pin is according to the table in Attachment 1, Section 1.4A.

3.4.1.3 Standard Warm Standby Operation and Protocol

This section defines a standard protocol and principles of operation for a warm standby configuration, to enable equipment from different manufacturers to cooperate.

This section is suitable for dual dissimilar satcom systems (e.g., Inmarsat SBB and Iridium Certus).

Implementation of the material in this section is optional. However, implementation is encouraged for any new terminals which aim to be candidates for dual satcom installations.

The dual satcom concepts and protocols in this section are intended to be agnostic of the manufacturer of and the satellite network used by each terminal. Any conforming terminals (similar or dissimilar) should therefore be able to cooperate in a dual satcom installation. This material is also intended to be coordinated with ARINC Characteristic 771 to ensure cooperation between conforming Inmarsat and Iridium terminals using standardized aircraft wiring.

The hardware interface between SDUs is defined in Section 3.4.1.2 and its subsections.

3.4.1.3.1 General Dual Operating Principles

Only one SDU can be Active at any one time, but both SDUs can be in Standby concurrently.

In case of SDU failure, the other SDU shall become Active if it is not at fault and believes it has coverage.

The Standby system is not allowed to interfere with the active system at any time. The impact of this rule will vary depending on the systems involved. In general, this relates to Iridium as Active and SBB as Standby.

3.0 SATCOM FUNCTIONS

If one system has been proven never to interfere with the other system when transmitting, it may be allowed to transmit even when on standby. This is controlled by a Secure ORT item for each SDU (example: two SBB systems or two Iridium systems).

If the Standby receiver is at risk of damage from the Active transmitter, it may have to protect itself by shutting down or take other measures to protect itself. This is determined by the design of such a system (example: SBB as Active and Iridium as Standby).

Only the Active system at a time may be associated with the 24-bit ICAO address. The Standby system, if allowed to transmit and receive, may be logged onto the satellite (e.g., to determine if it is within coverage, or to provide non-safety services) but may not provide conflicting safety data or voice services (example: two SBB or two Iridium).

Each SDU sends information to the other SDU over the crosstalk bus about:

- Its own health
- Its ability to provide service
- Its reading of ORT and configuration pin data
- Its reception of Satcom Select Mode changes from its MCDU interface

Each SDU design should determine its own criteria for indicating “able to provide service.” Examples:

- Signal lost for a period of time
- Geographical area where operation is prohibited

If the Active SDU has lost its connection, but has a good probability of reacquiring logon, it should try for a reasonable time to reestablish service and not immediately indicate “unable to provide service.” Example: A terminal performing a satellite handover. If another satellite is available that is likely to be able to provide service (e.g., based on elevation and footprint), the SDU should attempt to complete the satellite handover for a reasonable time before giving up and handing over to the other SDU.

Such time should be determined for the specific design. A recommended starting point is at least four times the period which would give the system a 90% probability of acquiring its network under normal satellite coverage conditions. This is to suppress frequent backward and forward handover between terminals.

Terminals should aim to perform handovers between SDUs to detract as little as possible from the end-to-end communications performance in the relevant MASPS.

If both terminals are in Standby, the non-preferred terminal should allow enough time for the preferred terminal to take on the Active role, as specified by the ORT.

3.4.1.3.2 ORT Items for Dual Satcom

The list of ORT items in Section 3.4.2.1.3, ORT Contents, include a sub-list of standardized ORT items applicable to Standard Warm Standby Operation. These can be found in ORT Section H: Standard Dual Warm Standby Configuration.

3.0 SATCOM FUNCTIONS

3.4.1.3.3 Power-up Sequence for Dual Satcom

Each SDU determines if it is SDU1 or SDU 2 from its Configuration Pin 5 (TP04D) input and checks the parity calculation using the Parity pin (TP03F).

Note: This allows the ORTs for similar SDUs in a dual system to be identical.

Each SDU determines from its ORT whether SDU1 or SDU2 is the preferred satcom.

Each SDU signals its own ORT and Configuration pin information related to Dual Satcom to the other SDU:

- SDU1/SDU2
- Default Satcom Select Mode SDU1/SDU2/Auto
- Preferred SDU (SDU1/SDU2) (Note: This setting has effect if Satcom Select is in Auto mode)

If a conflict in this information is detected:

If both SDUs have the same SDU number and no parity conflict is detected, both SDUs report the failure and do not provide service (Note: This would most likely only occur after installation or maintenance).

If one SDU detects a parity conflict on its configuration pins, it reports the failure and does not provide service.

If SDUs differ on which SDU is preferred, SDU1 reports a warning and considers itself to be the preferred SDU. SDU2 reports a warning and considers itself to be the non-preferred SDU.

If the Default Satcom Select Mode of the SDUs differ, both SDUs report a warning. The Default Satcom Select Mode of the preferred system should then be used by both SDUs.

Each SDU should report its failures and warnings appropriately through its normal BITE reporting methods, e.g., CMC, logs, MCDU technical pages.

Each SDU does its normal start-up process, including applicable self-tests.

Each SDU sets its record of the Satcom Select Mode to the Default Satcom Select Mode. Note: The Default Satcom Select Mode is only used at startup.

Each SDU checks whether it should be the active SDU. If the Satcom Select Mode is set to Auto, then the preferred SDU becomes the active SDU. Otherwise, the Satcom Select Mode determines directly whether SDU1 or SDU2 becomes active. The other SDU goes into standby mode, either when it decided this from the ORT information, or when it is suppressed by the Satcom Disable discrete signal.

Whenever the Satcom Disable discrete is asserted, even if asserted externally, the SDU shall be in Standby mode.

When the SDU is active, it logs-on to its network and provides service.

If Satcom Select mode is set to SDU1 or SDU2, the selected SDU remains active until the selection is changed on the MCDU.

If, after startup, an SDU does not receive data on the crosstalk bus from the other SDU, it continues its own start-up and assumes its role as active or standby SDU.

3.0 SATCOM FUNCTIONS

The check for conflicting configuration data should be completed when both SDUs have started up (this avoids one SDU waiting for the other at startup).

In “Auto” Mode, if the non-preferred system starts up first, it will assume the Active role if the system disable discrete is not asserted, after which, normal handover rules apply.

Normal System Select discrete behavior will prevent both systems from simultaneously logging on in the event of an ARINC 429 Bus Fault.

The sequence described above describes a normal startup and does not allow the standby SDU to log on. Testing is therefore limited to BITE. Should full testing be required before a flight, the crew should do this by switching to the second satcom manually using the MCDU.

COMMENTARY

Second SDU Startup testing may be added in a future Supplement.

3.4.1.3.4 Satcom Select “Auto” Mode

This section describes the SDU behavior when the Satcom Select mode is set to Auto.

At startup, the preferred SDU should become the Active SDU.

The preferred SDU remains Active until:

- It is unable to provide service, or
- It fails, or
- The crew overrides the Satcom Select mode from the MCDU.

When the Active SDU decides to hand over to the Standby SDU, it should simply go to Standby, releasing its System Select discrete.

When the Standby SDU detects the other SDU going into standby (its System Disable discrete being released), it should become Active if it is not at fault and believes it has coverage, and if so, assert the System Select discrete.

If the preferred SDU has handed over to the non-preferred service (e.g., due to leaving its coverage area), it may request back its primary role when it calculates that it should be able to provide service again. This should be done by setting the “Handover Request” bit in Label 273 on the crosstalk bus. The criteria for when this should be done is up to each SDU design. Possible examples are:

- A viable satellite becomes visible, with increasing elevation and beam coverage is available according to the beam map.
- Signal quality indications while monitoring the regional beam in receive-only mode while on Standby.
- The preferred SDU waking up last.

After receiving a handover request over the crosstalk bus, the Active (but non-preferred) SDU should go to Standby as soon as any active voice calls have been completed.

After requesting a handover, the preferred SDU should wait until the other SDU releases the System Disable Discrete, after which it should become the Active SDU and also clear the Handover Request bit on the crosstalk bus.

3.0 SATCOM FUNCTIONS

If the non-preferred SDU has not released its System Select discrete within 60 seconds after completing a call, the preferred system may seize the Active role by asserting its System Select discrete, and the non-preferred system should go into Standby mode.

The non-preferred system should not request handovers.

The preferred SDU should ignore handover requests received over the crosstalk bus.

If an SDU indicates a fault in its Label 273, the other SDU should become Active.

Note: When not in Auto mode, it is determined by the Crew to switch to the healthy satcom manually using the MCDU.

3.4.1.3.5 MCDU Menus

Each SDU should manage its own Satcom Menu on the MCDUs.

Each SDU should indicate the current Satcom Select mode in its Satcom Menu (SDU1, SDU2, Auto).

Each SDU should clearly indicate its own status in its Satcom Menu (Active or Standby).

Each SDU Satcom Menu should include the menu features to set the Satcom Select mode to “Make Active” or “Auto.” To manually make SDU1 active, the crew should go to SDU1’s menu.

Each SDU should update its own record of the Satcom Select Mode after receiving a change instruction from the MCDU.

Each SDU should signal to the other SDU any change in the Satcom Select Mode received from its MCDU menu by updating the “Current Satcom Select Mode” bits in Label 273 on the crosstalk bus.

Each SDU should update its own record of the Satcom Select Mode if it receives a change of the mode from the MCDU or from the other SDU.

Each SDU should reflect its current record of the Satcom Select Mode in the “Current Satcom Select Mode” in Label 273 on the crosstalk bus.

To avoid a race condition in the case where the two SDUs receive conflicting updates to Satcom Select Mode from their MCDUs, the following exceptions should be applied:

- If the preferred SDU receives conflicting updates to Satcom Select Mode from the MCDU and the crosstalk bus within one second of each other, it shall use the latest update from the MCDU.
- If the non-preferred SDU receives conflicting updates to Satcom Select Mode from the MCDU and the crosstalk bus within one second of each other, it shall use the latest update from the crosstalk bus.

The default Satcom Select Mode to be used at startup is set by a User ORT item.

3.4.1.3.6 Crosstalk Protocol

Each SDU should send ARINC 429 Label 270 as applicable to the MU/CMU. See Attachment 2, Section 2.2 for details on Label 270.

3.0 SATCOM FUNCTIONS

Each SDU should send Label 270, the same as what is sent to the CMU, to the other SDU via the crosstalk bus.

When in Standby, the SDU should always set Bits 11 and 13 of Label 270 to indicate that datalink and voice services are not available as well as Bit 18 to indicate it is inactive.

When Active, the SDU should clear Bit 11 of Label 270 when it is actually able to provide datalink service; otherwise, it should set Bit 11. For Certus safety data, the decision to set Bit 11 should be based on recent messages successfully exchanged with the datalink ground gateway, including keep-alive messages.

During a temporary outage, such as during a satellite handover, Bit 11 shall be set. Any delay in alerting the crew should be implemented in EICAS, not in the SDU.

When Active, the SDU should set Bit 13 of Label 270 if it is unable to provide voice service.

When Active, the SDU should continuously assert its System Select discrete (by pulling it to ground).

When Active, the SDU should release its System Select discrete when it is ready to hand over to the other SDU.

SDU hardware should be designed to not assert the System Select discrete when its circuitry loses power.

Each SDU (whether Active or Standby) should set Bit 17 when it is not logged onto the network.

COMMENTARY

The setting of Label 270, Bit 17 is different to the definition in ARINC Characteristic 741.

The SDU should clear Bit 18 of Label 270 if it is Active and set it if it is Standby. Each SDU shall send ARINC 429 Label 273 to the other SDU over the crosstalk bus.

Table 3-2 – Crosstalk Protocol Bit Functions

BIT	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
Function	P	SSM		Spare								Coverage	Current SS mode	Default SS Mode	Dual Satcom Parameters								SDI		Label 273 [1]								
				0	0	0	0	0	0	0														0	0	1	1	0	1	1	1	0	1
																										3		7		2			

3.4.1.3.7 Crosstalk Label 273 Definition

Table 3-3 – Satcom Select Mode

Default Satcom Select Mode			Current Satcom Select Mode		
(Default SS Mode)			(Current SS Mode)		
BITS		Coding	BITS		Coding
19	18	[2]	21	20	[3]
0	0	Auto	0	0	Auto
0	1	SDU1	0	1	SDU1
1	0	SDU2	1	0	SDU2
1	1	Reserved	1	1	Reserved

3.0 SATCOM FUNCTIONS

Table 3-4 – Sign Status Matrix

Sign/Status Matrix [60] [61] [62]		
BITS		Coding
31	30	
0	0	Failure Warning
0	1	Reserved
1	0	Functional Test [7]
1	1	Normal Operation

Dual Satcom Parameters		Values	
BIT	Description	0	1
11	I am SDU2	SDU1	SDU2
12	Preferred satcom	SDU1	SDU2
13	Fault (this satcom)	Normal	Fault
14	Request Handover [8]	Normal	Request pending
15	Crosstalk Inactive [4]	Normal	Inactive
16	System Select Status Sent [5]	Low	High
17	System Disable Status Received [6]	Low	High
23	Coverage [9]	Not in coverage	In coverage

Notes:

- Labels should be sent at 2 to 5 per second.
- Default Satcom Select Mode should be as read from ORT. Only used on start-up.
- Current Satcom Select Mode should reflect the SDUs local record of the Satcom Select Mode.
- “Crosstalk Inactive” should be set when the SDU receives no labels from the other SDU for more than two seconds. This bit is intended to aid BITE implementation.
- “System Select Status Sent” and “System Select Status Received” should be copies of the activity on the Dual Satcom discrete lines. These bits are intended to aid BITE implementation. The “System Select Status Sent” should be based on what the SDU intended to output on the discrete line, not on what its receiver reads back. A ‘0’ means the SDU is asserting the discrete output (pulled to ground). A ‘1’ means the discrete is released.
- The System Disable Status Received bit should be a copy of the information received on the System Disable discrete input. A ‘0’ means the discrete has been asserted (pulled to ground) by the other SDU, or an external switch if fitted. A ‘1’ means the discrete is released.

3.0 SATCOM FUNCTIONS

7. The SDU should set the Functional Test bit while it is busy with self-test, either after power-up, or otherwise initiated. The other SDU should ignore other information in the label during this time.
8. Only the preferred SDU can request a handover.
9. **The SDU believes it is within coverage and should be able to provide service.**

3.4.1.4 Interference between Terminals

Where the two terminals are expected to operate simultaneously (dual independent or dual cooperative), non-interference between the terminals must be ensured.

Inmarsat terminals using the same service (e.g., SBB and SBB) or dissimilar services (e.g., Classic and SBB) normally coexist well on the same airframe without mutual interference. Some minimum separation of the antennas may be required to prevent distortion of the antenna patterns. Antenna manufacturers should be able to provide guidance. Separation of less than 0.5 m between HGAs may suffice.

Iridium terminals can coexist on the same airframe without mutual interference. Some minimum separation of the antennas may be required to prevent distortion of the antenna patterns. Satcom system suppliers should provide guidance given the beam forming of the antenna has an impact on the separation required. Separation of at least 1 m between Certus antennas should suffice.

In dual satcom configurations where Inmarsat and Iridium satcom terminals are installed together, interference to the Iridium system is known to be problematic and solutions, while available, are not standardized. The terminals should be operated in a mutually exclusive manner, where one system is active and one on standby at any one time, typically by using the Dual Cold Standby or Dual Warm Standby configuration. This achieves the following:

- Prevents the transmit signal of the Inmarsat terminal from desensitizing (saturating) an active Iridium receiver.
- Prevents the out-of-band emissions from the Inmarsat transmitter (e.g., intermodulation products or noise floor) from acting as on-channel interference to an active Iridium receiver.
- Prevents the transmit signal of the Inmarsat terminal from permanently damaging the input of the Iridium receiver.
- Limits the ability for Iridium or Inmarsat to act in a Hot Standby configuration when dual dissimilar systems are installed.

3.4.2 Configuration and Identification Data

3.4.2.1 ORT

3.4.2.1.1 General

The Owner Requirements Table (ORT) is a table of configuration data that is used to customize the operation of the AES. The ORT is split in to two sub ORTs known as the Secure ORT and the User ORT. The Secure ORT holds configuration data which if changed would affect the certification of the aircraft. The User ORT holds configuration data which if changed would not affect the certification of the aircraft. Based on the definitions in RTCA DO-178B, the Secure and User ORT are both software programmed options. The Secure ORT is typically managed by the airframe

3.0 SATCOM FUNCTIONS

manufacturer. The User ORT is considered as User Modifiable Software (UMS) and is managed by the airline or operator.

The Secure ORT can be stored in one of three places:

- Type (1) within the SDU Configuration Module (SCM).
- Type (2) within the SDU but can be changed independently of the software.
- Type (3) as an integral part of the SDU software and hence cannot be changed without a software change.

The User ORT can be stored in one of two places:

- Type (4) within the SCM.
- Type (5) within the SDU, but can be changed independently of the software.

A mandatory system configuration pin (see Attachment 1, Section 1.4A) determines the location of both the Secure and User ORT.

Since certification criteria may be different between aircraft, an individual ORT parameter could be within the Secure ORT on one aircraft and within the User ORT on another aircraft. Hence, a flexible software design approach should be implemented such that a parameter can be defined as Secure or User.

For a Secure ORT of types (1) or (2) above, the Secure ORT will have its own part number and this part number will be certified as part of the Aircraft Certification. For a type (3) Secure ORT, the ORT does not have its own part number, but instead the Secure ORT contents are defined within the SDU part number. The SDU should also contain within its software load a default User ORT.

The data contained in the ORTs is shown in Section 3.4.2.1.3. One type of data is the equivalent data to that determined by the optional system configuration pin. A mandatory system configuration pin determines whether the SDU uses ORT data or the optional system configuration pins customize the SDU operation.

A data loader is used to upload to the SDU and download from the SDU ORTs which can be changed (i.e., ORTs (1), (2), (4), and (5)). Only complete User ORTs or complete Secure ORTs should be uploaded/downloaded. When an ORT of type (1) or (4) is uploaded to the SDU, the SDU should automatically (a) store within the SDU a local copy of the ORT in case the SDU finds that an SCM held ORT is not valid, (b) copy the ORT to the SCM, and (c) overwrite the old Secure ORTs or User ORTs respectively held within both the SCM and as an SDU local copy. When an ORT of type (1) or (4) is downloaded from the SDU, the SDU should download its local copy of the Secure ORT or User ORT.

A valid ORT is an ORT whose: CRC is OK, is of the right format, and is not empty. A valid ORT may have parameters within it or combinations of parameters within it which will cause the SDU to not function or only to partially function on a particular aircraft. A correct ORT is an ORT that is appropriate for that aircraft – appropriate for a Secure ORT is equivalent to it being certified for that aircraft. The SDU cannot determine if its ORT is correct for a given aircraft; this can be only be determined by manually comparing the part number of an ORT with the approved/certified ORT part number for that aircraft.

3.4.2.1.2 ORT Synchronization

For ORTs that are held in the SCM (i.e., types (1) and (4)), the SDU should read the ORT from the SCM after each power-up. Assuming it is valid, the SDU should

3.0 SATCOM FUNCTIONS

compare the just read SCM ORT with its local copy ORT. Normally, they are the same, but if different, the SDU should overwrite its local copy ORT with the ORT just read from the SCM. The SDU uses that ORT until the SDU is powered down. The SDU should store the local copy of type (1) and (4) ORTs over a power-down in case an ORT from the SCM is not valid when the SDU next powers up.

The operation of the SDU when it determines that an ORT is not valid is as follows:

- For type (1) and (4): If the ORT read from the SCM is not valid, then the SDU should attempt to read the ORT from the SCM again. If the ORT is still not valid after a number of such attempts, the SDU should use its “local copy” ORT and the SDU should also declare a failure (but keep operating). If the SDU has no valid local copy Secure ORT and it cannot read a valid Secure ORT from the SCM, then the SDU should declare a failure and stop operating. If the SDU has no valid local copy User ORT and it cannot read a valid User ORT from the SCM, then the SDU should (a) use the default User ORT, (b) declare a failure, and (c) continue operating.
- For types (2) and (3): The SDU should declare a failure and stop operating.
- For type (5): The SDU should (a) use the default User ORT, (b) declare a failure, and (c) continue operating.

ORT failures described above are cleared when the appropriate new ORT is uploaded to the SDU as described in Section 3.4.2.1.1.

This operation is summarized in Table 3-5 for type (1) and type (4) ORTs.

Table 3-5 – Operation of Type (1) and Type (4) ORTs

	State of SDU Local Copy ORT and SCM ORT	Logic for Type (1) ORT (Secure ORT stored in SCM)	Logic for Type (4) ORT (User ORT stored in SCM)
a	Both ORTs valid and same	Normal operation.	Normal operation.
b	Both ORTs valid but different	Use SCM ORT and transfer SCM ORT --> SDU Local Copy. Keep operating. No failures raised.	Same as for type (1).
c	Only SCM ORT valid	Use SCM ORT and transfer SCM ORT --> SDU Local Copy. Keep operating. No failures raised.	Same as for type (1).
d	Only SDU Local Copy ORT valid	Use SDU local copy. Do not transfer to SCM. Raise failure. Keep operating. Failure cleared by uploading new ORT.	Same as for type (1).
e	Neither ORT valid	Raise failure. Do not operate. Failure cleared by uploading new Secure ORT.	Use default User ORT. Do not transfer to SCM. Raise failure. Keep operating. Failure cleared by uploading new User ORT.

3.4.2.1.3 ORT Contents

This table may accommodate the following items. The terminal manufacturer should implement the appropriate ORT items required to support the functionality provided. This table is held in non-volatile memory. The table information can be updated and verified with the SDU connected on the aircraft. These updates are incorporated by means of a portable or connected data loading device. Due to the large number of ORT items, it is considered impractical to manually edit the ORT on the aircraft.

3.0 SATCOM FUNCTIONS

ORT Section A: Log-on Parameter Configuration

1. Log-on/Handover policy
 - a. Automatic
 - b. User commanded
2. Ground Earth Station (GES)/Land Earth Station (LES) Preferences
3. The SDU should include a GES/LES Preferences function to order the selection of GESs or LESs logons for the Inmarsat Classic and Swift64 services.
4. GES/LES preference settings should be available to the owner to prioritize GES/LES selections across Inmarsat Classic and Swift64 services. GES/LES preferences should be defined in decimal values as follows: Highest preference “1,” Lowest preference “9,” and Null (delisted) “0.”
5. GES/LES station identifications should be enterable in octal format.
6. Channel Unit Default Mode of Operation (one for each channel)
 - a. Classic
 - b. SwiftBroadband with Swift64 Reversion
 - c. SwiftBroadband
 - d. Swift64

Note: This item determines the operating mode of the associated channel module immediately after the power-up self-test sequence.

7. Psid frequency bootstrap table

Note: This table contains two initial P channel frequencies for each satellite ocean region. After the power-on self-test sequence, the SDU should use this frequency table to determine the initial frequency to tune the receiver in order to initiate the log-on sequence to the appropriate satellite based on current aircraft position. The SDU attempts to use the primary frequency in a particular ocean region first. If a P channel signal is not received on the primary frequency, the SDU tunes the receiver to the secondary frequency.

ORT Items for Standard Warm Standby Operation

The following ORT items are required in SDUs which implement the Standard Warm Standby dual satcom configuration as defined in Section 3.4.1.3.

8. Dual satcom installation: Yes/No. If No, then other dual satcom ORT settings are irrelevant.
9. SDU1 or SDU2 is the preferred SDU. Note: This setting is used if satcom selection is set to Auto.
10. Satcom Select mode at startup: SDU1/SDU2/Auto. This applies at start-up and can be changed from the MCDU.
11. SDU1 Tx allowed in Standby: Yes/No. Set to No unless SDU1 Tx is known not to interfere with SDU2.
12. SDU2 Tx allowed in Standby: Yes/No. Set to No unless SDU2 Tx is known not to interfere with SDU1.

3.0 SATCOM FUNCTIONS

13. SDU1 Rx allowed in Standby: Yes/No. Set to No unless SDU2 Tx is known not to damage SDU1 Rx.
14. SDU2 Rx allowed in Standby: Yes/No. Set to No unless SDU1 Tx is known not to damage SDU2 Rx.

ORT Section B: Interfacing Systems Configuration

1. ICAO code source (Reference Attachment 1, Section 1.4 Note 1)
 - a. ARINC 429 data bus – AES ID Input
 - b. ARINC 429 data bus – CMU Input
 - c. MCDU entry
2. AES ID Input bus speed (Reference Attachment 1, Section 1.4 Note 1)
 - a. ARINC 429 high-speed data bus
 - b. ARINC 429 low-speed data bus
3. Deleted
4. AES ID Input – Presence of GPS Position Data (Reference Attachment 1, Section 1.4 Notes 1 and 27)
 - a. GPS position data present
 - b. GPS position data not present
5. Primary IRS Input (Reference Attachment 1, Section 1.4 Notes 4 and 15)
 - a. Inertial data present
 - b. GPS position data present
 - c. Hybrid inertial and GPS data present
6. Secondary IRS Input (Reference Attachment 1, Section 1.4 Notes 4 and 15)
 - a. Inertial data present
 - b. GPS position data present
 - c. Hybrid inertial and GPS data present
7. CMU 1
 - a. Connected
 - b. Not connected

Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.

8. CMU 2
 - a. Connected
 - b. Not connected

Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.

9. ARINC 429 bus speed between SDU and CMUs
 - a. High-speed
 - b. Low-speed
10. Central Fault Display System (CFDS) type
 - a. CFDS not connected
 - b. Airbus type CFDS

3.0 SATCOM FUNCTIONS

- c. Boeing type CFDS
 - d. Other Airframe Manufacturers CFDS
11. MCDU/SCDU/WSC #1
- a. Connected
 - b. Not connected
- Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.
12. MCDU/SCDU/WSC #2
- a. Connected
 - b. Not connected
- Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.
13. MCDU/SCDU/WSC #3
- a. Connected
 - b. Not connected
- Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.
14. MCDU/SCDU/WSC Controller Type
- a. SCDU
 - b. WSC
- Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.
15. ARINC 429 bus speed to MCDU/SCDU/WSC #1, #2, and #3
- a. High-speed
 - b. Low-speed
- Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.
16. CCS connection
- a. Connected
 - b. Not connected
- Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.
17. CCS type
- a. ITU Standard
 - b. ARINC 746
18. SCM
- a. Connected
 - b. Not connected

3.0 SATCOM FUNCTIONS

Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.

- 19. Removed in Supplement 7
- 20. Removed in Supplement 7
- 21. Data from GNSS to SDU
 - a. Connected
 - b. Not connected

ORT Section C: Ethernet Ports Configuration

- 1. Ethernet port 1 configuration
 - a. Not Connected
 - b. Connected – speed auto detect
 - c. Connected – speed 10BASE-T
 - d. Connected – speed 100BASE-T

Note: If strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A, then this ORT item only applies for the Ethernet bus speed.

- 2. Ethernet port 2 configuration
 - a. Not Connected
 - b. Connected – speed auto detect
 - c. Connected – speed 10BASE-T
 - d. Connected – speed 100BASE-T

Note: If strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A, then this ORT item only applies for the Ethernet bus speed.

- 3. Ethernet port 3 (Quadrx) configuration
 - a. Connected (and whether IEEE 802.3 or ARINC 664)
 - b. Not connected

Note: If strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A, then this ORT item only applies for the type of Ethernet/ARINC 664.

- 4. Ethernet port 4 (Quadrx) configuration
 - a. Connected (and whether IEEE 802.3 or ARINC 664)
 - b. Not connected

Note: If strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A, then this ORT item only applies for the type of Ethernet/ARINC 664.

- 5. Ethernet port 5 (spare) configuration
 - a. Connected
 - b. Not connected

- 6. Ethernet port 6 (fiber) configuration (note port 6 refers to the fiber channel A – pin 8 of ARINC 600 connector)

3.0 SATCOM FUNCTIONS

- a. Connected
- b. Not connected
- 7. Ethernet port 7 (fiber) configuration (note port 7 refers to the fiber channel B – pin 9 of ARINC 600 connector)
 - a. Connected
 - b. Not connected
- 8. Ethernet port 8 (fiber) configuration (note port 8 refers to the fiber channel spare – pin 10 of ARINC 600 connector)
 - a. Connected
 - b. Not connected
- 9. Fiber Ethernet port 9 configuration (note port 9 refers to the fiber channel spare – pin 11 of ARINC 600 connector)
 - a. Connected
 - b. Not connected
- 10. Fiber Ethernet port 10 configuration (note port 10 refers to the fiber channel spare – pin 12 of ARINC 600 connector)
 - a. Connected
 - b. Not connected
- 11. IP Settings
 - a. IPv4 address for LAN

Note: This setting defines the IP address of an interface on the SDU. This setting is not applicable when the DHCP client is enabled.
 - b. Subnet mask for LAN

Note: This setting defines the subnetwork mask of an interface on the SDU. This setting is not applicable when the DHCP client is enabled.
 - c. Default gateway for LAN

Note: This setting defines the default gateway of an interface on the SDU. This setting is not applicable when the DHCP client is enabled.
 - d. MAC addresses
 - e. DHCP Client
 - i. Enabled
 - ii. Disabled

Note: Defines whether or not the interface receives an IP settings from an external DHCP server
 - f. Host Name
- 12. PPPoE Settings
 - a. PPPoE Access Concentrator (AC) name

Note: This setting defines the PPPoE access concentrator name for the interface. The SDU uses this feature, but it is optional for the client to use it.

3.0 SATCOM FUNCTIONS

b. Default Service Name Mapping

Note: When a PPPoE client requests a session to the SDU and does not specify the service name the SDU shall pick the service type based on this ORT value. This value is any Service name(s) as defined in Attachment 5, Section 3.3.11.

c. PPPoE Service Name Mapping to AT Commands

Note: This ORT item defines for each Service Name, the AT string that is sent over the air interface. This ORT item can also be used to define owner specific Service Names. In addition, ORT item C16 defines an APN that the SDU will use to replace the APN in these ORT based AT strings.

13. Telnet access (control function)

- a. Enabled (including TCP port (default 22222))
- b. Disabled

14. DHCP Server Options

- a. Minimum IP Address (default 192.168.x.x)
- b. Number of host IPs (default 50)

Note: The DHCP server will issue IP address between 'a' and 'a + b' above.

c. IP address of Default Gateway

Note: The default for this ORT parameter is to use the same IP address of the DHCP server's Ethernet interface.

d. Subnet Mask

Note: The default for this ORT parameter is to use the same subnet mask of the DHCP server's Ethernet interface.

15. SNMP Server Options

- a. Community String (default public)

Note This option is used to access protected parameters within the SNMP server.

16. APN

Note: This ORT item defines the APN that the SDU will use to replace the APN in the ORT based AT strings (reference ORT item C12).

17. Cockpit Ethernet Port

- a. None reserved
- b. Ethernet port X

Note: This could be used for the Safety IP Data as mentioned in Section 3.1.1.4, or other cockpit applications.

18. Ethernet port 11 Configuration

- a. Not Connected
- b. Connected – speed auto detect

3.0 SATCOM FUNCTIONS

- c. Connected – speed 10BASE-T
- d. Connected – speed 100BASE-T

Note: If strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A, then this ORT item only applies for the Ethernet bus speed.

19. Ethernet port 12 Configuration

- a. Not Connected
- b. Connected – speed auto detect
- c. Connected – speed 10BASE-T
- d. Connected – speed 100BASE-T

Note: If strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A, then this ORT item only applies for the Ethernet bus speed.

ORT Section D: Cockpit Voice Configuration

- 1. SDU codec #1 dedication
 - a. Cockpit audio system only
 - b. Cabin analog phone system only
 - c. Automatic sharing between cockpit and cabin
 - d. Not connected to cockpit audio or cabin analog phone system
- 2. SDU codec #2 dedication
 - a. Cockpit audio system only
 - b. Cabin analog phone system only
 - c. Automatic sharing between cockpit and cabin
 - d. Not connected to cockpit audio or cabin analog phone system
- 3. Ground-initiated cockpit call routing
- 4. This item determines the preferred cockpit voice channel for ground-initiated calls when two channels are available. In a dual satcom system, this item refers to a single AMS/ACP logical channel in the context of the combined dual system. Reference ORT items D1, D2, and D12.
 - a. Channel 1
 - b. Channel 2
- 5. Ground-initiated Public Correspondence call routing
 - a. Cabin Communication System (CCS)
 - b. Cabin analog phone system
 - c. Disallowed
 - d. Cockpit audio management system

COMMENTARY

The installer should consider regulatory and operational requirements for security before allowing public calls to the cockpit.

- 6. Cockpit Air-To-Ground call camp-on timer

3.0 SATCOM FUNCTIONS

7. This item determines if camped-on cockpit calls should stay camped-on indefinitely, or only until a timeout, and if the latter case, what the timeout period should be
 - a. Indefinite
 - b. Timed (allow entry of timeout period)

Note: Timeout period of 0 implies no camp-on/immediate preemption.
8. Noise insertion
9. This item determines whether noise is inserted in the Ground-To-Air direction for cockpit calls to prevent total silence when no audio is present. (minimize noise modulation effects).
 - a. -40 dBm0
 - b. -50 dBm0
 - c. -60 dBm0
 - d. Off
10. Cockpit hookswitch signaling method
 - a. Switched PTT and/or SCDU line switch(es)
 - b. Latched Audio Control Panel (ACP) satcom Mic-Switch
11. Telephone number pre-select
12. This item determines whether an Air-To-Ground cockpit call is immediately initiated when the number is selected on an MCDU menu; or the MCDU action merely pre-selects the number, with the call not initiated until after activation of the Audio Control Panel satcom mic select switch, whereupon the call to the pre-selected number is initiated. The latter case requires that ORT item D7 Cockpit hookswitch signaling method be in the Latched ACP satcom Mic Switch state.
 - a. Telephone number pre-select enabled
 - b. Telephone number dialed upon selection
13. SCDU line select key prompts for cockpit Air-To-Ground call
14. In the case of system configuration ORT item D7 Cockpit hookswitch signaling method set to the B state (latched ACP satcom Mic-Switch hook switch signaling), this item determines whether SCDU line select key prompts should be provided for air-initiated cockpit call setup acknowledgement and call clear, and for ground-initiated call answer and call reject; or whether all such prompts should be blanked (due to being redundant to discrete signaling provisions).
 - a. SCDU line select key prompts provided
 - b. SCDU line select key prompts not provided
15. Chime for cockpit Air-To-Ground call
16. This item determines whether bit 14 of Label 270, SDU to ACARS, and the chime discrete is set for Air-To-Ground calls upon call set up. The options to set bit 14 and the chime discrete for Air-To-Ground calls should be:
 - a. Always
 - b. Only after a camp on
 - c. Never

3.0 SATCOM FUNCTIONS

17. Placement of Cockpit Call using Place/End Call Discrete
18. This item determines whether or not the SDU provides the Place Cockpit Call capability, by interpreting the mic-on inputs as a function of the Call Light as described below. ORT item D8 Telephone Number Pre-select must be enabled in order to enable this ORT item.
19. If ORT item D7 is set to Latched mic-on input, the mic-on input going low while the Call Light is off means Place Cockpit Call to a pre-selected number.
20. If ORT item D7 is set to Switched PTT, the Place/End Call discrete are interpreted as Place Cockpit Call when exercised with the call light off.
21. If enabled, Cockpit Call initiation should be available from either channel. If resources are tied up by the cabin, then the Cockpit Call should either camp-on preempt the cabin call, depending on ORT item D5.
 - a. Enabled
 - b. Disabled
22. Dual satcom cockpit voice channel mapping to AMS/ACP
23. For a dual satcom system, whether the cockpit voice functional interfacing between the SDU physical channels and the AMS/ACP logical channels is fixed (i.e., each logical channel is interfaced with only one physical channel in only one SDU) or shared (i.e., each logical channel is interfaced with the same numbered physical channel in both SDUs).
 - a. Fixed
 - b. Shared
24. Manual dial of number not in directory
 - a. Enabled
 - b. Disabled (except for short codes)
25. Cockpit Headset Audio Gain
26. This item determines the headset audio level (both operational audio and test tone) with respect to the nominal level of 10mW.
 - a. -3 dB
 - b. -2 dB
 - c. -1 dB
 - d. 0 dB
 - e. +1 dB
 - f. +2 dB
 - g. +3 dB
 - h. +4 dB
 - i. +5 dB
 - j. +6 dB
27. Cockpit Headset Sidetone Gain
28. This item determines the headset sidetone level, with respect to the microphone input audio level.
 - a. 0 dB
 - b. -3 dB
 - c. -6 dB

3.0 SATCOM FUNCTIONS

- d. -9 dB
- e. -12 dB
- f. Sidetone off

ORT Section E: Miscellaneous Configuration Settings

1. Use of flight ID (i.e., airline identifier and flight number)
 - a. Enabled
 - b. Disabled
2. Use of circuit-mode data on Ground-To-Air calls
 - a. Enabled
 - b. Disabled
3. High-rate return data channel in global beam
4. This item determines, for an AES capable of high-rate packet data service, whether the AES should request not to be assigned high-rate return data channels while operating in the global beam.
 - a. High-rate return data channel enabled in global beam
 - b. High-rate return data channel disabled in global beam
5. Antenna configuration
 - a. ARINC 781 HGA
 - b. ARINC 781 IGA
 - c. LGA + LGA HPA
 - d. ARINC 741 Top Beam Steering Unit (BSU) + Top HGA + HGA HPA
 - e. ARINC 741 Port BSU + Port HGA + STARBOARD BSU + STARBOARD HGA + HGA HPA + HPR

Note: This ORT item is not applicable if strap pin TP3G is grounded.
Refer to Attachment 1, Section 1.4A.

6. GNSS Frequency Check Algorithm
 - a. Not required
 - b. Required with $f_{limit} = 1585$ MHz
 - c. Required with $f_{limit} = 1605$ MHz
7. Position reporting
 - a. Enabled
 - b. Disabled
8. Reserved
9. Minimum initial EIRP for Swift64
10. Weight on wheels input configuration
 - a. Not connected
 - b. Ground on pin MP7D = Aircraft on ground
 - c. Ground on pin MP7D = Aircraft in air

Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1, Section 1.4A.
Reference Attachment 1, Section 1.4 Note 19.

3.0 SATCOM FUNCTIONS

11. PIMBIT failure threshold level (reference Sections 3.7.2, 3.7.3.5, 3.7.3.8, and 3.7.3.12)
 - a. X dB channel degradation. The recommended default value is 3 dB.
12. PIMBIT antenna beam pointing angles to be used (reference Section 3.7.3.7)
 - a. Azimuth angles relative to true-north or true-south (depending on whether the aircraft is located in the northern or southern hemisphere, respectively). The recommended default values are -15, 0, +15 degrees for an HGA, and -10, 0 and +10 degrees for an IGA.
 - b. Elevation angles relative to the horizon. The recommended default values are +12.5 and +27.5 degrees for an HGA, and +12.5 and +18 degrees for an IGA.

COMMENTARY

Similar commentary as for the azimuth angles. IGA values are tighter in order to prevent unintended radiation into the geostationary orbit arc.

Note: This results in a total of six beam pointing angles being used for the test.

13. PIMBIT antenna beam pointing angles failure threshold (reference Section 3.7.4)
 - a. Any X or more angles “failed” out of Y angles total. The recommended default value is 1 or more out of 6.
14. PIMBIT measurement sample discard ratio (reference Section 3.7.3.10)
 - a. X%. The recommended default value is 5%. The computed number of samples to discard should be rounded up to the nearest integer as long as at least two samples are available.

ORT Section F: Telephone Directory

1. Telephone numbers
2. Telephone directory headings
3. Priority associated with each stored telephone number

COMMENTARY

The table and the method of update are handled by the AES owner.

“Connected” is defined to mean that the interface is wired to the SDU and that the interfacing equipment is connected.

Additional manufacturer-specific ORT items (mapping of Ethernet ports to channel cards, etc.) may be required.

ORT Section G: SwiftBroadband Safety Services Configuration

1. Safety Channel Identifier
 - a. No Safety Channel
 - b. Channel 1
 - c. Channel 2
 - d. Channel 3
 - e. Channel 4

3.0 SATCOM FUNCTIONS

2. Position Reporting Service

- a. Enabled
- b. Disabled

Note: This is separate from ORT Item E-6 and is used to enable/disable the Safety Position Reporting Service.

3. Safety Channel Access Class (0-15) – used to give priority network access to Safety

4. ACARS Data APN

5. Voice over IP APN

6. AGGW DNS Lookup Name

7. Aircraft Type in ICAO DOC 8643 format (e.g., B747-400, B747-800, A319, and A320)

8. Safety Service

- a. Standard
- b. Enhanced
- c. Disable

ORT Section H: ORT Items for Warm Standby Dual Satcom Operation

The following ORT items are required in SDUs that implement the Standard Warm Standby dual satcom configuration as defined in Section 3.4.1.3.

1. Dual satcom installation:

- a. Yes
- b. No.

Note: If NO, then other dual satcom ORT settings are irrelevant.

2. Preferred SDU:

- a. SDU1 is the preferred SDU
- b. SDU2 is the preferred SDU

Note: This setting is used if satcom selection is set to Auto.

3. Satcom Select mode at startup:

- a. SDU1
- b. SDU2
- c. Auto

Note: This applies at start-up and can be changed from the MCDU.

4. SDU1 Tx allowed in Standby:

- a. Yes
- b. No

Note: Set to NO unless SDU1 Tx is known not to interfere with SDU2.

5. SDU2 Tx allowed in Standby:

- a. Yes

3.0 SATCOM FUNCTIONS

b. **No**

Note: Set to NO unless SDU2 Tx is known not to interfere with SDU1.

6. **SDU1 Rx allowed in Standby:**

a. **Yes**

b. **No**

Note: Set to NO unless SDU2 Tx is known not to damage SDU1 Rx.

7. **SDU2 Rx allowed in Standby:**

a. **Yes**

b. **No**

Note: Set to NO unless SDU1 Tx is known not to damage SDU2 Rx.

3.4.2.2 System Configuration Pins

Certain pins have been reserved so that the SDU can determine the system configuration. These pins and the functions implemented by pin-programming are further described in Attachment 1, Section 1.4A.

The use of these pins is mandatory in order to determine:

- If an external HPA is fitted or not
- The location of the ORTs
- If other configuration pins should be used by the SDU
- Installed SDU number (1 or 2)

3.4.2.3 AES ID

The Classic Aero service and SwiftBroadband safety service require the SDU to use the Aircraft's ICAO Code identification. The ARINC 429 Label definition and interface is described in ARINC Characteristic 781 Attachment 1, Section 1-4, Note 1 and can be received on an aircraft bus. Alternatively, the AES ID can be entered via the MCDU and stored in the SCM.

3.4.2.4 Forward/Return ID (Swift64)

Inmarsat Swift64 operation requires a 24-bit Forward ID for each Swift64 channel and a corresponding 24-bit Return ID, which the SDU may derive from the Forward ID via an internal look-up table.

For certain aircraft that have the capability to broadcast information such as Forward IDs from a centralized source of aircraft data, the digital implementation is described in Attachment 2, Figures 8 and 9. This scheme allows an operator to enter all of their aircraft unique identification (such as ICAO Code, Tail Number, SELCAL, Forward ID, etc.) at one time to be broadcast and received by the intended equipment by the use of defined labels.

The SDU should expect only one base Forward ID per SDU and perform a lookup for the subsequent Forward IDs and all Return IDs for all Swift64 channels as defined in Attachment 2, Figures 8 and 9.

3.0 SATCOM FUNCTIONS

This base Forward ID is expected to be received on either the AES ID bus, CMU bus or the CFDS bus on the SDU.

Alternatively, the base Forward ID can be entered via the MCDU and stored in the SCM.

3.4.2.5 IMSI and IMEI(SV) (SwiftBroadband)

The International Mobile Subscriber Identity (IMSI) and International Mobile Equipment Identifier (IMEI) are used in SwiftBroadband in a similar manner to their use in GSM and UMTS.

The IMSI is used within SwiftBroadband to uniquely identify each SwiftBroadband channel within the AES. Each IMSI is stored on a USIM (in a secure manner) and the USIM(s) are housed in the SCM. The IMSI is the primary identification for addressing and billing within SwiftBroadband for non-safety services. The IMSI numbers are allocated by Inmarsat and are provided to the avionics suppliers. Avionics suppliers should inform their customers which IMSI(s) are installed in each delivered SCM.

The IMEI is used within SwiftBroadband to uniquely identify each SwiftBroadband hardware channel within an SDU as well as the manufacturer of the SDU. The International Mobile Subscriber Identity Software Version (IMEISV) is used to uniquely identify the software within the SDU. The IMEIs are allocated by British Approvals Board for Telecommunications (BABT) to the avionics suppliers, who then program the IMEIs into the SDU. The expected uses of IMEI and IMEISV are to allow the barring of stolen (or cloned) terminals and to identify the manufacturer and software version of faulty terminals.

3.4.2.6 Addressing for SwiftBroadband Safety Services

SwiftBroadband safety services use the ICAO AES ID as the identifier for both ACARS and voice services, thus ensuring commonality with Classic Aero as well as compliance to ICAO SARPs. The SDU uses both the IMSI and AES ID in signaling. Terrestrial side ACARS and voice signaling only uses the AES ID.

3.4.2.7 Aircraft Type

The Aircraft Type parameter allows the SDU to determine if there are any unique dependencies that the satcom system has to adjust to, based upon which airframe type it is installed in. For instance, one airframe type may have an MCDU implementation that is different to another MCDU format on another airframe type. Upon receipt of this digital label and coordination with aircraft manufacturers, the SDU could adjust to their new environment with pre-programmed MCDU menu settings.

Attachment 2, Figure 10 describes the ARINC 429 implementation for decoding which airframe type the SDU is being installed on.

This ARINC 429 word is expected to be received on either the AES ID bus, CMU bus, or the CFDS bus on the SDU.

3.4.3 Security

From a security perspective, the aircraft network systems are divided into three domains being: Aircraft Control (AC) Domain, Airline Information Services (AIS) Domain and Passenger Information and Entertainment Services (PIES) Domain. The satcom system should satisfy security requirements and this is particularly the case

3.0 SATCOM FUNCTIONS

when the satcom system is providing service to both the AC domain and AIS/PIES domains.

FANS services (e.g., Automatic Dependent Surveillance – Contract (ADS-C), Controller/Pilot Data Link Communications (CPDLC), and voice) to the cockpit, as provided by Classic Aero or SBB, is viewed as AC domain while, for example, EFB is viewed as AIS domain.

The security requirements are to demonstrate, by an appropriate security process, that the functions (shared or independent) contained within the SDU can provide adequate segregation between domains of traffic and withstand potential threats that are introduced by its use in an open network environment.

The security threats associated with the satcom system include, in order of severity:

1. Impersonation or modification of FANS messages to/from the cockpit
2. Insertion of malware into SDU and subsequent attack on equipment connected to SDU
3. Interruption or loss of satellite communications
4. Interception of communications by unauthorized parties

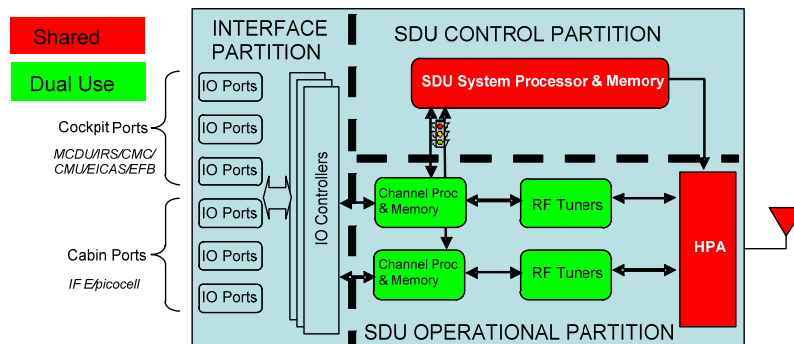
Additional, and potentially significant, risks are introduced from the ground network against the airborne resources and must be considered in any implementation of layered security but are out of scope for this document and not addressed here.

It is recommended that **EUROCAE ED-202/RTCA DO-326: Airworthiness Security Process Specification** be used as the basis of the security process; it defines the following steps in the security process.

- Identify the security scope
- Identify the security threats
- Develop the security architecture
- Assess the preliminary security risk
- Assess the final security risk
- Verify the implementation
- Ensure the security of the final product

Attachment 8 includes guidance on security considerations for SBB safety service terminals including the type of segregation that is expected to be acceptable to airlines, airframe manufacturers, and regulators for such terminals.

Appendix B is a security analysis of the Ethernet interface as defined in Attachment 5.



3.0 SATCOM FUNCTIONS

3.5 Priority, Precedence, Preemption, and Preference

Priority, precedence and preemption are defined for Classic Aero services in the ICAO Annex 10, Chapter 4 AMSS SARPs, the RTCA DO-210 AMSS MOPS, and the RTCA DO-270 MASPS for AMS(R)S. For priorities higher than Non-Safety/Public Communications (NS/PC), those definitions only pertain to the Classic interfaces for Cockpit Audio and CMU packet-mode data, as they are the only interfaces capable of specifying explicit priority/precedence levels for their associated communications. With the exception of satellite link signaling for the initial-phase establishment of Classic non-safety circuit-mode channels (which are afforded higher precedence levels for the sake of overall system efficiency), all other services on all other interfaces are handled as NS/PC (voice priority 4, or packet data subnetwork connection priority none).

However, although there are no means for the aforementioned NS/PC communications to compete among themselves for satellite link and terrestrial resources other than on a first-come, first-served basis, it is desirable to facilitate such functionality within each aircraft for the benefit of that aircraft's users. In order to preclude confusion with regulatory definitions of priority and precedence, this functionality is defined in this document in terms of preferences. For example, it may be preferred to establish an Air-To-Ground cabin voice call using SwiftBroadband instead of using Swift64 M-ISDN or a Classic Aero H+ C-channel, or to route a Ground-To-Air call to a particular Ethernet interface instead of the other possibilities.

Priority, Precedence, Preemption, and Preference should apply for the selection of the Inmarsat services, satellites, and ground stations defined in Section 3.1.2.6.

3.6 Future Growth

3.6.1 ARINC 664 Deterministic Ethernet

For newer generation of aircraft, the traditional ARINC 429 based interfaces are being superseded by ARINC 664 implementations. The benefits of this are that the wiring interfaces are greatly simplified by making use of existing data networks onboard the aircraft, thus allowing for greater weight savings. The physical medium for ARINC 664 can be simple twisted pair interfaces (for low bandwidth interfaces) or the newer Quadrax (ARINC Specification 600) and fiber (ARINC 801, 802, 803, 804, 805, and 806) definitions. Currently, the ARINC 664 interfaces defined in Attachment 1, Sections 1.3 and 1.4 specify two Quadrax and five fiber ports.

3.0 SATCOM FUNCTIONS

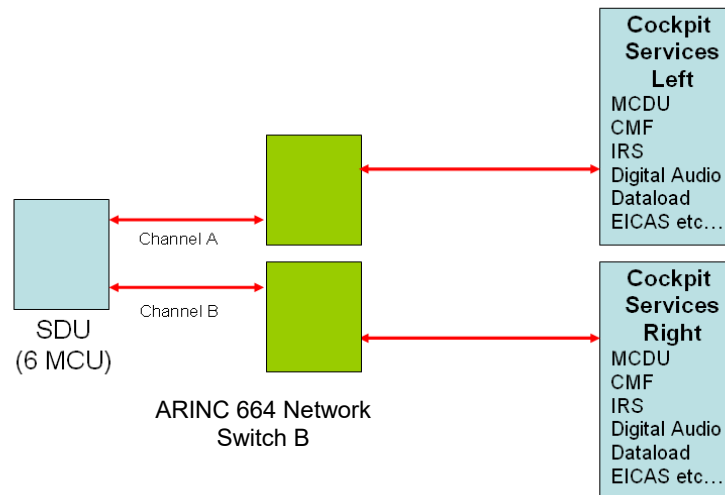


Figure 3-7 – ARINC 664 Interface Topology

3.6.2 Fiber Optic

Fiber Optic is the ARINC 664 interface medium by which higher data rates are accommodated. Each airframe manufacturer has its own policies for the use of Fiber Optic. The use of ARINC 664 also helps reduce wiring interface weight depending on how far the SDU is situated from the aircraft's avionics bay. ARINC 781 specifies five fiber optic ports of which only two ports are defined for cockpit interfaces. Channels A and B provide the redundancy for most of the above ARINC 664-based systems and functionalities.

3.6.3 FANS/ATS over SwiftBroadband

COMMENTARY

FANS/ATS over SwiftBroadband is now specified in the main body of this characteristic.

3.6.4 Multi-Frequency Band

This section was deleted by Supplement 5.

3.7 Passive Intermodulation Built-In Test (PIMBIT)

The material in this section is applicable to multi-channel system installations that support at least one SwiftBroadband channel. For the case of multiple system installations, each system can be treated independently of the others (in view of the assumed minimum propagation loss between the multiple systems' antennas).

3.7.1 Introduction

Intermodulation occurs whenever two or more RF signals at different frequencies mix together in any non-linear passive or active system element. Examples are beam-switching diodes in electronically-steered antennas, inherently nonlinear conductors such as nickel or stainless steel, corroded metallic contacts in materials such as cables (including their shields and connectors), the aircraft skin and rivets, nearby structures, etc. Passive Intermodulation in system elements preceding the DLNA (e.g., in the SDU/HPA) can be minimized by filtering it in the diplexer. However, (P)IM occurring in or after the diplexer cannot be filtered, so it must be managed in

3.0 SATCOM FUNCTIONS

other ways (Reference Section 2.3.6 regarding installation guidelines for minimizing the impact of PIM).

3.7.2 Technical Background

For Classic Aero and Swift64 channels, frequency management as has been implemented in the past by Inmarsat (i.e., restriction of AES-transmitted frequencies to a relatively narrow bandwidth of about 4 MHz) has resulted in PIM being of little concern with those services. However, with high-EIRP SwiftBroadband (SBB) signals being transmitted from the AES/UT at much greater frequency spacing (potentially up to the full bandwidth allocated to Inmarsat), and with Inmarsat discontinuing frequency management of Swift64, it is possible for relatively high-power, low-order PIM products (e.g., 5th, 7th, 9th, and 11th) to fall into the AES receive band, with the potential to interfere with active receive channels. As a result, Inmarsat and airframe manufacturers have required that the SDU perform a Built-In Test (BIT) to measure PIM (PIMBIT).

At a minimum, a manually-initiated two-tone CW form of PIMBIT is required in order to measure the PIM level from a pre-determined IM product (e.g., 9th order) under controlled test conditions. This PIM test can be performed at the time of initial system installation or upgrade, periodically, or whenever indicated by performance degradation that cannot be attributed to any other cause. If the PIMBIT fails, corrective maintenance action will be required to restore the system performance to a level sufficient for the test to pass.

It should be noted that a limitation of the manually-initiated two-tone CW PIMBIT is that it only utilizes three frequencies out of the many used in actual operation, checking against a threshold that may not correlate closely with the actual receiver robustness and is a function of the antenna G/T performance. As a result, it is *possible* that the manually-initiated two-tone CW PIMBIT could fail, but that the system could be operating satisfactorily, with or without resorting to the datalink layer and higher-layer automatic-retransmission protocols. To help minimize this possibility (which would result in nuisance failures), the failure criteria for the CW test are set such that any failure is most likely indicative of a problem of sufficient magnitude that it would affect normal operations under at least some, if not all, conditions. It is also recommended to not use the result of this test in isolation, but rather to use it as a means of confirmation of a PIM problem after another indication occurs, such as noticeable system performance degradation in the absence of any other failures in the system that could result in the performance degradation.

3.7.3 SDU Functionality

The subsections below summarize the issues that should be taken into consideration in the manually-initiated two-tone CW PIMBIT implementation in the SDU.

3.7.3.1 Frequencies Reserved for PIMBIT

From the perspective of the AES/UT, Inmarsat reserves one receive and two transmit frequencies for PIMBIT usage in each satellite region (or at least in each I-4 and Alphasat satellite region) (It is possible that a receive frequency may not be able to be reserved in each region). This information is made available to the SDU/UT via the SwiftBroadband bulletin board broadcasts and the Classic Aero system table broadcasts and is guaranteed to be usable for at least 168 hours (seven 24-hour periods) after being broadcast (for possible use in AESs/UTs that have not received an update within that time period immediately prior to PIMBIT initiation). The

3.0 SATCOM FUNCTIONS

frequencies are chosen such that the receive frequency corresponds to the n th-order IM product from the two transmit frequencies (n typically being 9). This allows the AES/UT to transmit CW test signals on the two transmit frequencies without interfering with other system users, and to monitor the receive frequency (nominally “quiet”) for any signal power that results from (P)IM from the two transmit frequencies.

3.7.3.2 Transmit Test Signal Levels (EIRP)

Test signal levels transmitted *away from* the geostationary orbit arc should be at 20 dBW EIRP per carrier (to emulate SBB transmissions). Any and all test signal levels transmitted *toward* the geostationary orbit arc must be limited to no more than 7 dBW EIRP per carrier (to limit side-lobe as well as intentionally-directed EIRP levels) (Any intentional transmission at such low levels usually results in PIM products being below the background noise level, so as a practical matter, transmission toward the geostationary arc at such low levels is generally useless for PIMBIT purposes. As a result, test transmissions are recommended to be only generally directed toward the north in the northern hemisphere, and only generally south in the southern hemisphere.).

3.7.3.3 Constant EIRP versus Constant Power to the Antenna

As long as the HGA gain equals or exceeds its nominal 12 dBic, then constant EIRP (20 dBW) should be used per CW test carrier during the test (i.e., the SDU/HPA output power should be adjusted as appropriate to compensate for reported antenna gain variations). If the HGA gain falls below 12 dBic, then constant HPA power of 8 dBW at the antenna input should be used at all such antenna gain levels. For the case of an IGA, the antenna gain threshold is 6 dBic, the constant EIRP case is 15.1 dBW, and the constant SDU/HPA output power case is 9.1 dBW at the antenna input.

3.7.3.4 ORT Parameters

Any PIMBIT parameters that may be subject to future change (as experience is gained with PIM and PIMBIT) should be stored as ORT items. Examples include failure threshold(s), the antenna beam pointing angles to be used during the test, the number of antenna beam pointing angles that must fail before declaring the overall PIMBIT test to have failed (e.g., any 1 or more out of 6), and the measurement sample discard ratio for the measurements taken for each antenna beam pointing angle. Reference ORT items 10E, 11E, 12E, and 13E (see Section 3.4.2.1.3).

3.7.3.5 IM Product Order to be Tested

The IM product order that was pre-determined in Inmarsat’s choice of test frequencies should be computed by the SDU and used for making appropriate adjustments to failure thresholds that are a function of the IM product order being tested. IM product orders of at least 7 through 19 should be able to be taken into account by the PIMBIT.

3.7.3.6 Transmit Signal Off/On Sequence for Receive Signal Monitoring

Monitoring of the receive frequency should be performed with the transmit frequencies both “on” and “off” during adjacent time periods in order to be able to attribute measured “on” signal levels to being from AES/UT-caused (P)IM (as opposed to other possible sources of signal power at that frequency at the same time). An off/on/off sequence of three measurements would further help to confirm

3.0 SATCOM FUNCTIONS

that conditions are stable during the measurement (by confirming that the two “off” measurements are essentially identical).

3.7.3.7 Antenna Beam Pointing Angles to be Tested

Monitoring should be performed at a number of different antenna beam pointing angles in order to aid with fault isolation. Reference ORT item 11E for the angles to be used, and item 12E for the number of beam angles that must fail in order to declare the PIM test to have failed.

3.7.3.8 PIMBIT Assessment Parameter

The industry-common parameter to be assessed by PIMBIT should be $\Delta T/T$ channel degradation (if expressed as a simple ratio), where T = the normal system noise temperature in Kelvins (316 for the system G/T spec of -13 dB/K and a minimum antenna gain of 12 dB), and where $\Delta T = T_2 - T$ (where ΔT is the increase in system noise temperature that is assumed to be due to PIM, T is the initial system noise temperature without PIM degradation (from the system G/T requirement), and T_2 is the effective system PIM-degraded noise temperature). Expressed as decibels (as preferred for the PIMBIT application), this degradation is:

- $10 \log_{10}(T_2/T) = 10 \log_{10}((T + \Delta T)/T) = 10 \log_{10}(1 + \Delta T/T)$.
- E.g., for a 100% increase in system noise temperature ($T_2 = 632$ Kelvins, $T_2/T = 2$, $\Delta T/T = 1$), channel degradation = 3 dB.

COMMENTARY

One recommended way of getting to this parameter is to make a determination of the ratio of $(PIM + N)/N$, where PIM is the averaged CW signal power level assumed to be from PIM during transmission of the two CW test signals, and N is the averaged power level of the noise floor (when the two CW test signals are not being transmitted). Such a ratio derived from measurements that can be made by the SDU eliminates installation variables such as the gain of the LNA and the losses in the rest of the receive signal path (which would otherwise need to be known if simply dealing with absolute signal levels at the SDU and attempting to relate them to levels at the antenna port). This is similar to how one would determine the channel degradation manually using a spectrum analyzer, by measuring the difference between the signal levels (assumed to be PIM) when the two CW test signals are transmitting versus the noise floor when no test signals are transmitting. For the recommended discard ratio, reference ORT item E13.

3.7.3.9 Stabilization and Measurement Times

The CW test transmissions should be sustained for at least one second after any change in order to allow thermal stability to be achieved in the antenna elements. The CW test transmissions must also be sustained for a sufficiently long time for the receiving demodulator to stabilize and to be able to take accurate measurements (this being modem-design-dependent) (these stabilization times proceed concurrently). The total stabilization time should be kept to the minimum necessary in order to minimize satellite illumination/interference time. Test measurements should then be taken for 10 seconds after achieving stabilization, and the subsequently-obtained results then processed appropriately.

3.0 SATCOM FUNCTIONS

3.7.3.10 Measurement Discard Ratio

It is permissible to discard a certain percentage of the worst test measurements for each beam pointing angle, and to perform the appropriate processing on the remaining best test samples. For the recommended discard ratio, reference ORT item E13.

3.7.3.11 Measurement of Additional IM Product Orders

As the antenna will presumably always be pointed away from the geostationary satellite arc (per Section 3.7.2 above), then unless there is some other L-band signal source present during the PIM test, the AES/UT could opt to measure PIM products at orders other than the one prescribed by the frequencies assigned for the CW test transmissions, by tuning the receiver to other appropriate frequencies (e.g., corresponding to the 7th, 11th, etc., products, even though the assigned frequencies were intended to allow for measurement of the 9th product). The need or advantage for doing such additional measurements remains to be determined.

3.7.3.11.1 PIMBIT Results Display/Storage and Immediate Clearing of any “Failure”

As the PIMBIT is a “snapshot” test, the detailed results should be stored (with certain relevant related parameters) for future reference, as well as displayed after completion of the test (until the test is fully terminated and normal operation is resumed), and a “pass” or “failure” declaration may be required by some aircraft manufacturers. The stored relevant related parameters should include, but not be limited to, the following:

- Aircraft-relative azimuth and elevation antenna beam pointing angles
- Test frequencies used
- ICAO address
- Average channel degradation results for each antenna beam
- Antenna serial number (as available)
- Date and time
- PIMBIT ORT item settings
- Standard deviation (1σ) of the measurement results for each antenna beam

Any failure should be immediately cleared following the test, as the test status is only relevant at the time of its execution, such that any such failure has no impact on normal system operation or on any subsequent reports to the central maintenance system/function.

3.7.4 Operational Considerations

3.7.4.1 Prerequisite Conditions

Certain prerequisite conditions should be confirmed to be met before initiating the test. These include having the satcom system successfully log-on or register recently (within the previous 168 hours (seven 24-hour periods)), having the IRS/ADIRS/GNSS operational/aligned/outputting valid data to the satcom system, having no other failures in the satcom system that could affect the PIM test (e.g., HPA, DLNA, antenna/BSU/Antenna Control Unit (ACU), interconnections (RF coax, discrete, ARINC 429, etc.), having the satcom system frequency reference being within its specified operating temperature range, etc.).

3.0 SATCOM FUNCTIONS

3.7.4.2 Aircraft Orientation

No special aircraft orientation requirements pertain for systems using an HGA, nor for those using an IGA with multi-dimensional beam steering. However, for testing with an IGA using one-dimensional beam steering (i.e., one that produces a fan-shaped beam), the aircraft must be oriented such that the nose is pointing toward true north or south (either way), along with steering the antenna as defined in Section 3.7.3.7.

3.7.4.3 Test Initiation

The PIMBIT should be initiated from the central maintenance system interface in the cockpit or similar (e.g., MCDU or maintenance terminal). Ideally, the test should be conducted while the aircraft is outside and at least 50 meters away from any adjacent structures, other aircraft, or other large vehicles. The test will typically take several minutes to execute.

3.7.4.4 Action Following Test Failure

If the test should fail when initiated inside a hangar or near large structures or vehicles (including other aircraft), the test should be repeated in an open area at least 50 meters away from any such adjacent structure/vehicle. If the re-test passes, the initial failure can probably be attributed to (additional) PIM from the other structures. If the re-test still fails, then corrective maintenance action should be taken until subsequent re-tests pass.

3.7.4.5 Interpreting Results of the PIMBIT

This is an area where experience conducting the test will be helpful. Note that PIM levels can vary considerably over time – repeated test attempts may be helpful in interpreting the results.

Some guidelines are provided below based on early limited experience with PIMBIT.

- Failure at only some antenna beam pointing angles would tend to indict the antenna, or possibly the aircraft skin.
- Failure at all angles would tend to indict a component such as the DLNA-to-antenna coaxial cable assembly or its mating connectors.
- High PIM levels at high elevation angles may indict the antenna. This could be true if the PIM levels are variable with beam azimuth.
- High PIM levels at low elevation could indict the antenna or the installation (adapter plate, etc.). There also may be an incompatibility with nearby installed systems. This could be especially true if the PIM is present if beams are steered fore and aft at low elevation along the axis of the aircraft.
- High PIM levels that are beam-independent might be indicative of a bad DLNA or cable from the antenna to the DLNA. Depending on the severity of the problem, they may be evident at the lower orders but in severe cases may persist to, e.g., the 45th order. In cases like this, it may be useful to remove the antenna from the chain and replace it with a low PIM load (e.g., a long cable bundle). This could serve to isolate the DLNA and cable. This will not be possible when the system is in service.
- Repeating the test after rotating the aircraft, or changing the antenna beam pointing angles via the respective ORT item, will typically give at least

3.0 SATCOM FUNCTIONS

somewhat different results and may provide additional insight to the source of the PIM.

3.7.4.6 AMM Recommendations

Recommended corrective actions to be performed when the test fails should be included in the Aircraft Maintenance Manual (AMM). It should be noted that PIM can be intermittent, and that PIMBIT may indicate a PIM failure on the aircraft but that it is very limited in its ability to isolate the failure to a specific area or to indicate the specific required corrective action. The AMM information should include but not be limited to the following (in the preferred order of execution for most aircraft – adjust as appropriate for the specific aircraft type):

- Visually inspect the DLNA-to-antenna coaxial cable for physical damage (cable jacket abrasion or cuts), violation of the minimum specified bend radius or the presence of kinking, loose or over-tight cable clamps, corrosion, etc.
- Check the DLNA-to-antenna cable assembly:
 - Disconnect the cable assembly between the DLNA and the antenna.
 - Inspect and clean (e.g., with isopropyl alcohol) the connectors on the cable assembly and on the DLNA and antenna (starting with the DLNA end first).
 - Reconnect and torque the connectors on the coaxial cable between the DLNA and the antenna.
- Clean the mating surfaces between the fuselage and the antenna adapter plate, and between the adapter plate and the antenna. Treat aluminum surfaces with chromate conversion coating (e.g., Alodine®).

Before performing any of the following replacement actions, it may be preferable to perform one or more of the “additional actions” listed further below if the necessary resources (personnel, equipment, and flight test opportunity) are available.

- Replace the antenna.
- Replace the DLNA.
- Replace the DLNA-to-antenna coaxial cable assembly.

Additional actions that may be taken by aircraft manufacturers and suppliers for fault isolation include but are not limited to the following:

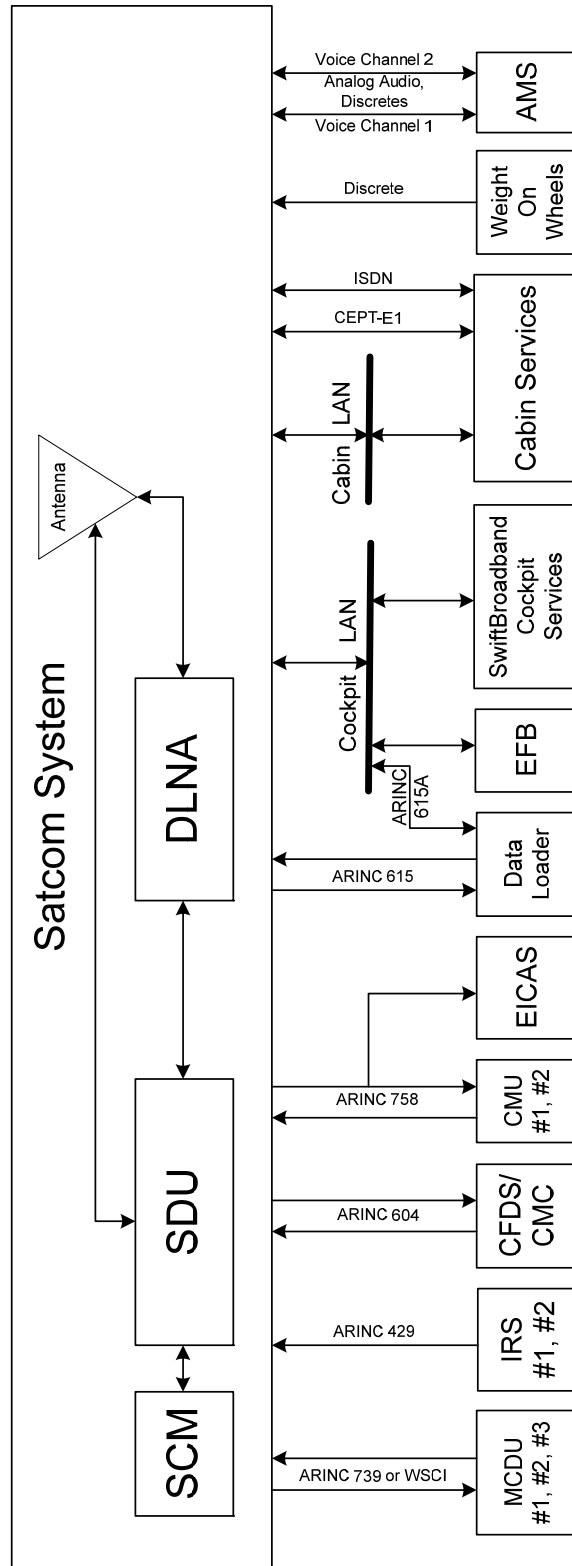
- Affix a low-PIM dummy load at the antenna port of the DLNA and repeat the PIM test.
- Affix a low-PIM dummy load at the antenna end of the DLNA-to-antenna coaxial cable assembly.
- Launch the PIMBIT while the aircraft is in-flight using special engineering test interfaces/modes.

The maximum recommended azimuth and elevation angle settings for the ORT items should be specified, based on the characteristics of the installed antenna.

ATTACHMENT 1
STANDARD INTERFACES

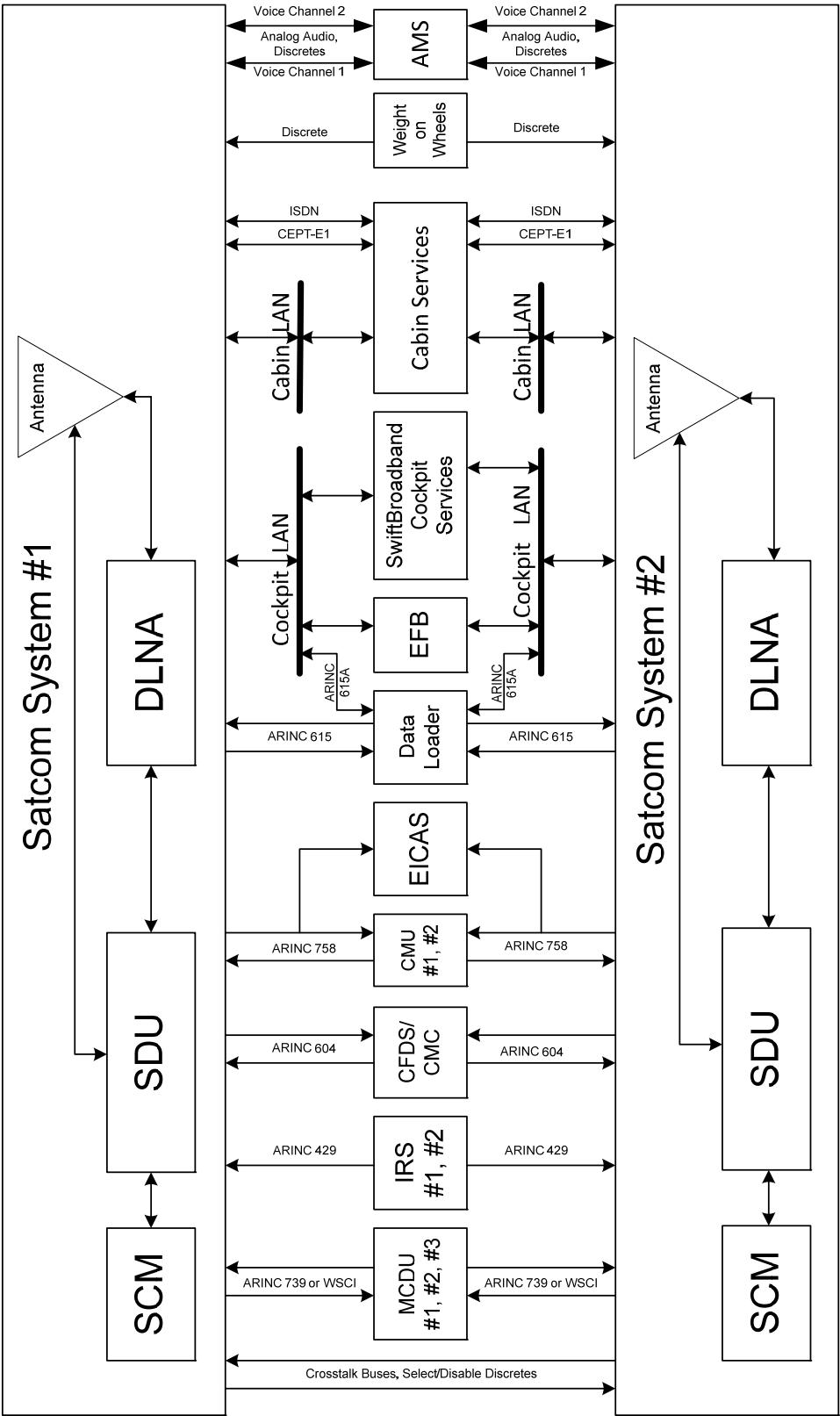
ATTACHMENT 1 STANDARD INTERFACES

1.1A General Configuration Overview – Single Satcom Installation



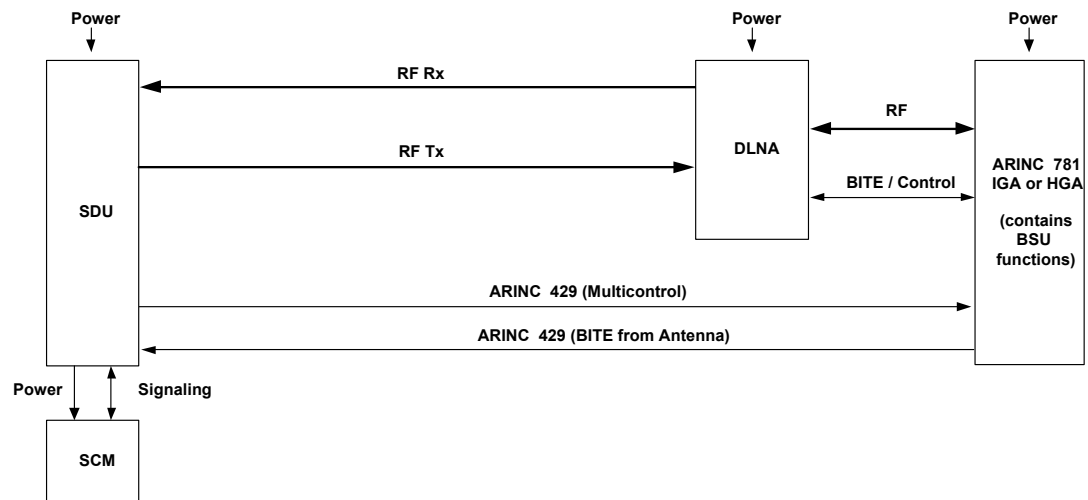
ATTACHMENT 1
STANDARD INTERFACES

1.1B General Configuration Overview – Dual Satcom Installation



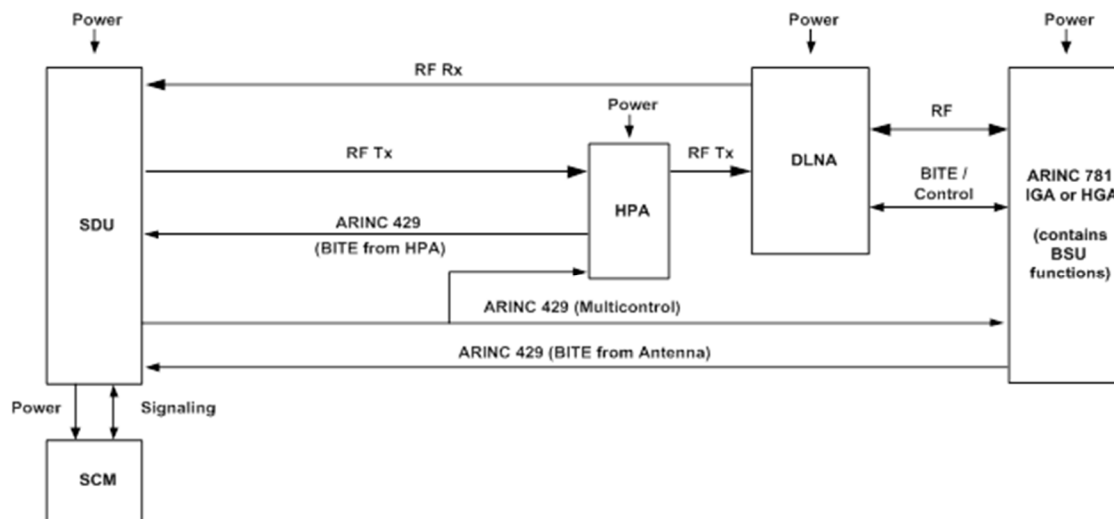
ATTACHMENT 1
STANDARD INTERFACES

1.2A Satcom System Configuration – HPA Integrated in SDU



ATTACHMENT 1
STANDARD INTERFACES

1.2B Satcom Configuration – Optional Flange Mounted HPA



Note: This configuration is expected to be used on those few aircraft where the installation loss between the SDU and antenna does not meet the 2.5 dB loss requirement.

**ATTACHMENT 1
STANDARD INTERFACES**

1.3 Standard Interwiring

SDU SIGNAL NAME	PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
SDU RF Output to DLNA (or HPA). Input/output for ELGA (SB200 Configuration 3)	TP71	50 ohm coax	DLNA/J3 or HPA/J2 or ELGA/J1	11
ATE Pins	TP01A			
ATE Pins	TP01B			
ATE Pins	TP01C			
ATE Pins	TP01D			
ATE Pins	TP01E			
ATE Pins	TP01F			
ATE Pins	TP01G			
ATE Pins	TP01H			
ATE Pins	TP01J			
ATE Pins	TP01K			
Ethernet Empty Cavity	TP02A			
Ethernet Empty Cavity	TP02B			
Ethernet Empty Cavity	TP02C			
ATE Pins	TP02D			
ATE Pins	TP02E			
ATE Pins	TP02F			
ATE Pins	TP02G			
Ethernet Empty Cavity	TP02H			
Ethernet Empty Cavity	TP02J			
Ethernet Empty Cavity	TP02K			
Ethernet 1 from SDU to User	TP03A	100BASE-TX	Electronic Flight Bag 1 (AISD)	37, 38
Ethernet 1 from User to SDU	TP03B	100BASE-TX	Electronic Flight Bag 1 (AISD)	37, 38
Ethernet Empty Cavity	TP03C			
Config Pin 1	TP03D	0 V common		17
Config Pin 2	TP03E	Discrete		17
Config Pin 3	TP03F	Discrete		17
Config Pin 4	TP03G	Discrete		17
Ethernet Empty Cavity	TP03H			
Ethernet 11 from SDU to User	TP03J	100BASE-TX	Electronic Flight Bag 2 (AISD)	37, 38, 39
Ethernet 11 from User to SDU	TP03K	100BASE-TX	Electronic Flight Bag 2 (AISD)	37, 38, 39
Ethernet 1 from User to SDU	TP04A	100BASE-TX	Electronic Flight Bag 1 (AISD)	37, 38
Ethernet 1 from SDU to User	TP04B	100BASE-TX	Electronic Flight Bag 1 (AISD)	37, 38
Ethernet Empty Cavity	TP04C			
Config Pin 5	TP04D	Discrete		17
Config Pin 6	TP04E	Discrete		17
Config Pin 7	TP04F	Discrete		17
Config Pin 8	TP04G	Discrete		17
Ethernet Empty Cavity	TP04H			
Ethernet 11 from User to SDU	TP04J	100BASE-TX	Electronic Flight Bag 2 (AISD)	37, 38, 39
Ethernet 11 from SDU to User	TP04K	100BASE-TX	Electronic Flight Bag 2 (AISD)	37, 38, 39
Ethernet Empty Cavity	TP05A			
Ethernet Empty Cavity	TP05B			

ATTACHMENT 1

STANDARD INTERFACES

SDU SIGNAL NAME		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Ethernet Empty Cavity		TP05C			
Config Pin 9		TP05D	Discrete		17
Config Pin 10		TP05E	Discrete		17
Config Pin 11		TP05F	Discrete		17
Config Pin 12		TP05G	Discrete		17
Ethernet Empty Cavity		TP05H			
Ethernet Empty Cavity		TP05J			
Ethernet Empty Cavity		TP05K			
Ethernet 2 from SDU to User		TP06A	100BASE-TX	Cabin Data 1 (PIESD)	37, 38
Ethernet 2 from User to SDU		TP06B	100BASE-TX	Cabin Data 1 (PIESD)	37, 38
Ethernet Empty Cavity		TP06C			
Config Pin 13		TP06D	Discrete		17
Config Pin 14 (Spare)		TP06E	Discrete		17
Config Pin 15 (Spare)		TP06F	Discrete		17
Config Pin 16 (Spare)		TP06G	Discrete		17
Ethernet Empty Cavity		TP06H			
Ethernet 12 from SDU to User		TP06J	100BASE-TX	Cabin Data 2 (PIESD)	37, 38, 39
Ethernet 12 from User to SDU		TP06K	100BASE-TX	Cabin Data 2 (PIESD)	37, 38, 39
Ethernet 2 from User to SDU		TP07A	100BASE-TX	Cabin Data 1 (PIESD)	37, 38
Ethernet 2 from SDU to User		TP07B	100BASE-TX	Cabin Data 1 (PIESD)	37, 38
Ethernet Empty Cavity		TP07C			
Config Pin 17 (Spare)		TP07D	Discrete		17
Config Pin 18 (Spare)	TP07E	Discrete		17	
Config Pin 19 (Spare)	TP07F	Discrete		17	
Config Pin 20 (Spare)	TP07G	Discrete		17	
Ethernet 12	TP07H				
Ethernet 12 from User to SDU	TP07J	100BASE-TX	Cabin Data 2 (PIESD)		
Ethernet 12 from SDU to User	TP07K	100BASE-TX	Cabin Data 2 (PIESD)		
Data from MCDU 1	A	MP01A	A429		3, 12
Data from MCDU 1	B	MP01B	A429		3, 12
Call Place/End Discrete Input 1		MP01C	Discrete		23, 28
CONFIG MODULE Power Source (+ 8 to 15 V)		MP01D		SCM/8	33
Multi-Control Output	A	MP01E	A429	HPA/P HGA/6 or IGA/6	4
Multi-Control Output	B	MP01F	A429	HPA/R HGA/8 or IGA/8	4
Reserved External Reset Discrete Input		MP01G	Discrete		7
Call Place/End Discrete Input 2		MP01H	Discrete		23, 28
Data from MCDU 2	A	MP01J	A429		3, 12
Data from MCDU 2	B	MP01K	A429		3, 12
					36
Data from Primary IRS/GNSS	A	MP02A	A429		4, 15, 21
Data from Primary IRS/GNSS	B	MP02B	A429		4, 15, 21
Cockpit Voice Chime Signal Contact 1		MP02C	Discrete		9
CONFIG MODULE Power Return		MP02D		SCM/15	33
BITE Input from HPA	A	MP02E	A429	HPA/A	3
BITE Input from HPA	B	MP02F	A429	HPA/B	3
Reserved Mfr. Specific 0-28V Discrete Output		MP02G	Discrete		36
Cockpit Voice Chime Signal Contact 2		MP02H	Discrete		9
Data from Secondary IRS/GNSS	A	MP02J	A429		4, 15, 21
Data from Secondary IRS/GNSS	B	MP02K	A429		4, 15, 21
Data from CMU 1	A	MP03A	A429		1, 2, 24
Data from CMU 1	B	MP03B	A429		1, 2, 24
Cockpit Voice Call Light Output 1		MP03C	Discrete		6, 28

**ATTACHMENT 1
STANDARD INTERFACES**

SDU SIGNAL NAME		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Data to SCM	A	MP03D	RS422	SCM/3	33
Discrete Output (Spare)		MP03E			6
Discrete Input (Spare)		MP03F			7
Spare		MP03G			
Cockpit Voice Call Light Output 2		MP03H	Discrete		6, 28
Data from CMU 2	A	MP03J	A429		1, 2, 24
Data from CMU 2	B	MP03K	A429		1, 2, 24
Cockpit Audio Input 1	Hi	MP04A	Analog		10, 28
Cockpit Audio Input 1	Lo	MP04B	Analog		10, 28
Cockpit Voice Mic On Input 1		MP04C	Discrete		7, 28
Data to SCM	B	MP04D	RS422	SCM/4	33
Spare Discrete Output		MP04E			6
Spare Discrete Input		MP04F			7
Spare		MP04G			
Cockpit Voice Mic On Input 2		MP04H	Discrete		7, 28
Cockpit Audio Input 2	Hi	MP04J	Analog		10, 28
Cockpit Audio Input 2	Lo	MP04K	Analog		10, 28
Cockpit Audio Output 1	Hi	MP05A	Analog		10, 28
Cockpit Audio Output 1	Lo	MP05B	Analog		10, 28
Cockpit Voice Go Ahead Chime Reset 1		MP05C	Discrete		7
Data from SCM	A	MP05D	RS422	SCM/1	33
Spare Discrete Output		MP05E			6
Spare Discrete Input		MP05F			7
Spare ARINC 429 Output	A	MP05G	A429		29
Spare ARINC 429 Output	B	MP05H	A429		29
Cockpit Audio Output 2	Hi	MP05J	Analog		10, 28
Cockpit Audio Output 2	Lo	MP05K	Analog		10, 28
Spare Discrete Input		MP06A			7
Spare Discrete Input		MP06B			7
Spare Discrete Input		MP06C			7
Data from SCM	B	MP06D	RS422	SCM/2	33
Ethernet 5 from SDU to User	+	MP06E	10BaseT	Cockpit Priority Data 2 (ACD)	38
Ethernet 5 from SDU to User	-	MP06F	10BaseT	Cockpit Priority Data 2 (ACD)	38
Spare ARINC 429 Input	A	MP06G	A429		29
Spare ARINC 429 Input	B	MP06H	A429		29
Data from GNSS to SDU	A	MP06J	A429		4
Data from GNSS to SDU	B	MP06K	A429		4
AES ID Input	A	MP07A	A429		1, 27
AES ID Input	B	MP07B	A429		1, 27
Spare Discrete Input		MP07C	Discrete		7
WOW Input 1		MP07D	Discrete		19
Ethernet 5 (Spare)from User to SDU	+	MP07E	10BaseT		
Ethernet 5 (Spare)from User to SDU	-	MP07F	10BaseT		
Spare ARINC 429 Output	A	MP07G	A429		29
Spare ARINC 429 Output	B	MP07H	A429		29
Data to CMU 1 and 2	A	MP07J	A429		2, 24, 25
Data to CMU 1 and 2	B	MP07K	A429		2, 24, 25

**ATTACHMENT 1
STANDARD INTERFACES**

SDU SIGNAL NAME		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Data from CFDS	A	MP08A	A429		3
Data from CFDS	B	MP08B	A429		3
BITE Input Top/Port BSU/Ant	A	MP08C	A429	HGA/3 or IGA/3	3
BITE Input Top/Port BSU/Ant	B	MP08D	A429	HGA/5 or IGA/5	3
Data Loader Link A		MP08E	Discrete		14
TX Mute Input		MP08F	Discrete		7
BITE Input STBD BSU	A	MP08G	A429		3
BITE Input STBD BSU	B	MP08H	A429		3
Data to CFDS	A	MP08J	A429		3
Data to CFDS	B	MP08K	A429		3
From Airborne Data Loader	A	MP09A	A429		4, 14
From Airborne Data Loader	B	MP09B	A429		4, 14
Crosstalk from Other SDU	A	MP09C	A429	Other SDU/MP09G	4, 22
Crosstalk from Other SDU	B	MP09D	A429	Other SDU/MP09H	4, 22
Dual System Select Discrete I/O		MP09E	Discrete	Other SDU/MP09F	31
Dual System Disable Discrete I/O		MP09F	Discrete	Other SDU/MP09E	31
Crosstalk to Other SDU	A	MP09G	A429	Other SDU/MP09A	4, 22
Crosstalk to Other SDU	B	MP09H	A429	Other SDU/MP09B	4, 22
To Airborne Data Loader	A	MP09J	A429		4, 14
To Airborne Data Loader	B	MP09K	A429		4, 14
Data from MCDU 3	A	MP10A	A429		3, 12
Data from MCDU 3	B	MP10B	A429		3, 12
Port BSU HPA Mute Input	A	MP10C	A429		32
Port BSU HPA Mute Input	B	MP10D	A429		32
LGA LNA On/Off Control		MP10E	Discrete		6
BITE Input from LGA LNA		MP10F	Discrete		5
STBD BSU HPA Mute Input	A	MP10G	A429		32
STBD BSU HPA Mute Input	B	MP10H	A429		32
Data to MCDU 1,2,3	A	MP10J	A429		12, 18
Data to MCDU 1,2,3	B	MP10K	A429		12, 18
POTS 1	A	MP11A	Analog		8
POTS 1	B	MP11B	Analog		8
Cabin CEPT-E1 Data Output	A	MP11C			20
Cabin CEPT-E1 Data Output	B	MP11D			20
Service Availability Discrete 1		MP11E	Discrete		30
Service Availability Discrete 2		MP11F	Discrete		30
Cabin CEPT-E1 Data Input	A	MP11G			20
Cabin CEPT-E1 Data Input	B	MP11H			20
POTS 2	A	MP11J	Analog		8
POTS 2	B	MP11K	Analog		8
Service Availability Discrete 3		MP12E	Discrete		30
Service Availability Discrete 4		MP12F	Discrete		30
Service Availability Discrete 5		MP13E	Discrete		30
Service Availability Discrete 6		MP13F	Discrete		30
Service Availability Discrete 7		MP14E	Discrete		30
Service Availability Discrete 8		MP14F	Discrete		30
Service Availability Discrete 9		MP15E	Discrete		30
Service Availability Discrete 10		MP15F	Discrete		30

**ATTACHMENT 1
STANDARD INTERFACES**

SDU SIGNAL NAME		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Ethernet 3 from SDU to User	+	MP1T1	Quadrap	Data Loader / A664P7 (ACD)	37, 38
Ethernet 3 from SDU to User	-	MP1T3	Quadrap	Data Loader / A664P7 (ACD)	37, 38
Ethernet 3 from User to SDU	+	MP1T2	Quadrap	Data Loader / A664P7 (ACD)	37, 38
Ethernet 3 from User to SDU	-	MP1T4	Quadrap	Data Loader / A664P7 (ACD)	37, 38
Ethernet 4 from SDU to User	+	MP2T1	Quadrap	Cockpit Priority Data 1 / A664P7 (ACD)	37, 38
Ethernet 4 from SDU to User	-	MP2T3	Quadrap	Cockpit Priority Data 1 / A664P7 (ACD)	37, 38
Ethernet 4 from User to SDU	+	MP2T2	Quadrap	Cockpit Priority Data 1 / A664P7 (ACD)	37, 38
Ethernet 4 from User to SDU	-	MP2T4	Quadrap	Cockpit Priority Data 1 / A664P7 (ACD)	37, 38
115 Vac Cold		BP01			
Reserved +28 Vdc Hot		BP02			
Chassis Ground		BP03			
Reserved +28 Vdc Ground		BP04			
115 Vac Hot		BP05			16
Coax (antenna control for CSDU)		BP06		ELGA/J2	11
Coax (from DLNA)		BP07		DLNA/J2	11
Fiber Cabin Port 1		BP08	Fiber		34
Fiber Cabin Port 2		BP09	Fiber		34
Fiber ACD Port 1		BP10	Fiber		34
Fiber ACD Port 2		BP11	Fiber		34
Fiber AISD Port 1		BP12	Fiber		34

ATTACHMENT 1 STANDARD INTERFACES

1.4 Notes Applicable to Standard Interwiring

1. The 24-bit ICAO SSR Mode S Address (used as the AES ID) should be read from the Data Bus from CMU #1 (SDU pins MP3A and MP3B) or the Data Bus from CMU #2 (SDU pins MP3J and MP3K) or the AES ID input (SDU pins MP7A and MP7B) if available. The Owner Requirements Table (ORT) item B1 identifies whether ARINC 429 data is available. Data from the CMUs is available on Labels 214 and 216 (as specified in ARINC Specification 429, Attachment 6), or on the AES ID input bus on Labels 275 and 276 (at 5 to 10 words per second) as specified in ARINC Specification 429 for the Mode-S Transponder to TCAS. ORT item B2 specifies the bus speed for the AES ID input. If the address is not available on any 429 input, it should be read from the ORT database or entered manually on the SCDU. If a Configuration Module is installed, the ICAO address should be stored on the module for use by the SDU if the ICAO Address is not available on a subsequent power-up.

The AES ID input may contain additional position labels (Latitude on Label 310, Longitude on Label 311), depending upon the setting of ORT item B4 AES ID Input – Presence of GNSS Position Data. When present on the AES ID input, Label 310 (Present Position Latitude) and 311 (Present Position Longitude) will be formatted per ARINC 429. These labels are intended to support SwiftBroadband transmit signal timing requirements on a B777 aircraft.

COMMENTARY

Installers wishing to use the Mode-S transponder as the source of the ICAO address should ensure that the transponder will continue to transmit a valid ICAO address when in standby mode. The satcom system may be rendered inoperative if a valid ICAO address cannot be obtained due to satcom attempting to read the ICAO address when the transponder is in standby mode. Transponders set the Sign/Status Matrix (SSM), bits 30 and 31, to No Computed Data (NCD) when in standby mode, so it is necessary that the SDU interpret ICAO data as valid when the SSM is set to NCD.

2. The CMU is an optional system that may not be available on all aircraft whereas the transponders are required equipment for Air Transport category aircraft. The Communications Management Unit (CMU) or equivalent is responsible for integrating data communications via the satellite communications system with data communications via other datalinks on the aircraft. It exchanges data with the SDU at the physical layer on an ARINC 429 data bus, and at the link layer using the bit-oriented file transfer protocol. It utilizes the ISO 8208 subnetwork layer (packet level) protocol, as described in that international standard.
3. ARINC 429 low-speed data bus.
4. ARINC 429 high-speed data bus.
5. Units functioning normally should annunciate this fact by placing a voltage between +15 Vdc and +36 Vdc relative to airframe dc ground, defined as 0 ± 3 Vdc, on the connector pins assigned to the BITE discrete output. Absence of this voltage will be interpreted as a fault annunciation. BITE annunciation is not required when the unit has been commanded “off.”
6. The SDU should provide an internal switch closure to ground. The switch contact should be open for (i) LNA off, (ii) no cockpit voice call annunciation, and closed for (i) LGA LNA on, (ii) cockpit voice call annunciation active, (iii) the polarity logic of spare outputs will be defined when the spare output functionality is defined. The open voltage hold-off should be 36 Vdc max., the potential across the closed switch should be 1 Vdc or less and the cold in-rush current handling capacity should be 500 mA max and the steady state value should be 50 mA max. The cockpit voice call annunciation is to be steady until reset.

ATTACHMENT 1

STANDARD INTERFACES

7. The SDU should sense the closure of an external switch to dc ground. The resistance to airframe dc ground, defined as 0 ± 3 Vdc, presented to the SDU connector pins should be 100,000 ohms or more when the external switch is open and 10 ohms or less when the switch is closed. The closed state of the external switches will indicate that (i) a cockpit microphone is in use with satcom, (ii) the Voice Go-Ahead (Chime) output should be reset, (iii) the satcom RF output should be muted, (iv) reset the SDU, (v) the polarity logic of spare inputs will be defined when the spare input functionality is defined. In the case of (i), this input can be wired to either the satcom-selected PTT switch, or to an ACP satcom mic transmit key switch suitably latched for the duration of the call as specified by ORT setting D7.

LATCHED Mic-On OPERATION (ORT setting D7)

If the Call Light is ON, the Mic-steady ground is interpreted as off-hook, which answers an incoming call when the signal goes low and ends the call when the signal goes high.

If the ORT (item D8) is set for ACP initiated Cockpit Calls and, if the Call Light is OFF, the Mic-On discrete going to ground is interpreted as Place Cockpit Call. Refer to ARINC Characteristic 741, Part 2, Section 4.13.

8. These SDU pins are intended to support two-wire analog Plain Old Telephone Service (POTS) circuit mode equipment such as telephones, fax machines, and circuit-mode data equipment including personal computers and secure voice terminals connected directly to the satcom system. Reference the Inmarsat Aeronautical System Definition Manual, Modules 1, 2, and 5, and the relevant suppliers for specific options and details.
9. When enabled by ORT item D10 and a cockpit air to ground call is placed, or upon receiving a ground to air cockpit call, the SDU should close a circuit between pins MP2C and MP2H when the voice go-ahead (chime) output is to be activated such that a current of 1 amp may flow through an external device fed from a 28 Vdc source. The current should flow from the chime to MP2C, and the current should flow to the chime from MP2H. Maximum hold-off voltage in the open circuit condition should be 36 Vdc. The minimum hold time (for both the on and off states) should be 250 ms. The chime should be single stroke.
10. The shields of twisted and shielded pairs of wires used for audio signal transfer should be grounded at the transmitter end only. While it is preferable to utilize two cockpit audio channels, the SDU is only required to interface with one channel.
11. The characteristic impedance of each coaxial interface should be 50 ohms.
12. This Satellite Control/Display Unit (SCDU) interface is required to permit the SDU to be managed by a cockpit control panel. The SDU should be capable of exchanging command and control information with the SCDU using the MCDU protocol standards defined in ARINC Characteristic 739 or WSCI (see ARINC 741, Part 2, Attachment 2F-42.1). Display and control details are manufacturer-specific. Note that no messages for the air-ground link will originate in or be routed to the SCDU over this interface. The details of this interface are manufacturer-specific.
13. All TNC and N type connectors should be provided with means to prevent the effects of vibration from causing the threaded collar with which the mating halves are secured together from becoming loose.
14. Interface details are per ARINC Report 615. Interwiring is only required on those aircraft having an ARINC 615 Airborne Computer High-Speed Data Loader installed. The Data Loader Link A discrete is used to enable the SDU to determine whether or not an ARINC 615 ADL is connected. A resistance to airframe dc ground, defined as 0 ± 3 Vdc, presented to the SDU connector pin of 100,000 ohms or more should be interpreted as the ADL is not connected, and a resistance of 1,500 ohms or less should be interpreted as the ADL is connected.

ATTACHMENT 1
STANDARD INTERFACES

15. There are four ARINC 429 inputs defined on the SDU connector for the purpose of receiving inertial data and GNSS data. The airframe manufacturer should provide a definition of what data is available on each of these four ports to the SDU manufacturer. The following table lists the possible functionality available on each ARINC 429 input:

SDU Middle Plug Pins	Pin Definition	Functionality
A2, B2	Data from Primary IRS	Inertial and/or GNSS Data
J2, K2	Data from Secondary IRS	Inertial and/or GNSS Data
J6, K6	Data from GNSS to SDU	GNSS Data
A7, B7	AES ID Input	Lat/Long (see Interwiring Note 1)

The following table defines the inertial and GNSS parameters and labels available from various aircraft inertial and GNSS systems. For inertial data and GNSS data available on IRS inputs for antenna control steering and computed Doppler correction, the ARINC 429 Octal labels in the left-hand column of the table below should be transmitted from an inertial system, such as IRS, ADIRS, ADSU, or equivalent equipment. In addition to the inertial labels, when the SwiftBroadband function is supported by the SDU, it is strongly recommended that the SDU obtain GNSS corrected position data (latitude/longitude). Depending on the aircraft, GNSS data may be obtained from various sources. If a hybrid inertial/GNSS system is available on the aircraft, the IRS input(s) should be wired to provide both inertial data and GNSS position data according to the right-hand column of the following table. If a hybrid inertial/GNSS system is not available on the aircraft, then one of the IRS inputs may be used to provide inertial data to the SDU while the other IRS input may be used to obtain autonomous GNSS data, or GNSS data may be provided on the Data from GNSS data to SDU input while maintaining primary and secondary IRS inputs for inertial data. If provided on the aircraft, GNSS data may also be obtained from the AES ID input per Interwiring Note 1. Each IRS input may be configured per ORT items B5 and B6 to receive the labels in any one column of the following table:

Inertial Data		GNSS Data		Hybrid Inertial/GNSS Data	
Parameter	Label	Parameter	Label	Parameter	Label
Present Position – Latitude	310	Latitude GNSS, Autonomous	110	Latitude GNSS, Hybrid or Autonomous	254 or 110
Present Position – Longitude	311	Longitude GNSS, Autonomous	111	Longitude GNSS, Hybrid or Autonomous	255 or 111
Ground Speed	312	Ground Speed GNSS, Autonomous	112	Ground Speed GNSS, Hybrid or Autonomous	175 or 112
Track Angle – True	313	Track Angle True GNSS, Autonomous	103	Track Angle True GNSS, Hybrid or Autonomous	137 or 103
True Heading	314	True Heading	N/A	True Heading, Hybrid or Inertial	132 or 314
Pitch Angle	324	Pitch Angle	N/A	Pitch Angle	324
Roll Angle	325	Roll Angle	N/A	Roll Angle	325
Inertial Altitude	361	GNSS Height (HAE) or GNSS Altitude	370 or 076	Hybrid Altitude MSL or GNSS Altitude	261, or 076
UTC	N/A	GNSS UTC (Binary)	150	GNSS UTC (Binary)	150
Date	N/A	GNSS Date	260	GNSS Date	260
GNSS Sensor Status	N/A	GNSS Sensor Status	273	GNSS Sensor Status	273
GNSS HDOP	N/A	GNSS HDOP	101	GNSS HDOP	101

ATTACHMENT 1 STANDARD INTERFACES

Refer to ARINC 429 for the format of labels in the above table.

Systems providing classic aeronautical services and Swift64 may only need to use the inertial labels in the left-hand column for inertial data. An SDU may be wired to any one or two of up to three IRSs. It is strongly recommended that systems providing SwiftBroadband service is wired to receive GNSS data to support SwiftBroadband transmit signal timing requirements in addition to receiving inertial data.

The hybrid inertial and GNSS data solution is preferred, as it allows for redundant Inertial and GNSS inputs to the SDU using the primary and secondary IRS inputs to the SDU.

If the aircraft is not equipped with hybrid inertial systems providing inertial and GNSS data on the same data bus, then the SDU should be wired to receive separate inertial and GNSS inputs.

- a. If the aircraft provides two inertial inputs to the SDU, then the primary and secondary IRS SDU inputs should be wired to receive inertial data. The Data from GNSS to SDU input should be wired to receive GNSS Data (unless lat/long is available on the AES Input Bus).
- b. If the aircraft provides one inertial input to the SDU, then the primary IRS input to the SDU should be wired to receive inertial data and either the secondary IRS input or the Data from GNSS to SDU Input can be used to receive GNSS data.

ORT items B4, B5, and B21 define which IRS pins on the SDU are wired to sources of IRS data and whether the GNSS to SDU bus is enabled.

For aircraft with hybrid inertial/GNSS systems inputs, Label 370 should not be used for altitude because it can be defined to be acceleration. Hybrid inertial/GNSS systems should use altitude Label 261 for altitude when available. If Label 261 is not available, then Label 076 should be used for altitude.

For aircraft that do not have hybrid inertial/GNSS systems inputs, Label 370 from GNSS should be used for altitude over Labels 076, and 361. If altitude Label 370 is not available, Label 076 should be used. If neither Label 370 nor Label 076 is available, then Label 361 should be used for altitude.

Track angle may not be available on the ground. The SDU should not declare a fault due to a lack of track angle or no computed data for track angle when the aircraft is on the ground.

16. Circuit breaker protection information for the single satcom system is as follows:

- One (1) 115 Vac 5 amp circuit breaker is provided for SDU-1, DLNA-1 and Antenna-1 for the majority of configurations.
- Two (2) 115 Vac 5 amp circuit breakers are provided, one for SDU-1 and one for HPA-1, DLNA-1 and Antenna-1 for aircraft with a long distance between the SDU and antenna components requiring an FMHPA installation.

The system installer should conduct a load analysis to ensure the total current draw of the total system does not exceed approximately 80% of the current rating of the circuit breaker, and in-rush current should be taken into consideration. After conducting the load analysis, a larger circuit breaker may be chosen or an additional circuit breaker used to power the antenna components (DLNA, antenna) if the above circuit breaker recommendations are insufficient.

Each circuit breaker should have a Type A (short delay) response. When dual satcom systems are installed, the circuit breakers utilized in each system are the same as those given above. It should be noted that the pin size for the high gain antenna connector allows a maximum of 22 gage wire to be installed to power the antenna. This wire size limits the antenna circuit breaker to a maximum of 5 amps in order to ensure that the circuit breaker protects the wire in the event of a short circuit.

**ATTACHMENT 1
STANDARD INTERFACES**

17. The System Configuration Pins definition and interpretation details are shown in Attachment 1, Section 1.4A. A small number of System Configuration Pins are mandatory. The others may be optionally used by installers to define additional configuration details. If the optional System Configuration Pins are not used, then the configuration information may be found in the ORT. TP3G is used to define whether the optional System Configuration Pins should be read by the SDU. The SDU should attempt to read the System Configuration Pins upon power-up.

It should be noted that the System Configuration Pins use 'multiplexed pin programming' and that 7 of the Service Availability Discrete are used to provide the multiplexed matrix select strapping. Although unlikely, the optional System Configuration Pins could be used on aircraft that also use the Service Availability Discrete. It is therefore recommended that (1) the SDU's System Configuration Pins are open circuit except when they are being read so that Service Availability lamps/LEDs are not partially illuminated, and (2) diode isolation (external to the SDU) of each Service Availability lamp/LED power may be needed to stop misreading of System Configuration Pins by the SDU if (and only if) the external power source of the lamps/LEDs could be grounded in the off state and the Service Availability Discrete is connected to a System Configuration Pin.

18. Reference Attachment 1, Section 1.4A or ORT item B15 for the definition of the speed (high or low) of this ARINC 429 bus.
19. This discrete will be used to enable the SDU to determine whether or not the aircraft is airborne. The WOW Input should be programmable such that the TRUE state may be annunciated by either an airframe dc ground, defined as 0 ± 3 Vdc or a resistance to airframe dc ground of less than 1500 ohms at the SDU connector pin MP7D, or an open circuit or voltage. An open circuit is defined as a resistance of 100,000 ohms or more between pin MP7D and airframe dc ground. The voltage relative to airframe dc ground at an input for a TRUE indication should be 7 Vdc or more (max 30 Vdc). For this condition, the SDU should present a load of at least 10,000 ohms at the input. Resistance sensing should be based on current flow from the SDU to airframe dc ground.

Programming should be either achieved by means of SDU system configuration pin TP6D or ORT item E6. This discrete is only required to be wired if equivalent information is not strapped as being available to the SDU on an ARINC 429 input, for example, IRS or the CFDS.

Appropriate fail-safe logic (assuming airborne when the air/ground state is unknown, or when multiple ARINC 429 sources contradict each other) should be used in most cases; however, when two or more ARINC 429 sources are wired and no valid data is available (including reception of invalid data), the on-ground state may be assumed in order to enable normal ground maintenance activities independent of other aircraft equipment.

20. CEPT-E1 data bus is defined in ITU-T Recommendation G.703 and ITU-T Recommendation G.704, and in ARINC Characteristic 746.

The SDU designer should be aware that some aircraft will use 100 ohm star quad cable rather than 120 ohm shielded twisted pair for this interface.

21. Deleted. Content consolidated into Note 15.
22. The protocol used on these interfaces is manufacturer specific.
23. The SDU should sense a momentary (typically no less than 100 milliseconds) closure of external switches to dc ground. The resistance to airframe dc ground presented to the SDU connector pins should be 100,000 ohms or more when open, and less than 10 ohms when grounded. The transition from open to ground on the external switches will indicate End Call for any ongoing call on the respective channel. If there is no ongoing call, and if ORT item D8 telephone number pre-select is enabled and ORT item D7 cockpit/hookswitch signaling is set to

ATTACHMENT 1 STANDARD INTERFACES

latched, then the transition from open to ground shall indicate Place Cockpit Call if a telephone number has been pre-selected.

24. Reference ORT item B9 for the definition of the speed (high or low) of these ARINC 429 buses.
25. This SDU output may also be wired to the EICAS/ECAM/EDU to permit that unit to monitor the Label 270 word, which is specified in ARINC Characteristic 741, Part 2, Section 4.7.3.1.
26. Reserved.
27. Reference ORT item B2 for the definition of the speed (high or low) of this ARINC 429 bus.
28. In a dual system, the physical channel 1 and 2 interfaces on each SDU map to the AMS/ACP logical channel interfaces per ORT items D1 and D2 (CODEC dedication) and D12 (codecs fixed/shared). The SDU cockpit telephony signaling outputs in a dual system should only be asserted by the SDU supporting a call with one of its physical channels. AMS/ACP systems with interfaces for two satcom audio channels typically use one physical channel from each SDU to provide two operational cockpit voice channels. AMS/ACP systems with interfaces for four satcom audio channels typically connect both physical channels from each SDU to the AMS/ACP system, providing redundancy for both cockpit voice channels in the event of a single channel failure.
29. These interfaces should support both ARINC 429 low-speed and high-speed.
30. The SDU should provide an internal switch closure to ground. The open voltage hold-off should be 36 Vdc max. The potential across the closed switch should be 1 Vdc or less and the cold in-rush current handling capacity should be 500 mA max and the steady state value should be 50 mA max. Some of these outputs will also be used as part of the System Configuration Pins (see note 17 and Attachment 1, Section 1.4A).
31. These two pins are cross coupled with the corresponding pins on the other SDU in a dual system. That is SDU#1 MP09E is connected to SDU#2 MP09F and SDU#1 MP09F is connected to SDU#2 MP09E. In addition, a switch closure to airframe dc ground, defined as 0 ± 3 Vdc, can also be wire OR-ed with either, or both, SDUs Dual System Disable Select and this switch closure should disable that SDU and hence the other SDU becomes master (see Section 3.4.1.2.2).
32. This input is defined in ARINC Characteristic 741, Part 1.
33. The protocol used on these interfaces is manufacturer specific. The length of the cable between the SDU and SCM should be no more than 10 m. The current on the SCM's power and power return lines should be limited by the SDU to no more than 300 mA. The choice of SCM and SDU power values is manufacturer specific but they should be a value in the range 8-15 V. Furthermore, the SCM should not be damaged by dc power values of up to 18 Vdc, in case one manufacturer's SCM is accidentally connected to another manufacturer's SDU.
34. See Table 1.4-3, Fiber Port Interwiring, below:

**ATTACHMENT 1
STANDARD INTERFACES**

Table 1.4-3 – Fiber Port Interwiring

ARINC 781 Fiber Optics Port	Pin Definition	Fiber Port Definition	Security Domain
Fiber Port 1 (Cabin Port 1)	BP08	Cabin Data1 (PIESD)	Passenger Information and Entertainment Services Domain (PIESD)
Fiber Port 2 (Cabin Port 2)	BP09	Cabin Data1 (PIESD)	Passenger Information and Entertainment Services Domain (PIESD)
Fiber ACD 1 (ACD Port 1)	BP10	Cockpit Priority Data1 (ACD)	Aircraft Control Domain (ACD)
Fiber ACD 2 (ACD Port 2)	BP11	Cockpit Priority Data 2 (ACD)	Aircraft Control Domain (ACD)
Fiber AISD 1 (AISD Port 1)	BP12	AISD 1 (AISD)	Airline Information Services Domain (AISD)

35. Screen twisted triple.

36. The electrical characteristics should be as in Note 30. The functionality is manufacturer specific.

37. Refer to Section 3.4.2.1.3, ORT items C1, C5, and C18-19, regarding actual operating speed of these.

38. TBD

39. See Table 1.4-4, Ethernet Port Wiring.

**ATTACHMENT 1
STANDARD INTERFACES**

Table 1.4-4 – Ethernet Port Interwiring

ARINC 781 Ethernet Port	Pin Definition	Ethernet Port Definition	Security Domain
Ethernet 1	TP 3A TP 3B TP 4A TP 4B Size 22 pins	Electronic Flight Bag 1	Airline Information Services Domain (AISD)
Ethernet 2	TP 6A TP 6B TP 7A TP 7B Size 22 pins	Cabin Data1 Cabin Voice over SIP protocol will utilize this interface.	Passenger Information and Entertainment Services Domain (PIESD)
Ethernet 3	MP 1T; 1, 2, 3, 4 Quadrax	Airborne Data Loader This port is by default Ethernet per ARINC 664, Part 2; it may be changed to ARINC 664, Part 7 by ORT. In ARINC 664, Part 7 configuration, this port would also support Data Loading. This would be the port used when the Communications Management Unit or equivalent function uses an Internet Protocol for ACARS Datalink communication.	Aircraft Control Domain (ACD)
Ethernet 4	MP 2T; 1, 2, 3, 4 Quadrax	Cockpit Priority Data1 This port is by default Ethernet per ARINC 664, Part 2; it may be changed to ARINC 664, Part 7 by ORT. In ARINC 664, Part 7 configuration, this port would also support Data Loading. This would be the port used when the Communications Management Unit or equivalent function use an Internet Protocol for ACARS Datalink communication.	Aircraft Control Domain (ACD)
Ethernet 5	MP 6E MP 6F MP 7E MP 7F Size 22 pins	Cockpit Priority Data 2	Aircraft Control Domain (ACD)
Ethernet 11	TP 3J TP 3K TP 4J TP 4K Size 22 pins	Electronic Flight Bag 2 This is a second EFB port for aircraft that have two EFBs and do not have an airborne network that can share the EFB1 connection with two EFBs.	Airline Information Services Domain (AISD)
Ethernet 12	TP 6J TP 6K TP 7J TP 7K Size 22 pins	Cabin Data 2 Cabin Voice over SIP protocol will utilize this interface.	Passenger Information and Entertainment Services Domain (PIESD)

ATTACHMENT 1 STANDARD INTERFACES

1.4A System Configuration Pins Definition and Interpretation

1.0 INTRODUCTION

1.1 Pins Used for Programming

The following 20 rear connector pins should be used for configuration programming:

- Configuration Pin #1 - TP3D (note that this pin is a 0 V output from the SDU).
- Configuration Pin #2 - TP3E
- Configuration Pin #3 - TP3F
- Configuration Pin #4 - TP3G
- Configuration Pin #5 - TP4D
- Configuration Pin #6 - TP4E
- Configuration Pin #7 - TP4F
- Configuration Pin #8 - TP4G
- Configuration Pin #9 - TP5D
- Configuration Pin #10 - TP5E
- Configuration Pin #11 - TP5F
- Configuration Pin #12 - TP5G
- Configuration Pin #13 - TP6D
- Configuration Pin #14 - TP6E
- Configuration Pin #15 - TP6F
- Configuration Pin #16 - TP6G
- Configuration Pin #17 - TP7D
- Configuration Pin #18 - TP7E
- Configuration Pin #19 - TP7F
- Configuration Pin #20 - TP7G

Configuration Pins #1 and #2 are used for determining if an external HPA is fitted.

Configuration Pins #3 through #20 are implemented (electrically) in the same way and they use 'multiplexed pin programming', that is where each input pin can be connected to one of the seven service availability discrete or remain not connected. Hence each of these input pin can have 8 possible states and thus, for example, can indicate 3 independent binary configuration options.

The following discrete outputs provide the multiplexed matrix select strapping:

- Service availability discrete #1 (MP11E)
- Service availability discrete #2 (MP11F)
- Service availability discrete #3 (MP12E)
- Service availability discrete #4 (MP12F)
- Service availability discrete #5 (MP13E)
- Service availability discrete #6 (MP13F)
- Service availability discrete #7 (MP14E)

ATTACHMENT 1 STANDARD INTERFACES

Mandatory Configuration Pins

Pins TP3D and TP3E should be used on all aircraft installations since they may be used by SDU manufacturers as a hardware-implemented safety override to force the internal HPA function into low-power mode when connected to an external HPA. These pins are considered mandatory for the aircraft, but not for the SDU.

Pin TP3F should be used on all aircraft installations since it indicates that the number of all configuration pins (excluding TP3D) including the parity pin itself connected to a service availability discrete (or TP3D) is odd.

Pin TP3G should be used on all aircraft installations since one of its functions is to indicate whether all other configuration pins (excluding TP3D, TP3E, TP3F, TP3G, and TP4D) should be used by the SDU.

Pin TP4D should be used on all aircraft installations since it indicates the SDU number (1 or 2).

Pin TP6D should be used to define sense of WOW input, rather than using an ORT item. Implementing this function in ORT could lead to inability to correct a mistake in the ORT while the aircraft is on the ground.

Optional Configuration Pins

All other configurations pins are optional and will not be used by the SDU if TP3G is connected appropriately.

Simplified Implementation of Mandatory Configuration Pins

This section describes an alternate, simplified implementation for an SDU which implements only the mandatory configuration PINs. It does away with the service availability discrete. This simplified implementation is well suited for compact SDUs (as described in Attachment 7) where space for implementing configuration pins is limited. An SDU implementing the full suite of configuration pins may also be made compatible with this Simplified Implementation by only reading essential information from the configuration pins and obtaining the rest of the information from the ORT. The pins operate as follows:

TP3D: 0 Vdc from SDU (no change from full configuration).

TP3E: When not grounded, it indicates that an external HPA is fitted (no change).

TP3F: Grounded or open so that the number of all configuration pins (**excluding the Service Availability Pins**) which are grounded (or connected to TP3D), including the parity pin itself, is odd.

TP3G: When not connected, it indicates that the non-essential configuration pins should be ignored (compatible with full configuration). An SDU which only implements the Simplified Implementation of configuration pins can therefore ignore this pin.

TP4D: When unconnected, it indicates SDU#1. Ground indicates SDU#2.

TP6D: When unconnected: WOW True (WOW input MP7D is grounded when aircraft is on the ground). When TP6D is grounded: WOW false (inverted sense on WOW input).

**ATTACHMENT 1
STANDARD INTERFACES**

Signal received by MP7D (WOW Input)	TP6D	Meaning
DC ground	Not connected (WOW True)	Aircraft on ground
Open circuit	Not connected (WOW True)	Aircraft in air
DC ground	Connected to TP3D (WOW False)	Aircraft in air
Open circuit	Connected to TP3D (WOW False)	Aircraft on ground

1.2 Functions Implemented by Pin Programming

The following provides a brief description of each programmable configuration, together with the SDU ARINC 600 pin that is used for programming:

TP3D and TP3E

- External HPA installed – Identifies if an external HPA is fitted or not. If an external HPA is fitted, this can be used to limit the SDU RF output power. Note that TP3D is a 0 V output from the SDU.

TP3F

- Program Pin Parity concerning pins TP3E, TP3G, TP4D, TP4E, TP4F, TP4G, TP5D, TP5E, TP5F, TP5G, TP6D, TP6E, TP6F, TP6G, TP7D, TP7E, TP7F, and TP7G.

TP3G

- SCM Presence – Identifies if a SCM is fitted or not.
- Use other straps – Identifies whether configuration pin, TP4E, TP4F, TP4G, TP5D, TP5E, TP5F, TP5G, TP6D, TP6E, TP6F, TP6G, TP7D, TP7E, TP7F, and TP7G should be read or not. If they are not read, then information for these parameters may be found in the ORT. In all cases configuration pins TP3D, TP3E, TP3F, TP3G, and TP4D should be used by the SDU.
- Secure ORT location – Identifies whether the Secure ORT is located in the SDU (and is modifiable or not) or in the SCM.
- User ORT location – Identifies whether the User ORT is located in the SDU or in the SCM.

Note: Although this pin defines 4 variables, they are not fully independent. The five most likely combinations have been defined in the table below.

TP4D

- SDU **Position** Number – Identifies the SDU installed **as SDU#1 or SDU#2** onboard the aircraft.

TP4E

- CCS Presence – Identifies whether or not a CCS is wired to the SDU CEPT-E1 port.
- CMU #1 Configuration – Identifies if CMUI #1 is installed.
- CMU #2 Configuration – Identifies if CMUI #2 is installed.

ATTACHMENT 1 STANDARD INTERFACES

TP4F and TP4G

- Antenna Subsystem Configuration – Identifies the antenna subsystem configuration.

TP5D

- SDU Controller Type – Identifies whether the controller type is ARINC 739 MCDU/SCDU or ARINC 741P2 Attachment 2F-42.1 WSC.
- SCDU/WSCI #1 Configuration – Identifies if SCDU/WSCI #1 is installed.
- SCDU/WSCI #2 Configuration – Identifies if SCDU/WSCI #2 is installed.

TP5E

- SCDU/WSCI #3 Configuration – Identifies if SCDU/WSCI #3 is installed.
- ARINC 429 Bus Speed to SCDU/WSCI #1, #2, #3 – Identifies the ARINC 429 Bus Speed to SCDU/WSCI #1, #2, #3.
- Swift64 Activation – Enables the Swift64 functionality.

TP5F

- Ethernet 11 Presence – Identifies whether or not this port is wired.
- Ethernet 12 Presence – Identifies whether or not this port is wired.
- Ethernet #1 Presence – Identifies whether or not this port is wired.

TP5G

- Ethernet #2 Presence – Identifies whether or not this port is wired.
- Ethernet #3 Presence – Identifies whether or not this port is wired.
- Ethernet #4 Presence – Identifies whether or not this port is wired.

TP6D

- WOW logic – Identifies the meaning of the WOW signal received by MP7D (WOW input) based on a TRUE/FALSE status of pin TP6D:

Signal received by MP7D	TP6D	Meaning
DC ground	Not connected or connected to MP11E or MP11F or MP12E (WOW True)	Aircraft on ground
Open circuit	Not connected or connected to MP11E or MP11F or MP12E (WOW True)	Aircraft in air
DC ground	Connected to MP12F or MP13E or MP13F or MP14E (WOW False)	Aircraft in air
Open circuit	Connected to MP12F or MP13E or MP13F or MP14E (WOW False)	Aircraft on ground

- SDU Configuration – Identifies whether or not the second SDU is installed.
- SwiftBroadband Activation – Enables the SwiftBroadband functionality.

ATTACHMENT 1 STANDARD INTERFACES

TP6E

- WOW Input Presence – Identifies whether or not the MP7D (WOW input) is wired.
- GNSS frequency check – Identifies whether or not the GNSS frequency check is implemented, and if so the value of f_{limit} (1585 MHz or 1605 MHz - see Section 3.1.2.4)
- SwiftBroadband Safety Activation – Enables the SwiftBroadband Safety functionality. (Note: SwiftBroadband must already be activated (TP6D).)

TP6F, 6G, 7D, 7E, 7F, 7G

- These pins are spares.

2.0 TP3D AND TP3E: TYPE OF HPA

These pins indicate if an external HPA is connected.

TP3D should be connected to 0 V inside the SDU.

	TP3D Connected to TP3E in Aircraft Wiring	TP3D not Connected to TP3E in Aircraft Wiring
Meaning	External HPA not fitted	External HPA fitted

3.0 TP3F: PROGRAM PIN PARITY:

This pin represents the parity concerning pins TP3E, TP3G, TP4D, TP4E, TP4F, TP4G, TP5D, TP5E, TP5F, TP5G, TP6D, TP6E, TP6F, TP6G, TP7D, TP7E, TP7F, and TP7G.

	TP3F not Connected	TP3F Connected to MP11E
Meaning	Number of all other straps (TP3E, TP3G, TP4D, TP4E, TP4F, TP4G, TP5D, TP5E, TP5F, TP5G, TP6D, TP6E, TP6F, TP6G, TP7D, TP7E, TP7F, TP7G) connected to a Service Availability discrete (or TP3D in the case of TP3E) is odd.	Number of all other straps (TP3E, TP3G, TP4D, TP4E, TP4F, TP4G, TP 5D, TP 5E, TP5F, TP5G, TP6D, TP6E, TP6F, TP6G, TP7D, TP7E, TP7F, TP7G) connected to a Service Availability discrete (or TP3D in the case of TP3E) is even.

Note: A more advanced and robust scheme could be defined for the parity in the future. Consequently, the SDU should be able to interpret when TP3F is connected to any service availability discrete used for strapping (MP11F, MP12E, MP12F, MP13E, MP13F, and MP14E).

4.0 TP3G, TP4D, TP4E, TP4F, TP4G, TP5D, TP5E, TP5F, TP5G, TP6D, AND TP6E: VARIOUS FUNCTIONS

Example (for pin TP4E)

If TP4E is not connected, then the SDU's interpretation should be:

- A CCS is not installed, CMU#1 is not installed, and CMU#2 is not installed.

If TP4E is connected to MP12F, then the SDU's interpretation should be:

- A CCS is installed, CMU#1 is not installed, and CMU#2 is not installed.

**ATTACHMENT 1
STANDARD INTERFACES**

	Config Pin Inputs	not connected	MP11E	MP11F	MP12E	MP12F	MP13E	MP13F	MP14E
	↓	SDU Interpretation of Config Pins When Config Pin Input is Connected to The Selected Service Availability Discrete							
	TP3G	Do not use other straps – info in ORT	Use other straps	Use other straps	Use other straps	Use other straps	Not defined	Not defined	Not defined
		SCM installed	SCM not installed	SCM installed	SCM not installed	SCM installed	Not defined	Not defined	Not defined
		Secure ORT in SCM	Secure ORT in SDU (non-modifiable)	Secure ORT in SDU (non-modifiable)	Secure ORT in SDU (modifiable)	Secure ORT in SDU (modifiable)	Not defined	Not defined	Not defined
		User ORT in SCM	User ORT in SDU	User ORT in SCM	User ORT in SDU	User ORT in SCM	Not defined	Not defined	Not defined
	TP4D Note 1	This is SDU1 Spare 1 Not installed Spare 2 Not installed	This is SDU1 Spare 1 Not installed Spare 2 installed	This is SDU1 Spare 1 Not installed Spare 2 Not installed	This is SDU1 Spare 1 Not installed Spare 2 installed	This is SDU2 Spare 1 Not installed Spare 2 Not installed	This is SDU2 Spare 1 Not installed Spare 2 installed	This is SDU2 Spare 1 Not installed Spare 2 Not installed	This is SDU2 Spare 1 Not installed Spare 2 installed
	TP4E	CCS Not Installed	CCS Not Installed	CCS Not Installed	CCS Not Installed	CCS Installed	CCS Installed	CCS Installed	CCS Installed
		CMU #1 Not Installed	CMU #1 Not Installed	CMU #1 Installed	CMU #1 Installed	CMU #1 Not Installed	CMU #1 Not Installed	CMU #1 Installed	CMU #1 Installed
		CMU #2 Not Installed	CMU #2 Installed	CMU #2 Not Installed	CMU #2 Installed	CMU #2 Not Installed	CMU #2 Installed	CMU #2 Not Installed	CMU #2 Installed
	TP5D	SDU Controller is MCDU/SCDU	SDU Controller is MCDU/SCDU	SDU Controller is MCDU/SCDU	SDU Controller is MCDU/SCDU	SDU Controller is WSCI	SDU Controller is WSCI	SDU Controller is WSCI	SDU Controller is WSCI
		SCDU#1 Not Installed	SCDU#1 Not Installed	SCDU#1 Installed	SCDU#1 Installed	WSCI#1 Not Installed	WSCI#1 Not Installed	WSCI#1 Installed	WSCI#1 Installed
		SCDU#2 Not Installed	SCDU#2 Installed	SCDU#2 Not Installed	SCDU#2 Installed	WSCI#2 Not Installed	WSCI#2 Installed	WSCI#2 Not Installed	WSCI#2 Installed
	TP5E	SCDU/WSCI#3 Not Installed	SCDU/WSCI#3 Not Installed	SCDU/WSCI#3 Not Installed	SCDU/WSCI#3 Not Installed	SCDU/WSCI#3 Installed	SCDU/WSCI#3 Installed	SCDU/WSCI#3 Installed	SCDU/WSCI#3 Installed
		Low-Speed ARINC 429 Bus to SCDU/WSCI #1, #2, #3	Low-Speed ARINC 429 Bus to SCDU/WSCI #1, #2, #3	High-Speed ARINC 429 Bus to SCDU/WSCI #1, #2, #3	High-Speed ARINC 429 Bus to SCDU/WSCI #1, #2, #3	Low-Speed ARINC 429 Bus to SCDU/WSCI #1, #2, #3	Low-Speed ARINC 429 Bus to SCDU/WSCI #1, #2, #3	High-Speed ARINC 429 Bus to SCDU/WSCI #1, #2, #3	High-Speed ARINC 429 Bus to SCDU/WSCI #1, #2, #3
		Swift64 disabled	Swift64 enabled	Swift64 disabled	Swift64 enabled	Swift64 disabled	Swift64 enabled	Swift64 disabled	Swift64 enabled
	TP5F	Ethernet 11 Not Wired	Ethernet 11 Not Wired	Ethernet 11 Not Wired	Ethernet 11 Not Wired	Ethernet 11 Wired	Ethernet 11 Wired	Ethernet 11 Wired	Ethernet 11 Wired
		Ethernet 12 Not Wired	Ethernet 12 Not Wired	Ethernet 12 Wired	Ethernet 12 Wired	Ethernet 12 Not Wired	Ethernet 12 Not Wired	Ethernet 12 Wired	Ethernet 12 Wired
		Ethernet #1 Not Wired	Ethernet #1 Wired	Ethernet #1 Not Wired	Ethernet #1 Wired	Ethernet #1 Not Wired	Ethernet #1 Wired	Ethernet #1 Not Wired	Ethernet #1 Wired
	TP5G	Ethernet #2 Not Wired	Ethernet #2 Not Wired	Ethernet #2 Not Wired	Ethernet #2 Not Wired	Ethernet #2 Wired	Ethernet #2 Wired	Ethernet #2 Wired	Ethernet #2 Wired
		Ethernet #3 Not Wired	Ethernet #3 Not Wired	Ethernet #3 Wired	Ethernet #3 Wired	Ethernet #3 Not Wired	Ethernet #3 Wired	Ethernet #3 Wired	Ethernet #3 Wired
		Ethernet #4 Not Wired	Ethernet #4 Wired	Ethernet #4 Not Wired	Ethernet #4 Wired	Ethernet #4 Not Wired	Ethernet #4 Wired	Ethernet #4 Not Wired	Ethernet #4 Wired
	TP6D	WOW True	WOW True	WOW True	WOW True	WOW False	WOW False	WOW False	WOW False
		2 nd SDU Not Installed	2 nd SDU Not Installed	2 nd SDU Installed	2 nd SDU Installed	2 nd SDU Not Installed	2 nd SDU Not Installed	2 nd SDU Installed	2 nd SDU Installed
		SwiftBroadband Disabled	SwiftBroadband Enabled	SwiftBroadband Disabled	SwiftBroadband Enabled	SwiftBroadband Disabled	SwiftBroadband Enabled	SwiftBroadband Disabled	SwiftBroadband Enabled
	TP6E	WOW Not Wired	WOW Not Wired	WOW Not Wired	WOW Not Wired	WOW Wired	WOW Wired	WOW Wired	WOW Wired
		No GNSS frequency check	GNSS frequency check with $f_{limit} = 1585\text{MHz}$	GNSS frequency check with $f_{limit} = 1605\text{MHz}$	GNSS frequency check with $f_{limit} = 1585\text{MHz}$	No GNSS frequency check	GNSS frequency check with $f_{limit} = 1585\text{MHz}$	GNSS frequency check with $f_{limit} = 1605\text{MHz}$	GNSS frequency check with $f_{limit} = 1585\text{MHz}$
		SwiftBroadband Safety Disabled	SwiftBroadband Safety Enabled	SwiftBroadband Safety Disabled	SwiftBroadband Safety Enabled	SwiftBroadband Safety Disabled	SwiftBroadband Safety Enabled	SwiftBroadband Safety Disabled	SwiftBroadband Safety Enabled

**ATTACHMENT 1
STANDARD INTERFACES**

Note 1: As long as Spare 1 and Spare 2 are not defined for TP4D, TP4D should either not be connected (SDU #1) or connected to MP12F (SDU #2).

5.0 TP4F AND TP4G: ANTENNA SUBSYSTEM CONFIGURATION

These pins are used to indicate one of 64 possible antenna configurations.

Configuration Number	Antenna Subsystem Configuration	Connect TP4F to:	Connect TP4G to:
1	ARINC 781 HGA	Open	Open
2	ARINC 781 IGA	Open	MP11E
3	LGA + LGA HPA	Open	MP11F
4	ARINC 741 TOP BSU + TOP HGA + HGA HPA	Open	MP12E
5	ARINC 741 PORT BSU + PORT HGA + STARBOARD BSU + STARBOARD HGA + HGA HPA + HPR	Open	MP12F
6	Reserved for future use.	Open	MP13E
7	Reserved for future use.	Open	MP13F
8	Reserved for manufacturer.	Open	MP14E
9	Reserved for future use.	MP11E	Open
10	Reserved for future use.	MP11E	MP11E
11	Reserved for future use.	MP11E	MP11F
12	Reserved for future use.	MP11E	MP12E
13	Reserved for future use.	MP11E	MP12F
14	Reserved for future use.	MP11E	MP13E
15	Reserved for future use.	MP11E	MP13F
16	Reserved for future use.	MP11E	MP14E
17	Reserved for future use.	MP11F	Open
18	Reserved for future use.	MP11F	MP11E
19	Reserved for future use.	MP11F	MP11F
20	Reserved for future use.	MP11F	MP12E
21	Reserved for future use.	MP11F	MP12F
22	Reserved for future use.	MP11F	MP13E
23	Reserved for future use.	MP11F	MP13F
24	Reserved for future use.	MP11F	MP14E
25	Reserved for future use.	MP12E	Open
26	Reserved for future use.	MP12E	MP11E
27	Reserved for future use.	MP12E	MP11F
28	Reserved for future use.	MP12E	MP12E
29	Reserved for future use.	MP12E	MP12F
30	Reserved for future use.	MP12E	MP13E
31	Reserved for future use.	MP12E	MP13F
32	Reserved for future use.	MP12E	MP14E
33	Reserved for future use.	MP12F	Open
34	Reserved for future use.	MP12F	MP11E
35	Reserved for future use.	MP12F	MP11F
36	Reserved for future use.	MP12F	MP12E
37	Reserved for future use.	MP12F	MP12F
38	Reserved for future use.	MP12F	MP13E
39	Reserved for future use.	MP12F	MP13F
40	Reserved for future use.	MP12F	MP14E

**ATTACHMENT 1
STANDARD INTERFACES**

Configuration Number	Antenna Subsystem Configuration	Connect TP4F to:	Connect TP4G to:
41	Reserved for future use.	MP13E	Open
42	Reserved for future use.	MP13E	MP11E
43	Reserved for future use.	MP13E	MP11F
44	Reserved for future use.	MP13E	MP12E
45	Reserved for future use.	MP13E	MP12F
46	Reserved for future use.	MP13E	MP13E
47	Reserved for future use.	MP13E	MP13F
48	Reserved for future use.	MP13E	MP14E
49	Reserved for future use.	MP13F	Open
50	Reserved for future use.	MP13F	MP11E
51	Reserved for future use.	MP13F	MP11F
52	Reserved for future use.	MP13F	MP12E
53	Reserved for future use.	MP13F	MP12F
54	Reserved for future use.	MP13F	MP13E
55	Reserved for future use.	MP13F	MP13F
56	Reserved for future use.	MP13F	MP14E
57	Reserved for future use.	MP14E	Open
58	Reserved for future use.	MP14E	MP11E
59	Reserved for future use.	MP14E	MP11F
60	Reserved for future use.	MP14E	MP12E
61	Reserved for future use.	MP14E	MP12F
62	Reserved for future use.	MP14E	MP13E
63	Reserved for future use.	MP14E	MP13F
64	Reserved for future use.	MP14E	MP14E

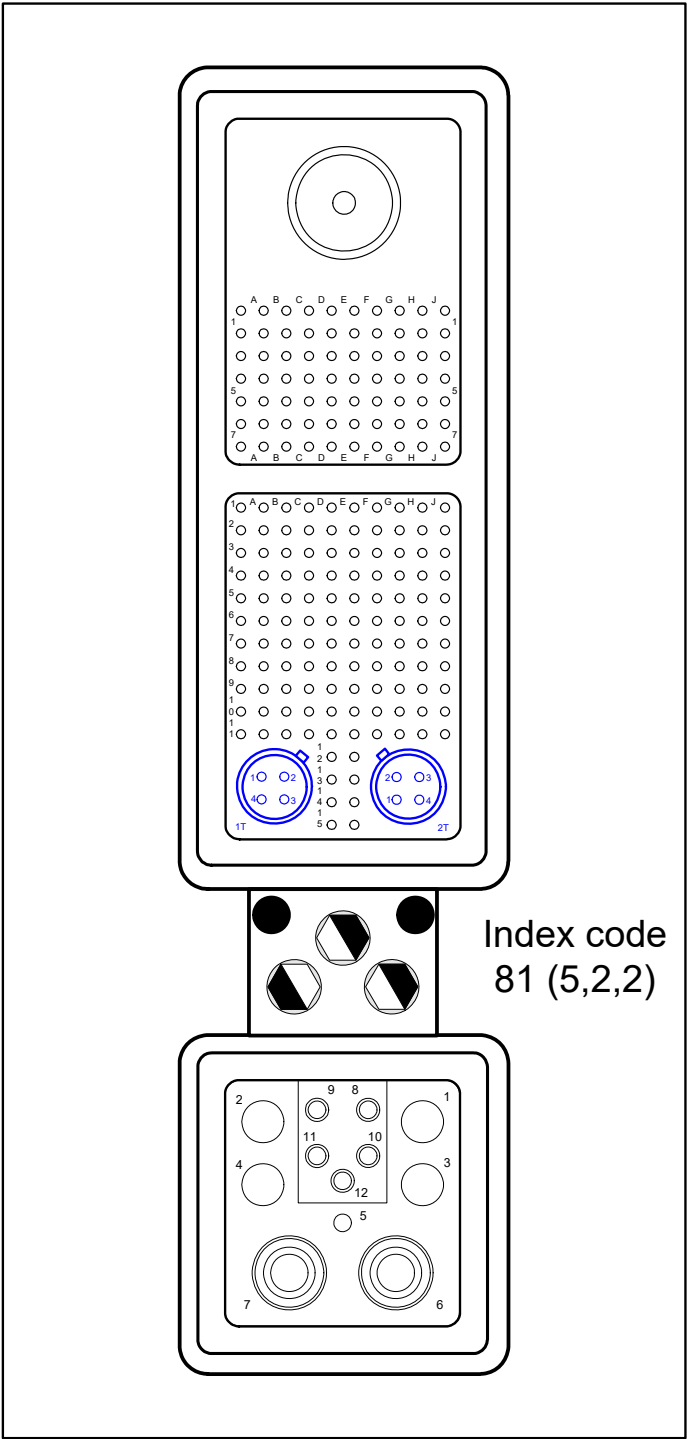
6.0 TP6F, TP6G, TP7D, TP7E, TP7F, AND TP7G: SPARES

These pins are reserved for future growth and will be implemented using the same multiplexed scheme as defined for TP3F, TP3G, TP4D, TP4E, TP4F, TP4G, TP5D, TP5E, TP5F, TP5G, TP6D, and TP6E.

ATTACHMENT 1
STANDARD INTERFACES

1.5 SDU Form Factor

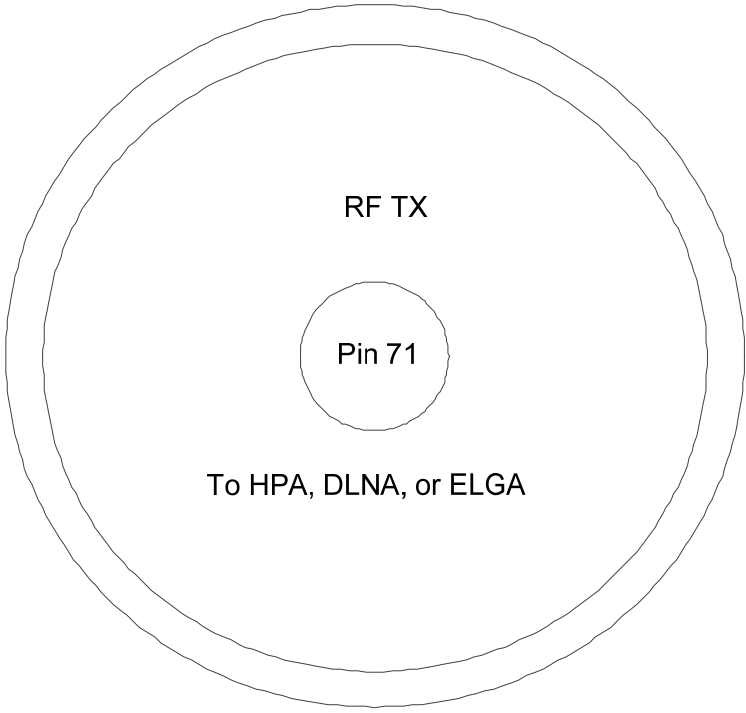
SIZE 6 MCU
#2 Shell Connector



For the index code pins above, the dark color represents the post.

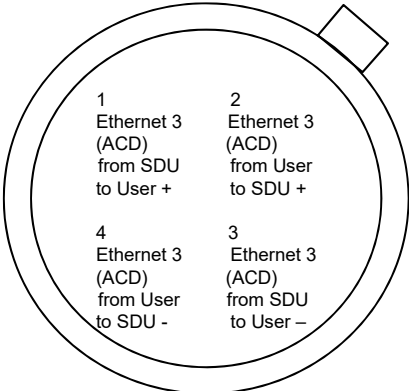
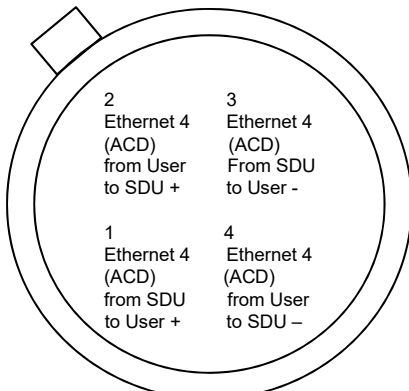
**ATTACHMENT 1
STANDARD INTERFACES**

1.5A SDU Top Plug Connector Layout

	A	B	C	D	E	F	G	H	J	K
										
1	ATE Pin 1	ATE Pin 2	ATE Pin 3	ATE Pin 4	ATE Pin 5	ATE Pin 6	ATE Pin 7	ATE Pin 8	ATE Pin 9	ATE Pin 10
2	Empty Cavity	Empty Cavity	Empty Cavity	ATE Pin 14	ATE Pin 15	ATE Pin 16	ATE Pin 17	Empty Cavity	Empty Cavity	Empty Cavity
3	Ethernet 1 (AISD) from SDU to User +	Ethernet 1 (AISD) from User to SDU +	Empty Cavity	Config Pin 1	Config Pin 2	Config Pin 3	Config Pin 4	Empty Cavity	Ethernet 11 (AISD) from SDU To User +	Ethernet 11 (AISD) from User to SDU +
4	Ethernet 1 (AISD) from User to SDU -	Ethernet 1 (AISD) from SDU to User -	Empty Cavity	Config Pin 5	Config Pin 6	Config Pin 7	Config Pin 8	Empty Cavity	Ethernet 11 (AISD) from User To SDU -	Ethernet 11 (AISD) from SDU to User -
5	Empty Cavity	Empty Cavity	Empty Cavity	Config Pin 9	Config Pin 10	Config Pin 11	Config Pin 12	Empty Cavity	Empty Cavity	Empty Cavity
6	Ethernet 2 (PIESD) from SDU to User +	Ethernet 2 (PIESD) from User to SDU +	Empty Cavity	Config Pin 13 [SPARE]	Config Pin 14 [SPARE]	Config Pin 15 [SPARE]	Config Pin 16 [SPARE]	Empty Cavity	Ethernet 12 (PIESD) from SDU to User +	Ethernet 12 (PIESD) from User to SDU +
7	Ethernet 2 (PIESD) from User to SDU -	Ethernet 2 (PIESD) from SDU to User -	Empty Cavity	Config Pin 17 [SPARE]	Config Pin 18 [SPARE]	Config Pin 19 [SPARE]	Config Pin 20 [SPARE]	Empty Cavity	Ethernet 12 (PIESD) from User to SDU -	ISDN 2 from SDU to User -

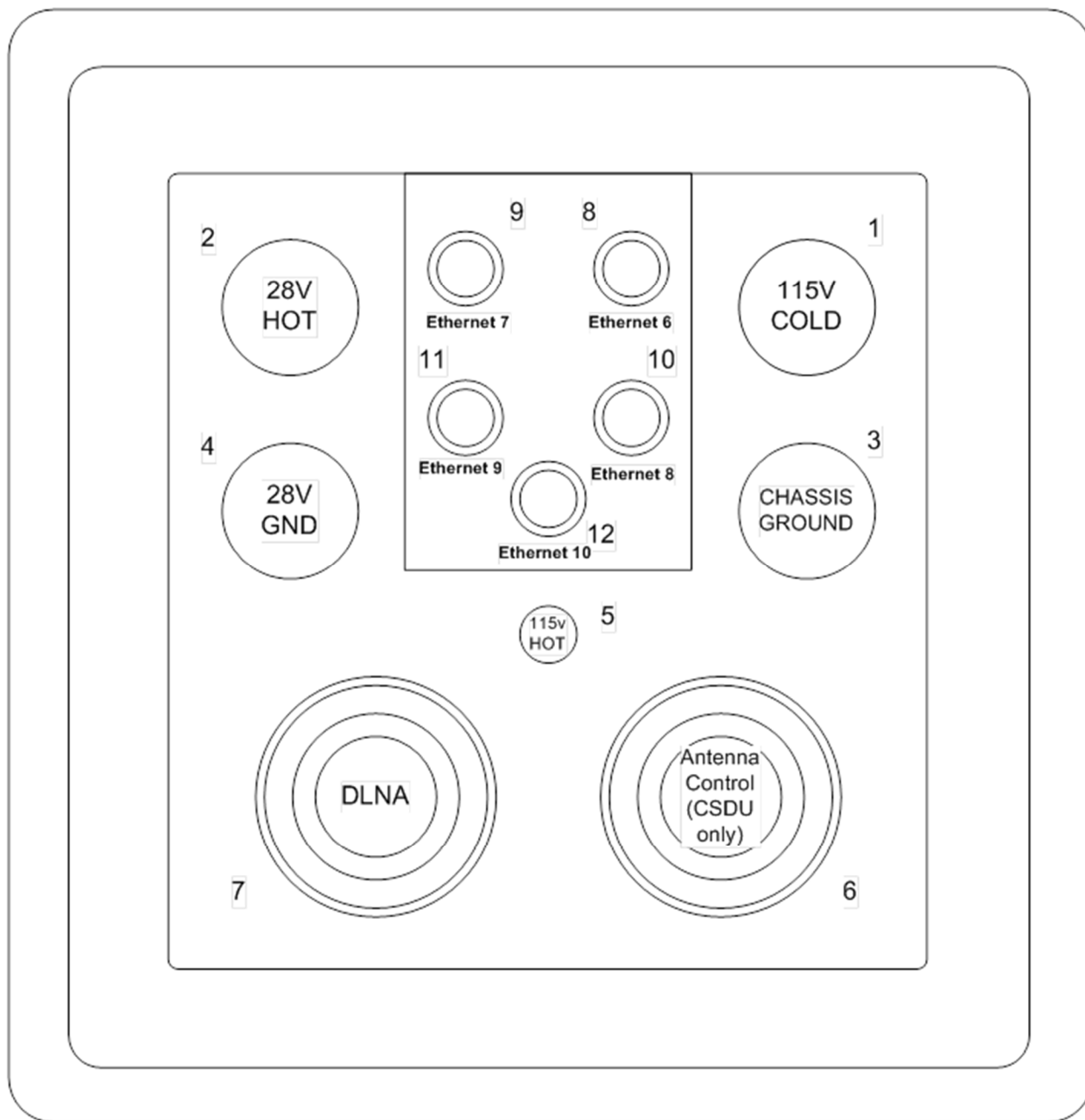
ATTACHMENT 1 STANDARD INTERFACES

1.5B SDU Middle Plug Connector Layout

	A	B	C	D	E	F	G	H	J	K
1	Data from MCDU 1 A	Data from MCDU 1 B	Call Place/End Discrete Input 1	SCM Pwr +8 to +15 V	Multi-Control Output A	Multi-Control Output B	Resv Ext Reset Discrete Input	Call Place/End Discrete Input 2	Data from MCDU 2 A	Data from MCDU 2 B
2	Data from Primary IRS/GNSS A	Data from Primary IRS/GNSS B	Cockpit Voice Chime Signal Contact 1	SCM Pwr Return 0 V	BITE Input From HPA A	BITE Input From HPA B	Rsvd Mfr - Specific 0-28V Discrete Output	Cockpit Voice Chime Signal Contact 2	Data from Secondary IRS A	Data from Secondary IRS B
3	Data from CMU 1 A	Data from CMU 1 B	Cockpit Voice Call Light Output 1	SDU Data to SCM A	Spare Discrete Output	Spare Discrete Input	SPARE	Cockpit Voice Call Light Output 2	Data from CMU 2 A	Data from CMU 2 B
4	Cockpit Audio Input 1 High	Cockpit Audio Input 1 Low	Cockpit Voice Mic-On Input 1	SDU Data to SCM B	Spare Discrete Output	Spare Discrete Input	SPARE	Cockpit Voice Mic-On Input 2	Cockpit Audio Input 2 High	Cockpit Audio Input 2 Low
5	Cockpit Audio Output 1 High	Cockpit Audio Output 1 Low	Cockpit Voice Go Ahead Chime Reset 1	SCM Data to SDU A	Spare Discrete Output	Spare Discrete Input	Spare ARINC 429 Output A	Spare ARINC 429 Output B	Cockpit Audio Output 2 High	Cockpit Audio Output 2 Low
6	Spare Discrete Input	Spare Discrete Input	Spare Discrete Input	SCM Data to SDU B	Ethernet 5 (ACD) from SDU to User+	Ethernet 5 (ACD) from SDU to User-	Spare ARINC 429 Input A	Spare ARINC 429 Input B	Data from GNSS to SDU A	Data from GNSS to SDU B
7	AES ID Input A	AES ID Input B	Spare Discrete Input	WOW Input 1	Ethernet 5 (ACD) from User to SDU+	Ethernet 5 (ACD) from User to SDU-	Spare ARINC 429 Output A	Spare ARINC 429 Output B	Data to CMU 1 and 2 A	Data to CMU 1 and 2 B
8	Data from CFDS A	Data from CFDS B	BITE Input Top/Port BSU/Ant A	BITE Input Top/Port BSU/Ant B	Data Loader Link A	TX Mute Input	BITE Input STBD BSU A	BITE Input STBD BSU B	Data to CFDS A	Data to CFDS B
9	From Airborne Data Loader A	From Airborne Data Loader B	Crosstalk from other SDU A	Crosstalk from other SDU B	Dual System Select Discrete I/O	Dual System Disable Discrete I/O	Crosstalk to other SDU A	Crosstalk to other SDU B	To Airborne Data Loader A	To Airborne Data Loader B
10	Data from MCDU 3 A	Data from MCDU 3 B	Port BSU HPA Mute Input A	Port BSU HPA Mute Input B	LGA LNA On/Off Control	BITE Input from LGA LNA	STBD BSU HPA Mute Input A	STBD BSU HPA Mute Input B	Data to MCDU 1, 2, 3 A	Data to MCDU 1, 2, 3 B
11	POTS 1 A	POTS 1 B	Cabin CEPT-E1 Data Output A	Cabin CEPT-E1 Data Output B	Service Availability Discrete 1	Service Availability Discrete 2	Cabin CEPT-E1 Data input A	Cabin CEPT-E1 Data Input B	POTS 2 A	POTS 2 B
12					Service Availability Discrete 3	Service Availability Discrete 4				
13					Service Availability Discrete 5	Service Availability Discrete 6				
14					Service Availability Discrete 7	Service Availability Discrete 8				
15					Service Availability Discrete 9	Service Availability Discrete 10				
	1T								2T	

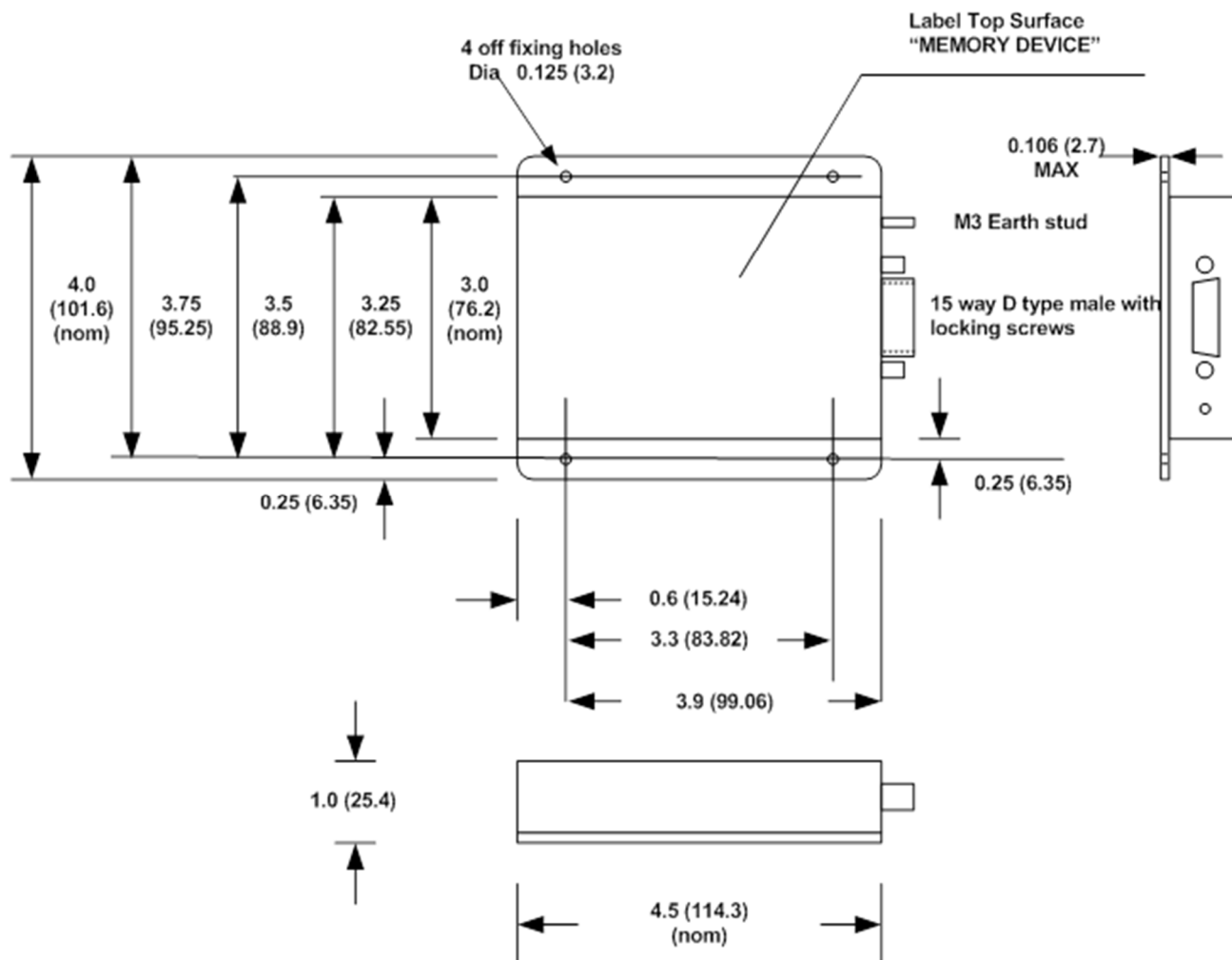
ATTACHMENT 1
STANDARD INTERFACES

1.5C SDU Bottom Plug Connector Layout



ATTACHMENT 1 STANDARD INTERFACES

1.6 SDU Configuration Module Form Factor



Note:

1. All dimensions in inches (mm) unless otherwise stated. Tolerance of fixing centers ± 0.004 (± 0.1).
Tolerance of fixing holes $+0.004$, -0.0 ($+0.1$, -0.0).
All other tolerances ± 0.015 (± 0.4).
Fixing holes are designed for either M3 or 4-40 UNC screws. Earth stud is metric.

**ATTACHMENT 1
STANDARD INTERFACES**

1.6A SDU Configuration Module Connector Layout

SCM Connector is 15-pin D-type male.

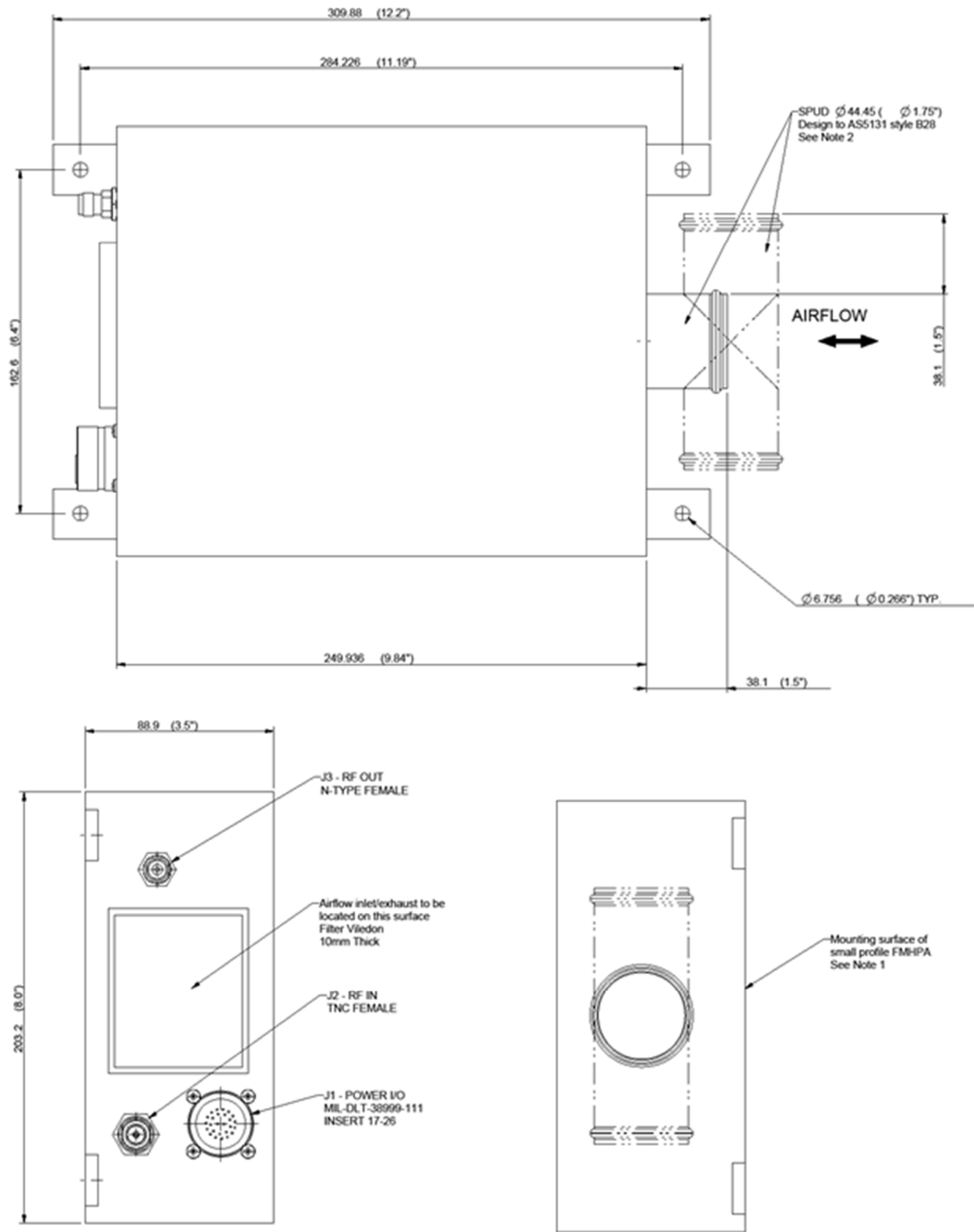
Data to SDU A 1	Data to SDU B	Data from SDU A	Data from SDU B	Reserved RS-232 Gnd	Spare	Chassis Ground	Power Input +8 to +15 V 8
Reserved Enable RS-232 9	Reserved 0 V strap output	Spare	Reserved RS-232 Tx	Reserved RS-232 Rx	Spare	Power Return 0 V 15	

- 1 Data to SDU A (RS-422)
- 2 Data to SDU B (RS-422)
- 3 Data from SDU A (RS-422)
- 4 Data from SDU B (RS-422)
- 5 Reserved – RS-232 Gnd Used for shop loading
- 6 Spare
- 7 Chassis Ground
- 8 Power Input +8 to +15 V
- 9 Reserved – Enable RS-232* Used for shop loading
- 10 Reserved – 0 V strap output Used for shop loading
- 11 Spare
- 12 Reserved – RS-232 Tx Used for shop loading
- 13 Reserved – RS-232 Rx Used for shop loading
- 14 Spare
- 15 Power Return 0 V

* To be used for shop loading of ORT (open = normal operation, connect to pin 10 = shop load and allow use of RS-232 port)

ATTACHMENT 1
STANDARD INTERFACES

1.7A Small Flange Mount HPA Form Factor



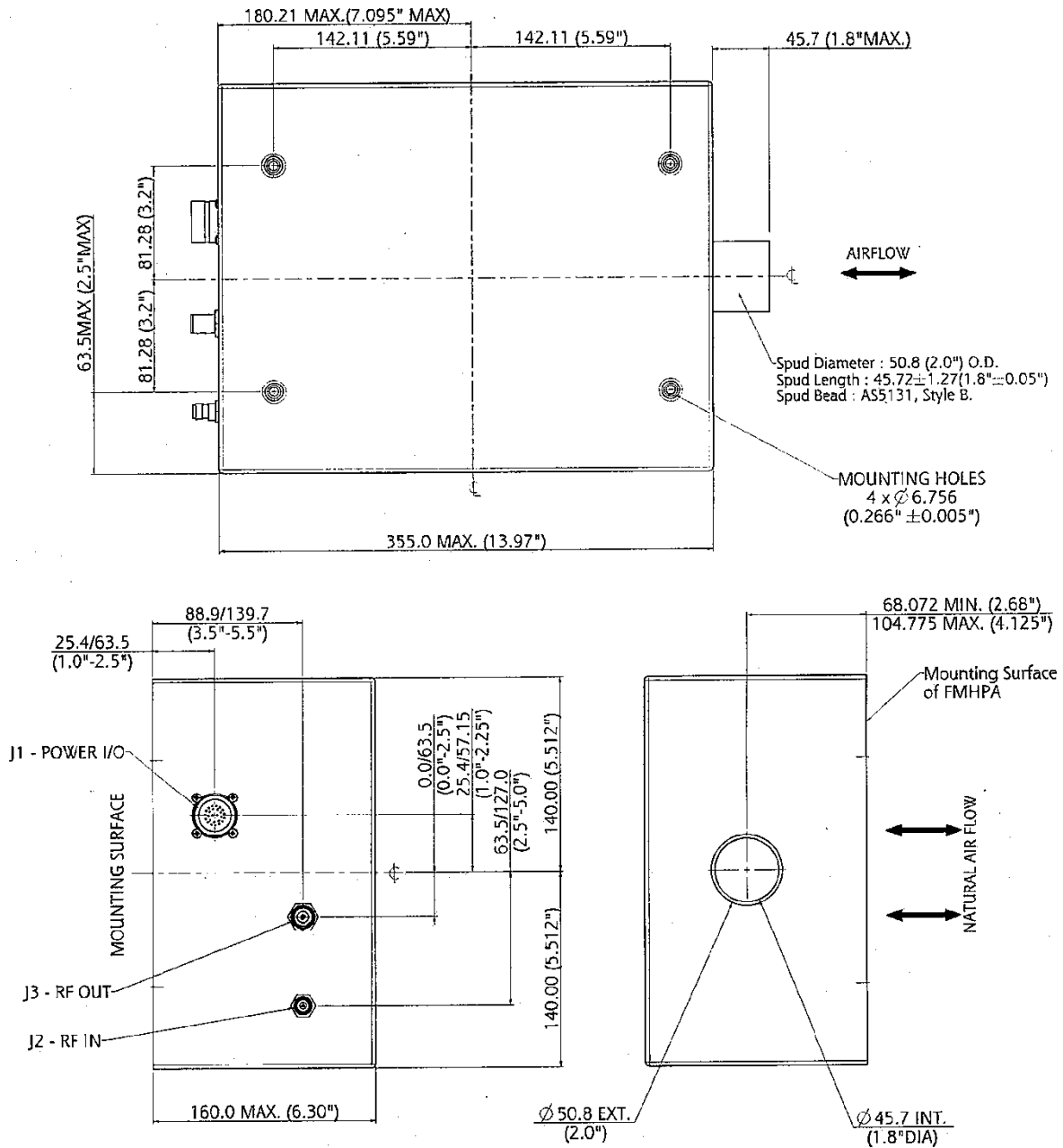
**ATTACHMENT 1
STANDARD INTERFACES**

Notes:

1. Small form factor FMHPA may be mounted in any orientation using the mounting surface defined.
2. Possible alternative cooling spud orientation to accommodate installation constraints.
3. The flange-mount HPA will have three connectors, located as shown:
 - a. J1 - Power/Control MIL-DTL-38999 Series III Insert Arrangement 17-26
 - b. J2 - RF Input; TNC Female
 - c. J3 - RF Output; N Type Female
4. Air filter/mesh may be necessary to prevent debris interference in applications with drawn airflow.

ATTACHMENT 1 STANDARD INTERFACES

1.7B Large Flange Mount HPA Form Factor



Notes:

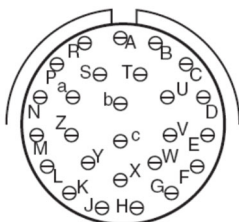
1. The mounting configuration is critical to operation in conditions of loss of cooling (see Section 2.2.2.3). The natural air flow shown represents that of a horizontally mounted FMHPA. Alternative mounting configurations should be discussed with FMHPA manufacturers.
2. Key features are the four mounting holes and the locations of the connectors and airflow adaptor. Clear and unobstructed access to

**ATTACHMENT 1
STANDARD INTERFACES**

mounting fasteners should be provided to facilitate aircraft installation. The envelope shown encompasses any mounting feet protruding from the main body of the unit.

3. A clearance of approximately 1 inch on top, bottom and sides of the large form factor HPA is recommended to facilitate natural cooling particularly in loss of cooling mode. See Section 2.2.2.3. Minor structure intrusions into this clearance may be accommodated with the agreement of both FMHPA manufacturer and installer
4. The flange-mount HPA has three connectors, located as shown:
 - a. J1 - Power/Control MIL-DTL-38999 Series III Insert Arrangement 17-26
 - b. J2 - RF Input; TNC Female
 - c. J3 - RF Output; N Type Female
5. Air filter/mesh may be necessary to prevent debris interference in applications with drawn airflow.

**ATTACHMENT 1
STANDARD INTERFACES**

1.7C Flange Mount HPA Connector Layout**17-26****MIL-DTL-38999 Series III Insert Arrangement 17-26**

External Flange Mounted HPA Connector Pin Layout:

Pin	Note	Signal	Description
A	*	HPA BITE A	ARINC 429 from HPA
B	*	HPA BITE B	ARINC 429 from HPA
C		RS422 RXD A	Serial data to HPA +
D		RS422 RXD B	Serial data to HPA -
E		RS422 TXD A	Serial data from HPA +
F		RS422 TXD B	Serial data from HPA -
G		SPARE	SPARE
H		SPARE	SPARE
J	*	Chassis Ground	Chassis Ground
K		SPARE	SPARE
L		SPARE	SPARE
M		Discrete BITE #1	Discrete BITE #1 from HPA
N		Discrete BITE #2	Discrete BITE #2 from HPA
P	*	HPA Control A	ARINC 429 to HPA
R	*	HPA Control B	ARINC 429 to HPA
S	*	HPA Control Shield	Shield for ARINC 429
T	*	HPA BITE Shield	Shield for ARINC 429
U		RS422 Shield	RS422 Shield
V		SPARE	SPARE
W		SPARE	SPARE
X	*	115 Vac Hot	Aircraft ac power
Y	*	115 Vac Return	Aircraft ac power
Z		SPARE	SPARE
A		Discrete BITE #3	Discrete BITE #3 from HPA
B		ATE Pin	Manufacturer-Specific
C		SPARE	SPARE

Note: * Normally wired in an aircraft

Note that the pins in the connector are believed to not have sufficient current carrying capability for 28 Vdc.

ATTACHMENT 1 STANDARD INTERFACES

1.8 Diplexer/Low-Noise Amplifier Form Factor

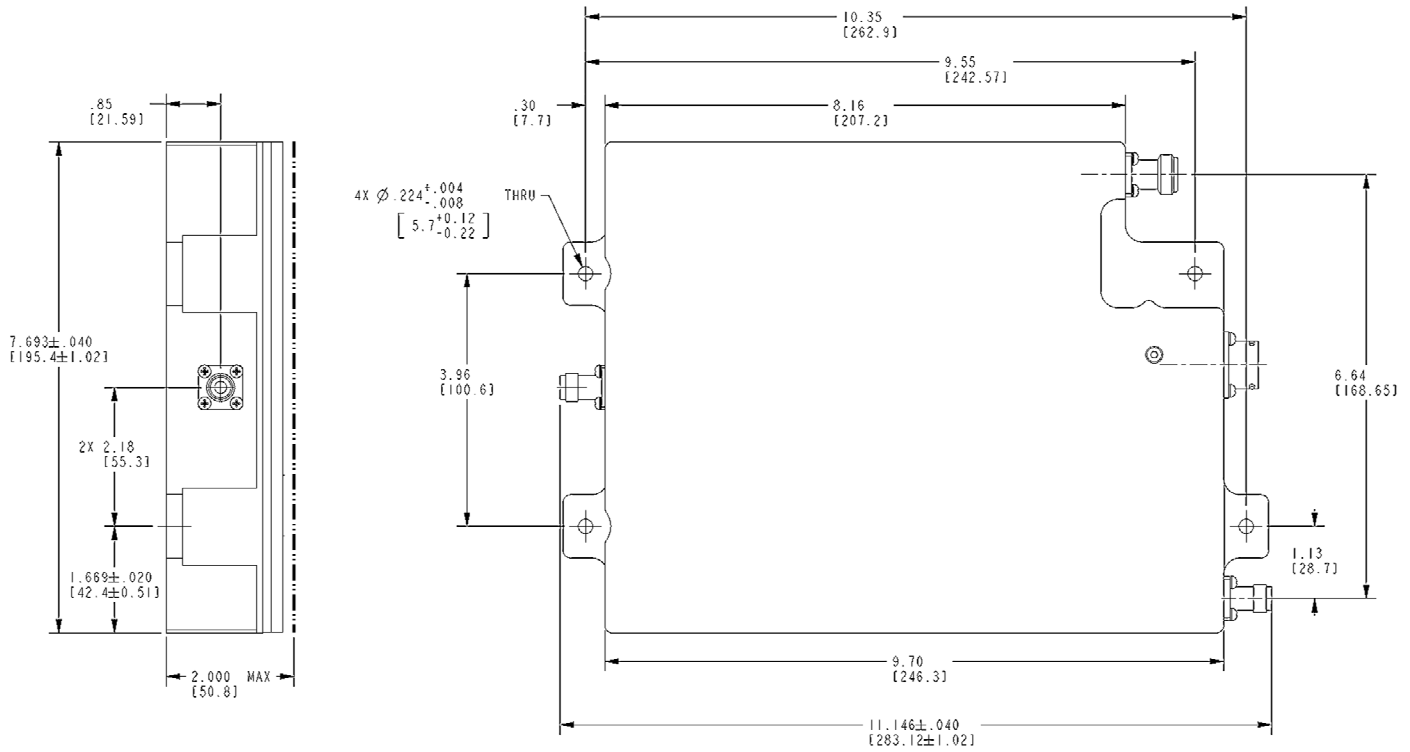


Figure 1 – Type D – Modified Type A DLNA Outline

ATTACHMENT 1
STANDARD INTERFACES

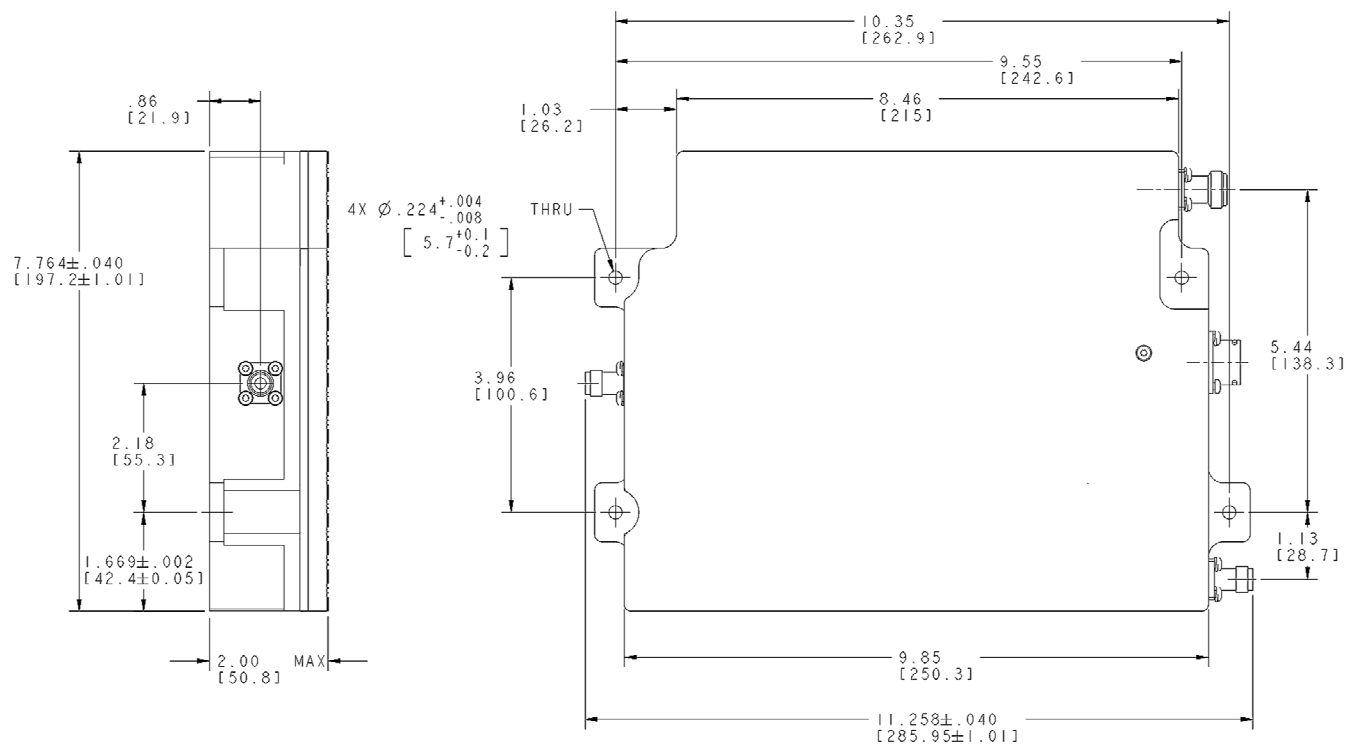
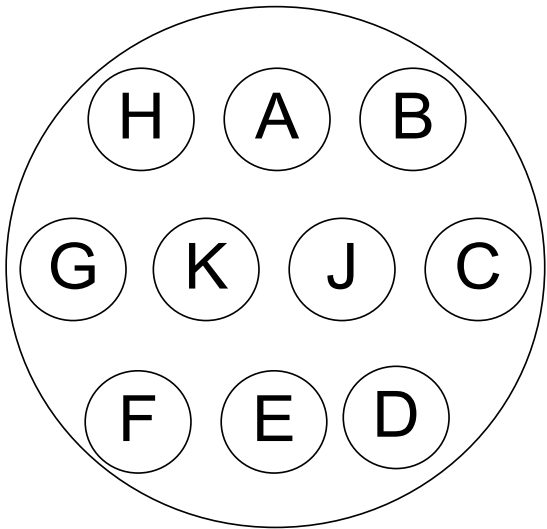


Figure 2 – Type F, H, J DLNA Outline

ATTACHMENT 1
STANDARD INTERFACES

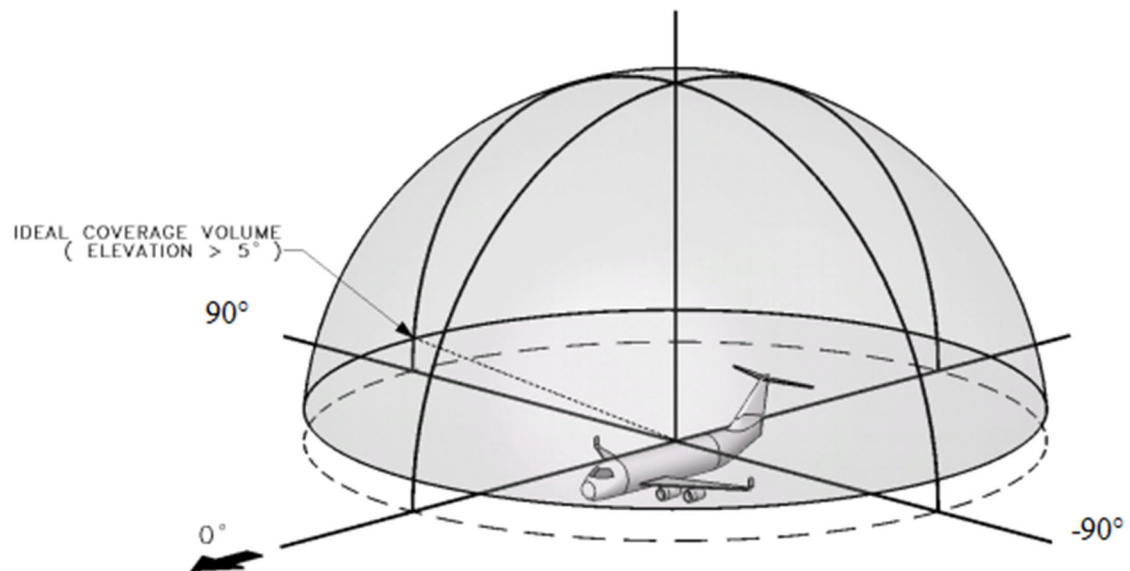
Pin	Description
Pin A	Chassis Ground
Pin B	LNA Control
Pin C	ARINC 429 A from SDU (Type J only) Spare (other DLNAs)
Pin D	ARINC 429 B from SDU (Type J only) Spare (other DLNAs)
Pin E	115 Vac Cold
Pin F	115 Vac Hot
Pin G	+28 Vdc Hot
Pin H	LNA BITE
Pin J	LNA BITE Ground
Pin K	+28 Vdc Return



The DLNA connector is MS3470L1210P or equivalent, which mates with MS3476L1210S or equivalent.

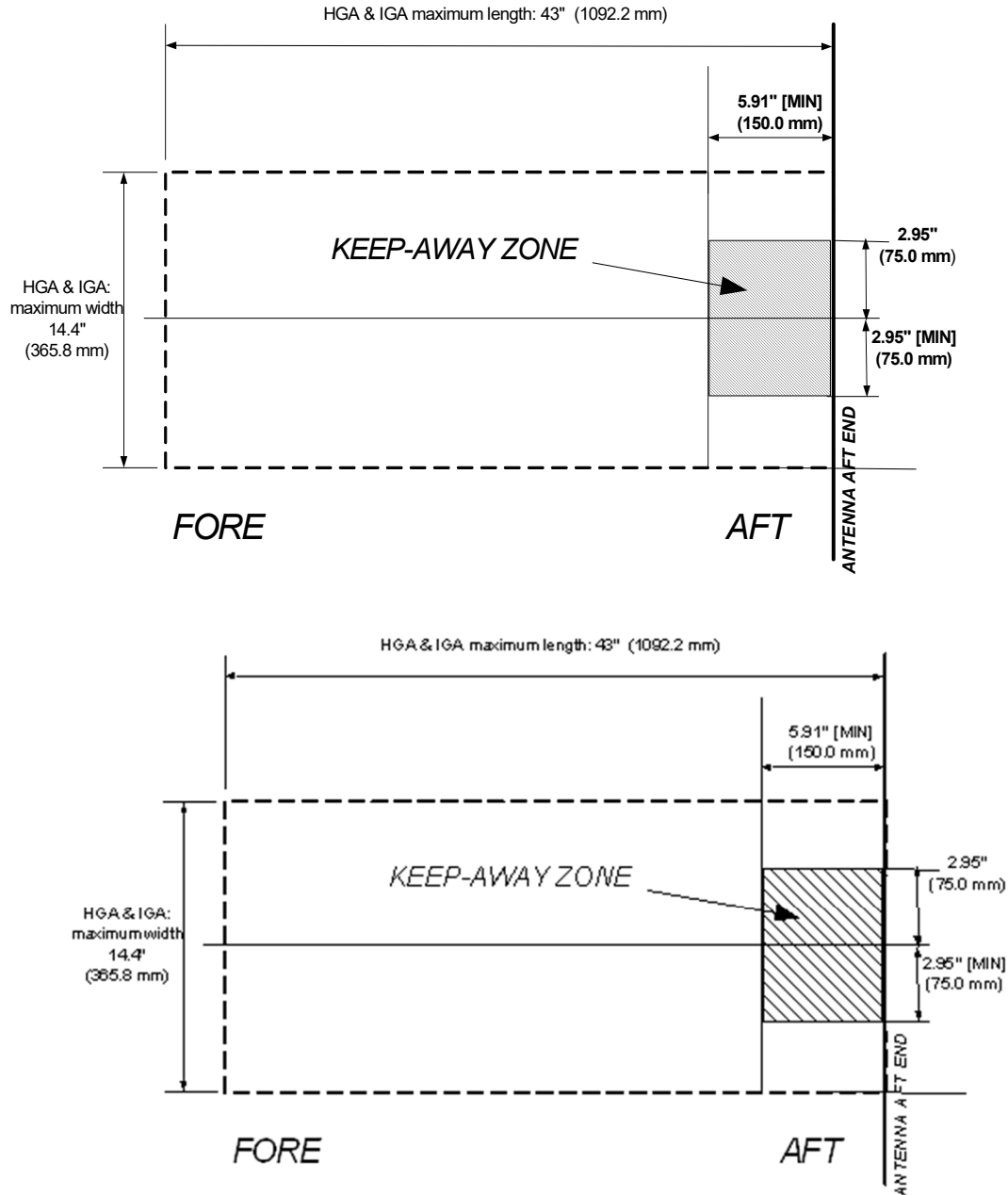
ATTACHMENT 1
STANDARD INTERFACES

1.9 Antenna Coverage



ATTACHMENT 1 STANDARD INTERFACES

1.10 High Gain and Intermediate Gain Top-Mount Antenna Footprint Maximum Dimensional Outline



Notes:

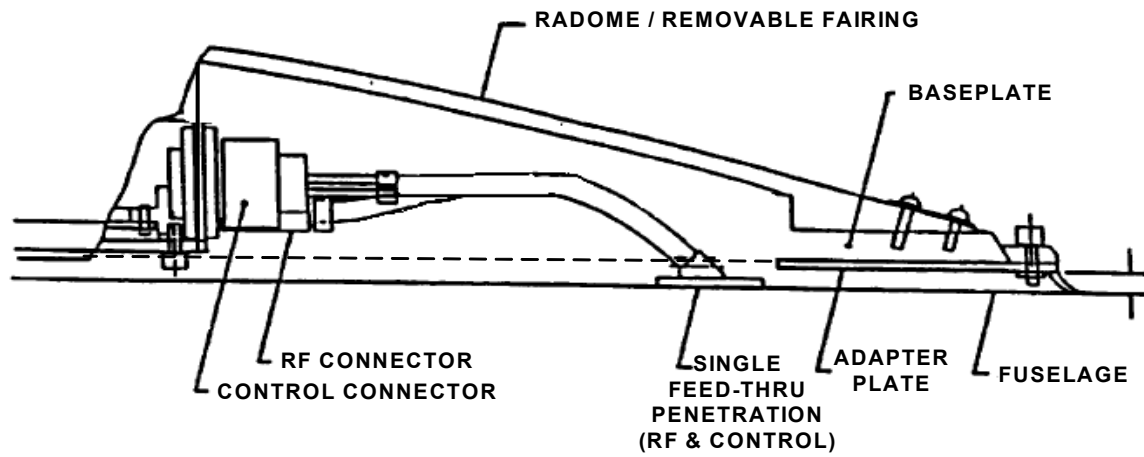
1. The antenna should have a removable aft radome fairing to allow access to connectors, cables and aircraft skin penetration area.
2. Connecting Control and RF cables should be routed through a feed-through skin penetration hole on the aircraft fuselage, which can be anywhere within the keep away zone.

**ATTACHMENT 1
STANDARD INTERFACES**

3. The antenna should be installable or removable while the aircraft cable installation remains in place.
4. The cable routing design should allow the cables to be routed from the skin penetration area to the antenna bulkhead connectors.
5. Sufficient access volume should be provided for cable routing and hand/tool access to prevent over bending the cabling beyond its bend allowances. As general guidance, coaxial cable should not be bent at a radius of less than 10 times its diameter for permanent installation, or less than 5 times its diameter during the connecting (insertion or removal) process.
6. Should a tool be required for cable installation, such tool should be clearly identified in the manufacturer's installation and maintenance procedures and be supplied upon request by the antenna manufacturer.
7. Antenna adapter plate design may need to be customized to accommodate the keep-away zone requirements.

ATTACHMENT 1
STANDARD INTERFACES

1.10A Antenna Coaxial Cable Interface



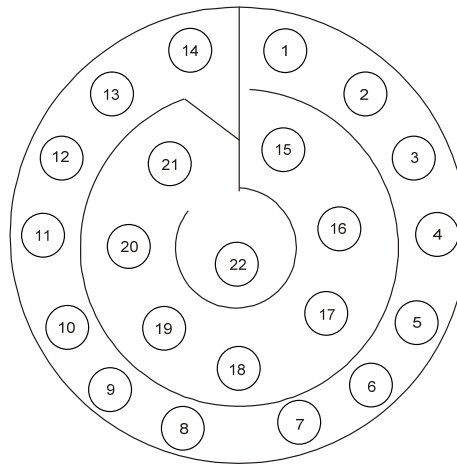
**ATTACHMENT 1
STANDARD INTERFACES**

1.11 No Longer Used

This section deleted by Supplement 5.

ATTACHMENT 1 STANDARD INTERFACES

1.12 High Gain and Intermediate Gain Antenna Control Connector Layout



HGA and IGA Connector PIN Layout

HGA and IGA pin assignments should conform to the table below.

HGA and IGA Connector Pin Assignments

PIN No	SIGNAL	DESCRIPTION
1	+28 Vdc	Aircraft dc Power
2	28 Vdc RTN	Aircraft dc Power
3	Antenna BITE A	ARINC 429 from antenna
4	Antenna BITE Shield	Screen for ARINC 429
5	Antenna BITE B	ARINC 429 from antenna
6	Antenna Control A	ARINC 429 to antenna
7	Antenna Control Shield	Screen for ARINC429
8	Antenna Control B	ARINC 429 to antenna
9	DLNA BITE	BITE from DLNA
10	DLNA Shield	Screen/RTN for DLNA
11	DLNA CTL	DLNA on/off control from antenna
12	Serial Shield ¹	Serial Screen/GND
13	RS-422 RX A ¹	Serial data to antenna +
14	RS-422 RX B ¹	Serial data to antenna -
15	RS-422 TX A ¹	Serial data from antenna +
16	RS-422 TX B ¹	Serial data from antenna -
17	ATE Pin	Manufacturer Specific
18	115 Vac Hot	Aircraft ac power
19	115 Vac Return	Aircraft ac power
20	--	Spare
21	--	Spare
22	Chassis Ground	Chassis Ground

Connector Type – 13-35 Insert of the MIL-DTL-38999 Series III Family

Note:

- These pins may be used to provide manufacturer-specific extended BITE/troubleshooting/software upload.

ATTACHMENT 2

ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

**ATTACHMENT 2 ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION
SATELLITE COMMUNICATIONS SYSTEM**

Figure 1 – Deleted

Figure 2 – Deleted

Figure 3 – Deleted

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

BIT	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Function	P	SSM	Undefined														Reserved				DIS	SDI	Label 144 [23] [4]									
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					0	0	1	0	0	1	1	0
																								4	4		1					

Sign/Status Matrix [19] [20] [21]		
Bits		Coding
31	30	
0	0	Failure Warning
0	1	No Computed Data
1	0	Functional Test
1	1	Normal Operation

Discrete [22]		Values	
BIT	Description	0	1
11	Antenna System Select	LGA	HGA/IGA
12	HPR Present	No	Yes

SDI Code [35]		
Bits		Coding
10	9	
0	0	All Call
0	1	Port/Top
1	0	Starboard
1	1	Reserved

See Note 49 for reserved labels on this bus

Figure 4 – Antenna Control Word - ARINC 781 SDU to ARINC 741/781 Antenna

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

BIT	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Function	P	SSM		E Q I D [43]	G a i n	S p a r e			Discrete								Gain				SDI		Label 144 [4]									
				1		0	0	0		0	0	0	0			0	0	0				0		1	0	0	1	0	0	1	1	0
																							4		4		1					

Sign/Status Matrix [17]		
Bits		Coding
31	30	
0	0	Failure Warning
0	1	No Computed Data
1	0	Functional Test
1	1	Normal Operation

Discrete		Values	
Bit	Description	0	1
18	Antenna Location	Top	Reserved
19	Antenna Type	HGA	IGA
20	Reserved		
21	Reserved		
22	Reserved		
23	Reserved		
24	HGA/IGA LNA Status	Disabled	Enabled
25	Reserved		
26	Tracking Mode	Open	Reserved

Note: Tracking mode is always set to 0.

Antenna Tx Gain [36]		
Bits 28	BITS 15-11	Coding
0	00000	0 dBic
1	00000	0.5 dBic
0	00001	1 dBic
Etc.	Etc.	
1	11111	31.5 dBic

SDI Code [18]		
Bits		Coding
10	9	
0	0	Reserved
0	1	Top
1	0	Reserved
1	1	Reserved

Figure 5 – Antenna Status Word - ARINC 781 Antenna to ARINC 741/781 SDU

ATTACHMENT 2

ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

BIT	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Function	P	SSM	C	Undefined	Discrete																		SDI		Label 350 [4]							
				0	0	0					0					0					0		0	1	0	0	0	1	0	1	1	1
																									0			5			3	

Sign/Status Matrix [41]		
Bits		Coding
31	30	
0	0	Failure Warning
0	1	No Computed Data
1	0	Functional Test
1	1	Normal Operation

Discrete [41]		Values	
Bit	Description	0	1
11	Class 1 HGA/IGA Failure [14]	OK	Failed
12	Reserved for A741 compatibility		
13	Control Bus Input	OK	Inactive
14	Internal RAM [14]	OK	Failed
15	Internal ROM [14]	OK	Failed
16	Power Supply Function [14]	OK	Failed
17	Reserved for ARINC 741 compatibility		
18	Beam Steering Function [46] [14]	OK	Failed
19	Antenna Array Function [14]	OK	Failed
20	LNA/Diplexer [38] [40]	OK	Failed
21	Reserved		
22	Class 1 Temperature [14]	OK	Over
23	Class 3 Temperature [14]	OK	Warning
24	Antenna Reset [44]	OK	Occurred
25	Class 3 HGA/IGA Failure [14]	OK	Warning

SDI Code [18]		
Bits		Coding
10	9	
0	0	Reserved
0	1	Top
1	0	Reserved
1	1	Reserved

Configuration Data		Values	
Bit	Description	0	1
29	Antenna configuration data being sent [45]	Not in progress	In progress

Figure 6 – Antenna Maintenance Word - ARINC 781 Antenna to ARINC 741/781 SDU

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

BIT	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Function	P	SSM		(MSB)					Azimuth					(LSB)	(MSB)					Elevation					(LSB)	Label 152						
									[25]											[24]						[26] [32]						
																									0	1	0	1	0	1	1	0
																									2	5					1	

Sign/Status Matrix		
Bits		Coding
31	30	
0	0	Failure Warning
0	1	No Computed Data
1	0	Functional Test
1	1	Normal Operation

See Note 49 for reserved labels on this bus.

Figure 7 – Open Loop Steering Word - ARINC 781 SDU to ARINC 741/781 Antenna

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			
P	SSM		A16-----A1																								Octal Label							
			MSB																								220 [50]							
																								0	0	0	0	1	0	0	1			

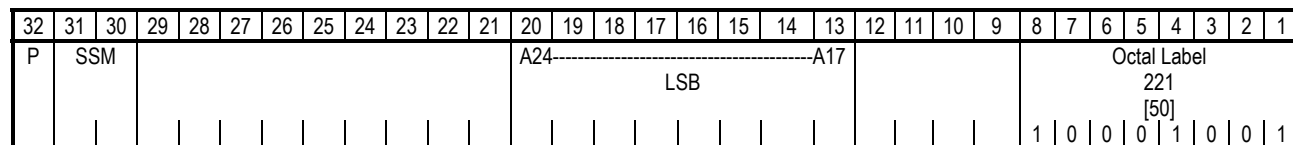
Bit	Function	Coding	Notes
1	Label	1	
2	.	<u>2</u>	<u>0</u>
3	.		0
4	.		1
5	.	<u>2</u>	<u>0</u>
6	.		0
7	.		0
8	Label	<u>0</u>	<u>0</u>
9	PAD		47
10	.		47
11	.		47
12	.		47
13	PAD		47
14	Swift64 Base Fwd ID (Part 1)	A1 (MSB)	48
15	.	A2	48
16	.	A3	48
17	.	A4	48
18	.	A5	48
19	.	A6	48
20	.	A7	48
21	.	A8	48
22	.	A9	48
23	.	A10	48
24	.	A11	48
25	.	A12	48
26	.	A13	48
27	.	A14	48
28	.	A15	48
29	Swift64 Base Fwd ID (Part 1)	A16	48
30	SSM		
31	SSM		
32	Parity	Odd	

Sign/Status Matrix (SSM) Definition per ARINC Specification 429 for DISC discrete data words.

Bits		Meaning
31	30	
0	0	Normal Operation
0	1	NCD
1	0	Functional Test (Not Used)
1	1	Failure Warning (Not Used)

Figure 8 – Label 220 Inmarsat Swift64 Base Forward ID Word #1 - (Discrete)

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM



Bit	Function		Coding	Notes
1	Label		1	
2	.	2	0	
3	.		0	
4	.		1	
5	.	2	0	
6	.		0	
7	.		0	
8	Label	1	1	
9	PAD			47
10	.			47
11	.			47
12	PAD			47
13	Swift64 Base Fwd ID (Part 2)		A17	48
14	.		A18	48
15	.		A19	48
16	.		A20	48
17	.		A21	48
18	.		A22	48
19	.		A23	48
20	Swift64 Base Fwd ID (Part 2)		A24 (LSB)	48
21	PAD			47
22	.			47
23	.			47
24	.			47
25	.			47
26	.			47
27	.			47
28	.			47
29	PAD			47
30	SSM			
31	SSM			
32	Parity		Odd	

Sign/Status Matrix (SSM) Definition per ARINC Specification 429 for DISC discrete data words.

Bits		Meaning
31	30	
0	0	Normal Operation
0	1	NCD
1	0	Functional Test (Not Used)
1	1	Failure Warning (Not Used)

Figure 9 – Label 221 Inmarsat 24-Bit Swift64 Base Forward ID Word #2 - (Discrete)

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

SATCOM AIRFRAME TYPE - LABEL 167 RATE = 1 SEC					
PAR	SSM	PAD	AIRFRAME TYPE	PAD	LABEL
Bit 32	Bits 31-30	Bits 29 – 25	Bits 24 – 11	Bits 10 – 9	Bits 8 – 1 [51]
p	ss	xxxxx	ddcccxbbbaaaa	xx	xxx xxx xx

Where:

- aaaa = Minor Model (e.g., -400, -800, -500).
- xbbb = Major Model (e.g., B787, B777).
- ccc = Airframe Manufacturer Specific.
- ddd = Airframe Manufacturer Specific.

The following xbbb have been reserved for Boeing application:

x	bbb	Aircraft Type
0	000	Boeing Aircraft #1
0	001	Boeing Aircraft #2
0	010	Boeing Aircraft #3
0	011	Boeing Aircraft #4
0	100	Boeing Aircraft #5
0	101	Boeing Aircraft #6
0	110	Boeing Aircraft #7
0	111	Boeing Aircraft #8
1	000	RSV
1	---	RSV
1	111	RSV

Sign/Status Matrix (SSM) Definition per ARINC Specification 429 for discrete data words.

Bits		Meaning
31	30	
0	0	Normal Operation
0	1	NCD
1	0	Functional Test (Not Used)
1	1	Failure Warning (Not Used)

Figure 10 – Aircraft Type Label

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

BIT	3 2	3 1	3 0	2 9	2 8	2 7	2 6	2 5	2 4	2 3	2 2	2 1	2 0	1 9	1 8	1 7	1 6	1 5	1 4	1 3	1 2	1 1	10	9	8	7	6	5	4	3	2	1	
Function	P	Spare		Satellite System Type												SDU SAL										Label 172							
	✕	0	0	0	0	0	0	0	0	0	0	0	✕ 0	✕ 0	✕	1	✕	✕	✕	✕	✕	✕	✕	✕	✕	0	1	0	1	1	1	1	0
																										2		7		1			

SDU Equipment Identifier Code: 041 (HEX)

Bit	Description	Coding
1	Label 172	0
2	.	1
3	.	1
4	.	1
5	.	1
6	.	0
7	.	1
8	Label 172	0
9	SDU SAL (307 for SDU #1 or 173 for SDU #2) (MSB)	1 or 0
10	.	1 1
11	.	0 1
12	.	0 1
13	.	0 1
14	.	1 0
15	.	1 1
16	SAL (LSB)	1 1
17	Inmarsat Classic Aero (see note 52)	0 or 1
18	Inmarsat SBB (see note 52)	1 or 0
19	Iridium Block 1 (see note 52)	0
20	Iridium Certus (see note 52)	0
21	Spare	0
22	Spare	0
23	Spare	0
24	Spare	0
25	Spare	0
26	Spare	0
27	Spare	0
28	Spare	0
29	Spare	0
30	Spare	0
31	Spare	0
32	Parity	Odd ✕

See Note 52 for [Satellite Service definition and](#) ARINC 761 multi-bearer systems.

Figure 11 – SDU Label 172

ATTACHMENT 2

ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

Notes

Notes 1-41 are numbered the same as the notes in ARINC 741, Attachment 2.

The SDU to/from antenna interface is based on ARINC 741, and supports the following combinations of equipment:

SDU	Antenna
ARINC 781	ARINC 781
ARINC 781	ARINC 741 (top mount or side mount)
ARINC 741	ARINC 781

This attachment specifies the output words from the ARINC 781 SDU and antenna, and these have been designed to allow ARINC 781 and ARINC 741 equipment to interoperate. For the definition of output words from ARINC 741 equipment, please refer to ARINC 741. The antenna does not need to know what type of SDU it is connected to.

1. Not used.
2. Not used.
3. Not used.
4. RATE: 5-10 words per second. This implies that the interval between the start of two words with the same label number should always be between 100 and 200 ms.
5. Not used.
6. Not used.
7. Not used.
8. Reserved.
9. Not used.
10. Not used.
11. Not used.
12. Not used.
13. Not used.
14. When Bit 11 or 25 is set, bits 14, 15, 16, 18, 19, and 22 are used to provide further detail (if known). "Failed" indicates that an immediate maintenance action is recommended (class 1). 'Warning' indicates that the system is expected to continue to operate but with degraded capability (class 3).
15. Reserved.
16. Not used.

ATTACHMENT 2

ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

17. The SSM should be used as follows:

FUNCTIONAL TEST = Test in Progress (ignore DISCRETE field, invalid).

NORMAL OPERATION = No failures detected in antenna.

FAILURE WARNING = Failure(s) detected in the antenna and indicated in DISCRETE field; does not include failures in the LNA/Diplexer, Control bus input, CLASS 3 TEMP, ANTENNA RESET, or CLASS 3 HGA/IGA FAILURE

NO COMPUTED DATA = No BSU Control Word or no BSU Open Loop Steering Word has been received from the SDU for one or more seconds.

The antenna shall indicate Functional Test following initiation, and during execution, of its Functional Test, whether commanded by the SDU or by any other means such as power-on or a front panel test switch. Upon the completion of Functional Test, the antenna shall indicate Normal Operation if no failures were detected or Failure Warning if one or more failures were detected. Failure Warning shall also be indicated at any time outside of Functional Test when a monitored (or otherwise tested) parameter is in its failure state.

18. An ARINC 781 antenna should set its SDI bits to TOP.

19. The state "Functional Test" in the SSM will command the destination antenna to conduct a self-test and respond with the appropriate data. These data are included in the Antenna MAINTENANCE WORD, which is output continuously at the rate specified.

20. While commanding the Functional Test mode, the SDU will continuously send the CONTROL WORD with the SSM set to "Functional Test." The antenna will continue to perform the self-test until the test is completed. The antenna will then automatically return to normal operation. Functional test will not be re-initiated by the antenna until after receipt of SSM fields in the antenna control word from the SDU containing normal operation followed by functional test.

21. The states "Failure Warning" and "No Computed Data" are not used and should be ignored.

22. The antenna should use the Antenna System Select discrete to turn on and off the DLNA.

23. ARINC 429 Labels 270 through 274 (octal) are reserved on all BSU ARINC 429 buses for testing and crosstalk.

24. Elevation data, bits 9-18, has a range of approximately +89.8 to -90 degrees. Bit 18 is used as the sign bit. A positive angle is considered upward toward the zenith. Resolution of angle is approximately 0.17 degrees. The elevation data is provided with reference to the antenna axes. The SDU should perform transformation for installation offset angles, as provided in the ORT.

25. Azimuth data, bits 19-29, has a range of approximately +179.8 to -180 degrees. Bit 29 is used as the sign bit. A positive angle is considered right of the nose reference. Resolution of the angle is approximately 0.17 degrees. The azimuth data is provided with reference to the antenna axes. The SDU should perform transformation for installation offset angles, as provided in the ORT.

26. Data is encoded in BNR, two's complement as defined in ARINC 429; with the exception of Note 24 above.

27. Reserved.

28. Not used.

ATTACHMENT 2

ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

- 29. Reserved.
- 30. Not used.
- 31. Not used.
- 32. RATE: 10-20 words per second. This implies that the interval between the start of two words with the same label number should always be between 50 and 100 ms.
- 33. Reserved.
- 34. Not used.
- 35. The SDI bits should be set to the code of the antenna(s) intended to receive and process the Control Word. An ARINC 781 antenna should always respond to SDI bits set to ALL CALL or TOP.
- 36. The antenna TX Gain field is used to report gain variations at different steering angles to the SDU. The SDU will use this information from the selected subsystem to vary the HPA gain accordingly so as to maintain the same effective transmitted power from position to position, except for changes commanded by the GES.
- 37. Not used.
- 38. If a parameter can only be tested in certain circumstances (e.g., LNA/Diplexer Failed [Antenna Maintenance Word bit 20] while the LNA is switched on), the failure indication should persist until a subsequent test or until the next monitored result indicates that the status has changed to "OK."
- 39. Not Used.
- 40. If the LNA was being commanded "off" before performing a Functional Test, the LNA should only be turned "on" momentarily (< 100 ms) during Functional Test.
- 41. Same as Note 17 except that there is no application for the No Computed Data State, which therefore should not be used. The same requirements as for the Failure Warning indication apply to the respective Discrete failure bit indications in the Maintenance Word. Failure Warning and respective DISCRETE failure bit indications should persist until all conditions and parameters are subsequently re-tested by appropriate tests and are found to be "OK."
- 42. Not used.
- 43. The Equipment Identifier Bit (EQID) bit No 29 should always be set to "1," identifying the antenna as ARINC 781 compliant.
- 44. After the antenna has performed a reset it should set bit 24 for 10 consecutive antenna maintenance words.
- 45. The antenna should set Bit 29 and respond with Configuration Data as per Attachment 2A. At conclusion of Configuration Data reporting the antenna should clear this bit.
- 46. Bit 18 is equivalent to "Any Other BSU Parameter" in ARINC 741.
- 47. All PAD bits are set to binary 0.
- 48. A1 - A24 represent Forward ID "address" bits 1 - 24.
- 49. The following list provides the labels that are reserved to SDU/antenna manufacturers for SDU to antenna communications on the SDU multicontrol bus common to both the antenna and external HPA when fitted. These labels shall not be used by SDU/external HPA manufacturers for communications from the SDU to the external HPA on the multicontrol bus:

ATTACHMENT 2

ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

- Labels 145 to 149
- Label 153

The following table provides the list of labels that are used by SDU/antenna manufacturers for SDU to antenna communications on the SDU multicontrol bus common to both the antenna and external HPA when fitted. These labels could be used by SDU/external HPA manufacturers for communications from the SDU to the external HPA on the multicontrol bus as far as they are used for their intended purpose as defined in the Label description field:

ARINC Label	Label Description
110	GNSS Latitude
111	GNSS Longitude
125	Universal Time Coordinated
150	Universal Time Coordinated
171	Manufacturer- specific Status Note: the antenna or external HPA should consider Labels 371 and 377 when processing this label
214	ICAO Address Part 1
216	ICAO Address Part 2
227	CFD BITE Summary
251	Flight Leg Counter
254	Hybrid Latitude
255	Hybrid Longitude
257	Hybrid Latitude, Fine
258	Hybrid Longitude, Fine
260	Date
261	Flight Number
275	Discrete #6 ICAO Address Part 1
276	Discrete #7 ICAO Address Part 2
277	General Test Label
310	Present Position, Longitude
311	Present Position, Latitude
361	Altitude (Inertial)
371	General Aviation Equipment Identifier
377	Equipment ID Note: The Antenna Equipment ID is 341 (corresponding to ACU in ARINC Specification 429) and the external HPA equipment ID is 241 (as defined in ARINC Specification 429)

50. The following labels are used for Swift64 Forward IDs that are obtained from a centralized source on certain aircraft:

- SDU #1: FWD ID #1 Word #1 = Label 220, Word #2 = Label 221.
- SDU #1: Reserved FWD ID #2 Word #1 = Label 222, Word #2 = Label 223.
- SDU #2: FWD ID #3 Word #1 = Label 224, Word #2 = Label 225.
- SDU #2: Reserved FWD ID #4 Word #1 = Label 226, Word #2 = Label 227.

Labels 220 - 221 (and 222 - 227) Inmarsat Swift64 Base Forward ID Words #1 and #2 - (Discrete)

Swift64 operation requires a 24-bit Forward ID for each Swift64 channel and a corresponding 24-bit Return ID, which the SDU may derive from the Forward ID via an internal look-up table. Some aircraft are able to supply Forward ID data from a centralized source to the SDU on its AES ID and/or CMU ARINC 429 inputs. The Swift64 Forward ID is structured and

ATTACHMENT 2

ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

communicated similarly to the ICAO Aircraft Address (reference Labels 214 and 216). It should be transmitted by the source system at a nominal rate of 1 Hz.

For a multi-channel SDU, Labels 220 and 221 communicate the Forward ID for the first (base) Swift64 channel of the SDU number 1, and the SDU may derive its additional Forward IDs from this base ID via an internal look-up table. Alternatively, Labels 222/223, formatted identically to Labels 220/221, may be used to explicitly communicate the Forward IDs for Swift64 channel number 2 of the SDU number 1.

In a dual satcom installation, Labels 224/225 and 226/227, formatted identically to Labels 220/221, may be used to explicitly communicate the Forward IDs for Swift64 channel numbers 1 and 2 of the SDU number 2.

The Forward ID is typically specified as a six-digit hexadecimal number (rarely as a seven-digit decimal number). In written form, it follows the usual big-endian convention of placing the Most-Significant Bit (MSB) and most-significant digit first (left-most), and the Least-Significant Bit (LSB) and least-significant digit right-most. Note, however, that the MSB is designated as ID (address) bit A1, and the LSB is designated as A24.

The following example illustrates the coding for “Normal Operation” Labels 220 and 221 for Forward ID 23 A5 1F hex (2 336 031 decimal, 10 722 437 octal, 0010 0011 1010 0101 0001 1111 binary):

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
P	SSM		A16-----A1																Octal Label												
			MSB																												
																			220												
0	0	0	1	0	1	0	0	1	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
P	SSM												A24-----A17								Octal Label										
													LSB																		
1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1

51. This label is used for Aircraft type definition that is obtained from a centralized source on certain aircraft.

Note: Labels to be confirmed by AEEC (Boeing to coordinate). The objective is to have these labels specified in ARINC 429 P2 but in the interim, these labels are described in this supplement.

52. **A single-bearer SDU (Inmarsat only) should assert (set to “1”) either bit 17 for Inmarsat Classic Service or bit 18 for Inmarsat SwiftBroadband (SBB) service, and should not assert bits 17 and 18 simultaneously. Single-bearer SDUs (Inmarsat only) should set Iridium bit 19 and Iridium Certus bit 20 to “0” at all times.**

For additional details, reference ARINC Characteristic 761 Attachment 2 Item 2, which defines a satcom multi-bearer system (MBS), wherein the ARINC 761 SDU may support multiple satellite systems (e.g., Inmarsat and Iridium). This capability is also defined from the CMU perspective in ARINC Characteristic 758 (Supplement 2 and subsequent, including in Attachment 6 Table 6-16). Included in this capability is the MBS SDU’s use of the ARINC 429 Label 172 subsystem identifier word, transmitted at a nominal rate of 1 Hz on its output bus to the CMU (and EICAS/ECAM/EDU), to indicate the satellite systems through which it is capable of providing service. In Characteristic ARINC 761, Label 172 thus has a unique definition and usage of bits 17-29 that are only defined as pad (zero) bits in the generic ARINC Specification 429 definition of Label 172 (ARINC Characteristic 758 has similar unique

ATTACHMENT 2

ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

definitions for some of the bits in its Label 172 output to the SDU and other air/ground datalink equipment).

The details of an MBS SDU beyond this definition of Label 172 are beyond the scope of ARINC Characteristic 781. However, at a minimum, an ARINC 781 SDU will set bit 17 **or 18 as appropriate** to indicate support of the Classic Aero service **or SwiftBroadband Safety Service respectively** and may also set other bits in the Satellite System Type field as applicable to the specific SDU design.

For backward compatibility with previous CMUs without SBB recognition, an ORT item should allow setting bit 17 to “1” and bit 18 to “0” on a system with SBB capability to emulate a classic system.

**ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING**

ATTACHMENT 2A ANTENNA CONFIGURATION DATA REPORTING

1.0 INTRODUCTION

This attachment defines how an ARINC 781 intermediate or high gain antenna, on request from an ARINC 781 SDU or a compatible ARINC 741/761 SDU, provides configuration data to the SDU for onward transmission to the central maintenance system.

The configuration data includes:

- LRU name
- LRU part number
- LRU serial number
- Software application name
- Software part number
- Optional additional undefined configuration data

2.0 PROTOCOL

This protocol is based on a subset of that specified in ARINC Report 604, Appendix 2.

The antenna configuration data may be requested by the SDU at any time once the antenna resets and initializes. This data is typically requested once per power cycle.

Configuration data is requested by the SDU via the Label 227 command word, using the “Configuration” function select code (see Section 3.2). Upon receipt of the “Configuration” function in Label 227, the antenna should set the “In Progress” bit (29) in its Antenna Maintenance Words (Label 350) within two seconds. When the SDU notes the set “In Progress” bit from the antenna, it sends Label 227 with the “Null” function selected as an acknowledgement. The antenna then proceeds with its data transmission. The antenna may alternatively proceed with its data transmission directly after setting the “In Progress” bit, without waiting for the “Null” function in Label 227.

The above definition regarding Label 227 represents the minimum functionality for SDU compatibility with the protocol. The SDU may transmit Label 227 as described above (i.e., a minimum of two times per power cycle), or it may transmit short bursts (e.g., four words with minimum inter-word time gaps of four bit times) of each Configuration/Null command to help ensure reception, or it may periodically transmit Label 227 continuously (with the “Null” function indicated when configuration data is not being requested). If the SDU does transmit Label 227 periodically, the transmission interval should nominally be one second (100 ms minimum), e.g., between Null words or between a Configuration word and the subsequent Null word.

For compatibility with ARINC 741/761 SDUs not implementing this protocol, the antenna must be tolerant with not receiving any Label 227 words. The antenna should not raise any ARINC 429 bus inactivity failure (or any other failure) based on Label 227.

After the “In Progress” bit in the antenna Maintenance Word (Label 350) has been set by the antenna (and possibly after waiting for acknowledgement by the SDU with a Label 227 “Null” word), the antenna transmits its configuration data using Label 356 (see Section 3.0). The STX word should be initiated no later than two seconds

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

after either (1) the antenna sets its Label 350 word bit 29 to 1; or, if it is required by the antenna, (2) the antenna's receipt of the SDU's "Null" acknowledgement word. The transmission interval of Label 356 words (while they are active) should be between 50-250 ms.

Although the application of this protocol is intended for antenna/SDU communications, its original ARINC 604 application was oriented to ARINC 739A MCDU displays. The response data transmitted is formatted so that it can be displayed with up to 24 characters per row and up to 10 rows per "page." All data is transferred using a subset of the ISO 8859-5 alphabet. Only one "page" of data should be sent from the antenna to non-specific SDUs using the protocol defined here. If it is desired to send more than one "page" of data to specific SDU models (e.g., for enhanced maintenance functionality between a same-manufacturer or otherwise compatible antenna and SDU, which is beyond the scope of this definition), then one or more manufacturer-specific Label 227 Function Select codes should be used by the SDU to request such additional information from a compatible antenna.

The data response words are transmitted in the following order:

1. The STX word is sent.
2. The SYN word is sent.
3. The first three characters (starting with information for row 1 column 1) are sent.
4. The next three characters for this row are sent (More words are transmitted as required for row 1).
5. At the conclusion of row one, the End of Text (ETX) word is sent, indicating that the character that follows it is for column 1 of the next row.
6. The first three characters (starting with information for the next row column 1) are sent.
7. The next three characters for this row are sent (More words are transmitted as needed for this row).
8. The ETX word is sent indicating that the character that follows it is for column 1 of the next row.

Steps 6 through 8 are repeated as needed to transmit all of the information except the information for the last word of the last row. The ETX word is not transmitted for the last row, and an End of Transmission (EOT) word is sent instead, indicating the end of block.

When all of the configuration data has been transmitted to the SDU, the antenna resets the "In Progress" bit (29) in the antenna Maintenance Word (Label 350).

The SDU should record all received configuration data, including any that it has no specific knowledge of from "rows" 6 through 10. The additional data should simply be recorded verbatim and made available for inspection (e.g., via a maintenance port).

The SDU should not raise any failures due to the non-successful receipt of the antenna configuration data (including protocol errors). Lack of this data should be indicated in a manner consistent with the central maintenance system's requirements (e.g., as all "dash" (-) characters).

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

3.0 DEFINITION OF ARINC 429 WORDS

3.1 Antenna Maintenance Word – Antenna to SDU (Label 350)

Reference Attachment 2, Figure 6. Bit 29 in Label 350 indicates that the antenna is in the process of sending configuration data to the SDU.

BIT	DESCRIPTION	BIT = 0	BIT = 1
29	IN PROGRESS	NOT IN PROGRESS	IN PROGRESS

3.2 Command Summary Word (SDU to Antenna)

The antenna receives this word from the SDU and responds according to the command contained in the Function Select field.

COMMAND SUMMARY WORD			LABEL 227		
32	31 → 25	24 → 13	12 → 11	10 → 09	08 → 01
P	FUNCTION SELECT	EQUIPMENT ID	PAD	SDI	LABEL
PAR	XXXXXXX	YYYYYYYYYYY	00	00	11101001

Function Select

000 0000 (0₁₀) = Null

000 0001 (1₁₀) = Reserved for future use

000 0010 (2₁₀) = Configuration Data

000 0011 (3₁₀) = Manufacturer-specific (see Section 2.0)

000 0100 (4₁₀) through 000 1100 (12₁₀) = Reserved for future use

000 1101 (13₁₀) through 111 1111 (127₁₀) = Manufacturer-specific

Equipment ID

0001 1000 0001 (181_H) = ARINC 781 satcom antenna

SDI

SDI CODE		
BITS		CODING
10	9	
0	0	All Call
0	1	Top
1	0	Reserved
1	1	Reserved

1. When the antenna receives a “Null” command word from the SDU, it takes no action.
2. When the antenna receives a “Configuration” command word from the SDU, it responds with its configuration data.

An ARINC 781-compliant antenna responds to Command words with the satcom equipment ID set to 181_H when the appropriate SDI code is set. If the SDI code ‘All Call’ or ‘Top’ is encoded in the SDI field, the antenna responds to the command word. If the SDI code is not equal to ‘All Call’ or ‘Top’, the antenna does not respond.

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

3.3 STX Word (Start of Text)

CONFIGURATION DATA				LABEL 356	
32	31 → 25	24 → 19	18 → 17	16 → 09	08 → 01
P	STX	SPARE	SDI	NUMBER OF WORDS	LABEL
PAR	0000010	XXXXXX	00	YYYYYYYY	01110111

BITS	DEFINITIONS
1 - 8	Octal Label 356
9 - 16	Number of 32-bit words to be transmitted including the initial and final words.
17 - 18	SDI
19 - 24	Unused
25 - 31	ISO 8859-5 code for "STX"

3.4 SYN Word (Synchronization Word)

CONFIGURATION DATA				LABEL 356		
32	31 → 25	24	23 → 17	16	15 → 09	08 → 01
P	SYN	PAD	# OF DATA PAGES	PAD	PAGE NUMBER	LABEL
PAR	0010110	UNUSED	XXXXXXX	UNUSED	YYYYYYY	01110111

BITS	DEFINITIONS
1 - 8	Octal Label 356
9 - 15	Present Data Page Number (normally 1 – see Section 2.0)
16	Unused
17 - 23	Total Number of Data Pages Available (normally 1 – see Section 2.0)
24	Unused
25 - 31	ISO 8859-5 code for "SYN"

**ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING**

3.5 Intermediate Word

CONFIGURATION DATA				LABEL 356		
32	31 → 25	24	23 → 17	16	15 → 09	08 → 01
P	NEXT +1 CHAR	PAD	NEXT CHAR	PAD	1 ST CHAR	LABEL
PAR	XXXXXXX	UNUSED	XXXXXXX	UNUSED	XXXXXXX	01110111

BITS	DEFINITIONS
1 - 8	Octal Label 356
9 - 15	First/Next Character of the Configuration Data
16	Unused
17 - 23	Next Character of the Configuration Data
24	Unused
25 - 31	Next + 1 Character of the Configuration Data

3.6 ETX Word (End of Text)

CONFIGURATION DATA				LABEL 356		
32	31 → 25	24	23 → 17	16	15 → 09	08 → 01
P	ETX	PAD	CHAR or NUL	PAD	CHAR or NUL	LABEL
PAR	0000011	0	XXXXXXX	0	XXXXXXX	01110111

The ETX word is used to indicate that the next character is to be displayed in column 1 of the next row (similar to CR/LF). All data is transferred using a subset of the ISO 8859 #5 alphabet as specified in Section 4.0. The ETX code must appear in bits 25-31 of the word. Any character positions in the ETX word not needed to complete the current row should be filled with the NUL code (0000000).

3.7 EOT Word (End of Transmission)

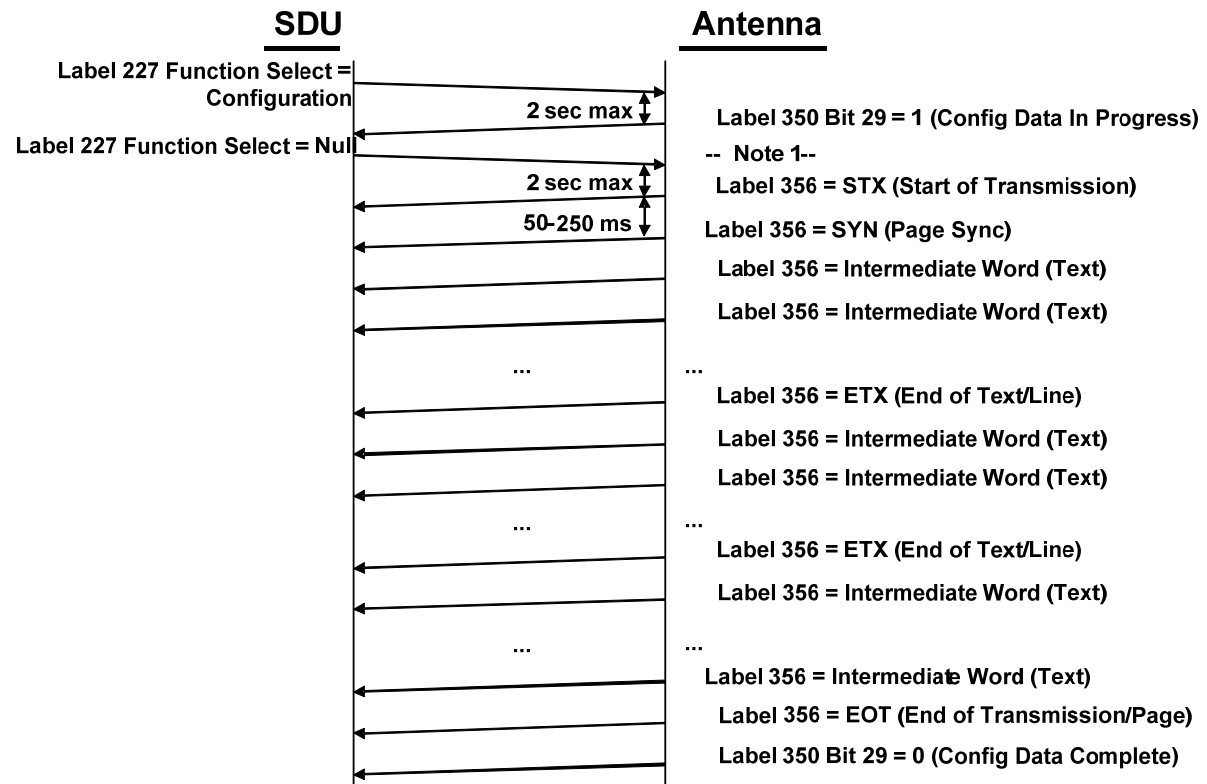
CONFIGURATION DATA				LABEL 356		
32	31 → 25	24	23 → 17	16	15 → 09	08 → 01
P	EOT	PAD	CHAR or NUL	PAD	CHAR or NUL	LABEL
PAR	0000100	0	XXXXXXX	0	XXXXXXX	01110111

The EOT code must appear in bits 25-31 of the word. Any character positions in the EOT word not needed to complete the current row should be filled with the NUL code (0000000).

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

BITS	DEFINITIONS
1 - 8	Octal Label 356
9 - 15	Configuration Data character or NUL
16	Unused
17 - 23	Configuration Data character or NUL
24	Unused
25 - 31	ISO 8859-5 code for "EOT"

3.8 Basic (Normal Operation) Sequence Diagram



Notes:

1. The antenna may start transmitting STX directly after transmitting Label 350 with Bit 29 set (i.e., without requiring the SDU's "Null" acknowledgement word).

**ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING**

4.0 CONFIGURATION DATA

All data is transferred using a subset of the ISO 8859-5 alphabet plus the STX, ETX, EOT, NUL and SYN control codes, as specified in ARINC Specification 429 Part 1 Attachment 5. The character subset should consist of upper-case-only A-Z, 0-9, space, hash (#), and the symbols corresponding to hex codes 25-2F [% & ' () * + , - . /].

The standard page of configuration data provided by the antenna is as follows:

Row	Data Type	Characters (max.)
1	LRU name	11
2	LRU part number	15
3	LRU serial number	15
4	Software application name	15
5	Software part number	15
6 up to 10	Manufacturer-specific (optional)	24 max

All rows are left justified and contain no more than the maximum number of characters for each line as listed in the table.

**ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL**

ATTACHMENT 2B BIT-ORIENTED FAULT REPORTING PROTOCOL

Staff Note: The BIT-ORIENTED FAULT REPORTING
 PROTOCOL (Fault Summary Words 1-9 for satcom) in
 this attachment will eventually be incorporated into
 ARINC Report 604. When incorporated, ARINC
 Report 604 will have precedence over this attachment.

**ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL**

**BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #1 for Satcom**

Bit No.	Function	Bit Status	
		1	0
1	Label 350 (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	Satellite Data Unit	Failure	OK
12	Reserved for ARINC 741 Radio Frequency Unit (Note 2)	Failure	OK
13	Reserved for ARINC 741 HGA High-Power Amp (Note 2)	Failure	OK
14	Reserved for ARINC 741 LNA to External HSU1 Rx Path (Note 2)	Failure	OK
15	Reserved for ARINC 741 LGA High-Power Amp (Note 2)	Failure	OK
16	Top/Port Diplexer/LNA (Note 4)	Failure	OK
17	ARINC 741 Starboard Diplexer/LNA (Note 3)	Failure	OK
18	Reserved for ARINC 741 LGA Diplexer/LNA (Note 2)	Failure	OK
19	ARINC 741 ACU or Top/Port BSU (Note 3)	Failure	OK
20	ARINC 741 Starboard BSU (Note 3)	Failure	OK
21	Top/Port High Gain or Intermediate Gain Antenna (Note 5)	Failure	OK
22	ARINC 741 Starboard High Gain Antenna (Note 3)	Failure	OK
23	Reserved for ARINC 741 HPA to LGA VSWR (Note 2)	Failure	OK
24	ARINC 741 High Power Relay (Note 3)	Failure	OK
25	System Configuration Pins	Error	OK
26	Reserved for ARINC 741 LNA to RFU Rx Path (Note 2)	Failure	OK
27	Reserved for ARINC 741 RFU to HPA Tx Path (Note 2)	Failure	OK
28	BITE Test Inhibit	Inhibit	Enable
29	Command Word Acknowledge	ACK	NAK
30	SSM		
31			
32	Parity (Odd)		

Notes:

1. OK status shall always be indicated for equipment not installed or data not used, as determined by the Satellite Data Unit system configuration pins or its design.
2. Bit reserved in ARINC Characteristic 781 to preserve compatibility with Central Maintenance Computers designed per ARINC Characteristic 741. Bits should always be set to OK in an ARINC 781 SDU.
3. Implementation required if the SDU is designed to interface with ARINC 741 antenna systems.
4. Applicable to any top-mount diplexer in an ARINC 781 antenna system (high gain, intermediate gain, low gain) or a top-mount diplexer in an ARINC 741 top-mount high gain antenna system or a port diplexer in an ARINC 741 side-mount high gain antenna system.

ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL

5. Applicable to a top-mount high gain, or intermediate gain antenna, or Enhanced Low Gain Antenna (ELGA) with or without a DLNA or HLD (either standalone or incorporated in the antenna) in an ARINC 781 antenna system or a top/port antenna in an ARINC 741 top-mount high gain antenna system.

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #2 for Satcom

Bit No.	Function	Bit Status	
		1	0
1	Label 351 (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	CMC to SDU Bus	Inactive	OK
12	SCDU-1 to SDU Bus	Inactive	OK
13	Primary IRS to SDU Bus	Inactive	OK
14	CMU-1 to SDU Bus	Inactive	OK
15	CMU-2 to SDU Bus	Inactive	OK
16	SCDU-2 to SDU Bus	Inactive	OK
17	SCDU-3 to SDU Bus	Inactive	OK
18	Reserved for ARINC 741 FMC-1 to SDU Bus (Note 4)	Inactive	OK
19	SDU Crosstalk Input Bus	Inactive	OK
20	Secondary IRS to SDU Bus	Inactive	OK
21	Reserved for ARINC 741 HGA HPA to SDU Bus (Note 4)	Inactive	OK
22	Reserved for ARINC 741 CPDF to SDU Bus (Note 4)	Inactive	OK
23	Reserved for ARINC 741 LGA HPA to SDU Bus (Note 4)	Inactive	OK
24	ARINC 741 ACU or Top/Port BSU to SDU Bus (Note 5)	Inactive	OK
25	ARINC 741 Starboard BSU to SDU Bus (Note 5)	Inactive	OK
26	Reserved for ARINC 741 RFU to SDU Bus (MP9E/F) (Note 4)	Inactive	OK
27	CTU to SDU Bus (CEPT-E1)	Inactive	OK
28	Reserved for ARINC 741 External HSDU #1 to SDU Bus (Note 4)	Inactive	OK
29	Reserved for ARINC 741 FMC-2 to SDU Bus (Note 4)	Inactive	OK
30	SSM		
31			
32	Parity (Odd)		

Notes:

1. OK status shall always be indicated for equipment not installed or buses not used, as determined by the Satellite Data Unit system configuration pins or its design.
2. An Inactive Bus report, if applicable, will supersede a data input Failure report.

ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #4 for Satcom

Bit No.	Function	Bit Status	
		1	0
1	Label 353 (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	Reserved for ARINC 741 SDU to RFU Bus (Note 4)	Inactive	OK
12	Reserved for ARINC 741 SDU/RFU Input Bus MP9J/K (Notes 1 and 4)	Inactive	OK
13	Reserved for ARINC 741 SDU/RFU Input Bus MP10A/B (Notes 1 and 4)	Inactive	OK
14	Reserved for ARINC 741 SDU/RFU Input Bus MP10C/D (Notes 1 and 4)	Inactive	OK
15	Reserved for ARINC 741 SDU/RFU Input Bus MP10E/F (Notes 1 and 4)	Inactive	OK
16	Reserved for ARINC 741 SDU/RFU Input Bus MP10G/H (Notes 1 and 4)	Inactive	OK
17	Reserved for ARINC 741 SDU/RFU Input Bus MP10J/K (Notes 1 and 4)	Inactive	OK
18	ARINC 741 SDU to HGA HPA Multi-Control Bus (Note 6)	Inactive	OK
19	ARINC 741 HGA HPA Over Temperature (Note 6)	Over Temp	OK
20	Reserved for ARINC 741 SDU to LGA HPA Multi-Control Bus (Note 4)	Inactive	OK
21	ARINC 741 SDU to ACU or Top/Port BSU Multi Control Bus (Note 5)	Inactive	OK
22	ARINC 741 SDU to Starboard BSU Multi-Control Bus (Note 5)	Inactive	OK
23	Aircraft ID (ICAO Address) 429 Data to SDU Bus	Inactive	OK
24	Reserved for ARINC 741 Redundant Weight-on-Wheels Discrete (Note 4)	Failure	OK
25	Reserved for ARINC 741 (ICAO) Address Bits (straps) (Note 4)	Error	OK
26	ARINC 741 Starboard BSU to Port BSU Crosstalk Bus (Note 5)	Inactive	OK
27	ARINC 741 Port BSU to Starboard BSU Crosstalk Bus (Note 5)	Inactive	OK
28	Reserved for ARINC 741 External HSDU1 to HPA Tx Path (Note 4)	Failed	OK
29	Reserved for ARINC 741 LGA HPA Over Temperature (Note 4)	Over Temp	OK
30	SSM		
31			
32	Parity (Odd)		

Notes:

1. Pin numbers are relative to the SDU.
2. OK status shall always be indicated for equipment not installed or buses not used, as determined by the Satellite Data Unit system configuration pins or its design.
3. An Inactive Bus report, if applicable, will supersede a data input Failure report.
4. Bit reserved in ARINC Characteristic 781 to preserve compatibility with Central Maintenance Computers designed per ARINC Characteristic 741. ARINC 781 SDUs should always set this bit to OK.
5. Bit used if the SDU is designed to interface with ARINC 741 high gain antenna systems.
6. Bit used if the SDU is designed to interface with ARINC 741 HPAs.

**ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL**

**BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #5 for Satcom**

Bit No.	Function	Bit Status	
		1	0
1 2 3 4 5 6 7 8	Label 354 (Octal)		
9 10	SDI		
11	Reserved for ARINC 741 SDU to External HSDU #1 Bus (Note 3)	Inactive	OK
12	Voice/Data Channel Module 1	Failed	OK
13	Voice/Data Channel Module 2	Failed	OK
14	Voice/Data Channel Module 3	Failed	OK
15	Voice/Data Channel Module 4	Failed	OK
16	Voice/Data Channel Module 5	Failed	OK
17	Voice/Data Channel Modules 6 and beyond	Note 2	Note 2
18	ARINC 741 HPA to HGA VSWR (Note 4)	Failed	OK
19	DLNA to SDU Rx Path	Failed	OK
20	ARINC 741 SDU to HPA Tx Path (Note 4)	Failed	OK
21	Reserved for ARINC 741 External HSDU #1 (Note 3)	Failed	OK
22	Reserved for ARINC 741 SDU to External HSDU #1 Disable discrete (Note 3)	Failed	OK
23	Reserved for ARINC 741 External HSDU #1 APM/CDM/FID Straps (Note 3)	Failed	OK
24	Reserved for ARINC 741 External HSDU #2 to SDU Bus (Note 3)	Inactive	OK
25	Reserved for ARINC 741 SDU to External HSDU #2 Bus (Note 3)	Inactive	OK
26	Reserved for ARINC 741 External HSDU #2 (Note 3)	Failed	OK
27	Reserved for ARINC 741 SDU to External HSDU #2 Disable discrete (Note 3)	Failed	OK
28	Reserved for ARINC 741 External HSDU #2 APM/CDM/FID Straps (Note 3)	Failed	OK
29	Shop Faults Mode Supported	Yes	No
30 31	SSM		
32	Parity (Odd)		

Notes:

1. OK status should always be indicated for equipment not installed or buses not used, as determined by the Satellite Data Unit system configuration pins or its design.
2. Logic 1 state = one or more of channel modules 6 and beyond have failed;
Logic 0 state = all of channel modules 6 and beyond are OK.
3. Bits reserved in ARINC Characteristic 781 to preserve compatibility with Central Maintenance Computers designed per ARINC Characteristic 741.
4. Used if the SDU is designed to interface with ARINC 741 HPAs.

ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #6 for Satcom

Bit No.	Function	Bit Status	
		1	0
1	Label 355 (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	Reserved for ARINC 741 LNA to external HSDU2 Rx Path (Note 4)	Failed	OK
12	Reserved for ARINC 741 External HSDU2 to HPA Tx Path (Note 4)	Failed	OK
13	Reserved for ARINC 741 External HSDU1 Ethernet Port (Note 4)	Inactive	OK
14	Reserved for ARINC 741 External HSDU2 Ethernet Port (Note 4)	Inactive	OK
15	Reserved for ARINC 741 SDU to RFU HSDU Disable Discrete (Notes 2 and 4)	Failed	OK
16	Reserved for ARINC 741 Straps for RFU HSDU (Notes 2 and 4)	Failed	OK
17	Reserved for ARINC 741 RFU HSDU Fail (Notes 2 and 4)	Failed	OK
18	Reserved for ARINC 741 SDU to RFU HSDU Bus (Notes 2 and 4)	Inactive	OK
19	Reserved for ARINC 741 RFU HSDU Channel #1 Fail (Notes 2 and 4)	Failed	OK
20	Reserved for ARINC 741 RFU HSDU Channel #2 Fail (Notes 2 and 4)	Failed	OK
21	Reserved for ARINC 741 RFU HSDU Channel #3 Fail (Notes 2 and 4)	Failed	OK
22	Reserved for ARINC 741 RFU HSDU Channel #4 Fail (Notes 2 and 4)	Failed	OK
23	Reserved for ARINC 741 RFU HSDU to SDU Bus (Notes 2 and 4)	Inactive	OK
24	Reserved for ARINC 741 LNA to RFU HSDU Rx Path (Notes 2 and 4)	Failed	OK
25	Reserved for ARINC 741 RFU HSDU to HPA Tx Path (Notes 2 and 4)	Failed	OK
26	Reserved for ARINC 741 RFU HSDU Ethernet Port 1 (Notes 2 and 4)	Inactive	OK
27	Reserved for ARINC 741 RFU HSDU Ethernet Port 2 (Notes 2 and 4)	Inactive	OK
28	Reserved for External HSDU 1 to SDU Tx Path (Notes 3 and 4)	Failed	OK
29	Reserved for External HSDU 2 to SDU Tx Path (Notes 3 and 4)	Failed	OK
30	SSM		
31			
32	Parity (Odd)		

Notes:

1. OK status should always be indicated for equipment not installed or buses not used, as determined by the Satellite Data Unit system configuration pins or its design.
2. RFU HSDU refers to a High-Speed Data Unit LRU that conforms in general to the wiring and form factor of a Radio Frequency Unit.
3. Intended for SDUs with internal high-power amplifiers.
4. Bits reserved in ARINC Characteristic 781 to preserve compatibility with Central Maintenance Computers designed per ARINC Characteristic 741.

**ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL**

**BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #7 for Satcom**

Bit No.	Function	Bit Status	
		1	0
1	Label 357 (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	SDU HSDU Channel Module #1	Failed	OK
12	SDU HSDU Channel Module #2	Failed	OK
13	SDU HSDU Channel Module #3	Failed	OK
14	SDU HSDU Channel Module #4	Failed	OK
15	External ARINC 781 HPA (Note 2)	Failed	OK
16	External ARINC 781 HPA to Antenna VSWR (Note 2)	Failed	OK
17	Reserved	Inactive	OK
18	Reserved	Inactive	OK
19	Reserved	Inactive	OK
20	Antenna Over Temperature (Note 3)	Over Temp	OK
21	ARINC 781 Antenna to SDU Data Bus (Note 3)	Inactive	OK
22	SDU to ARINC 781 Antenna Data Bus (Note 3)	Inactive	OK
23	SDU Over Temperature	Over Temp	OK
24	SDU to Antenna VSWR (Note 3)	Failed	OK
25	SDU to External ARINC 781 HPA Tx Path (Note 2)	Failed	OK
26	SDU to External ARINC 781 HPA Data Bus (Note 2)	Inactive	OK
27	SDU Configuration Module (SCM)	Failed	OK
28	SDU to SCM Data Bus	Inactive	OK
29	SCM to SDU Data Bus	Inactive	OK
30	SSM		
31			
32	Parity (Odd)		

Notes:

1. OK status should always be indicated for equipment not installed or buses not used, as determined by the Satellite Data Unit system configuration pins or its design.
2. This includes an external ARINC 781 HLD.
3. This includes an Enhanced Low Gain Antenna (ELGA) with or without a DLNA or HLD (either standalone or incorporated in the antenna).

ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #8 for Satcom

Bit No.	Function	Bit Status	
		1	0
1	Label 360 (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	Reserved for ARINC 741 HPA HSDU FID Straps (Note 3)	Failed	OK
12	Reserved for ARINC 741 HPA HSDU Ethernet Port 1 (Note 3)	Inactive	OK
13	Reserved for ARINC 741 HPA HSDU Ethernet Port 2 (Note 3)	Inactive	OK
14	Reserved for ARINC 741 HPA HSDU Channel #1 (Note 3)	Failed	OK
15	Reserved for ARINC 741 HPA HSDU Channel #2 (Note 3)	Failed	OK
16	Reserved for ARINC 741 HPA HSDU Channel #3 (Note 3)	Failed	OK
17	Reserved for ARINC 741 HPA HSDU Channel #4 (Note 3)	Failed	OK
18	Reserved for ARINC 741 HPA HSDU to SDU Bus (Note 3)	Inactive	OK
19	Reserved for ARINC 741 LNA to HPA HSDU Rx Path (Note 3)	Failed	OK
20	Reserved for ARINC 741 SDU to HPA HSDU Bus (Note 3)	Inactive	OK
21	Reserved for ARINC 741 HPA HSDU APM/CDM (Note 3)	Failed	OK
22	Reserved for ARINC 741 SDU to HPA HSDU Disable (Note 3)	Failed	OK
23	USIM #1	Failed	OK
24	USIM #2	Failed	OK
25	USIM #3	Failed	OK
26	USIM #4	Failed	OK
27	External ARINC 781 HPA to SDU Data Bus (Note 4)	Inactive	OK
28	External ARINC 781 HPA Over Temperature (Note 4)	Over Temp	OK
29	Reserved for ARINC 741 RFU HSDU APM/CDM (Notes 2 and 3)	Failed	OK
30	SSM		
31			
32	Parity (Odd)		

Notes:

1. OK status should always be indicated for equipment not installed or buses not used, as determined by the SDU system configuration pins or the SDU design.
2. RFU HSDU refers to a High-Speed Data Unit LRU that conforms in general to the wiring and form factor of a Radio Frequency Unit.
3. Bits reserved in ARINC Characteristic 781 to preserve compatibility with Central Maintenance Computers designed per ARINC Characteristic 741.
4. This includes an external ARINC 781 HLD.

**ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL**

**BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #9 for Satcom**

Bit No.	Function	Bit Status	
		1	0
1	Label 361 (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	SDU Ethernet Port #6 (fiber channel A)	Inactive	OK
12	SDU Ethernet Port #7 (fiber channel B)	Inactive	OK
13	SDU Ethernet Port #8 (fiber spare)	Inactive	OK
14	SDU Ethernet Port #9 (fiber spare)	Inactive	OK
15	SDU Ethernet Port #10 (fiber spare)	Inactive	OK
16	SDU Ethernet Port #1 (Size 22 Pins)	Inactive	OK
17	SDU Ethernet Port #2 (Size 22 Pins)	Inactive	OK
18	SDU Ethernet Port # 5 (Size 22 Pins, Spare)	Inactive	OK
19	SDU Ethernet Port #3 (Quadrax)	Inactive	OK
20	SDU Ethernet Port #4 (Quadrax)	Inactive	OK
21	Data from GNSS to SDU	Inactive	OK
22	Reserved for PIM Failure	Failed	OK
23	Reserved	Failed	OK
24	Reserved for ARINC 741 SDU HSDU Ethernet Port #1	Inactive	OK
25	Reserved for ARINC 741 SDU HSDU Ethernet Port #2	Inactive	OK
26	Reserved for ARINC 741 SDU HSDU Ethernet Port #3	Inactive	OK
27	Reserved for ARINC 741 SDU HSDU Ethernet Port #4	Inactive	OK
28	SDU Ethernet Port #11 (Size 22 Pins)	Failed	OK
29	SDU Ethernet Port #12 (Size 22 Pins)	Failed	OK
30	SSM		
31			
32	Parity (Odd)		

Notes:

1. OK status should always be indicated for equipment not installed or buses not used, as determined by the Satellite Data Unit system configuration pins or its design.

ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #10 for Satcom

Bit No.	Function	Bit Status	
		1	0
1	Label 362 (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	Manufacturer reserved	Failed	OK
12	Manufacturer reserved	Failed	OK
13	Manufacturer reserved	Failed	OK
14	Secure ORT Invalid	Failed	OK
15	User ORT Invalid	Failed	OK
16	Reserved for future ARINC 781 Characteristic update	Inactive	OK
17	Reserved for future ARINC 781 Characteristic update	Inactive	OK
18	Reserved for future ARINC 781 Characteristic update	Inactive	OK
19	Reserved for future ARINC 781 Characteristic update	Inactive	OK
20	Reserved for future ARINC 781 Characteristic update	Inactive	OK
21	Reserved for future ARINC 781 Characteristic update	Inactive	OK
22	Reserved for future ARINC 781 Characteristic update	Inactive	OK
23	Reserved for future ARINC 781 Characteristic update	Inactive	OK
24	Reserved for future ARINC 781 Characteristic update	Inactive	OK
25	Reserved for future ARINC 781 Characteristic update	Inactive	OK
26	Reserved for future ARINC 781 Characteristic update	Inactive	OK
27	Reserved for future ARINC 781 Characteristic update	Inactive	OK
28	Reserved for future ARINC 781 Characteristic update	Inactive	OK
29	Reserved for future ARINC 781 Characteristic update	Inactive	OK
30	SSM		
31			
32	Parity (Odd)		

Notes:

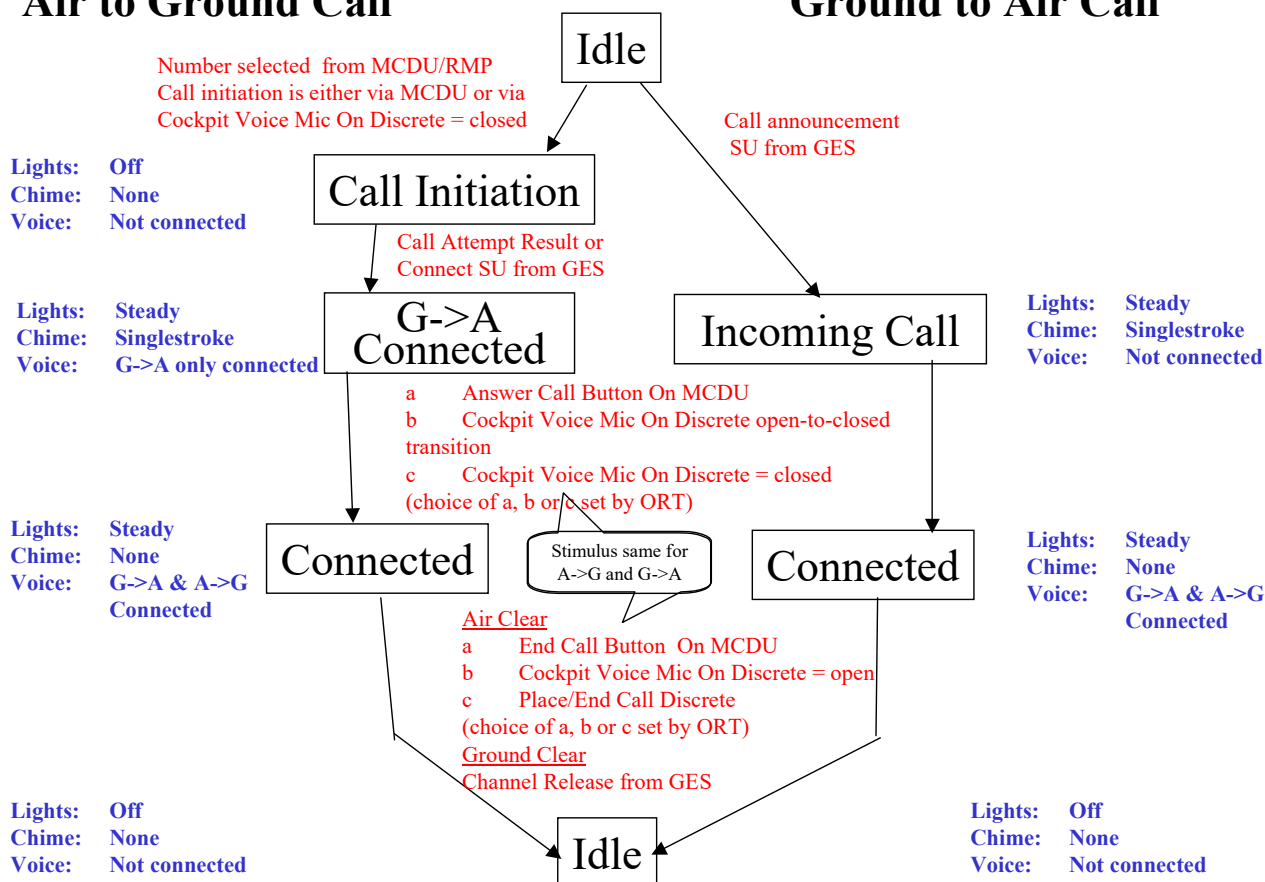
1. OK status should always be indicated for equipment, not installed or buses not used, as determined by the Satellite Data Unit system configuration pins or its design.
- 2.

ATTACHMENT 3
COCKPIT VOICE – SAT PHONE STATE MACHINE FOR NORMAL OPERATION

ATTACHMENT 3 COCKPIT VOICE – SAT PHONE STATE MACHINE FOR NORMAL OPERATION

Air to Ground Call

Ground to Air Call



ATTACHMENT 4A
ARINC 781 SDU FUNCTIONS MATRIX

ATTACHMENT 4A ARINC 781 SDU FUNCTIONS MATRIX

The SDU functions matrix seeks to define what features and functions are typically included in which model or version of satcom systems. ARINC 781 differs from previous satcom standards in that various features of the system can be optional. The following provides two examples of representative versions of satcom systems.

Section	Feature/Function	Options/ Comments	Cockpit and Cabin Satcom (Example)	Cabin-Only Satcom (Example)
2.10	BITE (CFDS interface)	OEM CFDSs	All	None
3.1.1	Inmarsat Services			
3.1.1.2	Classic Aero	Channels: 0-4 ¹	2	0
3.1.1.3	Swift64	Channels: 0-4 ¹	2	4
3.1.1.4	SwiftBroadband	Channels: 0-4 ¹	2	4
3.1.2	Radio Interfaces			
3.1.2.5	User/Radio Interfaces Mapping			
	Non-ATC Cockpit Voice	4-wire Analog	Yes	No
	ATC Cockpit Voice	4-wire Analog	Yes	No
	Cabin Voice	2-wire POTS/SLIC	Yes	Yes
	Non-ATC Cockpit Data	Data-2/3, Ethernet/ARINC 664	Ethernet/ ARINC 664	Ethernet/ ARINC 664
	ATC Cockpit Data	Data-2/3, Ethernet/ARINC 664	Data-2/3	None
	Cabin Data	CEPT-E1, Ethernet, 2 Wire POTS/SLIC	Ethernet Only	All
3.2.1	Pilot System Interfaces for Voice			
3.2.1.2	MCDU Menus	OEM Specific	OEM Compliant	None
3.2.1.6	SAT Phone – Classic Aero	Aero-H/H+/I	Yes	None
3.2.1.7	SAT Phone - SwiftBroadband	4 kbps AMBE+2, VoIP	Both	None
3.2.1.8	SAT Radio – SwiftBroadband	VoIP	Yes	None
3.2.1.9	Williamsburg SDU Controller		Yes	None
3.2.4	Ethernet	PPPoE, DHCP, SNMP, Telnet, Routed IP	All	All
3.3	Software Data Loader	ARINC 615-3/4, ARINC 615A	Both	ARINC 615A
3.4.1	Dual Satcom			
3.4.1.1	Classic Aero Operations	Independent, Cold Standby, Warm Standby, Hot Standby, Cooperative	Warm Standby, Cooperative	None
3.4.1.2	SwiftBroadband and Swift64 Operations	Independent, Cold Standby, Warm Standby, Hot Standby, Cooperative	Independent, Cooperative	Independent, Cooperative

**ATTACHMENT 4A
ARINC 781 SDU FUNCTIONS MATRIX**

Section	Feature/Function	Options/ Comments	Cockpit and Cabin Satcom (Example)	Cabin-Only Satcom (Example)
3.4.3	Security	Incorporated	Yes	No
3.6	Future Growth			
3.6.1	ARINC 664 Deterministic Ethernet		Yes – Future	No
3.6.3	FANS/ATS over SBB		Yes – Future	No
3.6.4	Multi-Frequency Band		Yes – Future	Yes – Future

Notes:

1. SDU manufacturers should clearly state what combination of channels is supported.

ATTACHMENT 4B
ARINC 781 SDU INTERFACES MATRIX

ATTACHMENT 4B ARINC 781 SDU INTERFACES MATRIX

The SDU interfaces matrix seeks to define which interfaces are typically included in which model or version of satcom systems. ARINC Characteristic 781 differs from previous satcom standards in that various interfaces of the system can be optional. The following provides two examples of representative versions of satcom systems.

Interfaces on ARINC 600 Connector	Options/ Comments	Cockpit and Cabin Satcom (Example)	Cabin-Only Satcom (Example)
Power			
115 Vac V/F		Yes	Yes
28 Vdc		No	No
Satcom Interfaces			
Tx RF (Power)		30W	25W
BSU Control	A781 HGA/IGA, A741 Top, A741 Side	All	A781 HGA/IGA
LGA Control		No	No
External HPA Control	A741, A781	A781	No
HPA Mute		Yes	No
SCM		Yes	Yes
Other SDU (dual)		Yes	No
User Interfaces		5	2
10/100BaseT on size 22 pins		5	2
10/100BaseT (Cockpit data) on Quadrax		No	No
ARINC 664 Copper (Cockpit voice and data)		No	No
ARINC 664 Fiber (Cockpit voice and data)		No	No
CEPT-E1		No	No
(C)MU		2	No
Cockpit Voice (4-wire and discrete)		Yes	No
MCDU		3	No
POTS/SLIC		No	No
BITE/Maintenance Interfaces			
CFDS/CMC on ARINC 429		Yes	Yes
ADL (ARINC 615/429)		Yes	Yes
Service Availability Status discrete		Yes	Yes
ATE pins		Yes	Yes
Miscellaneous Interfaces			
AES ID (ARINC 429)		Yes	No
IRS/GNSS		2	2
Configuration Straps		Yes	No
WOW		Yes	Yes
Tx Mute		No	No

ATTACHMENT 5 ETHERNET INTERFACE

ATTACHMENT 5 ETHERNET INTERFACE

1.0 INTRODUCTION

1.1 Purpose and Scope

This attachment describes how an SDU should set up, control, terminate and transfer packet data using the BGAN/SwiftBroadband packet data service via an IEEE 802.3 Ethernet interface(s) to Terminal Equipment. Services offered by the Terminal Equipment are out of scope of this document. Other uses of the physical interface, such as BITE and control of the SDU are outside the scope of this document.

The following uses of the interface as stated in Section 3.2.4 do not (currently) have detailed requirements described in this attachment.

- Routed Interface
- Security requirements

1.2 End to End Architecture Overview

The architecture below closely resembles that which would occur in an aircraft with a SwiftBroadband SDU. This represents a single channel. The interface to be implemented must support such architecture.

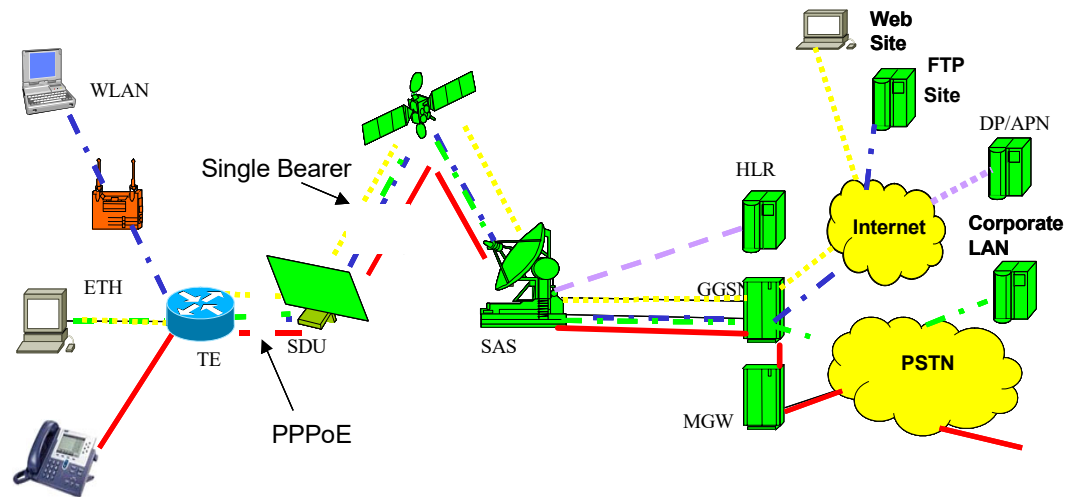


Figure 1 – Future Network Architecture

Note that in this model:

- PPP over Ethernet is carrying the PPP session between the TE/Router and the SDU.
- Multiple devices are attached to a network to access the SDU via a TE/Router device.
- Wireless devices may be deployed.
- Multiple sessions are in operation to different devices.
- Different services (for instance voice) may be offered (additional terrestrial infrastructure required and shown).

ATTACHMENT 5
ETHERNET INTERFACE

Note: The diagram does not show multiple SDUs or Channel Units, but these may be attached to the Router as an extension of this configuration. In addition, there may be scenarios where PPPoE originates in one or more TE/Router devices attached to the network.

ATTACHMENT 5 ETHERNET INTERFACE

2.0 OVERVIEW OF INTERFACE

2.1 Interface Purpose

To set up, control, and transfer packet data using SwiftBroadband packet data service.

The interface can also be used (backwards compatible) for the setup, termination and transfer of packet data using Swift64 (packet and circuit switched service)

Suitable for use with Terminal End Points containing unmodified COTS protocol stacks

Note: Control equates to: set up, modification and termination of primary contexts, and modification and termination of secondary contexts.

2.2 Aircraft Architecture

This Interface concept supports a wide variety of aircraft architectures including those:

- With or without servers
- With single or multi-channel SDUs
- With single or multiple SDUs
- With single or multiple servers

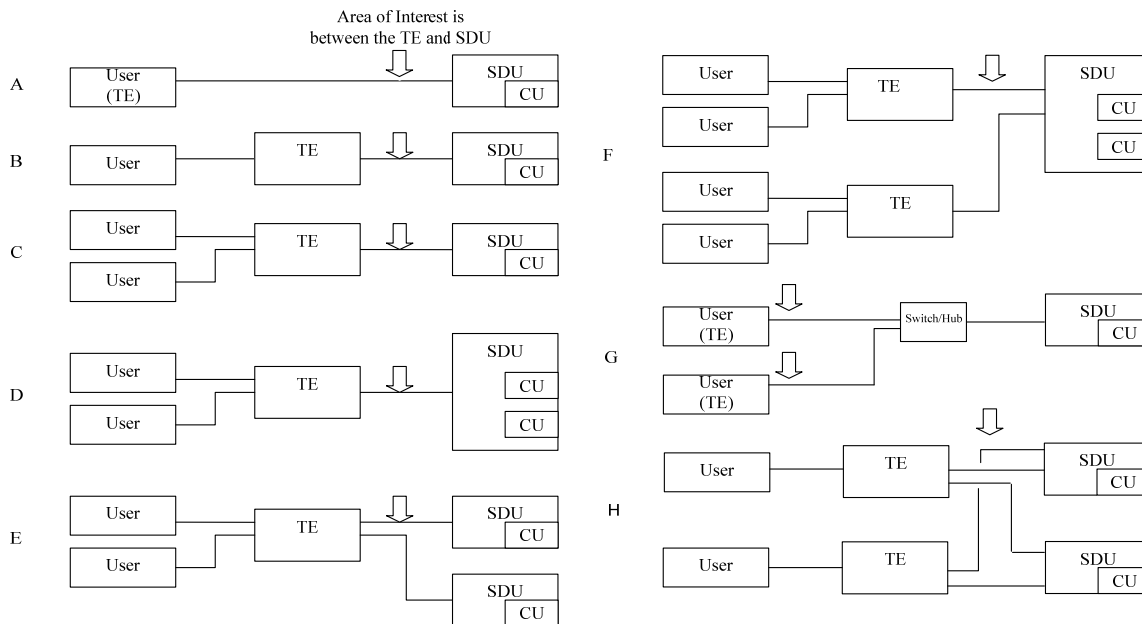


Figure 2 – Scenarios to be Supported by the Interface.

2.3 SwiftBroadband PDP Concepts

SwiftBroadband provides packet data services via Packet Data Protocol (PDP) contexts. Each SDU channel can support up to 11 concurrent contexts. Each context can be either a Background Class or Streaming Class.

**ATTACHMENT 5
ETHERNET INTERFACE****2.3.1 Primary PDP Context**

Each Primary PDP Context has a unique IP address. A Primary Context can have up to 10 Secondary Class Contexts within it.

2.3.2 Secondary PDP Context

A secondary context can only exist within a parent Primary PDP Context. It has the same IP as the Primary context. A secondary context needs a Traffic Flow Template (TFTs) to specify what traffic it should transport. Any traffic that is not specified in this template is sent over the Primary Context. Secondary Contexts are generally only utilized with a TE that employs a control line to the SDU.

2.3.3 Background Class

This class provides a shared IP service. The data rate is dependent on the class of the SDU and the number of other terminals operating on the channel. The operator pays only for the data sent and received using this service. This type of context is useful for general Internet access, email, web surfing, and VPN connections where guaranteed bandwidth is not required.

2.3.4 Streaming Class

This class provides dedicated data in rates of between 8 and 128 kbps in 8 kbps increments per Channel Unit. In addition, an X-Stream mode is available that assigns a 200 kHz bearer to the requesting AES for its exclusive use. The maximum data rate is dependent on the class of SDU. The operator is charged for the amount of time the Context is active. This context is used for a guaranteed data rate that ensures uniform latency (jitter) for applications such as videoconferencing, streaming video and voice over IP applications.

Note: X-Stream only supports one PDP context per channel.

2.4 Interface Fundamentals**2.4.1 Ethernet**

IEEE 802.3 Ethernet is the physical interface.

2.4.2 TCP/IP

SDU shall implement a TCP/IP V4 network stack.

2.4.3 PPPoE

PPPoE is the protocol used to establish a PDP Context. The SDU shall implement a RFC 2516 compliant PPPoE Access Concentrator.

2.4.4 PPP Server

PPP is terminated in the SDU. The SDU shall implement a RFC 1661 compliant PPP Server.

2.4.5 PPPoE Context Relationship

Each primary context is supported in a separate PPPoE session, and is allocated an IP address by either Inmarsat or the DP. Secondary context traffic is supported via the PPPoE session of the parent primary and shares the parent's IP address. Secondary contexts are established and controlled via a telnet service hosted by the SDU or with a Primary PDP Context request that is established via an AT string in a PPPoE service name.

**ATTACHMENT 5
ETHERNET INTERFACE****2.4.6 Control Line via Telnet**

The SDU shall accept TCP connections over port 22222 for establishing, modifying and creating secondary contexts.

Each control line equates to a single TCP session. The control line addresses a particular PDP context using a special AT command within a TCP session.

The name “telnet” is legacy from earlier implementations. See Section 4.2.4 of this attachment for further details.

2.4.7 Traffic Flow Templates

Traffic Flow Templates (TFTs) (based on 3G plus Inmarsat extensions) is the mechanism to specify the packet filter parameters between parent primary and secondary PDP contexts. They can be defined with PPPoE and Control Line via Telnet.

ATTACHMENT 5
ETHERNET INTERFACE

3.0 PPPOE

3.1 Description

Extract from introduction of RFC2516:

“PPP over Ethernet (PPPoE) provides the ability to connect a network of hosts over a simple bridging access device to a remote Access Concentrator. With this model, each host utilizes its own PPP stack and the user is presented with a familiar user interface. Access control, billing and type of service can be done on a per-user, rather than a per-site, basis.”

For SwiftBroadband, IP traffic between the SDU and end user (TE) will be via PPP over Ethernet (PPPoE). Multiple PPPoE sessions will be supported. This will allow multiple end users, each having a separate connection. It is assumed that each PPPoE client will be assigned the IP address associated with the packet data call (PDP context) and that each Primary PDP context will have a different IP address.

3.2 Protocol Layering

There are two conceptual models for operation of the protocols: Ethernet presentation to TE and IP presentation to TE.

The SDU interface remains the same in either case, and hence can support either model.

3.2.1 Layer 2 (Switched) Model – PPPoE Presentation at TE

The following diagram shows the user plane protocol stack for a single device attached to an SDU using PPPoE, where all the applications run on the Mobile Network Node (MNN) TE and Fixed Network Node (FNN) TE.

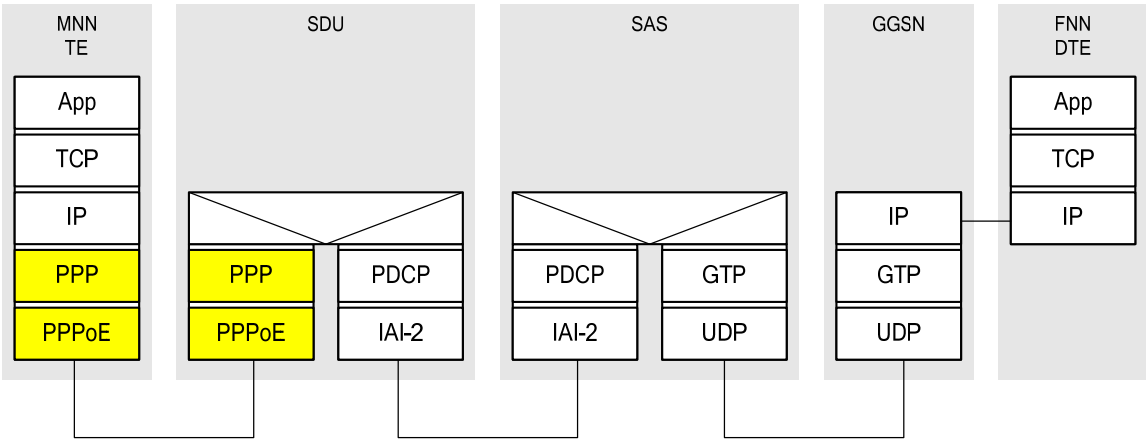


Figure 3 – Protocol Stack for User Plane for Routed Multiple TE Devices

In multiple user operation, a bridge, hub, or switch is placed between the MNN TE devices (each of which runs a PPPoE stack) and the SDU. The SDU is aware of all devices on the network.

ATTACHMENT 5
ETHERNET INTERFACE

3.2.2 Layer 3 (Routed) Model – IP Presentation at TE

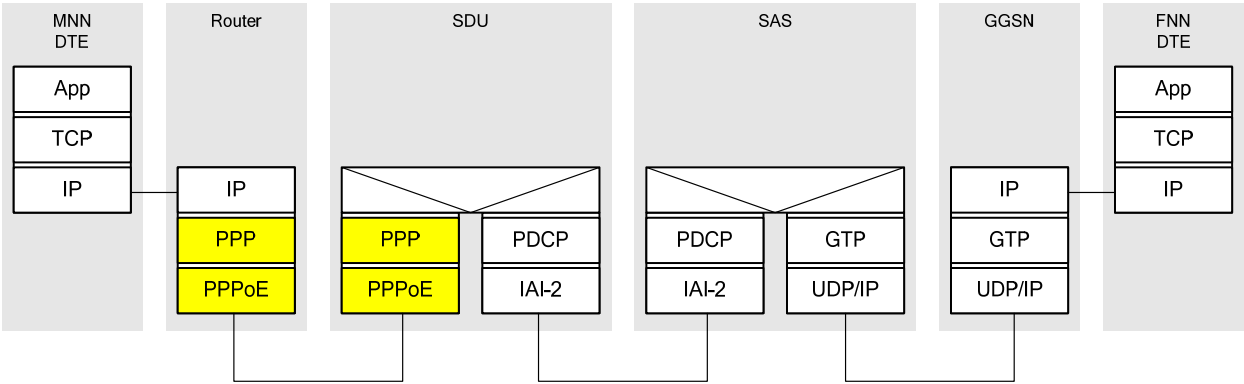


Figure 4 – Protocol Stack for User Plane for Routed Multiple TE Devices

In this case, there is only a single device (the Router) that is requesting service – the SDU does not need to know that there are multiple MNN TEs. The advantage of this approach is that it does not require PPPoE in the TE.

3.3 Protocol Operation for BGAN Context Setup

The following describes the PPPoE set up message sequencing including specific messaging that should be expected when implementing a PPPoE interface to a SBB SDU.

3.3.1 PPPoE Sequence

The sequence diagram below shows in broad terms the stages needed to establish an IP call from a PPPoE client (TE).

ATTACHMENT 5
ETHERNET INTERFACE

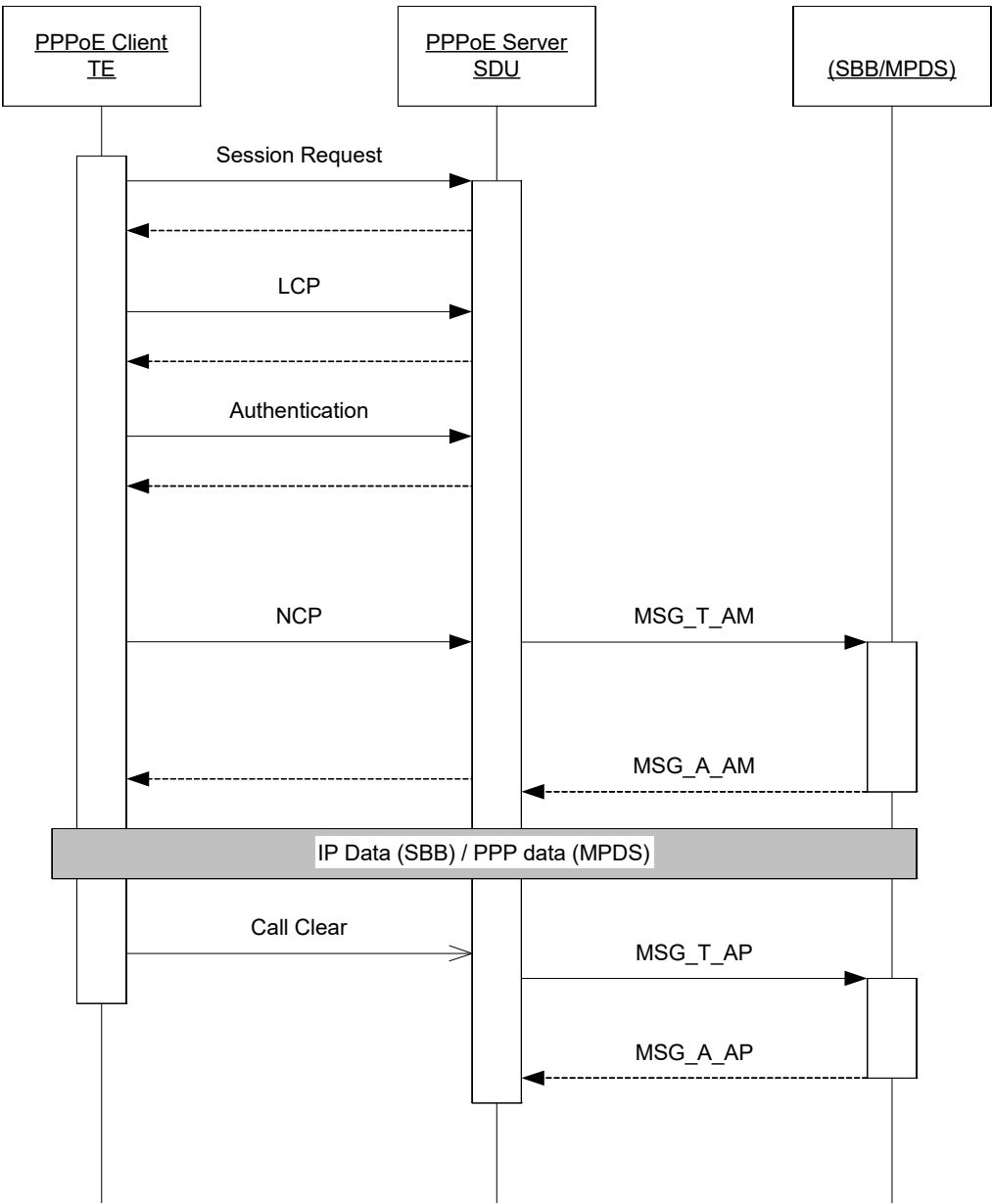


Figure 5 – PPPoE IP Call

3.3.2 PPPoE Session

A PPPoE session needs to be established between the TE (PPPoE client) and the SDU (PPPoE server). This would involve the discovery protocol, Link Control Protocol (LCP), authentication, and Network-layer Control Protocol (NCP) stages.

3.3.3 Discovery Stage

The discovery stage is initiated by the PPPoE client (TE) to find out if there are any PPPoE servers attached.

ATTACHMENT 5
ETHERNET INTERFACE

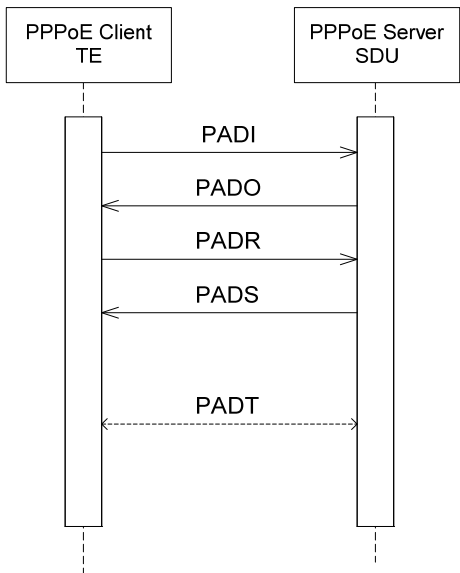


Figure 6 – PPPoE Discovery

Stage	Comment
1	The PPPoE client (TE) broadcasts a PPPoE Active Discovery Initiation (PADI) packet. As it is a broadcast packet all attached devices on the network, including the SDU, will receive it.
2	The PPPoE server (SDU) receives the PADI and responds to the PPPoE client with a PPPoE Active Discovery Offer (PADO) packet if the requested service is available ¹ . The PADO must uniquely identify the SDU. Additionally, the PADO may contain a number of Service-Name TAGs.
3	The PPPoE client (TE) sends a PPPoE Active Discovery Request (PADR) packet to the PPPoE server. This is analogous to a call request. It will also contain a Service-Name TAG_TYPE to indicate the SBB bearer type required.
4	The PPPoE server (SDU) responds with a PPPoE Active Discovery Session-confirmation (PADS) packet.
5	The session is now established. PPP traffic can pass between the PPPoE client (TE) and PPPoE server (SDU).
6	To terminate the session a PPPoE Active Discovery Terminate (PADT) packet is sent from either the PPPoE client (TE) or PPPoE server (SDU).

¹ Since a PADO is only returned if there is service availability, the use of PADI is not a reliable method of getting a list of available services. The service availability table (Section 5.3.2.2.1) accessible via SNMP is the recommended method. PADI is still a legitimate method for checking for the availability of a specific service. Sending a PADI does not infer any reservation of service; this is done through a PADR.

**ATTACHMENT 5
ETHERNET INTERFACE**

3.3.4 Link Control Protocol

LCP negotiates link configuration parameters between the SDU and PPPoE client (TE). Refer to RFC 1661 for further details. Failure of this phase will result in the PPPoE session being terminated.

3.3.5 Authentication

The authentication phase may include exchange of a user name and password between the TE's PPPoE client and the SDU's PPP Server. The SDU does not know if a user name and passwords is required by the APN prior to making the PDP Context activation request.

The SDU shall successfully authenticate the TE regardless of what it has been presented with (Spoof Authentication).

The SDU shall store the username and credentials from the TE for the PDP Context activation. Failure of the PDP Context activation authentication shall result in the SDU terminating the PPPoE session with a PADT. The PADT shall contain a specific failure code defined in Error codes section of this document.

The SDU shall support the following authentication protocols: PAP.

3.3.6 Network-layer Control Protocol

NCP is responsible for establishing the IP addresses that the TE's PPPoE client and SDU will use to exchange information between them.

Note that the IP address to assign to the PPPoE client will not be known until the PDP session has been established. The SDU will not respond to IPCP Config-Req's messages from the TE until the SDU has received an Activate PDP Context Accept message from the network. The Activate PDP Context contains the PPP IP parameters.

3.3.6.1 PPP Parameters Interfacing to UMTS during NCP

Failure of this phase will result in the PPPoE session being terminated

During the IPCP negotiations PPP parameters need to be passed or obtained from the SBB network.

**ATTACHMENT 5
ETHERNET INTERFACE**

Parameters	PPP	PDP Activate Context Message
IP Address	IPCP protocol RFC 1332 PPP Type = 3 Length = 6 IP address = 4 bytes If the IP address bytes are set to 0.0.0.0, then it is requesting a dynamic allocated address.	This is passed using the PDP Address IE detailed in 3GPP 24.008
Primary DNS Addresses	IPCP protocol Extensions for Name Server Addresses RFC 1877 PPP Type = 129 Length = 6 IP address = 4 octets	This is passed using the Protocol Configuration Options IE detailed in 3GPP 24.008
Secondary DNS Addresses	IPCP protocol Extensions for Name Server Addresses RFC 1877 PPP Type = 131 Length = 6 IP address = 4 octets	This is passed using the Protocol Configuration Options IE detailed in 3GPP 24.008

3.3.7 Data Transfer

The SDU's PPP/PPPoE stack will deliver IP packets to the SBB network by bridging the PPP session and the PDP context(s).

3.3.8 Call Termination

The PPPoE client will usually initiate call termination. The PADT packet sent by the PPPoE client will cause SDU to terminate the PDP Context. The call will then be cleared in an orderly manner. If the call clears for any other reason, a PADT will be sent from the PPPoE server to the PPPoE client to terminate the PPPoE session.

3.3.8.1 PADT Error Code

The PADT will contain a reason code that is mapped from the message derived from the Inmarsat cause code. These are documented in Section 6.0 of this document.

3.3.9 Access Concentrator Name

The SDU shall support the configuration of an Access Concentrator name via the ORT. This is needed where there are multiple SDU on a network.

A client can specify an AC-Name in a PADI. This field may be used by the SDU to determine whether the request was directed to itself. That is, if the AC-Name in the PADI does not match the AC-Name of the SDU, the SDU may simply ignore it.

ATTACHMENT 5
ETHERNET INTERFACE

3.3.10 PPPoE to Core SBB Network

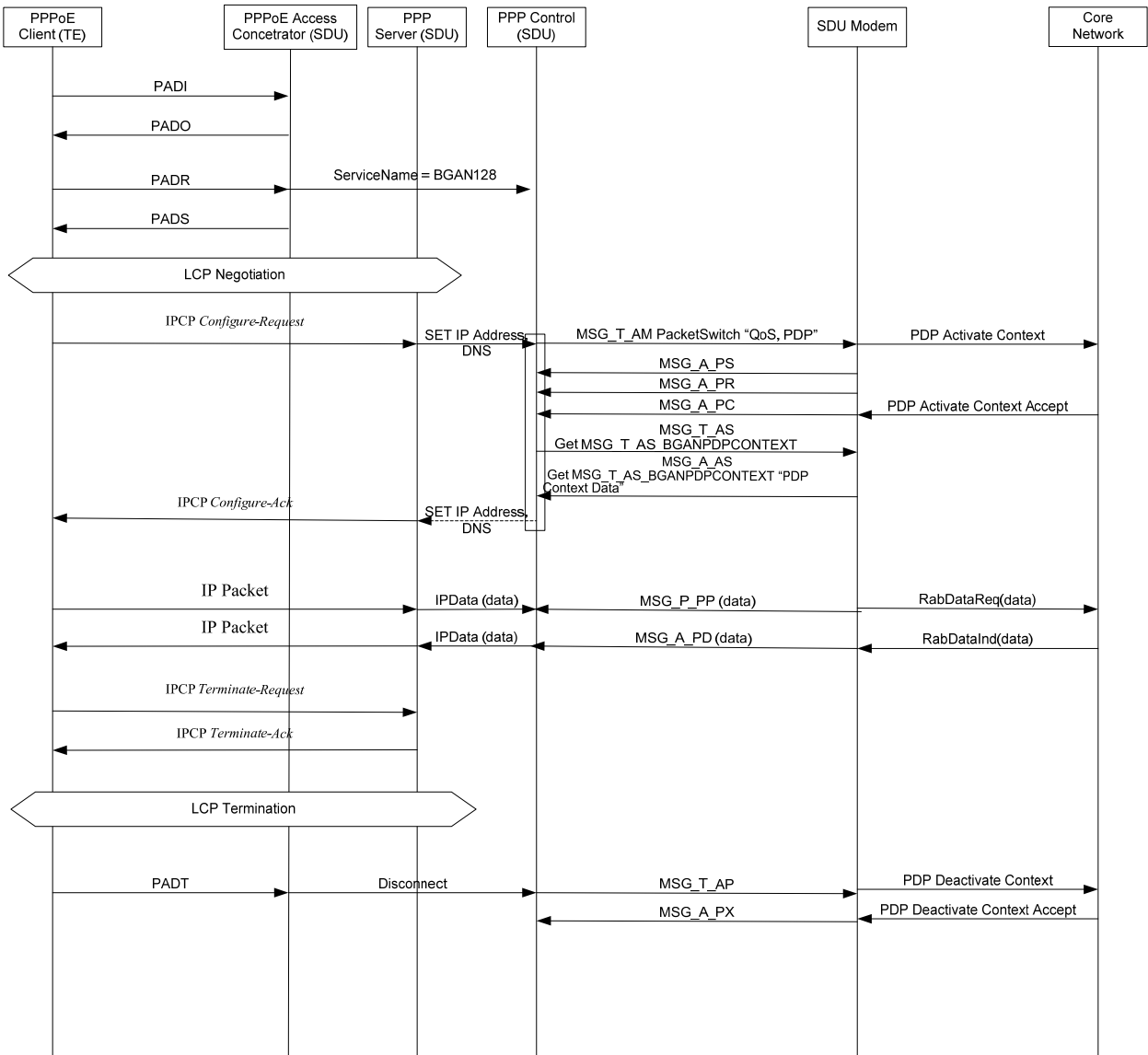


Figure 7 – Message Sequencing Chart

ATTACHMENT 5 ETHERNET INTERFACE

Stage	Comment
1	The PPPoE (TE) client requests a PPPoE session. Included in the request is the service type, which will be used to map to a SBB bearer type and QOS. The PPPoE access concentrator (SDU) completes the discovery stage.
2	With the call established, the PPPoE server can now configure the PPPoE client by continuing with LCP, authentication.
3	Once the NCP stage has requested an IP address, the SDU Channel Unit is instructed to start the packet data call, and is passed the PDP context information, required for the PDP context to be requested. The NCP request is acknowledged once the PDP context has accepted.
4	Data is passed between the PPPoE client and PPPoE server using PPPoE. Data is passed between the PPPoE server and Channel Unit SBB stack using IP packets.
5	The session terminates, usually at the request of the PPPoE client.

3.3.11 PPPoE Service Names

The PPPoE Service-Name is a string used to describe to the PPPoE Access Concentrator what service is being requested.

This string is commonly formed of a single Service Descriptor string, described below.

3.3.11.1 Service Descriptor String

The Service Descriptor string is being described separately from the Service-Name field, as the “Hunt Group” functionality described later calls for multiple Service Descriptor strings to be supplied within a Service-Name field.

The Service Descriptor shall be parsed as follows:

service[-channel][[:parameters]

This is: the optional name of the service, optionally followed by a channel specifier (separated by a dash), optionally followed by either a single SBB option name or an AT string (separated by a colon). Some services require parameters.

Example: SBB:STREAM64K

3.3.11.1.1 Service

The PPPoE Client (TE) needs to be able to specify the type of service desired. The SDU shall parse the first part of the Service Descriptor to determine which this is:

Service	Description
SBB	SwiftBroadband
MPDS	Swift 64 MPDS
ISDN	64K UDI CS Call

ATTACHMENT 5 ETHERNET INTERFACE

3.3.11.2 Channel

The PPPoE Client (TE) may wish to direct the request to a specific channel.

If no channel number is provided, the SDU is free to provide the service on whatever channel it deems appropriate.

If a channel is specified in the string, only this channel is considered for the service.

To provide an order of preference (such as “use channel 2 if available, but fall back to channel 1 if it’s not available”), the “Hunt Group” functionality should be used.

Example: SBB-2

3.3.11.3 Parameters

Parameters are dependent on the service being requested.

Parameters provided as part of a PPPoE string will have precedence over configuration provided by an ORT or factory defaults.

3.3.11.3.1 Parameters Field for SBB

This documents the parameters field for the SBB call type. If no parameters are supplied, the default service level will be supplied (usually BACKGROUND, but this could be overridden through an ORT parameter).

SBB Option Name	Description
BACKGROUND	Places a Primary Background PDP Context
STREAM8K	Places a Primary Streaming class PDP Context at the data rate of 8k
STREAM16K	Places a Primary Streaming class PDP Context at the data rate of 16k
STREAM32K	Places a Primary Streaming class PDP Context at the data rate of 32k
STREAM64K	Places a Primary Streaming class PDP Context at the data rate of 64k
STREAM128K	Places a Primary Streaming class PDP Context at the data rate of 128k
XSTREAM	Places a Primary Streaming class PDP Context with a dedicated 200 kHz bearer
STREAM	Places a Primary Streaming class PDP with upwards and downwards speeds specified in the @UP and @DOWN options (below)
AT String	This allows the TE PPPoE client to enter a full AT Context activation string. The letters “AT” must be present and the command string need to specify both CGEQREQ and CGEQMIN to ensure the desired QoS is provided. Example of full PPPoE service name string: SBB:AT+CGDCONT=1,“bgan.inmarsat.com”;+CGEQREQ=1,1,64,64,64,64,2,0,“0E0”,“0E0”,3,0,0;+CGEQMIN=1,1,64,64,64,64,2,0,“0E0”,“0E0”,3,0 Example of full PPPoE service name string for X-Stream: SBB:AT+CGDCONT=1,“bgan.inmarsat.com”;+CGEQREQ=1,1,512,512,512,512,2,0,“0E0”,“0E0”,3,0,0;+CGEQMIN=1,1,512,512,512,512,2,0,“0E0”,“0E0”,3,0

3.3.11.3.1.1 SBB Options (Optional)

Although defaults will usually be adequate, it is sometimes necessary to specify a user name, password and/or APN while starting a SBB PPPoE session. These can be passed either by supplying a full AT Context activation string (see above) or by appending these tagged options at the end with the syntax @tag=value:

ATTACHMENT 5 ETHERNET INTERFACE

Tag	Value
USER	User Name
PASS	Password
APN	Access Point Name
UP	Upward streaming speed, for use with STREAM option name above. The speed value can be a simple number (i.e., @UP=32) or a range of acceptable speeds (i.e., @UP=32-48).
DOWN	Downward streaming speed, for use with STREAM option name above. Its value follows the same convention as UP.
HCOMP	Per-PDP header compression: @HCOMP=<level> <level> is either 0 (zero) for explicitly disabled, or 1 for enabled. Other values are rejected. If the HCOMP option is not present, the default compression setting is used.

For example: SBB:BACKGROUND@USER=myuser@APN=bgan.inmarsat.org

These are equivalent to injecting these parameters into the AT Context activation's +CGDCONT command.

This syntax extension is optional, and may not be present in all boxes. Applications which need to be compatible with a variety of SDUs (including those which predate this extension) should instead provide AT command script.

Manufacturers may add new tags following the same @tag=value convention. Unknown tags should be ignored.

No mechanism is defined to programmatically determine which tags are supported.

3.3.11.3.2 Parameter Field for MPDS

This documents the Option field for the MPDS call type. Presenting it is optional

MPDS Option Name	Description
"AT String"	This allows the TE PPPoE client to enter a full AT Context activation string.

3.3.11.3.3 Parameter Field for ISDN

This documents the Option field for the ISDN call type. An option must always be presented for ISDN service.

ISDN Option Name	Description
Dial Number	This allows the TE PPPoE client to enter a dial string for the CS call. The trailing pound (#) character is optional. Example of full PPPoE service name string: ISDN:011555555555#

3.3.11.4 Paragraph Not Used

3.3.11.5 Hunt Group Syntax for Service Names

This feature is for use where the SDU may not support the preferred service and the PPPoE Client is willing to connect with another service. The PPPoE Client will specify a service name that conforms to the Hunt Group Syntax.

To do this, specify multiple Service Descriptor strings separated by the three characters: {?}.

**ATTACHMENT 5
ETHERNET INTERFACE**

Example:

SBB-1:STREAM128K {?}ISDN-2:28# {?}MPDS-2

The SDU will treat this request as being one for the first service it deems available (i.e., one which it would respond with a PADO in response to a PADI). The SDU will not automatically attempt the next service in the list in the event the selected service fails (for example, the SDU thought SBB was available, but it failed due to network congestion).

3.3.12 Offered Service Name

PPPoE must, in response to a PADI for an available service, provide all available services. Since it is not possible to provide every possible combination of every service with every set of parameters, the PADO is only expected to provide:

- Firstly, the Service-Name as requested (complete with parameters) as per RFC2516 requirements.
- All combination of Service and Channel (see Service Request description) that is available.

The SDU is free to offer services beyond this required list. The list may be cut short if there is insufficient space in the Ethernet frame to provide a full list. Because of this limitation, PADI is not a recommended way to get a list of available services; SNMP should be used instead.

ATTACHMENT 5 ETHERNET INTERFACE

4.0 PDP CONTEXT CONTROL

The following describes three options for interfacing a TE to a BGAN SDU utilizing PPPoE.

4.1 No Out of Band Control Line

This section details how a TE should operate with the SDU when the TE does not employ a control line.

4.1.1 Interface Stage 1 Implementation (No Control Line) Single TE

This section documents the relationship between a single TE and a SDU, where the TE does not employ a control line. The PDP context can be set up and initiated either by the use of ORT profiles stored at the SDU, or by placing a full context definition AT string in the PADR PPPoE message.

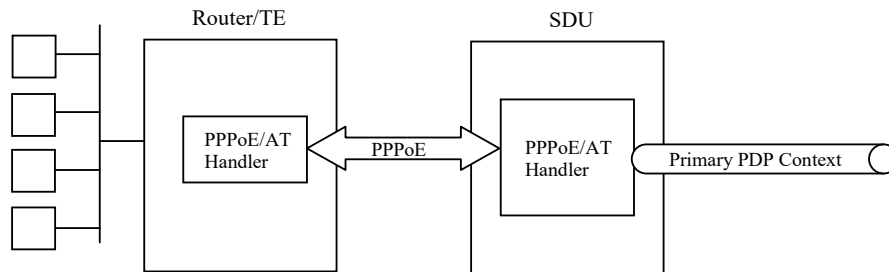


Figure 8 – Stage 1, No Control Line, Single User

4.1.2 Interface Stage 1 Implementation (No Control Line) Multi-User

The following shows the relationship between a single TE and a SDU, but with multiple Primary PDP contexts open. Again, each primary context is initiated then supported in a separate PPPoE Session.

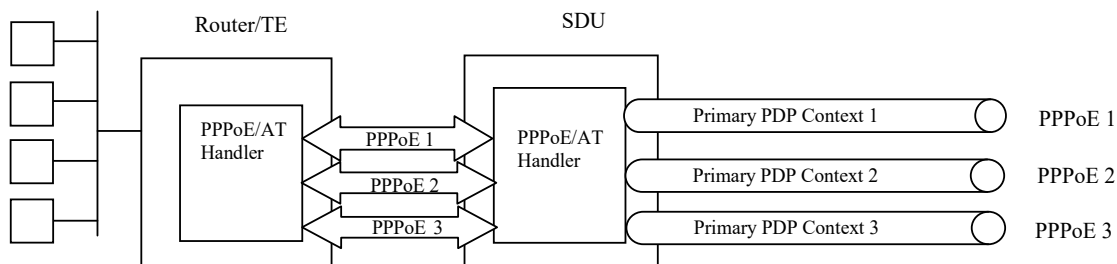


Figure 9 – Stage 1, No Control Line, Multiple PPPoE Sessions

4.2 Out of Band Control Line

4.2.1 Control Line Concept and Stack Diagram

The ability to readily modify and initiate additional secondary PDP contexts is a required feature of a scaleable SwiftBroadband based system. The following introduces and explains the concept of an 'out of band control line' between TE and SDU.

Using PPPoE as an interface mechanism between a TE and a SDU does have limitations. The PDP context definition, QoS and activation AT command strings have to be presented together via the PADR tag during the initial PPPoE Active Discovery Phase. Once this phase is complete, then no further transport mechanism

ATTACHMENT 5
ETHERNET INTERFACE

is available. This does pose a problem. Should the need arise for further TE to SDU transaction such as establishing a Secondary Context and Traffic Flow template, then PPPoE itself is not sufficient. This limitation highlights the need for a dedicated out of band TE to SDU control line.

To address this limitation, a Telnet session shall be used at the application layer to handle the AT commands for the purpose of implementing a control line. This requires the SDU to implement a Telnet server to pass AT commands to the SDU, and a TE with a Telnet based application to interact with it.

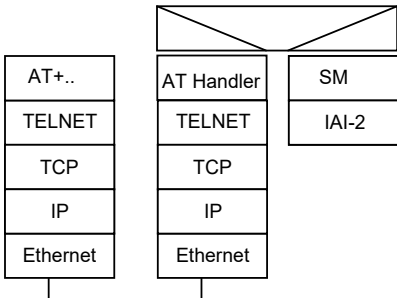


Figure 10 – Protocol Stack for a TE to SDU Control Line

4.2.2 Interface Stage 2 Implementation (with Control Line)

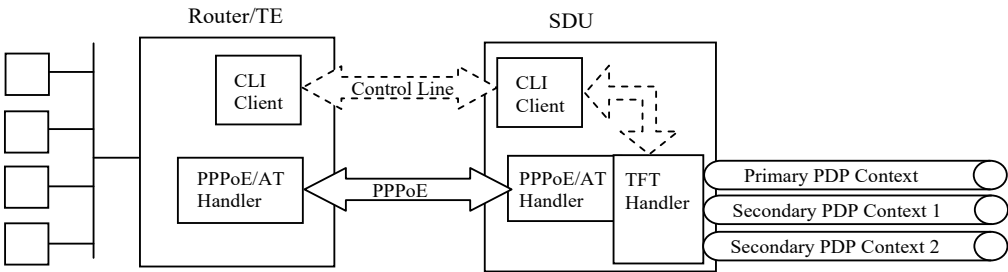


Figure 11 – Stage 2, Control Line Added, Single PPPoE Session

In addition to the standard PPPoE handler, a Command Line Interface (CLI) client is required on both the TE and SDU, as is a TFT handler. The CLI handler, via the command line, is used to pass further ‘AT’ commands to the SDU. As previously discussed, this facilitates PDP context modification and also provides a mechanism for creating secondary PDP contexts. The TFT handler has to be included in order to interpret the TFT as passed via the control line, and then route the upstream IP traffic between any active PDP contexts. The full format of the UT and GGSN TFT is described in 3GPP 27.00.7

4.2.2.1 Pairing of PPPoE Session and PDP Contexts

The use of PPPoE makes it possible to route the IP traffic from multiple PDP contexts via a single virtual PPPoE interface. It is considered that each Primary context and its associated Secondary contexts must share a single PPPoE session. This scheme is shown in the next figure.

ATTACHMENT 5 ETHERNET INTERFACE

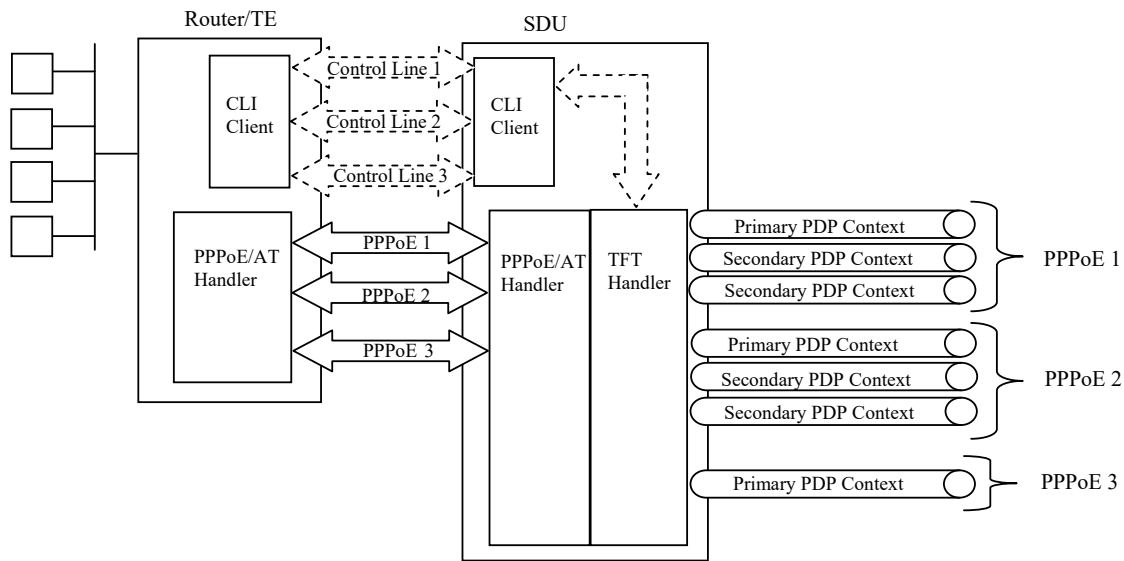


Figure 12 – Stage 2, Control Line Added, Multiple Contexts/PPPoE Sessions Sharing

In the previous diagram, the SDU has seven active contexts. Following the convention described, three PPPoE sessions are required. This scheme should also be used with a stage 1 implementation as well, where each separate primary context would therefore have its own PPPoE session.

The number of control lines shown in the diagram is not mandatory.

4.2.3 Stage 3 Implementation

As a further development, using the same interface as in the previous section, it may be desirable for a single/multiple SDUs to support multiple router/TEs. The diagram below shows such a configuration.

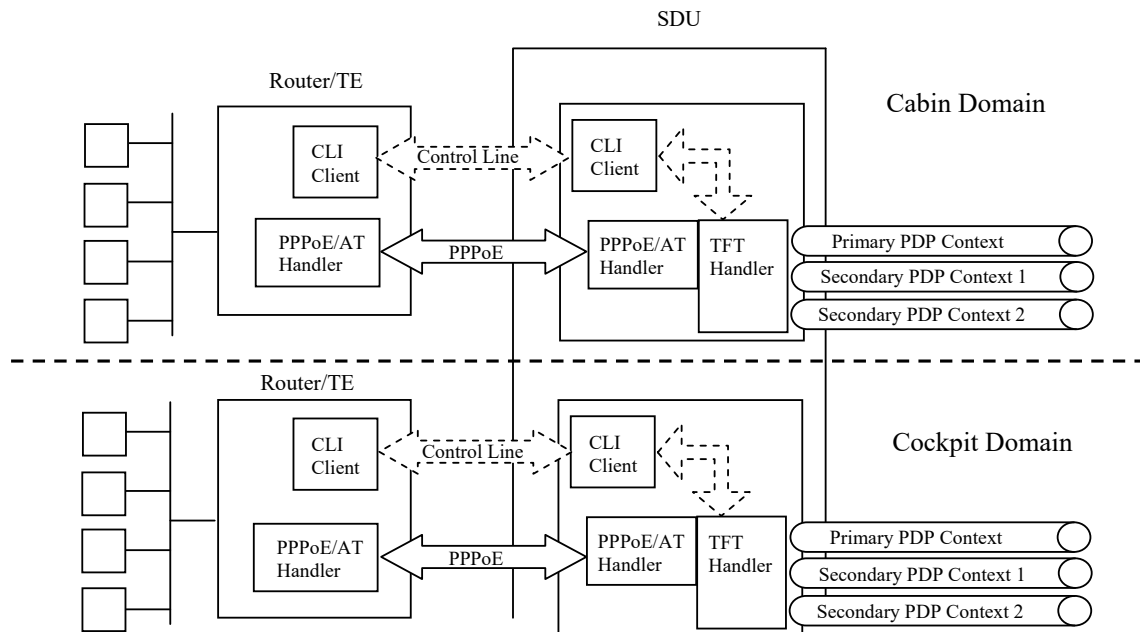


Figure 13 – Stage 3, Multiple Router/TEs with a Single SDU

ATTACHMENT 5

ETHERNET INTERFACE

It is possible that each router/TE could be connected to the SDU via separate physical Ethernet ports and also use pre-defined separate SDU channel cards. This arrangement could be used to separate cabin and cockpit connections for instance.

As with previous interface concepts the number of control lines employed is optional, and could be one or many.

4.2.4 Telnet Server

The SDU shall implement a Telnet Server. Refer to RFC 854. The Server should allow at least one TCP client session for each primary PDP context which can be brought up. This is to allow each primary to be controlled via its own session.

None of RFC854 is required to support the interface defined in UMTS 27.007, but it won't conflict with it either. The term "telnet" is retained in this document for historical purposes.

If a product already has a telnet service running on port 23, port 22222 is used as a fallback port. A client implementation should try 22222 first, and then port 23 to avoid having to parse an unexpected interface.

4.2.4.1 AT Handler

The TCP session shall be implemented to accept UMTS TS 27.007 commands and defined extensions for the purpose of command and control of Secondary PDP Context and Traffic Flow Templates.

4.2.4.2 Welcome Message

The TCP session may contain a welcome message sent by the SDU upon initial connection. This message should not exceed a few lines.

A client application should discard this data before issuing AT commands.

COMMENTARY

Provisions should be included in the terminal to disable or modify the welcome message.

4.2.4.3 Local Echo

An application can send an ATE0 command to turn echo off. ATE1 can be used to turn in back on.²

4.2.5 Control Line IP Addressing

The TE shall know the IP address of the SDU(s). The SDU shall derive its IP address from the ORT.

Optionally the SDU may be configured via the ORT to obtain its IP address from a DHCP server. In this scenario, the TE shall address the SDU(s) via Host Name. This implies that there is a mechanism for name resolution, such as DNS.

² The default echo state is currently undefined. Some manufacturers have it on (as per V.250) while others have opted to have it off (as per Internet service convention). Applications which need it in one specific state should send an appropriate command to put it in the desired state upon connection and be ready to discard potential echo (i.e., a response line which starts with AT).

ATTACHMENT 5 ETHERNET INTERFACE

4.2.6 Pairing of Control and Data Lines

It is not suggested that there be any mandated matching or pairing of PPPoE session/PDP Contexts and the control line. It is desirable that a single control line be capable of addressing multiple and single contexts. See IPDS in AT Command set.

4.3 Scaling PDP Contexts Concepts

Presented below are four examples of how one might wish to scale the BGAN service mid connection:

1. Replacing a primary context with a new primary context
2. Adding an additional primary
3. Adding an additional secondary
4. Modifying an existing primary or secondary context

In the following simplified examples an initial Primary PDP context of streaming class 32 kbps is negotiated and activated via the initial PPPoE connection. The need arises for a higher bandwidth streaming class connection.

4.3.1 Scaling a PDP Context without a Control Line

4.3.1.1 Replacing a Primary Context

In this scenario, no out of band control line to the SDU is available. The only method available to scale up the bandwidth is to specify and activate a new primary context.

Here, the current PDP context is terminated and a new higher bandwidth context is defined and activated. Though this is a valid method of scaling up the bandwidth available, it does require that the controlling server handling IP traffic have the ability to buffer the IP traffic in order to suspend the session whilst the new context is initiated. Ideally the same IP address would be allocated to the new context by means of a static IP request in the PDP context definition. Though the actual time to carry out this exchange is minimal, this is unacceptable to certain traffic types, transcoded GSM voice calls and other application types may be intolerant of the momentary interruption in end-to-end IP connectivity.

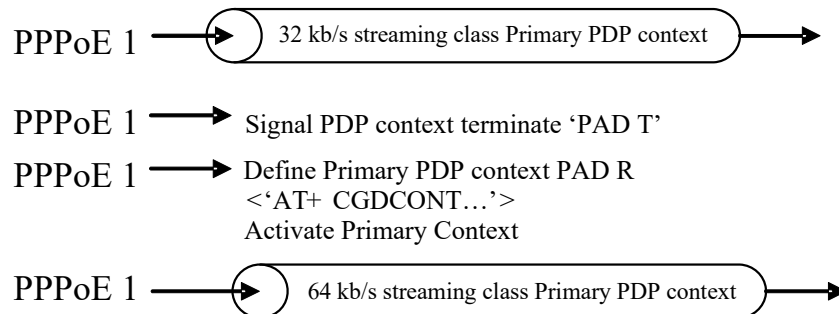


Figure 14 – Scaling with New Primary Context

4.3.1.2 Adding an Additional Primary Context

In this example, bandwidth scaling is achieved by defining and activating an additional primary context. The IP addresses of the two connections will not be the same. This calls for the management entity/server to provide intelligent bandwidth sharing capabilities in order to make best use of the aggregate bandwidth available.

ATTACHMENT 5 ETHERNET INTERFACE

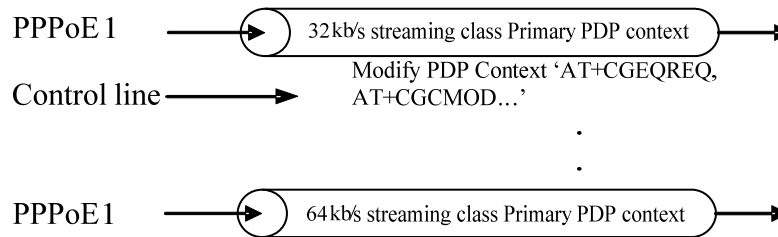


Figure 17 – Scaling by Modifying the Primary Context

4.4 AT Commands

Editor's comment: The AT command section of this document has been replaced with a table that defines the supported AT commands that are documented in 3GPP 27.0007 with the exception of the ARINC 781 defined AT commands. This change is not marked with track changes in order to improve readability.

4.4.1 AT Command Interface Support

M = Mandatory

O = Optional

N = Not required/Not defined or Not Supported

Table 1 – Inmarsat UT-TE Interface Spec and ARINC 781 Cross Reference [D.G.2]

3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
	SMS SERVICE - GENERAL CONFIGURATION AT-COMMANDS (3GPP TS 27.005)		
+CSMS	Select Message Service	M	O
+CPMS	Preferred Message Storage	M	O
+CMGF	Message Format	M	O
+CMS ERROR	Message Service Failure Result Code	M	O
	MESSAGE CONFIGURATION AT-COMMANDS (3GPP TS 27.005)		
+CSCA	Service Centre Address	M	O
+CSMP	Set Text Mode Parameters	O	O
+CSDH	Show Text Mode Parameters	O	O
+CSAS	Save Settings	O	O
+CRES	Restore Settings	O	O
	MESSAGE RECEIVING AND READING AT-COMMANDS (3GPP TS 27.005)		
+CNMI	New Message Indications to TE	M	O
+CMGL	List Messages	M	O
+CMGR	Read Messages	M	O
	MESSAGE SENDING AND WRITING AT-COMMANDS (3GPP TS 27.005)		
+CMGS	Send Message	M	O
+CMSS	Send Message from Storage	M	O
+CMGW	Write Message to Memory	M	O

ATTACHMENT 5
ETHERNET INTERFACE

3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
+CMGD	Delete Message	M	O
	GENERAL AT-COMMANDS (3GPP TS 27.007)		
+CGMI	Request Manufacturer Identification	M	M
+CGMM	Request Model Identification	M	M
+CGMR	Request Revision Identification	M	M
+CGSN	Request Product Serial Number Identification	M	M
+CSCS	Select TE Character Set	O	O
+CIMI	Request International Mobile Subscriber Identity	M	M
+CMUX	Multiplexing mode	O	O
	ITU-T V.25TER TE-TA INTERFACE COMMANDS		
S0	Number of rings until auto-answer	N	O
S2	Escape character	N	O
S3	Command line termination character	M	O
S4	Response formatting character	M	O
S5	Command line editing character	M	O
S6	Pause before blind dialing	N	O
S7	Connection completion timeout	N	O
S8	Comma dial modifier time	N	O
S10	Automatic disconnect delay	N	O
S12	Escape guard time (0.02s)	N	O
A	Go on-line in answer mode	N	O
D	Go on-line in originating mode	N	O
E	Echo	M	O
H	Hang up	N	O
O	Return to on-line state	N	O
P	Set pulse dial	N	O
Q	Result code display	M	O
S	S registers	N	O
T	Set tone dial	N	O
V	Select word or digit result code	M	O
X	Select result codes	M	O
&C	Select DCD options	M	O
&D	Select DTR options	M	O
&V	View configuration profile	N	O
&W	Store current configuration profile	N	O
=	Write to selected S register	N	O
?	Read from selected S register	N	O
+IPR	Fixed TE data rate	O	O
+ICF	TE-TA character framing	O	O
+IFC	TE-TA local flow control	O	O
+ILRR	Report local TE-TA data rate	O	O
	ITU-T V.25TER GENERIC TA CONTROL COMMANDS		
Z	Reset	M	O
&F	Fetch factory defaults	M	O

**ATTACHMENT 5
ETHERNET INTERFACE**

3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
I	Request Manufacturer Information	O	O
+GMI	Request Manufacturer Identification	M	O
+GMM	Request Model Identification	M	O
+GMR	Request Revision Identification	M	O
+GSN	Request Product Serial Number	O	O
+GOI	Request ISO Identification	O	O
+GCAP	Request Overall Capabilities of TA	M	O
+GCI	Selects the country of installation	O	O
	CALL CONTROL COMMANDS AND METHODS		
D	ITU-T V.25ter dial command	M	O
+CHUP	Hangup call	O	O
+CEER	Extended error report	O	O
+CSDF	Settings date format	O	O
+CSIL	Silence Command	O	O
+CSTF	Settings time format	O	O
.	NETWORK SERVICE RELATED AT-COMMANDS		
+CNUM	Subscriber Number	O	O
+CREG	Network registration	M	O
+COPS	PLMN Selection	O	O
+CLCK	Facility Lock	M	O
+CPWD	Change Password	M	O
+CLIP	Calling line identification presentation	O	O
+CLIR	Calling line identification restriction	O	O
+COLP	Connected line identification presentation	O	O
+CDIP	Called line identification presentation	O	O
+CCUG	Closed User Group	O	O
+CCFC	Call forwarding number and conditions	O	O
+CCWA	Call waiting	O	O
+CHLD	Call related supplementary services	O	O
+CTFR	Call deflection	O	O
+CUSD	Unstructured Supplementary Service Data	O	O
+CAOC	Advice of Charge	O	O
+CSSN	Supplementary service notifications	O	O
+CLCC	List current calls	O	O
+CAEMLPP	eMLPP Priority Registration and Interrogation	O	O
+CPPS	eMLPP subscriptions	O	O
+CFCS	Fast call setup conditions	O	O
+CAAP	Automatic answer for eMLPP Service	O	O
	MOBILE TERMINATION CONTROL AND STATUS AT-COMMANDS (3GPP TS 27.007)		
+CPAS	Phone Activity Status	O	O
+CFUN	Set Phone Functionality	M	O
+CPIN	Enter PIN	M	O
+CBC	Battery Charge	M	O
+CSQ	Signal Quality	O	O

ATTACHMENT 5
ETHERNET INTERFACE

3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
+CMEC	Mobile Termination control mode	O	O
+CKPD	Keypad control	O	O
+CDIS	Display control	O	O
+CIND	Indicator Control	O	O
+CMER	Mobile Termination event reporting	M	O
+CCLK	Clock	O	O
+CSIM	Generic SIM access	O	O
+CRSM	Restricted SIM access	M	O
+CALM	Alert sound mode	O	O
+CRSL	Ringer sound level	O	O
+CMUT	Mute control	O	O
+CACM	Accumulated call meter	O	O
+CSVM	Set Voice Mail Number	O	O
+CMAR	Master Reset	O	O
+CLAC	List all available AT commands	N	O
	MOBILE EQUIPMENT ERRORS		
+CMEE	Report Mobile Termination error	M	O
	PDP CONTEXT AT-COMMANDS (3GPP TS 27.007)		
+CGDCONT	Define PDP Context	M	M
+CGDSCONT	Define Secondary PDP Context	M	M
+CGTFT	Traffic Flow Template	M	M
+CGQREQ	Quality of Service Profile (Requested)	O	M
+CGQMIN	Quality of Service Profile (Minimum acceptable)	O	O
+CGEQREQ	3G Quality of Service Profile, Requested	M	M
+CGEQMIN	3G Quality of Service Profile, Minimum	M	M
+CGEQNEG	3G Quality of Service Profile, Negotiated	M	M
+CGATT	PS Attach or Detach	O	M
+CGACT	PDP Context Activate or Deactivate	M	M
+CGCMOD	PDP Context Modify	M	O
+CGDATA	Enter data state	O	O
+CGPADDR	Show PDP Address	O	M
+CGCLASS	GPRS mobile station class	O	O
+CGEREP	Packet Domain Event Reporting	M	M
+CGREG	GPRS Network Registration Status	O	M
+CGSMS	Select service for MO SMS messages	O	O
	MODEM COMPATIBILITY COMMANDS		
D*98#	Request Packet Domain IP service	M	O
	VOICE CONTROL COMMANDS		
+VTS	DTMF and tone generation	O	O
	BGAN SPECIFIC AT-COMMANDS		
_IPOINT	Antenna Pointing	M	O
_IGPS	GPS Location Information	M	O
_INIS	Network Interface Status	O	O
	BLUETOOTH COMMANDS		
_IBLTH	Manage Bluetooth Pairing	O	O
_IBTIF	Configure UT Bluetooth Interface	O	O

**ATTACHMENT 5
ETHERNET INTERFACE**

3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
_IBTINQ	Sets the Bluetooth Interface in Device Inquiry Mode	O	O
	ADDITIONAL BGAN COMMANDS		
_ITFT	UT Traffic Flow Template	M	M
_ITEMP	UT Temperature	M	O
_ILOG	Retrieve UT log file	N	O
_ISLEEP	UT Sleep Mode Timeout	O	O
_IMETER	Call Metering	M	O
_ISIG	Signal quality indication	M	O
_IBALARM	Report the Alarm State of the Terminal	M	O
_IBNOTIFY	Control the sending of unsolicited result codes	O	O
_ICSEV	Circuit Switch Domain Event reporting	O	O
	ARINC 781 Attachment 5		
_IPDPS2	Binding Telnet session to PPPoE context	N	M

Note: Former Section 4.4.1.1, AT Command Timeouts, was deleted for further consideration in the next supplement.

4.4.2 ARINC 781 Defined AT Commands

4.4.2.1 IPDS AT Command Extension for Binding a TCP Session to PDP Primary Context

The AT command for binding between a TCP Session and one or more PPPoE Sessions is “_IPDPS.”

- “_I” means it is part of the Inmarsat BGAN AT command extension.
- “PDPS” means Primary PDP Context Select.

The purpose of this select command is to select a particular PPPoE Session from one or more PPPoE Sessions established with the Server.

This AT command/response shall be used over a TCP session; it shall not available via PPPoE.

Command		Possible response(s)
Set Command	_IPDPS=<IP_addr>	OK
	_IPDPS=PPPoE_Session_ID	ERROR
Read Command	_IPDPS?	_IPDPS: <PPPoE_Session_ID>,<IP_addr>
Test Command	_IPDPS=?	ERROR
Unsolicited result code		_IPDPS: <PPPoE_Session_ID, IP_addr>

4.4.2.1.1 Set Command

The set command specifies one *primary* PDP to be selected with the TCP Session that sends the set command. Each *primary* PDP has a corresponding PPPoE

ATTACHMENT 5 ETHERNET INTERFACE

Session ID. All subsequent PDP Context related AT commands from the TCP Session are applicable to the specified PPPoE Session.

AT commands that are unrelated to PDP Context are not affected by the set command.

Returns `ERROR` if the `primary` PDP does not exist.

If the primary PDP is already in use, the previous owner of the primary PDP is notified of the loss of ownership through a spontaneous `_IPDPS:0,0.0.0.0` message. The same `_IPDPS:0,0.0.0.0` is also used when the call is torn down (as it is not possible to send further commands to a call which no longer exists).

4.4.2.1.2 Read Command

The read command returns the currently selected `primary` PDP by the TCP Session that sends the read command. If no PPPoE Session selected, 0, 0.0.0.0 is returned.

4.4.2.1.3 Test Command

Not supported.

4.4.2.1.4 Unsolicited Result Code

(Section deleted as it contradicted programming model and introduced unnecessary complexity.)

4.4.2.1.5 Defined Values

`<PDP_addr>`: a string parameter that identifies the PPPoE by the address of the Primary PDP Context.

Two values are possible, the PPPoE session ID or the IP address associated with that primary PDP. The two are recognized by their format. The PPPoE session ID is a simple number, while the IP address is an IPv4 address in the form `aaa.bbb.ccc.ddd`.

4.5 Virtual Context IDs

A method of making the equipment shareable between multiple users without requiring manual configuration or cooperating between these users is to simulate each of them being alone on the system (as far as context IDs go).

To achieve this, the system maintains a map of requested IDs (logical IDs), versus those actually used (actual IDs) for each user. Each user is represented by a PPPoE session (which infers a primary PDP, which infers an IP address).

For example, a user might issue a command such as:

```
AT+CGEQMIN=2,1,32,32,32,32,"0E0","0E0",3,0,0
```

The first parameter is a secondary context ID, the second one is a primary context ID. Assuming this user's logical ID 1 was mapped to actual ID 10 and logical ID 2 was mapped to actual ID 17, this command would be modified to the following before being processed by the BGAN stack:

```
AT+CGEQMIN=17,10,32,32,32,32,"0E0","0E0",3,0,0
```

Responses to commands must also go through the same mapping, to maintain the illusion of exclusivity.

ATTACHMENT 5 ETHERNET INTERFACE

The actual numbers are effectively reserved until the user terminates the PPPoE connection. The filter should fail (return ERROR) if there is no actual context ID available. This should not be a problem in normal usage.

4.6 Service Name Tag

The ServiceName TAG_value shall be a concatenation of one or more of the AT commands specified in 3GPP 27.0007. Each AT command shall be separated by a semicolon. The entire ServiceName TAG_value string is not null terminated.

The following rules apply:

- The ServiceName TAG_value shall include exactly one +CGDCONT
- Optionally the service name tag may include one or more +CGDSCONT commands to create secondary contexts. For each +CGDSCONT there shall be at least one +CGTFT command to associate a traffic flow template with the secondary context.

Optionally, the ServiceName TAG_value may include commands such as +CGEQREQ to specify the quality of service.

ATTACHMENT 5 ETHERNET INTERFACE

5.0 EDITOR'S COMMENT

This section describes the mechanism for how the satcom systems provide status information to the client systems (e.g., a cabin server).

5.1 Public Standards

5.1.1 Institute of Electrical and Electronics Engineers Documents

Table 2 – IEEE Documents

Reference	Title/Content
IEEE 802.3	10 base T full duplex

5.1.2 Internet Engineering Task Force Standard Documents

Table 3 – Applicable IETF Standards and RFCs

IETF STD	Reference	Title/Content	Relevant
STD0016	IETF - RFC 1155	Structure and Identification of Management Information for TCP/IP-based Internets	Yes
	IETF - RFC 1212	Concise MIB Definitions	Yes
STD0017	IETF - RFC 1213	Management Information Base for Network Management of TCP/IP-based internets: MIB-II	Yes
STD0043	IETF - RFC 1042	Standard for the transmission of IP datagrams over IEEE 802 networks	Yes
STD0051	IETF - RFC 1661	The Point to Point Protocol (PPP)	Yes
STD0058	IETF - RFC 2578	Structure of Management Information Version 2 (SMIv2)	Yes
	IETF - RFC 2579	Textual Conventions for SMIv2	Yes
	IETF - RFC 2580	Conformance Statements for SMIv2	Yes
STD0062	IETF - RFC 3411	An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks	Yes
	IETF - RFC 3412	Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)	Yes
	IETF - RFC 3413	Simple Network Management Protocol (SNMP) Applications	Yes
	IETF - RFC 3414	User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)	No
	IETF - RFC 3415	View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)	No
	IETF - RFC 3416	Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP)	Yes
	IETF - RFC 3417	Transport Mappings for the Simple Network Management Protocol (SNMP)	Yes
	IETF - RFC 3418	Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)	Yes
none	IETF - RFC 1471	The Definitions of Managed Objects for the Link Control Protocol of the Point-to-Point Protocol	Yes
none	IETF - RFC 2516	A Method for Transmitting PPP Over Ethernet (PPPoE)	Yes
none	IETF - RFC 3339	Date and Time on the Internet: Timestamps	Yes
none	IETF - RFC 3410	Introduction and Applicability Statements for Internet-Standard Management Framework	Yes

Table 4 – Useful IETF Best Common Practice Documents

IETF BCP	Reference	Title/Content
BCP0074	IETF - RFC 3584	Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework

ATTACHMENT 5 ETHERNET INTERFACE

5.2 Basic Structure

In a segregated environment (multiple network stacks) there is no requirement to provide information of one stack to the other.

5.2.1 MIB-II Objects and Enterprise OID

The basic SNMP MIB II based object structure shall be defined as shown in the following figure:

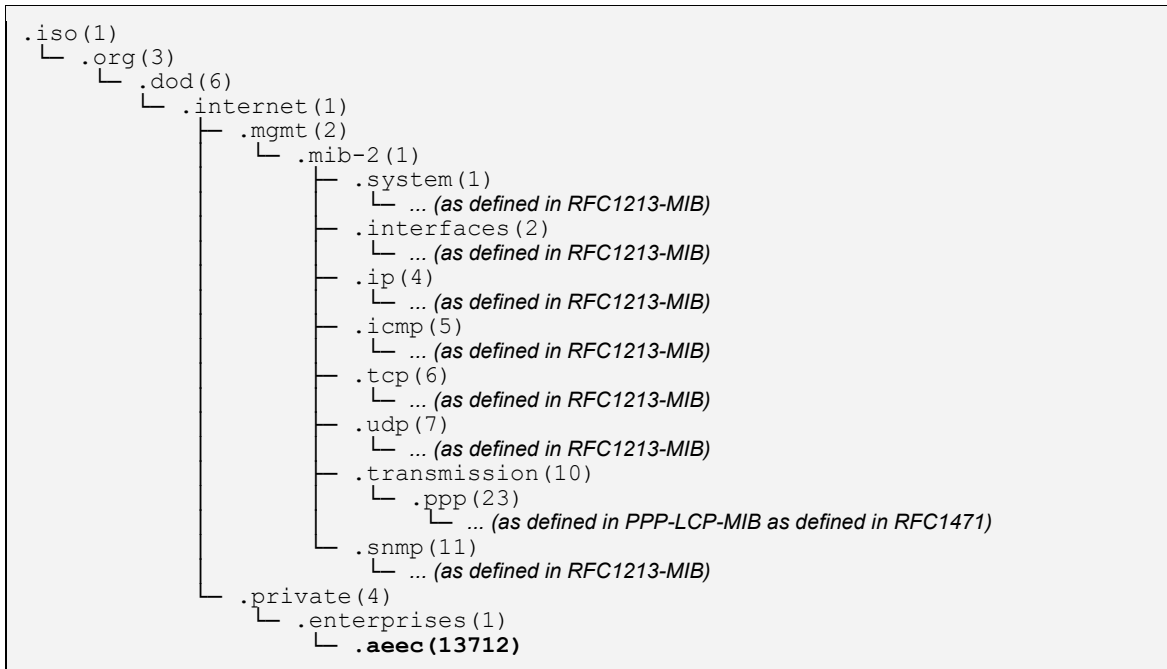


Figure 18 – Basic Used SNMP MIB Structure

The enterprise OID for all ARINC 781 related MIBs is **.aeec(13712)**. Each ARINC 781 MIB has to be located under this branch.

COMMENTARY

The industry already uses an alternative MIB under entry number 1.3.6.1.4.1.16727.3.3. This alternative MIB should be used for existing SBB-only modems and client applications connecting them.

Some entries in RFC1213 are defined as read/write, although read-only is generally desired for this implementation (for security purposes). Standard SNMP implementations may not have a simple mechanism to make these read-only. For the time being, this issue is unresolved (determined by the supplier).

**ATTACHMENT 5
ETHERNET INTERFACE****5.2.2 MIB Entry Point**

The level 1 OIDs under that branch will be managed by the AEEC NIS group. The primary structure of the MIB entry is defined as shown in the following figure:

```
.iso(1)
└ .org(3)
  └ .dod(6)
    └ .internet(1)
      └ .private(4)
        └ .enterprises(1)
          └ .aeeec(13712)
            └ .arincSwift(781)
              └ ...
```

Figure 19 – MIB Entry Point

All definitions in this document are related to the MIB Entry Point. Inside this definition, all structures will only be shown with the shortened prefix ".arincSwift(781)".

5.2.3 General MIB Branches

The Basic Structure has yet to be defined:

[TBD]

Figure 20 – ARINC Swift MIB Structure**5.3 Detailed MIB Definition****5.3.1 Object Types**

This ARINC 781 MIB uses some additional Types, which are not defined in the SNMP and MIB standards. All used Types are described in this section. Each type definition has a prefix of AS (which means arinc swift).

ATTACHMENT 5 ETHERNET INTERFACE

5.3.1.1 Health Status Type Definition

The SNMP Type **ASHealthState** indicates the health status of the system, a unit or applications hosted on units. The possible values are:

Table 5 – Health Status Type Definition

SNMP Type	Number	Description
pass	1	The system is working.
fail	2	The system has an error.
absent	3	The system is not reachable.

5.3.1.2 Test Status Type Definition

The SNMP Type **ASTestState** indicates the status of an initiated test or a finished test. It is an enumerated **Integer** value with the following Structure:

Table 6 – Test Status Type Definition

SNMP Type	Number	Description
pass	1	The test was successfully finished.
fail	2	The test was stopped with an error.
ongoing	3	The test is still running.
aborted	4	The test was stopped before it had a chance to complete.

5.3.1.3 Link Status Type Definition

The SNMP Type **ASLinkState** indicates the status of a link (e.g., Ethernet, context, etc.). It is an enumerated **Integer** value with the following Structure:

Table 7 – Link Status Type Definition

SNMP Type	Number	Description
up	1	Link is working correct and in use.
down	2	Link is working correct but down.
unconnected	3	No cable is plugged to the port.
errorHW	4	Link has a hardware error.

5.3.1.4 Satellite Lock State Type Definition

The satellite Lock State will be reflected by the Type **ASSatLockState**. It is an enumerated **Integer** value with the following Structure:

Table 8 – Satellite Lock State Type Definition

SNMP Type	Number	Description
inLock	1	This value indicates that the satcom system is connected to a satellite and correctly decoding receives data.
notInLock	2	This value indicates that the satcom system is not connected to a satellite or that it is connected, but is not correctly decoding received data.

ATTACHMENT 5 ETHERNET INTERFACE

5.3.1.5 Restart Reason Type Definition

The restart reason of the unit or their software will be reflected by the Type **ASRestartReason**. It is an enumerated **Integer** value with the following Structure:

Table 9 – Restart Reason Type Definition

SNMP Type	Number	Description
longPowerCut	1	The system has been reset due to a long power interruption.
shortPowerCut	2	The system has been reset due to a short power interruption.
safetyTest	3	The system has been reset due to a safety test.
lruReconfig	4	The system has been reset due to a reconfiguration.
dataloadCompl	5	The system has been reset after a completed data loading process.
dataloadComplCSW	6	The system has been reset after a completed data loading process including CSW.
fpButtonRequest	7	The system has been reset after pushing a reset button.
snmpTestRequest	8	The system has been reset after a Self-Test request via SNMP.
atCommand	9	The system has been reset after a request per AT command.
maintEquipSelfTest	10	The system has been reset after a maintenance equipment self-test.
maintEquipDefSet	11	The system has been reset after resetting the default settings during maintenance process.
snmpResetRequest	12	The system has been reset after a SNMP reset request.
maintEquipRequest	13	The system has been reset after an equipment maintenance request.
osFailDetect	14	The system has been reset after an operating system failure detection.
externalDiscrete	15	The system has been reset after a discrete request.

5.3.1.6 LRU Thermal State Type Definition

The thermal state of a LRU will be reflected by the Type **ASUnitThermState**. It is an enumerated **Integer** value with the following Structure:

Table 10 – LRU Thermal State Type Definition

SNMP Type	Number	Description
normal	1	The unit is working within its normal operational temperature.
overheat	2	The unit is non-critical working outside its normal operational temperature.
shutdown	3	The unit is critical working outside its normal operational temperature and has to be shutdown.

5.3.1.7 Thermal Antenna State Type Definition

The thermal antenna state will be reflected by the Type **ASAntThermState**. It is an enumerated **Integer** value with the following Structure:

Table 11 – Thermal Antenna State Type Definition

SNMP Type	Number	Description
ok	1	The antenna works fine.
class1	2	The thermal antenna state is in class1 mode.
class3	3	The thermal antenna state is in class3 mode.

ATTACHMENT 5 ETHERNET INTERFACE

5.3.2 Mandatory Branches

The structure is divided into five mandatory main branches, which are shown in the following figure:

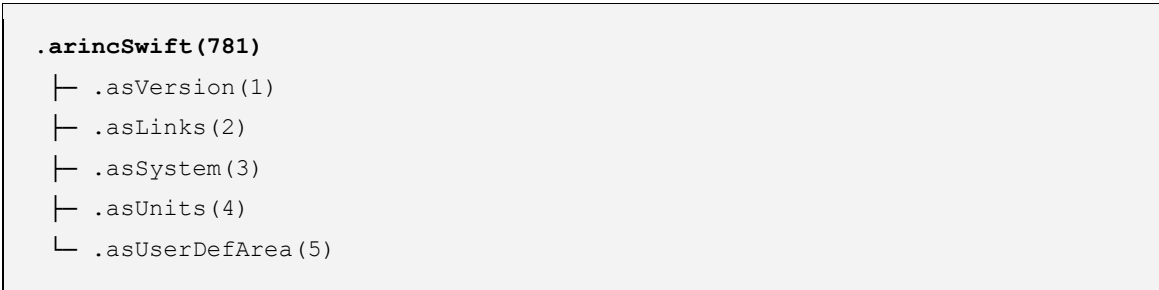


Figure 21 – Main Branches

5.3.2.1 MIB Version Related Objects

The **.asVersion(1)** folder contains only two objects. The first object is the major version number. The second object is the minor version number. Both objects are from the Type **Integer32** and the sub version is limited to the range from 0 to 99. The following table shows the object details of this folder:

Table 12 – Version Object Details

Object Identifier	Type	Range	Description
.asvMajor(1)	Integer 32		This object defines the major version of the arincSwift MIB definition. The current major version number is 1.
.asvMinor(2)	Integer 32	0..99	This object defines the minor version of the arincSwift MIB definition. The current minor version number is 0.

5.3.2.2 Link Related Objects

The **.asLinks(2)** folder contains the most important objects to monitor the satellite link. The objects are grouped in the two subfolders showed in the following figure.

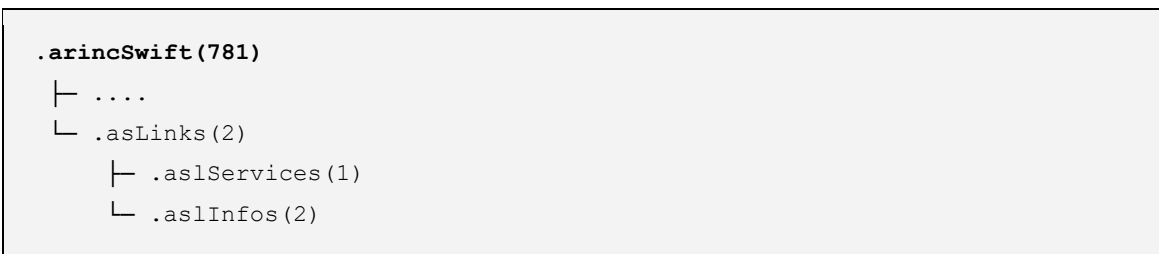


Figure 22 – Link Related Subfolders

5.3.2.2.1 Service Availability Related Sub Branch

5.3.2.2.1.1 Object Structure

The first subfolder in the **.asLinks(2)** branch is **.aslServices(1)**. It contains one table and one **Integer32** object. The integer object is called **.aslsNumbers(1)**. It indicates the number of entries in the table and has a range from 0 to 100.

The table object is called **.aslsTable(2)** and shows the available services, which a client can currently establish. The table is a sequence of the column entries shown in Table 13.

ATTACHMENT 5 ETHERNET INTERFACE

It is not required to have channel-specific entries. If these are present, they must appear after the general ones.

For BGAN services, each streaming class (Stream32K, Stream64K...) will have a separate entry, to show the availability of each of these services.

Table 13 – Service Related Object Details

Object Identifier	Type	Range	Unit	Description
.aslsIndex (1)	Integer32	1..32767	none	This column contains a unique identifier for this entry.
.aslsName (2)	DisplayString	0..63	none	This column contains the name of the service in the following form: "Service:Subservice." These are expected to match the PPPoE Service-Names. User-defined services and sub-services will not necessarily be present in this table, as it may not be possible to determine their availability.
.aslsInUse (3)	Integer32	0..127	none	Number of instances of this service currently in use.
.aslsAvailable (4)	Integer32	0..127	none	Number of instances potentially remaining. Note that number of remaining instances are not necessarily max-in_use, as other services may consume resources required by this service. Due to system dynamics, there is no guarantee that the user will be able to place this many additional calls, even if it is alone on the system. This value can be seen as a best-case scenario.
.aslsMaxChannels (5)	Integer32	0..127	none	This value indicates, how many instances of this service type are maximum available. Must be zero for invalid entries.
.aslsMaxBWPerChannel (6)	Integer32	0..32767	kbps	This value indicates the maximum bandwidth available on one instance of this service.
.aslsMaxBW (7)	Integer32	0..32767	kbps	This value indicates the maximum bandwidth available to all instances of this service.

5.3.2.2.1.2 Object Behaviors

The value of the **.aslsNumbers (1)** object has to be constant.

The table has to be initialized after the start of the unit. It has to contain all services that the unit can support.

The following table shows a content example, how the service availability can look like for a two-channel unit:

ATTACHMENT 5 ETHERNET INTERFACE

Table 14 – Example Link Service Table Content³

Row	.aslsIndex(1)	.aslsName(2)	.aslsAvailable(4)	.aslsMaxChannels(5)	.aslsMaxBW(7)
1	1	ISDN	0	4	256
2	2	MPDS	0	2	128
3	3	SBB:BACKGROUND	22	22	864
4	4	SBB:STREAM32K	14	14	448
5	5	SBB:STREAM64K	6	6	384
6	6	SBB:STREAM128K	2	2	256
7	7	SBB:XSTREAM	1	2	512

The value of **.aslsNumbers (1)** is 4 in this case. The content of the table indicates that Swift 64 services MISDN and MPDS can be supported by the unit, but are not available and that the SwiftBroadband services are available. The client can establish up to 22 background channels with up to 864 kbps, up to 14 32K streaming channels with up to 448 kbps, up to 2 128K streaming channels, or a mixture of thereof.

If, for example, an application opens a 128 kbps SBB Streaming class, available background channels will go down by one (as a primary slot is being used), STREAM32K channels will go down by 4, etc.

5.3.2.2.2 Link Related Information Sub Branch

5.3.2.2.2.1 Object Structure

The second subfolder in the **.asLinks (2)** branch is **.aslInfos (2)**. It contains two tables and four objects.

Table 15 – Satellite Related Object Details

Object Identifier	Type	Range	Description
.asliSatState (1)	ASSatLockState		This object shows, if the satellite is locked or not. The type is an enumerated integer value.
.asliSatID (2)	DisplayString	0..32	This object shows, which satellite is connected by the satcom system (e.g., "IOR")
.asliSatIDNum (3)	Integer32	0..63	Unique numeric identifier for the connected satellite.
.asliSatHandoverPending (8)	TruthValue		Set if the system believes it will need to do a handover soon.
.asliSatNetworkName (9)	DisplayString	0..16	This object indicates to which satellite network the SDU is connected, because the satellite identification numbers may not be unique between the different networks (I3 and I4) Possible values should be for example "GAN" for I3 and "BGAN" for I4.

The **Integer32** object **.asliActLinkEntryNumbers (4)** indicates the number of the entries in the first table and has a range from 0 to 50.

The first table object is called **.asliActLinkTable (5)** and shows the currently established links.

Another **Integer32** object **.asliHistLinkEntryNumbers (6)** indicates the number of the entries in the second table and has an open range.

³ In practice, there will be many more entries than this. There will be separate entries for each streaming class, and separate entries for each channel (i.e., SBB-2:STREAM64K). These names follow the PPPoE service-name convention. SDUs may include non-data services (such as voice) as this information would help diagnose scenarios where services are not available due to non-data usage of the SDU.

**ATTACHMENT 5
ETHERNET INTERFACE**

The second table object is called `.asliHistLinkTable (7)` and shows the terminated links.

The tables are a sequence of the column entries shown in Table 16. The first identifier is related to the link table for the actual links and the second identifier is related to the link table for the history entries.

Table 16 – Link Information Table Related Object Details

Object Identifier	Type	Range	Unit	Description
<code>.asliActLinkIndex (1)</code> <code>.asliHistLinkIndex (1)</code>	Integer32	1..32767	none	This object is a unique identifier for the current link entry and can be considered a handle for the session. With each new link, this number is to be incremented by one, wrapping around (but avoiding conflicts).
<code>.asliActLinkReleaseType (2)</code> <code>.asliHistLinkReleaseType (2)</code>	Integer32		none	This object shows the release type of the current link as numeric codes as described in Attachment 5, Section 6.
<code>.asliActLinkReleaseReason (3)</code> <code>.asliHistLinkReleaseReason (3)</code>	DisplayString	0..128	none	This object shows the reason for the release type in a displayable form.
<code>.asliActLinkStatus (4)</code> <code>.asliHistLinkStatus (4)</code>	ASLinkState		none	This object shows if the current link is up or not. Because entries are only removed 30 seconds after going down, it is important to check this field while reading the active link table.
<code>.asliActLinkChanNo (5)</code> <code>.asliHistLinkChanNo (5)</code>	Integer32	0..31	none	This object shows which channel is used on the card by the current link. Might be zero if a request for service failed before it was assigned to a channel.
<code>.asliActLinkContextID (6)</code> <code>.asliHistLinkContextID (6)</code>	Integer32	0..255	none	In case of a SBB link, this object shows which context ID is assigned to this link. If the current link is a swift 64 link, this entry has to be set to zero. These are virtual (logical) context ID specific to that user session (tied to a primary PDP). For primary PDPs initiated through the normal service names (i.e., SBB: BACKGROUND), this number will be 1. Secondaries will show up with the number supplied by the user. The user could also use a different primary ID if initiating a SBB primary through an AT command string. For detailed information to the virtual context IDs refer to Section 4.2.2.1.
<code>.asliActLinkActualContextID (7)</code> <code>.asliHistLinkActualContextID (7)</code>	Integer32	0..255	none	The context ID used over the air. This ID is unique per channel card in the system while it is active. The association between a ContextID and the ActualContextID remains for the duration of the primary PDP. A zero indicates that the actual entry is not mapped to a PDP context (e.g., in case of S64 link).

ATTACHMENT 5
ETHERNET INTERFACE

Object Identifier	Type	Range	Unit	Description
.asliActLinkConnectionID(8) .asliHistLinkConnectionID(8)	DisplayString	0..128	none	This object shows information about the connection (e.g., initialization string of the current link in form of the used AT command). If the original string was longer than can fit in this field, it will be truncated.
.asliActLinkNegotiatedBW(9) .asliHistLinkNegotiatedBW(9)	Integer32	0-2048	kbps	This object shows the currently negotiated bandwidth of the link in this table entry. Variable-rate connections (SBB:BACKGROUND, MPDS) with no guaranteed bandwidth and show up as 0. Connections with asymmetric speeds use the lesser speed for this entry.
.asliActLinkIpAddress(10) .asliHistLinkIpAddress(10)	IpAddress	0.0.0.0/0	none	This object contains the IP-Address of the current link. If this link is a sub-link of another entry, which does not have an own IP address (e.g., a part of a bundle or a secondary context), this field must contain the address of the primary context to which it is related.
.asliActLinkTxTrafficVol(11) .asliHistLinkTxTrafficVol(11)	Integer32		kBytes	This object contains the information about the total transmitted bytes over this link in kBytes. See Note 1.
.asliActLinkRxTrafficVol(12) .asliHistLinkRxTrafficVol(12)	Integer32		kBytes	This object contains the information about the total received bytes over this link in kBytes. See Note 1.
.asliActLinkBeamID(13) .asliHistLinkBeamID(13)	Integer32	0-255	none	This object shows, which spot beam is connected by the current link.
.asliActLinkSigQual(14) .asliHistLinkSigQual(14)	Integer32		dBHz*10	This object shows the Quality in dBHz*10 of the current link.
.asliActLinkMaxSigQual(15) .asliHistLinkMaxSigQual(15)	Integer32		dBHz*10	Expected maximum/ideal values for Link Signal Quality. See Note 2.
.asliActLinkMainIndex(16) .asliHistLinkMainIndex(16)	Integer32	0..32767	none	If this link entry is part of bundle (e.g., a secondary context), this object refers the main entry (e.g., the primary context) in this table to which this subentry is related.
.asliActLinkServiceIndex(17) .asliHistLinkServiceIndex(17)	Integer32	0..100	none	This object is a link to the aslsServiceTable by referring the used Service. A “3” defines in accordance with “Example Link Service Table Context,” that the Link is from the type SBB:Background. For links not related to an PPPoE service, this value is 0. For streaming services which don’t fit one of the standard services, this should point to generic SBB or to the closest streaming class.

ATTACHMENT 5
ETHERNET INTERFACE

Object Identifier	Type	Range	Unit	Description
.asliActLinkContrInterfIndex(18) .asliHistLinkContrInterfIndex(18)	Integer32	0..32767	none	This object contains the index number of the PPP control interface, which is related to this link. It is a crosslink into the pppLinkStatusTable of the PPP-LCP-MIB by referring the value of the according pppLinkStatusPhysicalIndex. For links not related to PPP connections (voice calls, for example), this value is 0. Also zero for secondary PDP's.
.asliActLinkPhysInterfIndex(19) .asliHistLinkPhysInterfIndex(19)	Integer32	0..32767	none	This object contains the index number of the physical interface, where this link is related to. The value is a crosslink into the ifTable of the RFC1213-MIB by referring the according value ifIndex. For links not related to an IP interface (analog POTS, for example), this value is 0.
.asliActLinkStartTime(20) .asliHistLinkStartTime(20)	ASDateTime	RFC3339		Time at which the link was brought up.
.asliActLinkEndTime(21) .asliHistLinkEndTime(21)	ASDateTime	RFC3339		Time at which the link was brought down. If the link is still connected this field has to contain the same value as the start time.
.asliActLinkPPPoEID(22) .asliHistLinkPPPoEID(22)	Integer32		none	PPPoE Session ID which started the call. For links not started through PPPoE, this value is zero. For secondary PDP's, this value is the one from the related primary PDP.
.asliActLinkQueueTotalSize(23) .asliHistLinkQueueTotalSize(23)	Integer32	-1..32767	kBytes	This value defines the queue size for the current Air-To-Ground link. It can be set to zero if the actual link is a sub link of another entry and has no own queue (e.g., a secondary context). See Note 1.
.asliActLinkQueueFreeSize(24) .asliHistLinkQueueFreeSize(24)	Integer32	-1..32767	kBytes	This value defines how much space is available in the air to ground queue. See Note 1.
.asliActLinkNegotiatedBWUp(25) .asliHistLinkNegotiatedBWUp(25)	Integer32	0..2048	kbps	This object shows the currently negotiated outbound bandwidth of the link in this table entry. For links with no guaranteed bandwidth, the value will be 0.
.asliActLinkNegotiatedBWDown(26) .asliHistLinkNegotiatedBWDown(26)	Integer32	0..2048	Kbps	This object shows the currently negotiated inbound bandwidth of the link in this table entry. For links with no guaranteed bandwidth, the value will be 0.
.asliActLinkPeerIP(27) .asliHistLinkPeerIP(27)	IpAddress	0.0.0.0/0	none	The IP address of the remote end of the connection. The value will be 0.0.0.0 if unknown or not applicable.

**ATTACHMENT 5
ETHERNET INTERFACE**

Object Identifier	Type	Range	Unit	Description
.asliActLinkDNS1 (28) .asliHistLinkDNS1 (28)	IpAddress	0.0.0.0/0	none	The first DNS server as negotiated over the PPPoE session. The value will be 0.0.0.0 if unknown or not applicable.
.asliActLinkDNS2 (29) .asliHistLinkDNS2 (29)	IpAddress	0.0.0.0/0	none	The second DNS server as negotiated over the PPPoE session. The value will be 0.0.0.0 if unknown or not applicable.
.asliActLinkRequestSource (30) .asliHistLinkRequestSource (30)	DisplayString	0..32	none	This object shows the manner and interface through which this link was brought up. The syntax is <METHOD>[-<PORT>]. Methods can be one of: - PPPoE - NAT - Bridge - Internal The optional <PORT> will display the port name as appropriate for that SDU, but typically it will be "Eth1" and such. Internal connections do not use an external connection but can use that part of the name to indicate which internal connection it is (for example, "Internal-SafetyData"). An automated process checking this field should not assume specific capitalization. Other values may be present for non-PPPoE interfaces (for example, ISDN1-B1, E1-B4, Handset1, etc.). The field will be blank if it could not be resolved.

Note 1: The values of the previous table referring to this note can also be set to -1, if the system (e.g., for temporary design reasons) cannot provide it. Due to the fact that all these values are very useful for the client applications to calculate the throughput, the satcom systems shall implement this feature as soon as possible.

Note 2: Recommended values for MaxSigQual are as follows:

64 dBHz	BGAN Global Beam
68 dBHz	BGAN Regional Beam
80 dBHz	BGAN Spot Beam
75 dBHz	Swift64 (Spot/Regional Beam)
65 dBHz	Swift64 NCS (Global beam)

5.3.2.2.2 Object Behavior

The **.asliActLinkTable (5)** is the main table in the MIB. It contains all relevant information of the established links. Due to the fact that new links will be established or established links will be updated or closed, this table has to be updated very often. It has a very dynamic content. This section describes how the values in one

ATTACHMENT 5 ETHERNET INTERFACE

entry have to be updated, how a new entry has to be attached, and how an entry has to be removed.

The following table shows a content example of the table:

Table 17 – Example 1 of the Actual Link Table Content

Table Row	...Index(1)	...Status(4)	...LinkNegotiatedBW(10)	...BeamID(14)	...MainIndex(16)	...ServiceIndex(17)
1	1	up	0	101	0	3
2	9	up	128	101	0	6
3	11	up	64	101	9	5

The following table shows a content example of the history table:

Table 18 – Example 1 of History Link Table Content

Table Row	...Index(1)	...Status(4)	...LinkNegotiatedBW(10)	...BeamID(14)	...MainIndex(16)	...ServiceIndex(17)
1	3	down	0	100	0	3
2	2	down	128	100	0	6
3	4	down	64	100	3	5
4	8	down	0	100	0	3
5	5	down	0	100	0	3
6	6	down	64	101	8	5
7	7	down	64	101	5	5
8	10	down	0	101	6	3

In accordance with Table 14 – Example Link Service Table Content, the values are indicating the following scenario:

The satcom has established two primary contexts:

- One primary context is located in row 1 with index 1 and is related to service index 3 (SBB:Background).
- The other primary context is located in row 2 with index 9 and is related to service index 4 (SBB: STREAM32K).
- The entry in row 3 indicates a secondary context with a current allocated bandwidth of 64 kbps on spot beam 101 from the type SBB: STREAM32K. This entry is related to the one in row 2, because the asliLinkServiceIndex is set to 9.

5.3.2.2.2.1 Insertion of a New Entry into the Table

A new entry has to be attached on the end of the table. The first entry, which will be attached, has to start with a **.asliActLinkIndex(1)** of “1.” Each time, where a new service entry will be inserted, the **.asliActLinkIndex(1)** of the new entry has to be increased. If the maximum value has been reached, the index has to start with 1 again. If the table already has an entry with the index 1, the value has to be increased to 2. This has to continued, until a free index value has been found. Index numbers are unique across both tables (the active and terminated calls).

The new content with a new secondary background link for the bundle in row 2 and 3 in beam 101 has to look as shown in the following table:

**ATTACHMENT 5
ETHERNET INTERFACE**

Table 19 – Example 2 of the Actual Link Table Content

Table Row	.asliActLink...					
	...Index(1)	...Status(4)	...LinkNegotiatedBW (10)	...BeamID(14)	...MainIndex(16)	...ServiceIndex(17)
1	1	up	0	101	0	3
2	9	up	128	101	0	6
3	11	up	64	101	9	5
4	12	up	0	101	9	3

The history table still has the same content. This is shown in the following table:

Table 20 – Example 2 of the History Link Table Content

Table Row	.asliHistLink...					
	...Index(1)	...Status(4)	...LinkNegotiatedBW(10)	...BeamID(14)	...MainIndex(16)	...ServiceIndex(17)
1	3	down	0	100	0	3
2	2	down	128	100	0	6
3	4	down	64	100	3	5
4	8	down	0	100	0	3
5	5	down	0	100	0	3
6	6	down	64	101	8	5
7	7	down	64	101	5	5
8	10	down	0	101	6	3

5.3.2.2.2.2 Removal of an Entry in the Table

If a link goes down, the corresponding **.asliActLinkStatus (5)** values have to be changed and a timer has to be started for 30 seconds.

A link's lifetime is defined by its activation and deactivation. This also applies to secondary PDPs. If a secondary PDP is torn down and later re-activated, a separate link entry will be created for the re-activation.⁴ As mentioned in **asliActLinkActualContextID's** entry, a re-activated secondary will have the same actual context ID as its first activation.

When the timer expires, the system has to send an **.assLinkRemovedTrap (6)** (if the trap mechanism is activated) and the corresponding table entry has to be moved to the end of the **.asliHistLinkTable (7)**.

When an entry is removed, the next scan of the active link table will no longer contain it (that is, there will be no hole). This is normal SNMP behavior.

If the link with the Index 1 will be closed, the **.asliActLinkStatus (5)** value of the according row has to be changed to down. After the timer has expired, that entry is moved to the history link table.

⁴ In an earlier version of the document, the lifetime of a link was not explicitly defined and could have allowed a secondary to be re-activated within the 30 second timer and be considered the same link instance.

**ATTACHMENT 5
ETHERNET INTERFACE**

The new table looks as shown below:

Table 21 – Example 3 of the Actual Link Table Content

Table Row	.asliActLink...					
	...Index(1)	...Status(4)	...LinkNegotiatedBW(10)	...BeamID(14)	...MainIndex(16)	...ServiceIndex(17)
1	9	up	128	101	0	6
2	11	up	64	101	9	5
3	12	up	0	101	9	3

The history table now has one entry more at the end of the table. This is shown in the following table:

Table 22 – Example 3 of the History Link Table Content

Table Row	.asliHistLink...					
	...Index(1)	...Status(4)	...LinkNegotiatedBW(10)	...BeamID(14)	...MainIndex(16)	...ServiceIndex(17)
1	3	down	0	100	0	3
2	2	down	128	100	0	6
3	4	down	64	100	4	5
4	8	down	0	100	5	3
5	5	down	0	100	0	3
6	6	down	64	101	8	5
7	7	down	64	101	6	5
8	10	down	0	101	6	3
9	1	down	0	101	0	3

If a primary context with bundled secondary contexts will be closed, all corresponding secondary contexts have to be closed as well. In this case, only one timer can be used, for the removal of the according rows.

Table 23 – Example 4 of the Actual Link Table Content

Table Row	.asliActLink...					
	...Index(1)	...Status(4)	...LinkNegotiatedBW(10)	...BeamID(14)	...MainIndex(16)	...ServiceIndex(17)

The history table now has one entry more at the end of the table. This is shown in the following table:

Table 24 – Example 3 of the History Link Table Content

Table Row	.asliHistLink...					
	...Index(1)	...Status(4)	...LinkNegotiatedBW(10)	...BeamID(14)	...MainIndex(16)	...ServiceIndex(17)
1	3	down	0	100	0	3
2	2	down	128	100	0	6
3	4	down	64	100	4	5
4	8	down	0	100	5	3
5	5	down	0	100	0	3
6	6	down	0	101	8	3
7	7	down	0	101	6	3
8	10	down	0	101	6	3
9	1	down	0	101	0	3
10	9	down	128	101	0	6
11	11	down	64	101	9	5
12	12	down	0	101	9	3

Note: If after that a new link will be opened, it has to be attached to row 1 and the corresponding index value would be 13.

ATTACHMENT 5 ETHERNET INTERFACE

5.3.2.2.2.3 Identifying a PDP Bundle

A PDP bundle is a primary PDP and its associated secondaries. The recommended way of locating which secondaries are associated to a primary is through the MainIndex field.

The IP address will typically be unique to the primary PDP (and copied to the secondaries) and this does look like an alternate way of finding this association, but the IP address is a parameter defined by the ground infrastructure and is not guaranteed to be unique in all cases (two APNs could be using NAT-type technology and serving up the same IP addresses).

The PPPoE session ID is another alternative. A PPPoE session ID could get re-used (if a call was up while 32000 others went up and down), but there will not be two active sessions with the same PPPoE session ID.

5.3.2.3 System Related Objects

The **.asSystem(3)** folder contains all system relevant information and some configurable parameters that can be set by a client application. The structure is shown in Figure 23.

```
.arincSwift(781)
├── ...
└── .asSystem(3)
    ├── .assConfig(1)
    ├── .assInfos(2)
    ├── .assTraps(3)
    ├── .assSelfTestAvailable(4)
    └── .assSelfTest(5)
```

Figure 23 – System Subfolders and Objects

5.3.2.3.1 System Configuration Related Sub Branch

The **.assConfig(1)** sub folder is mandatory and contains objects for the configuration of the trap behavior of the satcom system. The objects are shown in Table 25 – System Configuration Related Object Details.

Table 25 – System Configuration Related Object Details

Object Identifier	Type	Range	Description
.asscTrapDest(1)	IpAddress		A client can define the destination of the traps by setting this object to the expected address. The default value of this entry is 0.0.0.0, indicating no client.
.asscTrapDestPort(2)	Integer32	0..65535	A client can define the destination port on which the traps are expected. The standard SNMP Trap port is 162, but any other can be used. The default value is 0.

5.3.2.3.2 System Information Related Sub Branch

The **.assInfos(2)** sub folder is mandatory and contains some general objects for the identification and the overall status of the SNMP-providing system.

ATTACHMENT 5
ETHERNET INTERFACE

Table 26 – System Information Related Object Details

Object Identifier	Type	Range	Description
.assiHealthStatus(1)	ASHealthState		This object shows the health state of the whole system.
.assiVendor(2)	DisplayString	0..64	This object contains information about the system supplier.
.assiHWPN(3)	DisplayString	0..32	This object contains the hardware part number.
.assiSerialNumber(4)	DisplayString	0..32	This object contains the serial number of the system.
.assiHWFunction(5)	DisplayString	0..32	This object contains a string to describe the general hardware function (e.g., 'High-Speed SBB Satellite Modem').
.assiShortName(6)	DisplayString	0..16	This object contains a short name (e.g., 'HS720').

5.3.2.3.2.1 System Trap Related Sub Branch

The following Trap Objects are mandatory for the **.assTraps(3)** sub tree:

Table 27 – System Traps

Trap (OID)	Monitored Objects	Description
.asstHealthStatusTrap(1)	.assiHealthStatus	This trap has to be sent, if the health status of the system changes.
.asstLinkSatusTrap(2)	.asliActLinkIndex, .asliActLinkReleaseType, .asliActLinkStatus	This trap has to be sent, if one of the objects related to the Link status changes. If the satcom system changes more than one object within 1 second, it may only send the trap once.
.asstLinkBeamIDTrap(3)	.asliSatID, .asliActLinkIndex, .asliActLinkBeamID, .asliSatState	This trap has to be sent, if the system changes the beam or the satellite. It has also to be sent, if the lock state changes.
.asstServiceAvailabilityTrap(4)	.aslsIndex, .aslsAvailable	This trap has to be sent, if the availability status of a service changes in the service table.
.asstLinkInsertedTrap(5)	.asliActLinkIndex	This trap has to be sent, when the system inserts a new entry into the link table.
.asstLinkRemovedTrap(6)	.asliActLinkIndex	This trap has to be sent, if the timer for the deletion of a link table entry has expired. After this trap, the according entry has been moved to the link table.
.asstSatHandoverPending(7)	.asliSatHandoverPending	This trap will be sent if the system knows it may need to do a handover soon.

5.3.2.3.3 System Self-Test Related Sub Branch

The **.assSelfTest(4)** sub folder and its containing objects are optional, so it is not required to implement it. Due to the fact that a client application has to know if the objects are available or not, a helper object is included in the **.asSystem(3)** branch. This object is mandatory and is called **.assSelfTestAvailable(4)**. The type of the object is **TruthValue**. If this value is true, the objects of **.assSelfTest(5)** sub branch are accessible. The basic structure is shown in Figure 24, **.assSelfTest** Subfolders.

ATTACHMENT 5 ETHERNET INTERFACE

```
.arincSwift(781)
├── ....
└── .asSystem(3)
    ├── ....
    ├── .assSelfTestAvailable(4)
    └── .assSelfTest(5)
        └── .asssTestcaseTable(2)
```

Figure 24 – .assSelfTest Subfolders

The **.assSelfTest(5)** folder itself has a Table, some readable and two writable objects.

Table 28 – System Self-Test Related Object Details

Object Identifier	Content Type	Range	Description
.asssTestcaseNumber(1)	Integer32	0..100	This object indicates how many entries are in the test case table.
.asssTestCommand(3)	Integer32	0..100	This is a writable object. By setting this value to a non-zero value, the corresponding test case of the test case table will be started. Starting a test will stop a previously running one. Setting it to zero will stop any running test.
.asssTestUpTime(4)	TimeTicks		This is a writable object. A client application can control the run time of the test case.
.asssTestStatus(5)	ASTestState		This value shows the status of the current running self-test.
.asssTestLastResult(6)	ASTestState		This value indicates the result of the last finished test.
.asssTestReturnCode(7)	Integer32		This field covers a unique return code of the self-test, which can easily be validated.
.asssTestReturnMessage(8)	DisplayString	0..256	This field contains a textual result message of the last self-test, which can be logged.

The **.asssTestcaseTable** has the following columns:

Table 29 – System Test-case Table Related Object Details

Object Identifier	Content Type	Range	Description
.asssTestCaseIndex(1)	Integer32	1..100	This object defines a unique identifier for the according test case.
.asssTestCaseName(2)	DisplayString	(1..50)	This object shows the name of the test case (e.g., 'Link-Test'). IF the system will offer the possibility to reset it via this interface, it has to insert an entry with the name 'Reset-System.'

5.3.2.4 Unit Related Objects

This folder contains information about the components in the system. The subfolders are optional. Each sub folder has a related object that indicates if the folder information is implemented or not. Each folder has to contain three sub folders (one with writable objects to configure the unit itself, one with information about the unit and one with trap objects).

The objects in the Configuration and Information folder are grouped in a table. For each subunit connected to the system, an entry has to be inserted into the

ATTACHMENT 5 ETHERNET INTERFACE

Information table. An **Integer32** object related to each table shows the number of table entries.

Due to security reasons, it may be that a sub unit is not allowed to be configured. If so, it has no entry in this table. Both tables (configuration and information) have their own index values. These index values have to be the same for one unit. For example: if “Antenna1” is not configurable and “Antenna2” is configurable, the table entries in the **.asuAntConfig(2)** and **.asuAntInfo(1)** tables are shown as in the tables below:

Table 30 – Relation Between Unit Config and Unit Info Table

Table Row	asuAntConfig... ...Index	...Name
1	32	Antenna2

Table Row	asuAntInfo... ...Index	...Name
1	17	Antenna1
2	32	Antenna2

5.3.2.4.1 SDU Unit Related Objects

This subsection contains all objects related to the SDU. They are grouped in tables to cover that the unit can be available multiple times. Due to the fact, that the SDU is mainly the unit providing this MIB, the tables should only have one entry, because the SDU will provide its own MIB on a separate IP address.

5.3.2.4.1.1 Information Sub Branch for the SDU Unit Related Objects

The **.asuSduInfo(1)** sub branch shows all objects, which are related to the information part of the SDU related objects. These objects are read only values to provide more detailed information about the unit status itself.

The basic substructure of this MIB section defined as follows:

Table 31 – SDU Info Sub Structure

```
.arincSwift(781)
├─ ...
└─ .asUnits(4)
    ├─ .asuSDUAvailable(1)
    └─ .asuSDU(2)
        └─ .asuSduInfo(1)
            ├─ .asuSduInfoTableNumbers(1)
            └─ .asuSduInfoTable(2)
```

This object has to be implemented, if a supplier decides to support the optional **.asuSDU(2)** sub branches by setting the **.asuSDUAvailable(1)** object to “True.” The object **.asuSduInfoTableNumbers(1)** indicates the number of entries in the table. It is from the Type **Integer32** and has a value range of 0..10. It has at to contain 1 entry per connected unit.

**ATTACHMENT 5
ETHERNET INTERFACE**

The objects in the table are defined as shown below:

Table 32 – SDU Unit Information Table Object Details

Object Identifier	Content Type	Range	Description
.asuSduInfoIndex (1)	Integer32	1..10	This object describes the unique identifier for the current unit.
.asuSduInfoVendor (2)	DisplayString	0..22	ASCII String with up to 22 characters to show the short name of the LRU supplier.
.asuSduInfoHWPN (3)	DisplayString	0..22	ASCII String with up to 22 characters to show the Hardware Part number of the LRU.
.asuSduInfoSN (4)	DisplayString	0..22	ASCII String with up to 22 characters to show the Hardware Serial Number of the LRU.
.asuSduInfoHWFunction (5)	DisplayString	0..22	ASCII String with up to 22 characters to show the Functional description of the SDU unit itself.
.asuSduInfoDesignation (6)	DisplayString	0..22	ASCII String with up to 22 characters to show the Short Name of the LRU.
.asuSduInfoSWVersion (7)	DisplayString	0..22	ASCII String with up to 22 characters to show the Software Version of the LRU.
.asuSduInfoOverallStatus (8)	ASHealthState		General Status of the LRU.
.asuSduInfoPowerOnSelfTest (9)	ASTestState		Shows the Power On Self-Test Results of the SDU.
.asuSduInfoInteractiveSelfTest (10)	ASTestState		Shows interactive self-test results of the SDU.
.asuSduInfoFailureCode (11)	Integer32		This object defines a unique failure code for a test. The values are grouped. 0..999 is reserved for general standard codes which have to be defined later. Values greater 999 are supplier-specific fault code of latest system error.
.asuSduInfoFailureReason (12)	DisplayString	0..255	Human readable supplier-specific failure message related to the latest system error.
.asuSduInfoTemperature (13)	Integer32	-65..150	The temperature of the SDU in °C.
.asuSduInfoThermalState (14)	ASUnitThermState		Shows the thermal state of the SDU.
.asuSduInfoCC1Status (15)	ASHealthState		Status of the channel card 1.
.asuSduInfoCC2Status (16)	ASHealthState		Status of the channel card 2.
.asuSduInfoInthHPAState (17)	ASHealthState		Status of the internal high-power amplifier.
.asuSduInfoQuadrax1Status (18)	ASLinkState		Status of the Ethernet quadrax port 1.
.asuSduInfoQuadrax2Status (19)	ASLinkState		Status of the Ethernet quadrax port 2.
.asuSduInfoIRS1BusStatus (20)	ASHealthState		Status of the IRS1 Bus.
.asuSduInfoIRS1SystemStatus (21)	ASHealthState		Status of the IRS1 Equipment.
.asuSduInfoPSMState (22)	ASHealthState		Status of the Power Supply Module.
.asuSduInfoOcxoState (23)	ASHealthState		Status of the Oven Controlled Crystal Oscillator.
.asuSduInfoSecureORTStatus (24)	ASHealthState		Status of the secured Owner Requirements Table.
.asuSduInfoUserORTStatus (25)	ASHealthState		Status of the user based Owner Requirements Table.

ATTACHMENT 5 ETHERNET INTERFACE

Object Identifier	Content Type	Range	Description
.asuSduInfoStrapsState (26)	TruthValue		This value indicates, if the parity of configuration straps is valid or not. A true means it is valid and a false indicates that it is not valid.
.asuSduInfoMultiControlBus (27)	ASHealthState		This object indicates availability of ARINC 429 bus from CSDU to Antenna.
.asuSduInfoCPUStatus (28)	ASHealthState		Status of the main Central Processing Unit.
.asuSduInfoTxMuteActual (29)	TruthValue		Actual value of the TX mute discrete. True means muted and false means not muted.
.asuSduInfoRetLossToAntenna (30)	Integer32		VSWR towards the antenna in dB.
.asuSduInfoOutputFwdPower (31)	Integer32		The output forward power in dB.
.asuSduInfoOutputRetPower (32)	Integer32		The output return power in dBW.
.asuSduInfoAntennaBus (33)	ASHealthState		State of the antenna bus.
.asuSduInfoRestartReason (34)	ASRestartReason		The reason for the SDU's last restart.
.asuSduInfoUTCDateTime (35)	ASDateTime	RFC3339	Current UTC date and time in RFC3339 format.
.asuSduInfoSWInstallDate (36)	ASDateTime	RFC3339	The install date of the software in RFC3339 format. An empty string indicates that this value is not available.
.asuSduInfoInspectionDate (37)	ASDateTime	RFC3339	The inspection date of the SDU in RFC3339 format. An empty string indicates that this value is not available.
.asuSduInfoOnGroundState (38)	TruthValue		This value provides the SDU's version of the Air/Ground State. True means on ground.

5.3.2.4.1.2 Configuration Sub Branch for the SDU Unit Related Objects

This subsection shows all objects, which are related to the configuration part of the **.asuSDU (2)** sub branch.

The basic substructure of this MIB section defined as follows:

```

.arincSwift(781)
├── ....
└── .asUnits(4)
    ├── .asuSDUAvailable(1)
    └── .asuSDU(2)
        ├── ...
        └── .asuSduConfig(2)
            ├── .asuSduConfigTableNumbers(1)
            └── .asuSduConfigTable(2)

```

Figure 25 – .asuSDU Configuration Sub Structure

These objects have to be implemented if a supplier decides to support the optional **.asuSDU (2)** sub branch by setting the **.asuSduAvailable (2)** object to “True.” The object **.asuSduConfigTableNumbers (1)** indicates the number of entries in

ATTACHMENT 5 ETHERNET INTERFACE

the table It is from Type **Integer32** and has a value range of 0..10. If for security reasons no configuration shall be available, the table can be empty. The objects in the table are defined as shown below:

Table 33 – SDU Configuration Table Object Details

Object Identifier	Content Type	Range	Description
.asuSduConfIndex(1)	Integer32	1..10	Unique identifier of the table entry.
.asuSduConfUTCDateTime(2)	ASDateTime	RFC3339	This value allows a client to set the time in the SDU according to RFC3339.
.asuSduConfTxMuteRequested(3)	TruthValue		Allows external equipment to request a state change of the TX mute discrete.
.asuSduConfTailNumber(4)	DisplayString	0..30	This field allows a client to provide the tail number of the current plane to the SDU.
.asuSduConfCityPair(5)	DisplayString	0..30	This field allows a client to provide the city-pair of the current flight to the SDU.
.asuSduConfFlightNumber(6)	DisplayString	0..30	This field allows a client to provide the Flight Number of the current flight to the SDU.
.asuSduConfFlightPhase(7)	DisplayString	0..30	This field allows a client to provide the actual flight phase to the SDU.
.asuSduConfClientOnGroundSate(8)	TruthValue		This field allows a client Application to provide its on ground state to the SDU. True means on ground. If the SDU has no other possibility to set its own on ground state it can copy this value into the info table value.

5.3.2.4.1.3 Trap Sub Branch for the SDU Unit Related Objects

In the moment, no Traps are identified for the SDU. This subsection is a placeholder for future updates and can be used to insert trap objects in the **.asuSDUTraps(3)** subfolder.

5.3.2.4.2 SCM Unit Related Objects

This subsection contains all objects related to the SCM. They are grouped in tables to cover that the unit can be available multiple times.

5.3.2.4.2.1 Information Sub Branch for the SCM Unit Related Objects

This subsection shows all objects, which are related to the information part of the **.asuSCM(4)** sub branch.

The basic substructure of this MIB section defined as follows:

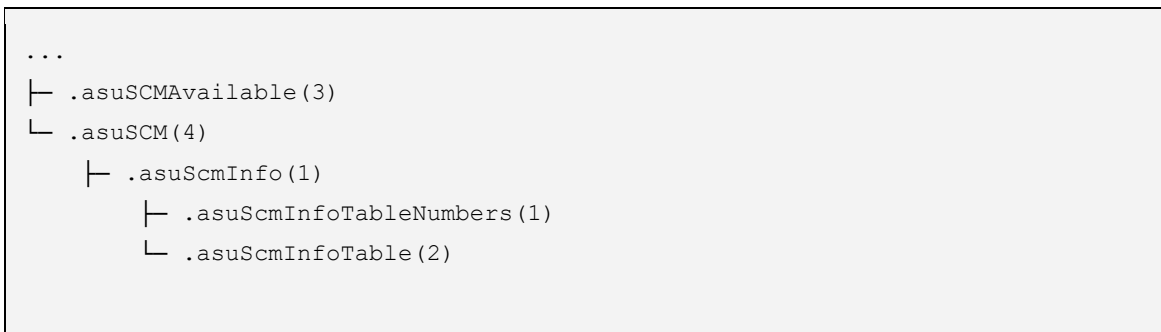


Figure 26 – SCU Info Sub Structure

ATTACHMENT 5 ETHERNET INTERFACE

These objects have to be implemented, if a supplier decides to support the optional **.asuSCM(4)** sub branch by setting the **.asuSCMAvailable(3)** object to “True”. The object **.asuScmInfoTableNumbers(1)** indicates the number of entries in the table. It is from Type **Integer32** and has a value range of 0...10 and should contain at least one entry.

The objects in the table are defined as shown below:

Table 34 – asuSCM Unit Information Table Object Details

Object Identifier	Content Type	Range	Description
.asuScmInfoIndex(1)	Integer32	1..100	This object describes the unique identifier for the current unit.
.asuScmInfoVendor(2)	DisplayString	0..22	ASCII String with up to 22 characters to show the short name of the LRU supplier.
.asuScmInfoHWPn(3)	DisplayString	0..22	ASCII String with up to 22 characters to show the Hardware Part number of the LRU.
.asuScmInfoSN(4)	DisplayString	0..22	ASCII String with up to 22 characters to show the Hardware Serial Number of the LRU.
.asuScmInfoHWFunction(5)	DisplayString	0..22	ASCII String with up to 22 characters to show the Functional description of the unit itself.
.asuScmInfoDesignation(6)	DisplayString	0..22	ASCII String with up to 22 characters to show the Short Name of the LRU.
.asuScmInfoSWversion(7)	DisplayString	0..22	ASCII String with up to 22 characters to show the Software Version of the LRU.
.asuScmInfoOverallStatus(8)	ASHealthState		General Status of the unit.
.asuScmInfoSimsInstalled(9)	Integer32	0..4	The number of SIMS installed in the SCM. The following four objects are containing useful IMSI numbers depending on this object.
.asuScmInfoIMSI1(10)	DisplayString	0..30	ASCII String with up to 30 characters to show the IMSI number of SIM card 1 (e.g., +17659850986). If less than one SIMS, are installed this parameter must contain an empty string.
.asuScmInfoIMSI2(11)	DisplayString	0..30	ASCII String with up to 30 characters to show the IMSI number of SIM card 2 (e.g., +17659850987). If less than two SIMS are installed, this parameter must contain an empty string.
.asuScmInfoIMSI3(12)	DisplayString	0..30	ASCII String with up to 30 characters to show the IMSI number of SIM card 3 (e.g., +17659850988). If less than three SIMS are installed, this parameter must contain an empty string.
.asuScmInfoIMSI4(13)	DisplayString	0..30	ASCII String with up to 30 characters to show the IMSI number of SIM card 4 (e.g., +17659850989). If less than four SIMS are installed, this parameter must contain an empty string.

5.3.2.4.2.2 Configuration Sub Branch for the SCM Unit Related Objects

In the moment no configuration items are identified for the SCM. This subsection is a placeholder for future updates and can be used to insert configuration objects in the **.asuScmConfig(2)** subfolder.

5.3.2.4.2.3 Trap Sub Branch for the SCM Unit Related Objects

In the moment, no Traps are identified for the SCM. This subsection is a placeholder for future updates and can be used to insert trap objects in the **.asuSCMTraps(3)** subfolder.

ATTACHMENT 5 ETHERNET INTERFACE

5.3.2.4.3 DLNA Unit Related Objects

This subsection contains all objects related to the DLNA. They are grouped in tables to cover that the unit can be available multiple times.

5.3.2.4.3.1 Information Sub Branch for the DLNA Unit Related Objects

This subsection shows all objects, which are related to the information part of the **.asuDLNA (6)** sub branch.

The basic substructure of this MIB section defined as follows:

```

...
├─ .asuDLNAAvailable(5)
└─ .asuDLNA(6)
    └─ .asuDlnaInfo(1)
        ├─ .asuDlnaInfoTableNumbers(1)
        └─ .asuDlnaInfoTable(2)

```

Figure 27 – DLNA Info Sub Structure

These objects have to be implemented, if a supplier decides to support the optional **.asuDLNA (6)** sub branch by setting the **.asuDLNAAvailable (5)** object to “True.” The object **.asuDlnaInfoTableNumbers (1)** indicates the number of entries in the table. It is from Type **Integer32** and has a value range of 0...10 and should then contain at least 1 entry.

The objects in the table are defined as shown below:

Table 35 – DLNA Unit Information Table Object Details

Object Identifier	Content Type	Range	Description
.asuDlnaInfoIndex(1)	Integer32	1..100	This object describes the unique identifier for the current unit.
.asuDlnaInfoVendor(2)	DisplayString	0..22	ASCII String with up to 22 characters to show the Short name of the LRU supplier.
.asuDlnaInfoHWPN(3)	DisplayString	0..22	ASCII String with up to 22 characters to show the Hardware Part number of the LRU.
.asuDlnaInfoSN(4)	DisplayString	0..22	ASCII String with up to 22 characters to show the Hardware Serial Number of the LRU.
.asuDlnaInfoHWFunction(5)	DisplayString	0..22	ASCII String with up to 22 characters to show the Functional description of the LRU itself.
.asuDlnaInfoDesignation(6)	DisplayString	0..22	ASCII String with up to 22 characters to show the Short Name of the LRU.
.asuDlnaInfoSWVersion(7)	DisplayString	0..22	ASCII String with up to 22 characters to show the Software Version of the LRU.
.asuDlnaInfoOverallStatus(8)	ASHealthState		General status of the LRU.

5.3.2.4.3.2 Configuration Sub Branch for the DLNA Unit Related Objects

In the moment no configuration items are identified for the DLNA. This subsection is a placeholder for future updates and can be used to insert configuration objects in the **.asuDlnaConfig (2)** subfolder.

ATTACHMENT 5
ETHERNET INTERFACE**5.3.2.4.3.3 Trap Sub Branch for the DLNA Unit Related Objects**

In the moment no Traps are identified for the DLNA. This subsection is a placeholder for future updates and can be used to insert trap objects in the **.asuDlnaTraps (3)** subfolder.

5.3.2.4.4 Antenna Unit Related Objects

This subsection contains all objects related to the antenna. They are grouped in tables to cover that the unit can be available multiple times.

5.3.2.4.4.1 Information Sub Branch for the Antenna Unit Related Objects

This subsection shows all objects, which are related to the information part of the **.asuAntenna (8)** sub branch.

The basic substructure of this MIB section is defined as follows:

```
...  
├ .asuAntennaAvailable(7)  
└ .asuAntenna(8)  
  └ .asuAntInfo(1)  
    ├── .asuAntInfoTableNumbers(1)  
    └ .asuAntInfoTable(2)
```

Figure 28 – Antenna Info Sub Structure

These objects have to be implemented, if a supplier decides to support the optional **.asuAntenna (8)** sub branch by setting the **.asuAntAvailable (7)** object to “True.” The object **.asuAntInfoTableNumbers (1)** indicates the number of entries in the table. It is from Type **Integer32** and has a value range of 0...10 and should contain at least 1 entry.

**ATTACHMENT 5
ETHERNET INTERFACE**

The objects in the table are defined as shown below:

Table 36 – Antenna Unit Information Table Object Details

Object Identifier	Content Type	Range	Unit	Description
.asuAntInfoIndex(1)	Integer32	1..100	none	This object describes the unique identifier for the current antenna.
.asuAntInfoVendor(2)	DisplayString	0..22	none	ASCII String with up to 22 characters to show the short name of the supplier from the referred antenna.
.asuAntInfoHWPN(3)	DisplayString	0..22	none	ASCII String with up to 22 characters to show the Hardware Part number of the antenna.
.asuAntInfoSN(4)	DisplayString	0..22	none	ASCII String with up to 22 characters to show the Hardware Serial Number of the antenna.
.asuAntInfoHWFunction(5)	DisplayString	0..22	none	ASCII String with up to 22 characters to show the Functional description of the antenna.
.asuAntInfoDesignation(6)	DisplayString	0..22	none	ASCII String with up to 22 characters to show the Short Name of the antenna.
.asuAntInfoSWVersion(7)	DisplayString	0..22	none	ASCII String with up to 22 characters to show the Software Version of the antenna.
.asuAntInfoOverallStatus(8)	ASHealthState		none	General Status of the antenna.
.asuAntInfoTemperatureStatus(9)	ASAntThermState		none	Thermal state of the antenna.
.asuAntInfoGain(10)	Integer32	-1..315	dB/10	The antenna gain currently utilized from 0.0 to 31.5 dB. ("-1" indicates invalid data).

5.3.2.4.4.2 Configuration Sub Branch for the Antenna Unit Related Objects

In the moment no configuration items are identified for the antenna. This subsection is a placeholder for future updates and can be used to insert configuration objects in the **.asuAntConfig(2)** subfolder.

5.3.2.4.4.3 Trap Sub Branch for the Antenna Unit Related Objects

In the moment no Traps are identified for the antenna. This subsection is a placeholder for future updates and can be used to insert trap objects in the **.asuAntTraps(3)** subfolder.

5.3.2.4.5 Future Units

If a new unit will be identified to be added in the unit sub branch, this structure can be extended by adding a new **.asu<Unitname>(OID)** sub branch with the same restrictions, as described in Unit Related Objects.

5.3.2.5 User Defined Area

This MIB structure has a sub branch to insert supplier-specific information. A supplier is free to bring any kind of readable and writable objects in any user defined structure. The only restriction to be covered is to use a dedicated subfolder. The following subfolders are identified until now within the **.asUserDefArea(5)** sub branch.

**ATTACHMENT 5
ETHERNET INTERFACE**

Table 37 – User Defined Area Supplier OIDs

Supplier Name	<Supplier>	Supplier sub OID	complete Supplier OID
EMS	EMS	.asudaEMS(1)	1.3.6.1.4.1.13712.781.5.1
Honeywell	Honeywell	.asudaHoneywell(2)	1.3.6.1.4.1.13712.781.5.2
Rockwell/Collins	RockColl	.asudaRockColl(3)	1.3.6.1.4.1.13712.781.5.3
Thales	Thales	.asudaThales(4)	1.3.6.1.4.1.13712.781.5.4
Thrane Thrane	Thrane	.asudaThrane(5)	1.3.6.1.4.1.13712.781.5.5
Chelton	Chelton	.asudaChelton(6)	1.3.6.1.4.1.13712.781.5.6

If a new supplier needs its own place for user defined and supplier-specific information (and is not covered by the table above), he has to request an entry ID for its own objects from Air/Ground Communication Systems Subcommittee to avoid OID conflicts within the whole structure.

Each of the supplier sub OIDs contains two mandatory objects to define the version of the sub folder. The first object is the major version number. The second object is the minor version number. Both objects are from the Type **Integer32** and the sub version is limited to the range from 0 to 99.

The following table shows the object details of this folder:

Table 38 – Supplier Related Version Objects

Object Identifier	Type	Range	Description
.asuda<VENDOR>VersMajor(1)	Integer32		This object defines the major version of the supplier-specific sub branch. The current predefined default major version number is 0 to indicate an empty sub branch.
.asuda<VENDOR>VersMinor(2)	Integer32	0..99	This object defines the minor version of the supplier-specific sub branch. The current predefined default minor version number is 0.

ATTACHMENT 5 ETHERNET INTERFACE

6.0 ERROR CODES FOR PADT PPPOE MESSAGES

The ARINC 781 SDU⁵ will provide a PPPoE Active Discovery Termination (PADT) packet in response to termination of the PPPoE session.

The PPPoE session may be terminated by the SDU or by a PADT from the host.

The SDU will send periodic Echo-Request packets to the host to assess continued connectivity.

The SDU will generate a Generic Error tag upon termination of every session, including those that terminate normally. The Generic-Error tag is of the following format:⁶

SLCV – nnnn/dddd: SLCV_cause_string [detailed_cause_string]

- Where:
 - nnnn is, for Swift64 M-ISDN, the Inmarsat SLCV termination code as defined in the mini-M SDM Section A Table 15 Element #8 (Cause Indication) and Section B-4.21.2 and 4.21.3. Certain SLCV codes may be manufacturer-specific. For MPDS, this value is always 0000, with the dddd field providing further error description (see below). For BGAN, reference 3GPP TS 24.008, 27.005, 27.007 and the BGAN SDM Volume 2, Chapter 2, Section 3.1.4.3.
 - dddd is a detailed cause code. For Swift64 M-ISDN, this value is defined by the equipment manufacturer. For MPDS, this value is derived from the IPDS SDM Volume 2, Chapter 2, Section 7.2.11, Tables 21 and 22; Volume 2, Chapter 3, Section 4.12.10, Table 12; Volume 2, Chapter 11, Tables 7 and 8; and Volume 3, Chapter 2, Table 4. (AT +WQ cause code decimal values are converted to hexadecimal).

SLCV_cause_string is the (modified) Inmarsat standard cause code text defined for Swift64 M-ISDN in the mini-M SDM Section B, Section 4.21.4, Table 4.9. For MPDS, the text is the +WQ cause code string associated with the cause code derived from the AT +WQ values in the IPDS SDM Volume 2, Chapter 11, Tables 7 and 8. For BGAN, reference 3GPP TS 24.008, 27.005, 27.007 and the BGAN SDM Volume 2, Chapter 2, Section 3.1.4.3 detailed_cause_string is extended cause description as defined by the equipment manufacturer.

The SDU will generate an AC-System-Error tag upon termination of every session, including those that terminate normally. The AC-System-Error tag is as defined below.

If the PPPoE session was a Swift64 64k UDI session, the AC-System-Error tag will be of the following format:

Q850 – qqq: Q.850_string

- Where:
 - qqq is the ISDN Q.850 cause code defined in ITU-T Q.850 Table 1.
 - Q.850_string is the Q.850 cause string defined in ITU-T Q.850 Table 1.

⁵ For ARINC 741 architectures, replace “SDU” with “HSDU”.

⁶ Manufacturers may utilize non-standard formats in addition to the standard/generic formats shown, but they should not use the following reserved names: “SLCV”, “Q850”, “MPDS”, “BGAN”. Consult Inmarsat for further details.

**ATTACHMENT 5
ETHERNET INTERFACE**

If the PPPoE session was a Swift64 MPDS session, the AC-System-Error tag will be of the following format:

MPDS – mmm: +WQ_cause_string

- Where:
 - mmm is the MPDS cause code defined in the IPDS SDM Volume 2, Chapter 11, Tables 7 and 8.
 - +WQ_cause_string is the MPDS AT +WQ cause string defined in the IPDS SDM Volume 2, Chapter 11, Tables 7 and 8.

If the PPPoE session was a SwiftBroadband PS session, the AC-System-Error tag will be of the following format:

BGAN – bbb: BGAN_string

- Where:
 - bbb and BGAN_string are defined in 3GPP TS 24.008, 27.005, 27.007 and the BGAN SDM Volume 2, Chapter 2, Section 3.1.4.3

Example terminations:

1. ISDN termination due to SDU:

- Generic Error:
 - SLCV – 12B1/00XX: call cleared by MES for unspecified reason [Channel cleared, SDU reporting system failure]
 - AC-System Error:
 - Not Applicable
- Note: Text in [square brackets] is manufacturer-specific.

2. ISDN termination due to network issue:

- Generic Error:
 - SLCV – 1F11/0000: call failed, terrestrial party busy
- AC-System Error:
 - Q850 - 17: User busy

3. MPDS protocol error:

- Generic Error:
 - SLCV - 0000/031c: MPDS channel cleared [Control sub-layer protocol failure]
- AC-System Error:
 - MPDS - 796: Control sub-layer protocol failure

4. BGAN PDP Context activation failure protocol error:

- Generic Error:
 - Not Applicable
- AC-System Error:
 - BGAN - 033: requested service option not subscribed

ATTACHMENT 5 ETHERNET INTERFACE

5. BGAN CS call failure:

- Generic Error:
 - SLCV – 3711/0000: international call busy
- AC-System Error:
 - Not Applicable

7.0 ASN.1 SNMP MIB CODE

The ASN.1 SNMP MIB source code is available via a binary file from www.aviation-ia.com/aeec/SupportFiles/781-2.

8.0 TO BE ADDRESSED IN A FUTURE REVISION

The following were discussed without resolution in the development of this standard. They are recorded here for future consideration.

8.1 Quality of Service Entries

The asli*LinkNegotiatedBW field doesn't match well the four bandwidth parameters used in 3GPP (min up, min down, max up, max down).

8.2 Owner Requirement Table Branch

SDUs generally have a configured configuration block with their own version, date and part number. It would be useful to be able to verify these through SNMP.

8.3 Optional Features Flags

There is currently no way for an application to verify whether certain optional features are present on the SDU.

One way to implement this is through a new SNMP table which would have a string indicating the feature and a numeric value indicating support level. The use of the table means that the MIB will not need to be changed every time a new feature is made, and that manufacturers can put their own flags.

Feature flags that were brought up: PPPoE BGAN Options (@APN, @USER, @PASS, etc.), over-the-air compression control, over-the-air crypto control.

ATTACHMENT 6
ARINC 781 OUTPUT POWER USE CASES

ATTACHMENT 6 ARINC 781 OUTPUT POWER USE CASES

The table below contains various scenarios and service combinations used as a basis for developing the RF output power ranges for the Internal, Small Form Factor External and Large Form Factor External HPA using the EIRPs defined in Section 1.7.1, Table 1-2 and noted below.

Case	Description	Ant. Gain (dBic)	Cable Loss (including DLNA loss) (dB)	Aero C-Channels (Global beam)	Aero R/T- Channel (Global beam)	SBB Channels	HPA Output Power (Watts)
1	Classic Only HGA Internal HPA	12.0	2.5	2 x 8400	10.5K	-	28
2	SBB Only IGA Internal HPA	6.0	2.5	-	-	2 x Class 7	29
3	SBB Only HGA Small Form Factor FMHPA	11.5	1.5	-	-	2 x Class 6	20
4	SBB Only IGA Small Form Factor FMHPA	6.5	1.5	-	-	2 x Class 7	21
5	Multi-Service HGA Small Form Factor FMHPA	11	1.5	1 x 8400	1200	1 x Class 6	20
6	Multi-Service HGA Large Form Factor FMHPA	11.5	1.5	1 x 8400	10.5K	1 x Class 6	28
7	Loss of Cooling HGA Large Form Factor FMHPA	11	1.5	1 x 8400	1200	-	9
8	HGA Large Form Factor FMHPA	11	2.2	2 x 8400	10.5K	2 x Class 6	60

Note: The following EIRP requirements (dBW per channel) are assumed in these Use Cases.

Aero C-Channels (8400) (Global beam)	Aero R/T-Channel (1.2K) (Global beam)	Aero R/T-Channel (10.5K) (Global beam)	SBB Channels Class 6	SBB Channels Class 7	SBB Channels Class 4
18.5	9.1	20.4	20.0	15.1	10.0

Note: For SB200 (Class 4), there is an example in Attachment 7.

ATTACHMENT 6
ARINC 781 OUTPUT POWER USE CASES

Other use cases of HPA Output Powers (watts) can be calculated using the following tables and formula:

Antenna Gain (dB) [X]	Antenna Gain Factor [$10^{(X/10)}$]
12.0	15.85
11.5	14.13
11.0	12.59
6.5	4.47
6.0	3.98

Cable Loss (dB) [Y]	Cable Loss Factor [$10^{(Y/10)}$]
2.5	1.78
2.2	1.66
1.5	1.41

Channel (use case)	EIRP Power/Channel (dBW) [Z]	EIRP Power/Channel (watts) [$10^{(Z/10)}$]
Aero C (8.4 kbps) initial ¹	18.50	70.79
Aero C (8.4 kbps) settled *	~ 13.50	~ 22.39
Aero R/T (1.2 kbps)	9.10	8.13
Aero R/T (10.5 kbps)	20.40	109.65
Swift64 initial ¹	22.50	177.83
Swift64 settled ¹	~ 18.50	~ 70.79
SBB Channels (Class 6)	20.00	100.00
SBB Channels (Class 7)	15.10	32.36

Note:

- For this channel type, there is typically no more than one channel at a time at the initial power level (for only a few seconds), with any other channels of the same type typically at the settled power level. The worst (unrealistic) case would be for all such channels to be at the initial power level simultaneously; the best (unrealistic) case would be for all such channels to be at the settled power level simultaneously. Realistic cases involving more than one channel of this type may be estimated as desired by selecting an appropriate mix of the power levels in the overall desired Use Case. Settled power levels are approximate.

HPA Output Power (watts) for a desired Use Case

$$= \frac{CL_{\text{factor}}}{AG_{\text{factor}}} [(\# \text{channels})(\text{UseCase}_{\text{watts}})]$$

Where:

CL_{factor} = Cable Loss Factor

AG_{factor} = Antenna Gain Factor

ATTACHMENT 6

ARINC 781 OUTPUT POWER USE CASES

#channels = number of channels for a given Use Case

UseCase_{watts} = Watts per channel of the desired Use Case

Total HPA Output Power (watts) = The sum of the output power (watts) for each Use Case calculated above.

Example: For 12 dB Ant Gain, 2.5 dB cable loss, 2 channels Aero C (8.4 kbps), 4 channels SBB (Class 6), and 1 channel Aero R/T (10.5 kbps):

$$\begin{aligned}
 \text{Total HPA Output Power (watts)} &= \frac{1.78 \text{ CL}_{\text{factor}}}{15.85 \text{ AG}_{\text{factor}}} [(2 \text{ channels})(70.79 \text{ watts Aero C } 8.4 \text{ kbps}) \\
 &+ (4 \text{ channels})(100 \text{ watts SBB Class } 6) \\
 &+ (1 \text{ channel})(109.65 \text{ watts Aero RT } 10.5 \text{ kbps})] \\
 &= 73.13 \text{ watts}
 \end{aligned}$$

COMMENTARY

When multiple channels are in operation simultaneously, the Peak-to-Average Power Ratio (PAPR) should be examined. In the example above, the multiple channels also include 4 SBB channels. The SBB channel uses both $\pi/4$ -QPSK modulation for the power efficiency and 16-QAM modulation for the bandwidth efficiency. The 16-QAM modulation, however, will generate high PAPR. The component (including power amplifier) and system designers need take the PAPR into account to avoid deteriorating the system performance.

The Power Complementary Cumulative Distribution Function (CCDF) curves provide critical information about the signals encountered in the digital modulation systems. The CCDF display shows the peak powers and how often they occur, or how many symbols require those power levels. The CCDF plays an important role in characterizing of power amplifiers and predicting BER/PER performance.

For more information on PAPR and CCDF see:

- Agilent Technologies Application Note, Characterizing Digital Modulated Signals with CCDF Curves, Agilent Technologies, Copyright 2000
- Rumney, Moray (Editor), Agilent Technologies Staff. LTE and the Evolution to 4G Wireless: Design and Measurement Challenges, Padstow, Cornwall Great Britain for Agilent Technologies by John Wiley & Sons, Ltd, 2009

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

1.0 Introduction

This attachment describes Compact Satcom Systems. It is intended as a small form-factor, lower-cost alternative configurations, with primary function being to delivering safety services to the cockpit. Two variants of compact systems are defined in this attachment. Class 4 compact system and compact Class 6 or 7 systems.

The Compact Satcom System can, in its simplest form, deliver the Inmarsat SwiftBroadband Class 4 service, operating over the Inmarsat I-4 and Alphasat satellites. A Class 4 is by definition a single-channel system, allowing reduced size, power dissipation and cost. A compact Class 4 solution is defined in Section 2.0 below.

In Section 3.0 of this attachment, a Multicarrier High-Power Amplifier (MHPA) LRU is defined. Using this LRU in combination with the CSDU, defined in Section 2.0 of this attachment, and an HGA/IGA antenna, defined in the main body of this standard, it is possible to form compact systems operating in Class 6 or 7. These systems can provide one or more simultaneous SBB channels. These combined systems, and the additional LRU needed are defined in Section 3.0 of this attachment.

The interfaces to the aircraft as well as wiring provisions are designed to have a high level of commonality with the full-size ARINC 781 system. Due to the high similarity with the full-sized system, the detail definitions of various interfaces are not repeated in this attachment. This attachment aims to describe the differences found in the compact system.

While a single system configuration for all aircraft types is highly desirable, this was found to be difficult to achieve due to varying and conflicting requirements in different airframes. Multiple configuration options are therefore described.

While the focus of this standard is on the provision of safety services to the cockpit, the system may also be suitable for providing limited cabin services. The compact system is well suited to airline applications where segregation is required between the cockpit and cabin from a network security perspective. Cabin connectivity may then be provided by a separate satcom system.

2.0 Class 4 Safety Service Overview

The Inmarsat Class 4 service is designed to enable compact airborne equipment, particularly the antenna. The main characteristics are:

- Service down to 5 degrees elevation (The SB200 Class 15 service provides coverage only above 20 degrees elevation)
- Provided over I-4 satellites and Alphasat
- ACARS messaging service
- Dual voice channels, for safety or non-safety services
- IP data connection, up to 200 kbps. Safety or non-safety use
- Streaming service up to 32 kbps to support multi-voice services
- Priority and pre-emption of safety voice and data services
- Small antenna (e.g., a blade antenna)

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

2.1 Airborne Terminal Configurations

Despite the desire to standardize one configuration of the Class 4 Compact Satcom System, conflicting requirements for different airframes led to three configurations.

- Configuration 1 is included for those aircraft that can provide cooling air in the crown of the aircraft. For these aircraft, it is optimal to co-locate the HPA function (high-power amplifier) with the DLNA function in the crown of the aircraft. This allows for the use of medium-loss coaxial cables leading to a weight saving. The HPA and DLNA functions are combined into a single HLD (high-power amplifier/low-noise amplifier/diplexer) unit.
- Configuration 2 is included for those aircraft that cannot provide cooling air in the crown of the aircraft, making the location of the HPA function in the crown impossible. In this case, the HPA function should be located in the equipment bay where adequate cooling air is generally available. For the sake of installation simplicity and cost, it is desirable that the HPA function is included inside the SDU. It is desirable in most, if not all, airframes to place the SDU in the avionics bay or similar location, remote from the antenna. In this case a low-loss transmit coaxial cable is required. The requirement for low cable loss can be alleviated somewhat by the capability for the HPA to provide more power. A DLNA (Diplexer/Low Noise Amplifier) needs to be situated close to the antenna to minimize receive-path cable loss between the antenna and the DLNA.
- Configuration 3 is included for those aircraft that wish to minimize the number of components installed as part of the Compact Satcom System. In this case the DLNA and HPA functions are contained within the ELGA antenna.

The system configurations each consist of a Compact SDU (CSDU), an Enhanced Low Gain Antenna (ELGA), an SCM, an optional HLD or DLNA, and associated wiring. A CSDU should support an external SCM (see Attachment 1, Section 1.6), and may optionally include an internal SCM. The three configurations are shown in Section 7.0. Configurations 1 and 2 have baseline and alternate aircraft wiring defined, while Configuration 3 has only one aircraft wiring defined. The equipment manufacturer should be consulted to determine which configurations and/or wiring is appropriate.

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

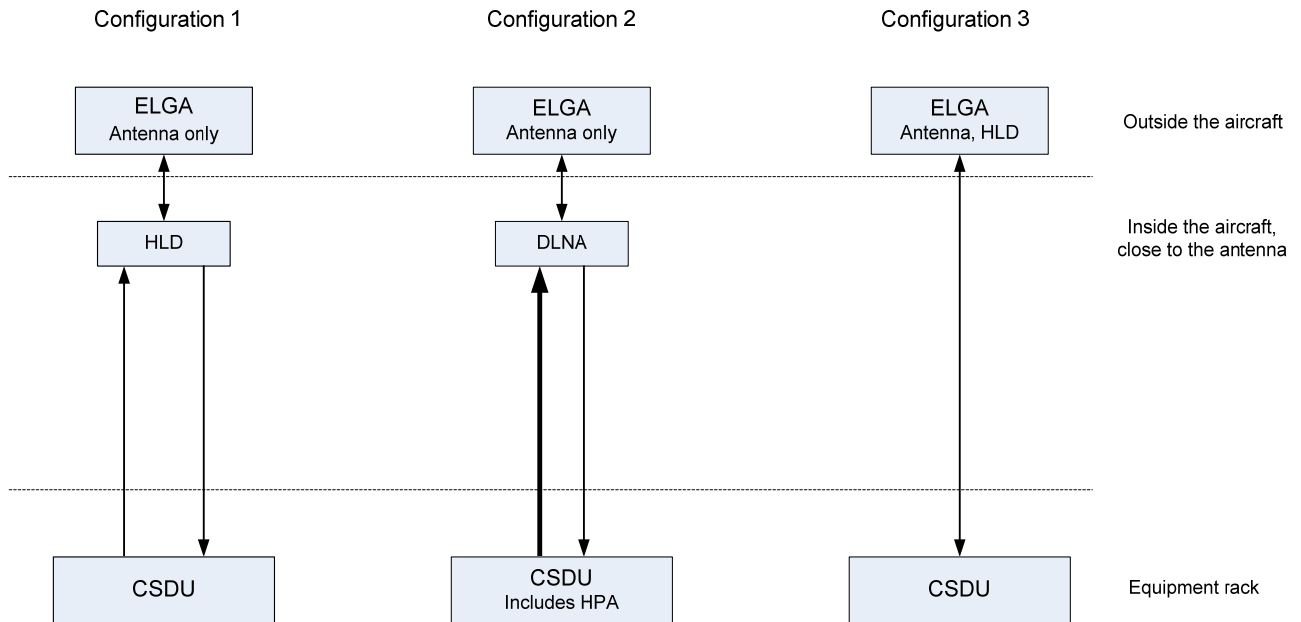


Figure 1 – Compact Satcom System Configurations

2.2 LRU Definitions

2.2.1 Compact Satcom Data Unit (CSDU)

The CSDU is functionally similar to the full-sized (6 MCU) SDU described in Section 1.6.1. The major differences are:

- The form factor is a 2 MCU ARINC 600 enclosure (as opposed to 6 MCU for the full-sized SDU)
- When operating in Class 4, it provides one channel of service only (see below)

The connector definition of the CSDU is identical to that on the 6 MCU (full-sized) SDU.

Like the full-sized SDU, the Class 4 CSDU can operate with high RF power when the CSDU is used with a DLNA, or low RF power when used with an HLD.

Manufacturers may choose to include these two modes of operation in a single part number.

Manufacturers may wish to provide a multi-channel SDU in the 2 MCU form factor. A multi-channel 2 MCU SDU can operate with an IGA or HGA, just like the full-sized (6 MCU) SDU. The RF power requirements and other characteristics (other than form factor) for a multi-channel 2 MCU SDU should be as defined in Section 2.2.1 in the body of this characteristic. Within the rest of this attachment, the term “Class 4 CSDU” single-channel is used to refer to the single channel CSDU.

2.2.1.1 CSDU Form Factor

The SDU should comply with the dimensional standards in ARINC Specification 600 for the 2 MCU size.

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

2.2.1.2 CSDU Interfaces

The connector, index pin coding, and pin definitions are identical to that of the full-sized (6 MCU) SDU, as defined in Section 2.2.1.2.

The following table gives a subset of the electrical interfaces defined for this connector which are considered as essential for a Class 4 single-channel CSDU. Other interfaces are considered optional.

INTERFACES ON ARINC 600 CONNECTOR	Required for SB200 safety system?	Comments
Power		
115 Vac Variable Frequency	Yes	
28 Vdc	No	Required for business jets.
Satcom System Interfaces		
Tx RF (Power)	Yes	For single-channel SB200.
BSU Control	Yes	For A781 HGA/IGA. Optional for ELGA.
ELGA Control	No	Optional via co-ax or ARINC 429.
External HPA Control (A429)	If required for HLD	
HPA Mute	No	
SCM	Yes	Per A781 wiring provisions.
Other SDU (dual)	No	
User Interfaces		
10/100BaseT on size 22 pins	Yes – 2 for cabin	
10/100BaseT on Quadrax	Yes – 2 for cockpit	
ARINC 664 copper (Cockpit voice and data)	No	
ARINC 664 fiber (Cockpit voice and data)	No	
ISDN	No	
CEPT-E1	No	
(C)MU	Yes – 2	Two for B777. Two ACRs in A350/380.
Cockpit Voice (4-wire and discrete)	Yes – 2 sets	
MCDU	Yes – 3	
POTS/SLIC	No	
BITE/Maintenance Interfaces		
CFDS/CMC on ARINC 429	Yes	
ADL (ARINC 615/429)	Ethernet and ARINC 429	For Ethernet: Quadrax Ethernet 3 preferred.
Service Availability Status discrete	No	Optional. Desirable for certain business jet applications.
ATE pins	No	
ARINC 664 copper or fiber	No	ARINC 664 copper desirable for A350/380.
Miscellaneous Interfaces		
AES ID (429)	Yes	
IRS/GNSS	Yes – 3	
Configuration Straps	Yes	
WOW	Yes	
Tx Mute	Yes	
ARINC 664 copper or fiber	No	ARINC 664 copper desirable for A350/380.

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

2.2.1.3 Class 4 Single-Channel CSDU Services and Features

The following table indicates services and features which should be supported as a minimum. Others are optional at manufacturer's discretion.

A781	Feature/Function	Required for SB200 safety system?	Comments
2.10	BITE (CFDS interface)	Yes – 1 ARINC 429 Rx/Tx	Used on selected airframes.
3.1.1	Inmarsat Services		
3.1.1.2	Classic Aero	No	
3.1.1.3	Swift64	No	
3.1.1.4	SwiftBroadband	1 channel	
3.1.2	Radio Interfaces		
	Non-ATC Cockpit Voice	Yes – 2	Two cockpit voice interfaces with priority and pre-emption.
	ATC Cockpit Voice	Yes – 2	
	Cabin Voice	No	
	Non-ATC Cockpit Data	Yes	Ethernet for EFB.
	ATC Cockpit Data	Yes	SBB ACARS over A429.
	Cabin Data	Ethernet	See Attachment 8 for security considerations.
3.2.1	Pilot System Interfaces for Voice		
3.2.1.2	MCDU Menus	Yes – 3 MCDUs	
3.2.1.6	SAT Phone – Classic Aero	No	
3.2.1.7	SAT Phone – SwiftBroadband	Yes. 2 channels (AMBE+2 and VOIP)	Some require DTMF dialing.
3.2.1.8	SAT Radio – SwiftBroadband	No	Not defined.
3.2.1.9	Williamsburg SDU (WSCI) Controller	No	Used on selected airframes (A350, A380, Dassault).
3.2.4	Ethernet	Yes, all	
3.3	Software Dataloader	Both. S/W and ORT	
3.4.1	Dual Satcom	No	Interest from one OEM noted.
3.4.1.1	Classic Aero Operations	No	Would have required multiple channels.
3.4.1.2	SwiftBroadband and Swift64 Operations	N/A	
3.4.3	Security	No PIES support required.	See Attachment 8 for security considerations.
3.5	Future Growth		
3.5.1	ARINC 664	No	
3.5.4	Multi-Frequency Band	No	

2.2.1.5 CSDU Cooling

The CSDU with internal HPA requires forced air cooling. Due to the compact design the required airflow may be higher than that specified in ARINC Specification 600. Manufacturers should specify cooling airflow requirements.

The CSDU without active HPA may be sufficiently cooled by convection. Manufacturers should specify any additional cooling airflow requirements.

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

2.2.1.5 CSDU Loss of Cooling

The CSDU with internal HPA should be designed to deliver service in a case where cooling air is lost in flight. There is no need to deliver service in the case of loss of cooling when the aircraft is on the ground.

An acceptable duty cycle restriction could then be applied as necessary and could consist of the CSDU restricting services to retain cockpit functions where the ambient temperature is at an extreme.

The system should continue to provide ACARS messaging and 1 voice channel at 100% duty cycle as a minimum.

2.2.2 SDU Configuration Module (SCM)

The SCM in the compact system is identical to that for the full-sized system, as defined in Section 1.6.2. In this case, however, the SCM is only required to contain a single USIM to support one channel of SwiftBroadband service. The SCM also contains memory to store system configuration parameters.

2.2.3 HLD**2.2.3.1 HLD Description**

The HLD (High-power Amplifier/LNA/Diplexer) combines the functions of the HPA and the DLNA (as described in Sections 1.6.3 and 1.6.4) into one unit. The HLD is intended for installation inside the fuselage, close to the antenna.

The HLD is required to provide RF power for transmission of one radio channel. Hence no intermodulation requirements are specified for the HLD. The HLD should satisfy all the relevant Inmarsat requirements.

The choice of the method to provide power to the HLD is at the manufacturer's discretion. Options for providing power are:

1. The aircraft AC or DC power bus or
2. From the SDU via the coaxial cables or
3. Both

The HLD may also make provision for powering the antenna through the coaxial cable.

If the HLD is powered through coaxial cables then control and BITE communications between the SDU and HLD, and between the HLD and ELGA should also be through the coaxial cables. This simplifies the installation.

As an alternative, manufacturers may choose to use ARINC 429 buses for control and BITE communications to the HLD. In this case a multi-pin connector provides for power and ARINC 429 connections. If manufacturers opt for supplying power, control and BITE connections through the coaxial cables, the multi-pin connector may be omitted.

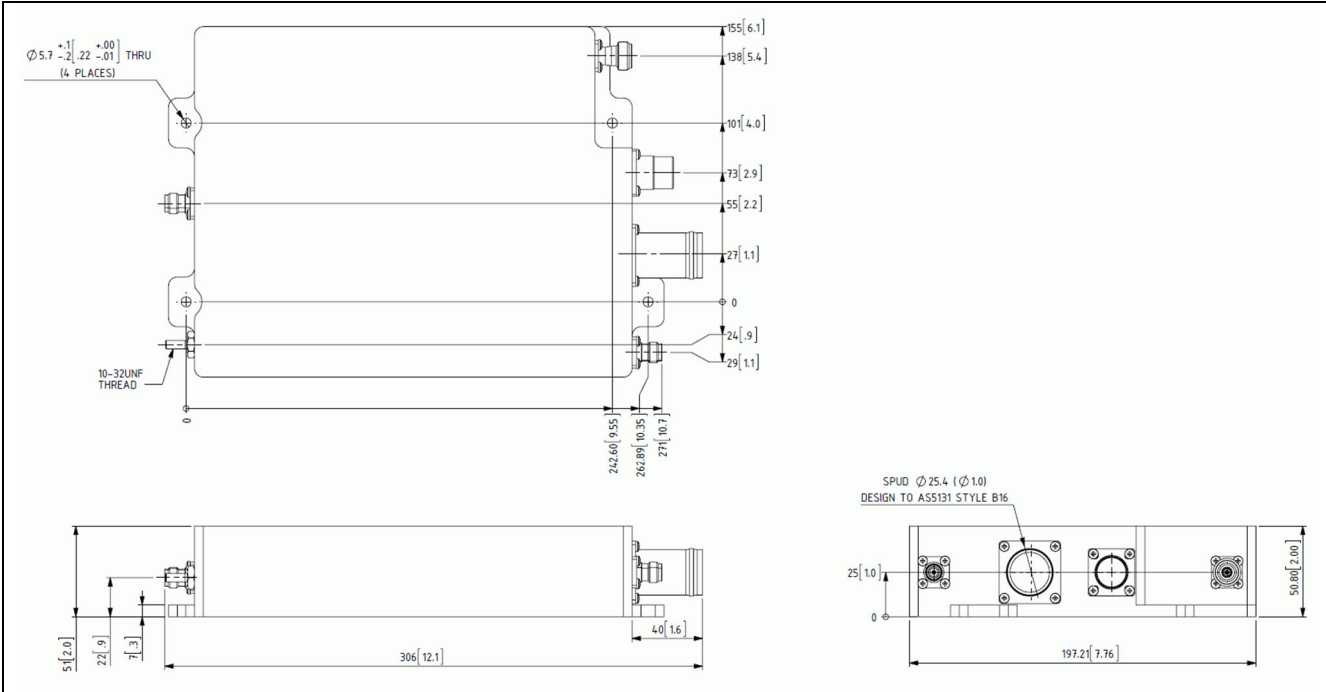
If ARINC 429 is used for control and BITE, an additional ARINC 429 input should be provided on the HLD. The BITE output from the antenna is then routed to the HLD, which then relays the antenna's BITE information, along with its own, to the CSDU.

2.2.3.2 HLD Form Factor

The HLD form factor is shown in Figure 2.

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

The outline resembles that of a Type F DLNA, but it uses a different multi-pin connector. The position of the connectors and cooling spigot may be positioned in the areas shown.



Note: Baseline drawing – Consult manufacturer to confirm outline.

Figure 2 – HLD Outline

2.2.3.3 HLD Connectors

The DLNA uses the following connectors for its RF ports:

- Transmit Port (from SDU): N Jack (Female)
- Receive Port (to SDU): TNC Jack (Female)
- Antenna Port: TNC Jack (Female)

The optional power/control connector type is D38999/20ME26PA or equivalent which mates with a D38999/26ME26SA. It has a 17-26 insert arrangement, which is shown in Figure 3. The pin allocations are shown in the table below.

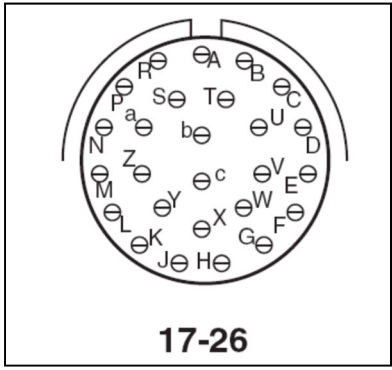


Figure 3 – HLD Multi-pin Connector Insert Arrangement

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

Pin		Signal	Description
A	*	HLD ARINC 429 BITE A	ARINC 429 from HLD (to SDU)
B	*	HLD ARINC 429 BITE B	ARINC 429 from HLD (to SDU)
C		Antenna/BSU ARINC 429 BITE A	ARINC 429 to HLD from Antenna/BSU
D		Antenna/BSU ARINC 429 BITE B	ARINC 429 to HLD from Antenna/BSU
E		RS-232 from HLD	For shop use – not expected to be wired on aircraft
F		RS-232 to HLD	For shop use – not expected to be wired on aircraft
G		(spare#1)	
H		(spare#2)	
J	*	Chassis Ground	
K		+28 Vdc Hot	
L		+28 Vdc Return	
M		Reserved (LNA BITE Discrete)	
N		Reserved (LNA Control Discrete)	
P	*	HLD ARINC 429 Control A	ARINC 429 to HLD from SDU (multi-control)
R	*	HLD ARINC 429 Control B	ARINC 429 to HLD from SDU (multi-control)
S	*	HLD ARINC 429 Control Shield/Strap Ground	
T	*	HLD ARINC 429 BITE Shield/Strap Ground	
U		Antenna ARINC 429 BITE Shield/Strap Ground	
V		Reserved (attenuator #3)	
W		Reserved (disable Autosense)	
X	*	115 Vac Hot	
Y	*	115 Vac Return	
Z		Reserved (parity)	
a		Reserved (LNA BITE Discrete Ground)	
b		Reserved (attenuator #1)	
c		Reserved (attenuator #2)	

Note: Configuration 1 baseline does not require the multi-pin connector. Signals marked “*” are standard wiring for Configuration 1 – Alternate wiring.

2.2.3.5 HLD Loss of Cooling

The HLD should also be designed to deliver service in a case where cooling air is lost in flight. There is no need to deliver service in the case of loss of cooling when the aircraft is on the ground.

Continuous operation within the output power range is expected when cooling is lost. An acceptable duty cycle restriction could then be applied as necessary and could consist of the CSDU restricting services to match the HLD capability to retain cockpit functions where the ambient temperature is at an extreme.

The system should continue to provide ACARS messaging and 1 voice channel at 100% duty cycle as a minimum.

2.2.3.6 HLD Grounding and Bonding

The HLD should provide a flat surface underneath around each of the 4 mounting holes for direct bonding to the airframe.

A 10-32UNF thread grounding stud should be provided to allow fixing of a bonding strap lug.

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

2.2.4 DLNA

As the RF performance of individual units of the RF Satcom System is not specified, there are no specific RF performance requirements for the DLNA in this attachment. Despite this, the system should accommodate the use of any standard Type A, modified Type A or Type F diplexer, modified to accommodate the extended L-Band (XL-Band). This should generally be possible as these diplexers were specified for multi-channel use, and should therefore be more than adequate for a single-channel system.

The physical outline of the diplexer is shown in Attachment 1, Section 1.8.

2.2.5 ELGA (Enhanced Low Gain Antenna)**2.2.5.1 ELGA Description**

The ELGA is aimed at providing a nominal gain of 3 dBic above 20 degrees elevation and 2 dBic between 5 and 20 degrees elevation. This low-elevation performance distinguishes the antenna from the LGA originally defined in ARINC 741. To achieve this enhanced performance some form of beam steering is expected to be required. Because of the low gain required the beams are relatively broad when compared to an HGA.

As described in Section 7.0, the ELGA may be controlled and powered using any one of the following interfaces:

- The RF coaxial cable.
- A multi-pin connector. The multi-pin connector and its pin assignments are the same as the connector on the HGA/IGA.
- A second coaxial cable, instead of the multi-pin connector.

The ELGA should also provide BITE information through the same chosen interface.

2.2.5.2 ELGA Form Factor

The ELGA footprint is shown in Figure 4, Figure 5, and Figure 6. This footprint partially matches the footprint of the LGA, as defined in ARINC Characteristic 741. The ELGA is shorter, however, and does not use the rear pair of mounting screw holes.

2.2.5.3 ELGA Operation at High Ambient Conditions

Where system configuration 3 is adopted, the performance of the system should provide continuous operation within the expected output power range when the ambient air temperature is as an extreme. An acceptable duty cycle restriction could then be applied as necessary and could consist of the CSDU restricting services to retain cockpit functions.

The system should continue to provide ACARS messaging and 1 voice channel at 100% duty cycle as a minimum.

2.2.5.4 ELGA Connectors

The ELGA should be equipped with a TNC female connector for Tx and Rx radio signals.

A second connector may be fitted for power, control and BITE. This connector should be a multi-pin connector or a TNC female connector as described in Section 7.0. If a multi-pin connector is used it should be identical to that defined for

ATTACHMENT 7
COMPACT SATCOM SYSTEMS

the HGA in Section 2.3.2.2 and Attachment 1, Section 1.12. If the ELGA contains two TNC connectors, then they should be color coded.

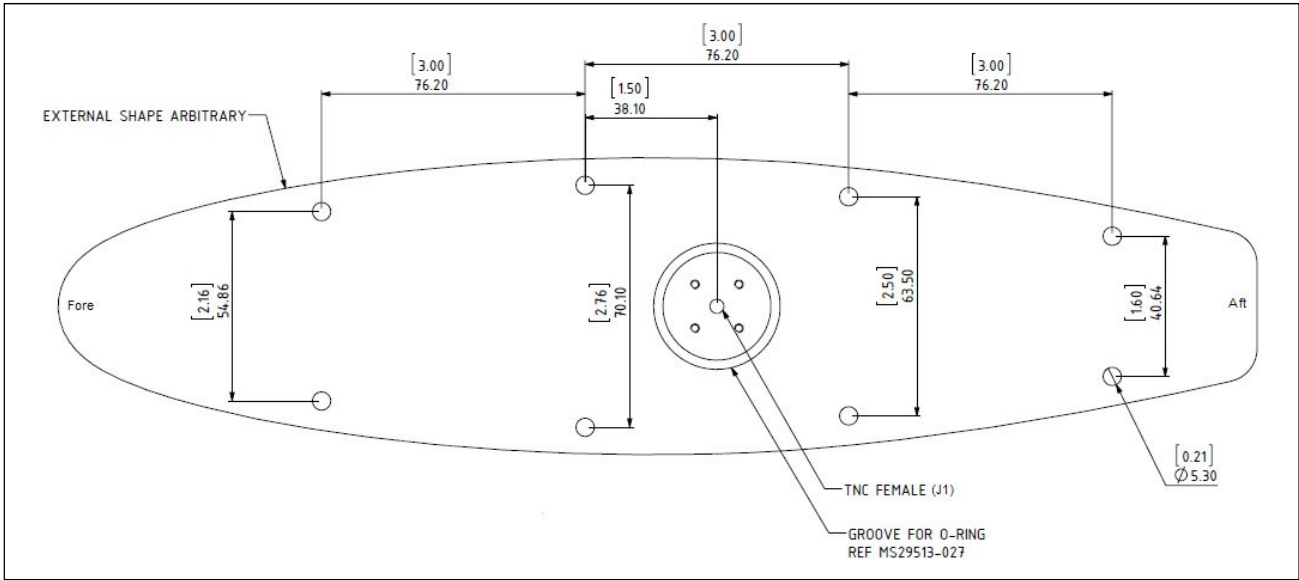


Figure 4 – ELGA with Single TNC Female Connector

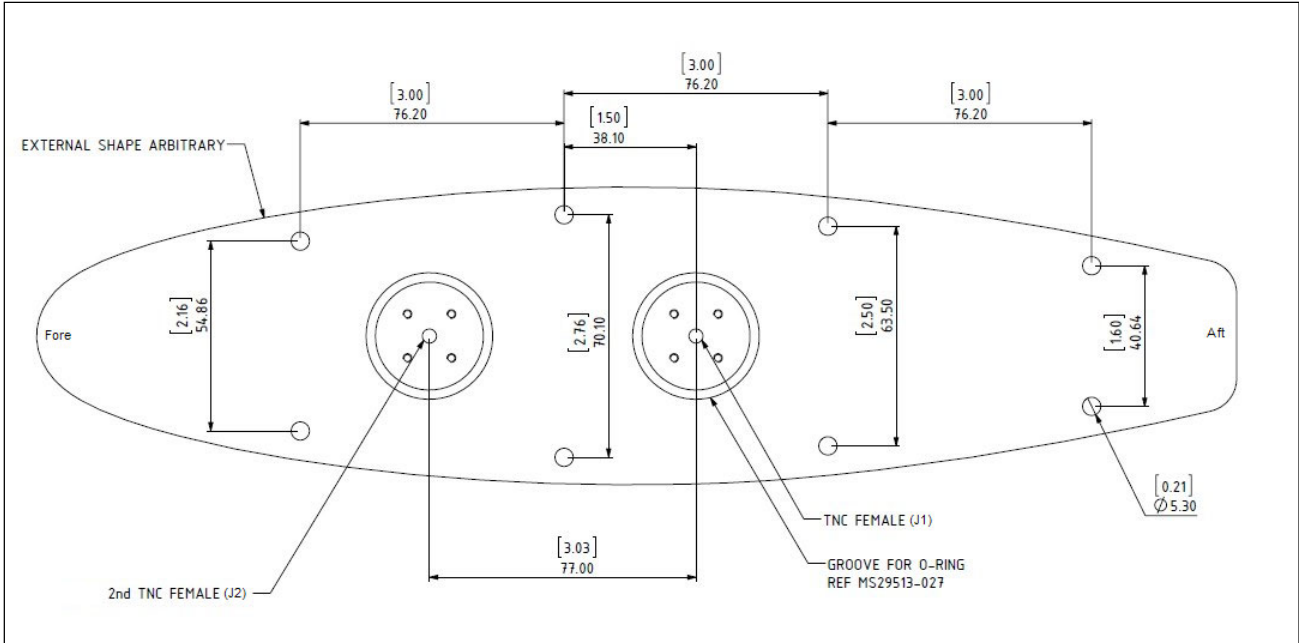


Figure 5 – ELGA Footprint, with 2nd TNC Connector

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

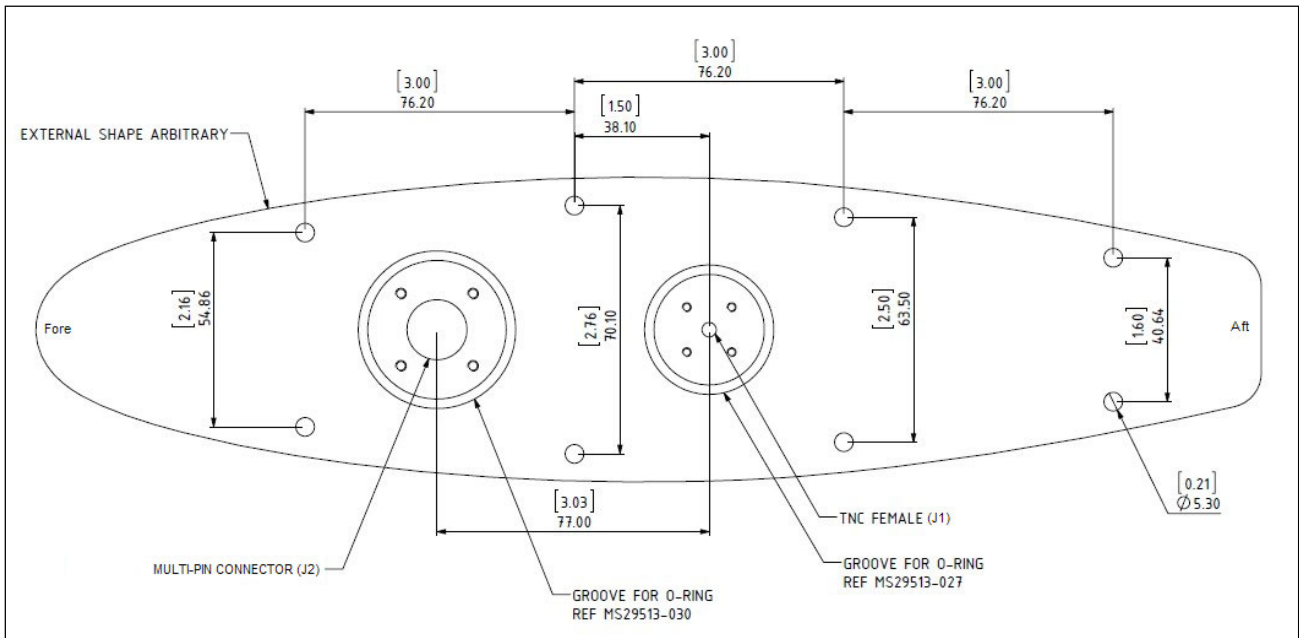


Figure 6 – ELGA Footprint, with Multi-pin Connector

2.2.6 Coaxial Cables

If an HLD is used (Configuration 1), the system should meet its requirements with the following cable loss ranges:

Cable	Loss (dB)
Tx cable, CSDU to HLD	6 to 18 dB (0 to 18 dB is desirable)
Rx cable, HLD to CSDU	6 to 25 dB (0 to 25 dB is desirable)
Antenna cable, HLD to ELGA	0 to 0.5 dB

If a DLNA is used (Configuration 2), the system should meet its requirements with the following cable loss ranges:

Cable	Loss (dB)
Tx cable, CSDU to DLNA	0 to 3 dB
Rx cable, DLNA to CSDU	6 to 25 dB (0 to 25 dB is desirable)
Antenna cable, DLNA to ELGA	0 to 0.5 dB

If the ELGA requires a second coaxial cable between the ELGA and CSDU, the system should operate with cable losses in the range 0 to 25 dB.

If the installation is designed to allow power on a coaxial cable, then its DC resistance should be no more than 0.6 Ohms.

If the HPA, DLNA and antenna are combined (Configuration 3), the system should meet its requirements with the following cable loss ranges:

Cable	Loss (dB)
Tx/Rx cable, CSDU to ELGA	0 to 18 dB

All RF losses should be measured at 1.6 GHz.

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

2.3 Interchangeability

The Class 4 single-channel CSDU, SCM, HLD or DLNA and ELGA are designed as a functional set. Individual LRUs are therefore not specified to be interchangeable with similar LRUs from a different manufacturer. Interfaces between units are therefore not standardized at the electrical signal level.

Equipment should, however, be manufactured and calibrated as individual units and not as matched sets. Any individual unit may therefore be replaced without replacing any other LRU.

The footprint and RF connector of the ELGA (but not the electrical interface or performance) has commonality with the LGA, as defined in ARINC Characteristic 741, to allow use of existing aircraft provisioning. The ELGA is shorter, however, and does not use the rear pair of mounting holes. A second optional connector position has been defined, where the second connector may be a 2nd TNC or a multi-pin connector with the same definition as that of the HGA.

The footprint, fixing holes, and all the RF connectors of the HLD are intended to be compatible with the Type F DLNA footprint defined in Attachment 1, Section 1.8. The optional power/control connector of the HLD is the same as the Flange Mount HPA except a different keying is used.

The connector and electrical interfaces of the CSDU are intended to be compatible with the full-size (6 MCU) SDU, except that electrical details may differ on the interface to the HLD (e.g., power and control over coaxial cables instead of ARINC 429).

2.4 Performance Criteria

The Class 4 single-channel CSDU, SCM, HLD or DLNA and ELGA are designed as a functional set. The performance criteria for individual units are not described in this document. The complete system is required to comply with the requirements as set out in the relevant Inmarsat System Definition Manual (SDM). Below follows a short selection of requirements for information.

2.4.1 Transmitter Equipment Performance

The equipment is aimed at supporting the Inmarsat SB200 Evolution (Class 4) Safety Service. The nominal EIRP required is 10 dBW. The transmit system is equipped to reduce the EIRP below this level according to commands from the earth station (back-off).

Table 1 – Worked Example of Transmitter Performance Criteria for Configuration 2

System Component	Value	Unit
EIRP	10.0	dBW
Ant Gain (min)	1.0	dB
Ant-DLNA Cable Loss	0.5	dB
DLNA Insertion Loss	0.8	dB
CSDU-DLNA Tx Cable Loss	3.0	dB
CSDU Output Power	13.3	dBW
CSDU Output Power	21.4	W

The transmit gain of the ELGA may vary as its beam position is changed while tracking a satellite from an aircraft in motion. To maintain a more constant EIRP as

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

the antenna's beam position is changed, the system may make appropriate RF power adjustments to compensate for the change in antenna gain.

If the antenna beam steering function uses attitude, then aircraft attitude rates of change should be assumed to be up to 7.5 degrees per second.

The transmitter should operate over the frequency bands 1626.5 to 1660.5 and 1668.5 to 1675.5 MHz. This includes the extended L-band (XL-band) used by Alphasat.

There is no intermodulation requirement, as this is a single channel system.

2.4.2 Receiver Equipment Performance

To support the Inmarsat SB200 Evolution (Class 4) Safety Service, the receiver chain should provide a nominal G/T performance of better than -21 dB/K for elevation angles above 5 degrees (This is an approximation. Consult the Inmarsat SDM for detailed requirements).

The receiver system performance is intended to provide a packet error rate (PER) of 1×10^{-3} or better for SwiftBroadband packet-switched services and 1×10^{-2} or better for SwiftBroadband circuit-switched voice.

The receiver should operate over the frequency band 1518 to 1559 MHz. This includes the extended L-band (XL-band) used by Alphasat.

2.5 Interwiring

This section deals specifically with wiring between the Class 4 single-channel CSDU, HLD/DLNA and ELGA. Wiring to other avionics in the aircraft is simplified as “aircraft interfaces” in the figures in this section. Refer to Sections 2.2.1, 2.2.3, 2.2.4, and 2.2.5 of this attachment as well as Attachment 1, Section 1.3 and Attachment 1, Section 1.5 (A, B, and C) for the connector and pin allocation detail.

The multi-pin connector on the HLD is defined to be the same as on the FMHPA except that a different keying is used.

Aircraft installers should contact equipment manufacturers to determine which of the wiring schemes presented in this section are appropriate for their equipment.

Notes on wiring configurations:

1. Power, ARINC 429 buses (labeled ‘A429’) and SCM signaling are all shown as a single line in the drawings for simplicity. These are wire pairs in reality.
2. The HLD connector definition has connections defined for both the DLNA BITE Discrete and an ARINC 429 BITE bus. Whether both are used is the manufacturer’s choice.
3. “SCM signaling” includes duplex RS422 connections.
4. The 2nd coaxial cable between the CSDU and the ELGA connects to the CSDU bottom plug, insert 6 (see Attachment 1, Section 1.5C).

2.5.1 Configuration 1 – Systems Using a HLD

This system is suitable for aircraft where some cooling can be provided in the crown of the aircraft. Because the HLD contains a power amplifier, it can compensate for increased loss in the RF TX cable as specified in Section 2.2.6 of this attachment. A weight saving can be achieved this way.

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

The baseline interwiring method is shown in Figure 7. Power and HLD control and BITE information is supplied through the coaxial cables. The ELGA should also receive power, control, and provide BITE information via the single coax from the HLD.

The alternate interwiring method shown in Figure 8 allows the antenna and HLD to be controlled via ARINC 429. The antenna BITE ARINC 429 bus is fed to the HLD. The intention of this BITE scheme is that the HLD receives BITE words from the antenna, adds its own BITE words and then reports all of these to the SDU on one ARINC 429 bus (marked 'HLD BITE A429' in the drawings). This scheme only needs to be supported by manufacturers who offer an HLD, and who make provision for ARINC 429 control of the antenna. Power to the HLD and the antenna may also be supplied through the multi-pin connectors.

2.5.2 Configuration 2 – Systems Using a DLNA

When using a standard DLNA, control of the antenna through the antenna RF coaxial cable is normally not possible. Either a second coaxial cable or ARINC 429 control is required. The design of the specific ELGA will determine which of the two methods applies.

Power is supplied to the DLNA through the multi-pin connector.

The loss in the RF TX cable needs to be kept low, as specified in the following figure. This configuration is suitable for aircraft where cooling of the HLD in the crown of the aircraft is not possible. The power dissipation in the DLNA is much less than that of the HLD.

The baseline interwiring method is shown in Figure 9. DLNA control and BITE information is supplied via the antenna ARINC 429 interface. The ELGA should also receive power, control and provide BITE information via the multi-pin connector.

The alternate interwiring method shown in Figure 10 makes provision for DLNA BITE and control using discrete wires from the CSDU. Power to the DLNA may also be supplied through the multi-pin connector.

2.5.3 Configuration 3 – Systems Using a Combined HPA, DLNA and Antenna

This system is suitable for aircraft with high or low cable losses. Because the antenna contains a power amplifier, it can compensate for increased loss in the coaxial cable as specified in Section 2.2.6 of this attachment. A weight saving may be achieved as only one cable is required between the two LRUs.

The interwiring method is shown in Figure 11.

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

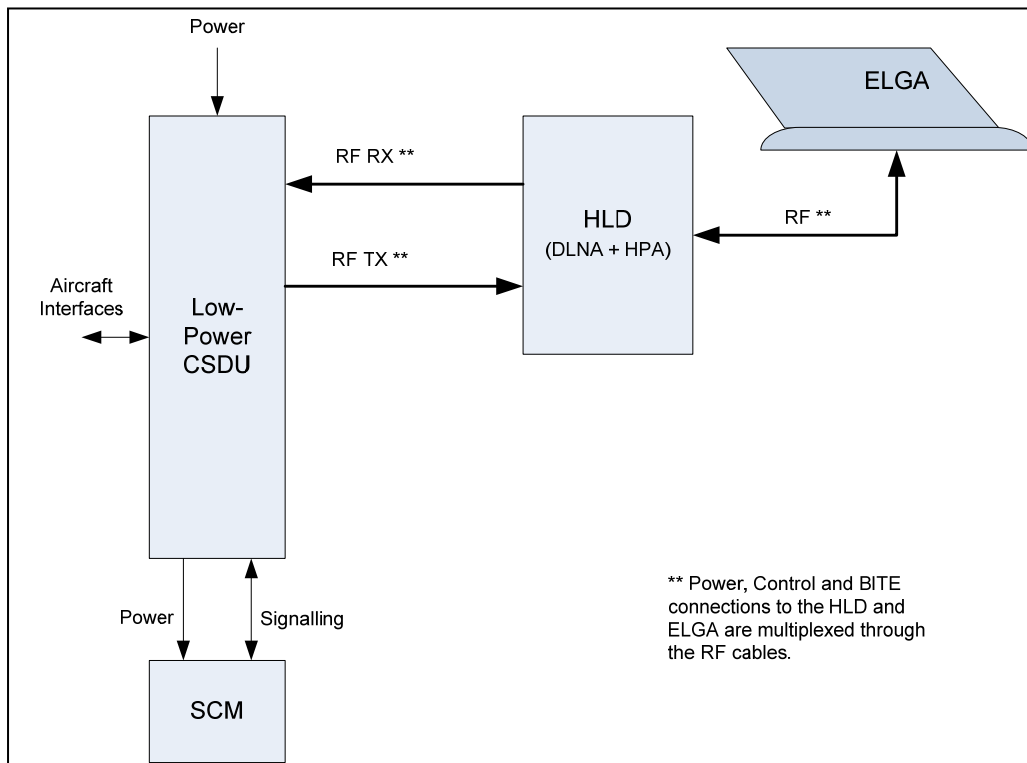


Figure 7 – Compact Satcom System – Configuration 1 – Baseline Wiring

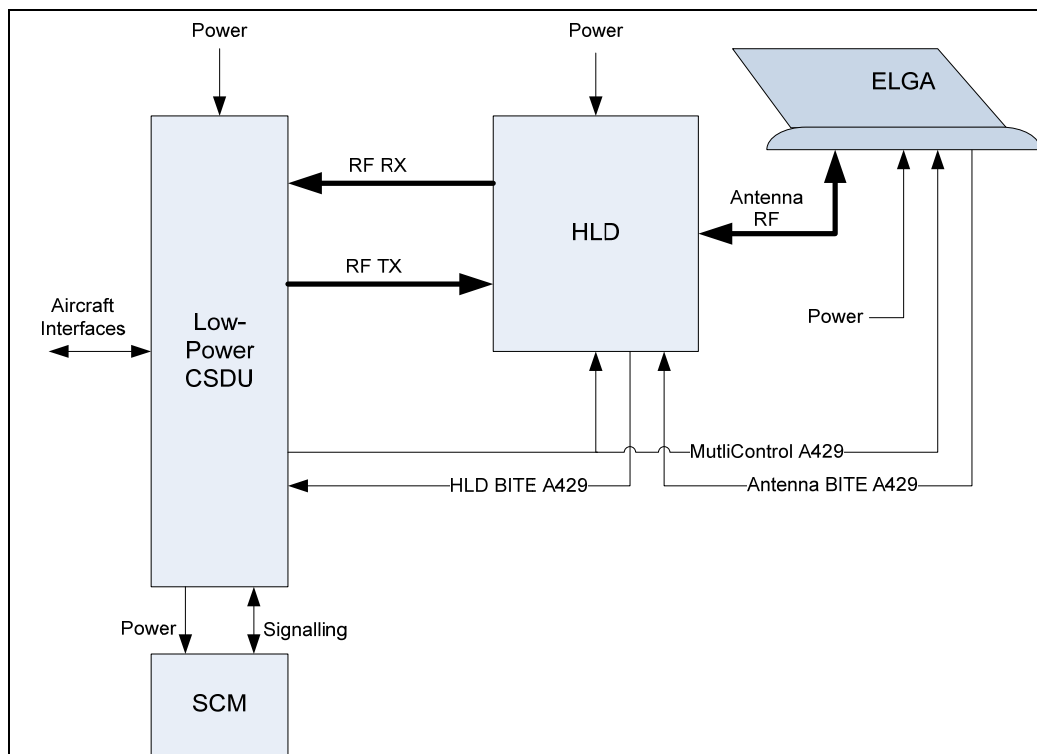


Figure 8 – Compact Satcom System – Configuration 1 – Alternate Wiring

ATTACHMENT 7
COMPACT SATCOM SYSTEMS

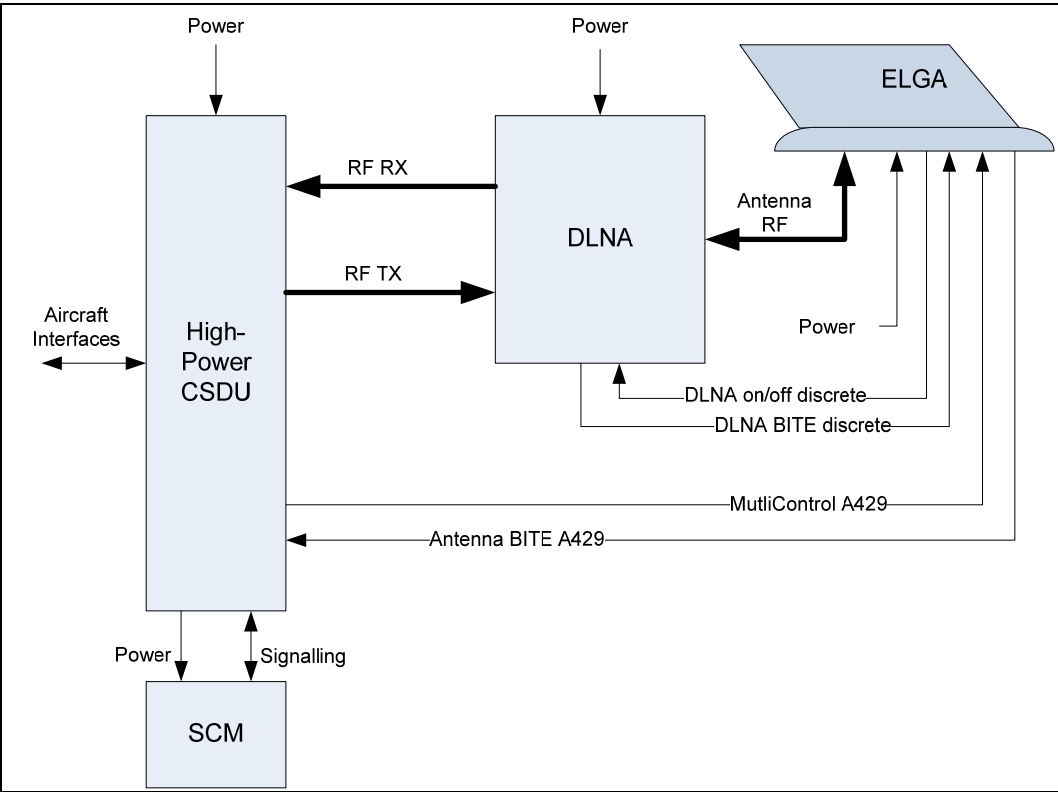


Figure 9 – Compact Satcom System – Configuration 2 – Baseline Wiring

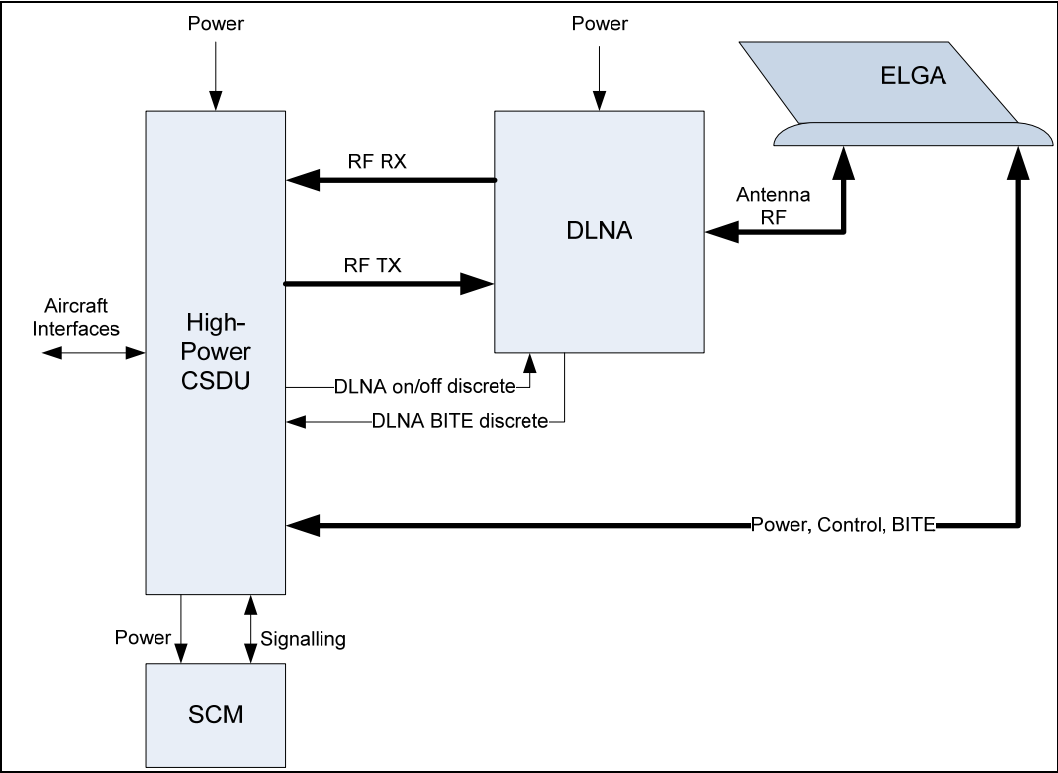


Figure 10 – Compact Satcom System – Configuration 2 – Alternate Wiring

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

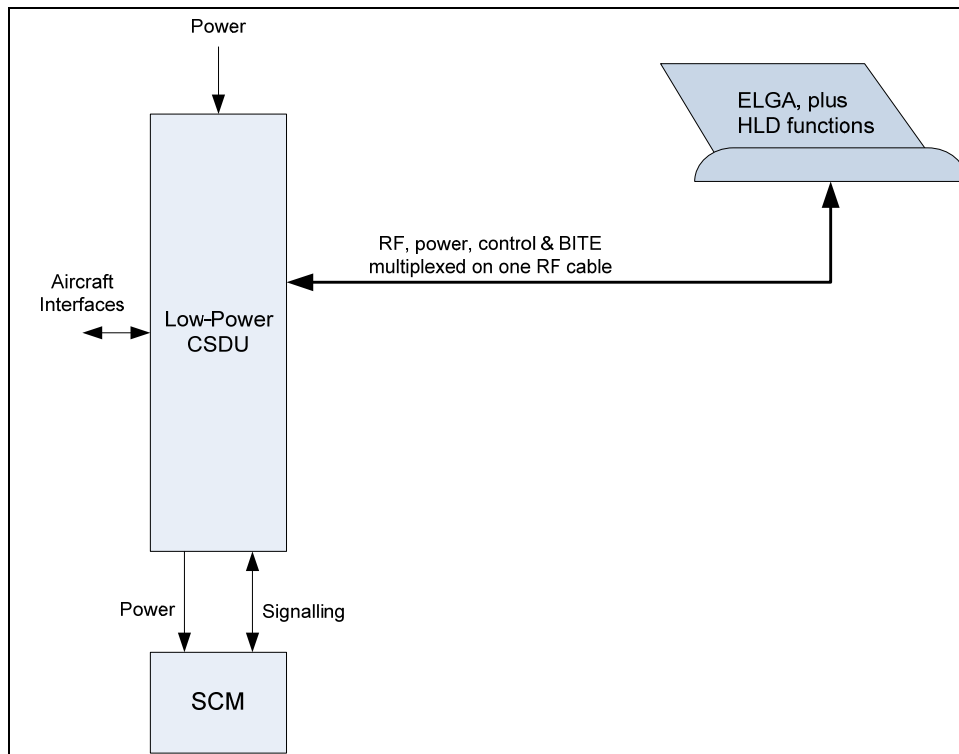


Figure 11 – Compact Satcom System – Configuration 3

3.0 Compact Safety Service Systems (Class 6 and 7) Overview

The main characteristics of Inmarsat Class 6 and 7 systems are:

- Service down to 5 degrees elevation.
- Provided over I-4 satellites and Alphasat.
- ACARS messaging service.
- Dual voice channels, for safety or non-safety services.
- IP data connection, up to 432 kbps (Class 6) or 332 (Class 7). Safety or non-safety use.
- Streaming service up to 128 kbps to support multi-voice services.
- Priority and pre-emption of safety voice and data services.
- IGA antenna (Class 7) or HGA antenna (Class 6).

3.1 Airborne Terminal Configurations

Configurations shown below are combinations of the IGA and HGA antennas defined in the main body of this standard, the Compact CSDU and SCM described in Section 2.0 of this attachment and a Multi Carrier High-Power Amplifier (MCHPA). The description of the MCHPA LRU can be found below.

ATTACHMENT 7 COMPACT SATCOM SYSTEMS

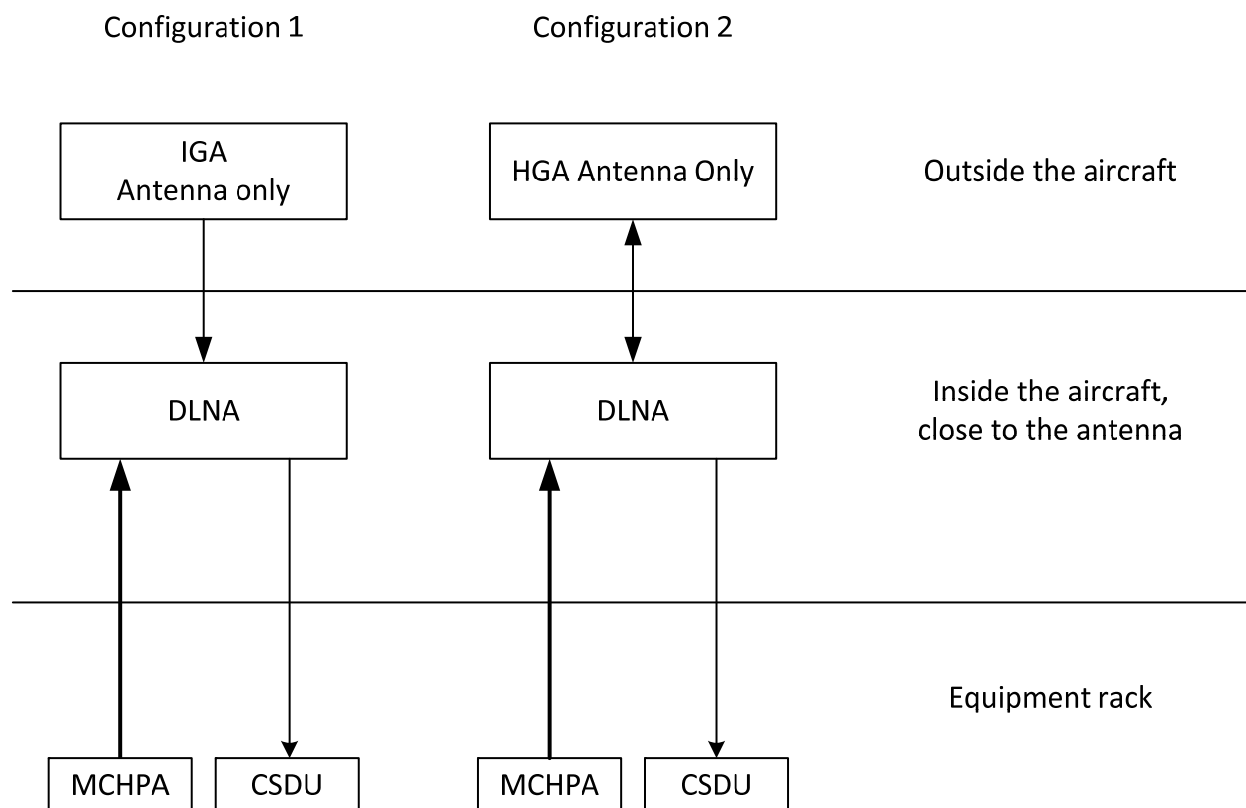


Figure 12 – Compact Satcom System Configurations of Class 6 and 7

3.2 LRU Definitions

3.2.1 Multi Carrier High-Power Amplifier (MCHPA)

The function of the MCHPA is to perform amplify the signal to the correct high power levels required. It also applies gain variations or adjustments (dynamically variable) of the transmit signal fed to the antenna through the DLNA. It is a similar function as for the HPAs defined in Section 2.2.2 in the main body of this standard. The major differences are:

- The form factor is a 2 MCU ARINC 600 enclosure (not flange mounted)
- It provides one or more channel of service
- It can operate with a cable loss of 0-25 dB from the SDU to the HPA
- Possible to place next to CSDU

3.2.1.1 MCHPA Form Factor

The MCHPA should comply with the dimensional standards in ARINC Specification 600 for the 2 MCU size.

3.2.1.2 MCHPA Interfaces

The connector definition, including Index Pin, of the MCHPA is identical to that of the High-Power Amplifier defined in ARINC 741, Part 1, Section 3.2.1.3 and Attachment 1, Sections 1-10, 1-10A, 1-10B, and 1-10C. The HPA is therefore functionally equivalent to this ARINC 741 HPA, but in a much smaller form factor.

**ATTACHMENT 7
COMPACT SATCOM SYSTEMS**

An HPA does not have to support the functions of all pins in the multi-pin connector. Control of the amplifier as well as data loading may optionally be performed by the SDU via the co-axial cables.

3.2.1.3 MCHPA Services and Features

The CSDU and MCHPA will be a functional doublet. This implies they are designed to operate together, and the signaling between them is not standardized. The services and features for the MCHPA/CSDU combination can be found in Section 2.2.1.3 of this attachment.

Feature	Description
Control IF	ARINC 429 or propriety interface over RF interface
Power supply	28 VDC and/or 115 VAC (400Hz) at the manufacturer's discretion
Gain and output power	As needed to comply with class 6 or 7 EIRP requirements

3.2.1.4 MCHPA Cooling

The MCHPA can be operated with supplied airflow cooling (aircraft-supplied cooling air), forced air cooling (fan tray), or convection air cooling at the manufacturer's discretion.

Manufacturers should specify the required type of cooling and specific cooling airflow requirements. The required airflow may be higher than that specified in ARINC Specification 600.

3.2.1.5 MCHPA Loss of Cooling

If the MCHPA uses supplied or forced airflow for cooling, it should be designed to deliver service in a case where this cooling air is lost in flight. There is no need to deliver service in the case of loss of cooling when the aircraft is on the ground.

The MCHPA should, in combination with the CSDU, continue to provide ACARS messaging and 1 voice channel at 100% duty cycle as a minimum.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

ATTACHMENT 8 NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

1.0 INTRODUCTION

In 2009 Inmarsat announced its intention to offer safety services over SwiftBroadband (SBB) as an alternative to the Classic Aero service in oceanic regions.

This attachment contains security guidance for SwiftBroadband safety services that is intended to facilitate the sharing of SDU resources with safety communications and other lower-assurance applications such as EFBs and passenger Internet access. This guidance is intended for the ARINC 781 system designer involved in the development of the 2 MCU single channel Compact SDU or the 6 MCU, multi-channel SDU. It provides detailed guidance that will assist in development of a system design that is intended to satisfy regulatory requirements by providing adequate risk mitigation against threats that could result in undetected corruption of FANS messages, the loss of the FANS messaging service, or the loss of cockpit voice services and shall not increase the security risks to installed systems (e.g., CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.). Most of the requirements herein are not necessary for strict functional compliance with the ARINC Characteristic 781 but were developed to support overall system security. These requirements should be subject to the same verification, validation, and testing as that of any other functional requirements.

Some sample architectures (i.e., reference designs) are presented and are then used as a basis for a security analysis based on the process defined in **RTCA DO-326A/EUROCAE ED-202A: Airworthiness Security Process Specification** and **EUROCAE ED-203: Airworthiness Security Methods and Considerations**. This security analysis enabled the development of recommended security requirements for ARINC 781 systems supporting safety services over SBB. It is expected that the RTCA DO-326A/ED-202A Security Level (SL) should be defined according to the process defined in RTCA DO-326A/EUROCAE ED-202A for each single security function.

The reference architecture employs the use of separate physical processors to achieve segregation. However, as noted in EUROCAE ED-203, physical processor segregation is not the only viable solution and other means are possible. A manufacturer may choose to use a secure partitioned operating system to achieve the equivalent segregation, or a combination of methods, e.g., employing multiple physical processors where specified processors can support segregated functions. All implementations should be supported by a security analysis to show that it provides segregation equivalent to that provided by the reference architecture.

Supplement 7 introduced a VPN between the ground and aircraft to support the ACARS service to provide additional security. ACARS using a VPN is known as Enhanced ACARS while ACARS without the VPN is known as Standard ACARS. **Supplement 8 extends the use of the VPN for the PS Voice Service. PS Voice using a VPN is known as Enhanced PS voice while PS Voice without the VPN is known as Standard PS voice.** For a security analysis for **Standard ACARS**, the reader should consult Supplement 6.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

2.0 OBJECTIVES

When designing a secure system, it is important to first document the overall security objectives. These objectives are typically based on the experience of the system designer and security experts and guided by an understanding of the functional role of the system, the threat environment in which it will operate, and its criticality level. These general objectives are intended to be further refined and augmented during the security analysis phase.

The following high-level objectives have been identified for ARINC 781 systems supporting SBB safety services, including both compact and full-size SDUs. They are not in ranked order and should all be taken into consideration for a system design.

1. The SDU software should remain Level D to the extent possible (the RTCA DO-178 design assurance level). If assurance requirements necessitate any Level C functions, they should be as small as possible.
2. The SB200 design should be able to support SBB safety services and an EFB running on a single channel card, including support for required priority and preemption for safety services.
3. SDU designs should ensure that security threats targeting the SDU or using the SDU as an attack vector cannot cause any safety impact to the aircraft.
4. Security controls should not unduly complicate maintenance and operations activities.
5. Data loading functions should be designed to preclude the creation of new vulnerabilities that could be exploited by an attacker or malware directed at the system software or that of any connected system.
6. Data loading operations should be performed only when explicitly enabled by authorized maintenance personnel.
7. Packet Data Protocol (PDP) context control should be protected from unauthorized manipulation.
8. Means should be provided to prevent spoofing of safety-related communications.
9. Security measures should be designed to prevent attacks that would result in the decreased or loss of availability of services (e.g., via resource exhaustion).
10. The SDU channel card should act as much as possible as a transparent modem (even though it plays an active role in PDP context processing and allocation of data to AC and AIS domains). In order to reach this objective, PDP context processing should be robust in the SDU channel card to ensure that it cannot be corrupted by any malformed/spurious PDP context commands.
11. The SDU should provide a means for detecting when it is out of software conformity and generate the appropriate fault notification.

The following security areas are explicitly not addressed by this security guidance:

1. Authentication of ACARS messaging endpoints. Other specifications address this area (i.e., **ARINC Specification 823: Data Link Security, Part 1, ACARS Message Security**).
2. Security requirements for ground systems.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

3.0 ARCHITECTURE

The safety services to be delivered over SwiftBroadband include ACARS, cockpit voice, and an IP Priority data service. The ACARS service packages ACARS messages into IP packets for transmission between air and ground. For voice, the first cockpit voice call is delivered using a circuit switched connection, while a second cockpit voice call is delivered over IP. The ADS-C and CPDLC FANS Air Traffic Control (ATS) applications utilize the ACARS service over VHF, HF, and Inmarsat Classic Aero satcom links.

3.1 End-to-End ACARS System Architecture

Figure 1 is a block diagram describing the end-to-end architecture for the ACARS service, where a single SBB channel (e.g., SB200) is used to deliver the ADS-C and CPDLC FANS applications, as well as Electronic Flight Bag (EFB) services. See Figure 1, next page.

**ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES**

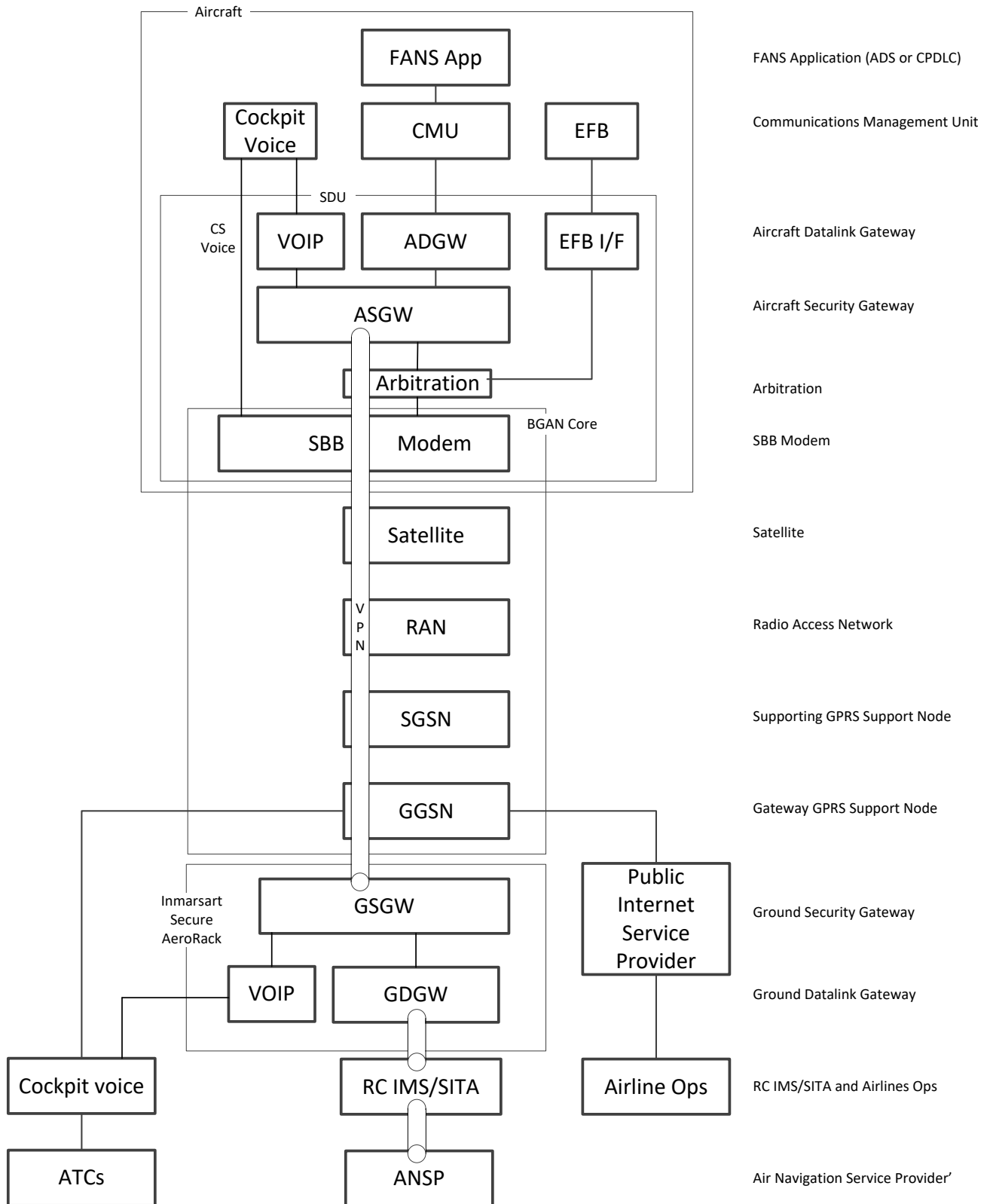


Figure 1 – End-to-End Architecture

Figure 1 shows those functions that are resident in the SDU, the aircraft, and the BGAN Core network. The BGAN Core network, which provides SBB non-safety

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

communication services, provides standard 3G IP service which is then used by the air and ground ACARS gateways (ADGW and GDGW) to encapsulate the ACARS messages as a UDP datagram for transport over IP.

The ground infrastructure is assumed to be operating at the appropriate security level. Analysis for the appropriate ground security level is outside the scope of this standard and may impact the overall onboard design depending on the level of demonstration of ground security.

3.2 Compact SDU Reference System Architecture

A reference architecture for an SB200 compact SDU (CSDU) capable of supporting SwiftBroadband Safety Services and EFB communications on a single-channel card is shown in the figure that follows.

The key security features of the CSDU system architecture are:

- A hardware-segregated function developed to RTCA DO-254 and to the required RTCA DO-178 design assurance level as derived from the system safety assessment to control and mitigate data access from two domains to the single channel card, providing necessary separation and prioritization.
- The required security assurance level of the data arbitration function should be determined per RTCA DO-326A and EUROCAE ED-202A.
- A VPN between the SDU ACD and Inmarsat's secure aero rack on the ground for the carriage of ACARS messages **and VoIP**.
- Resource isolation on the single channel card further ensures separation.
- Data loading is only possible while in maintenance mode on the ground. During data loading, all other data paths to the AISD processor should be disabled via hardware logic based on the air-ground state and the data load enable discrete input.
- EFB traffic will always have a lower priority than safety services.
- The EFB uses a pre-established background context that cannot be changed in operation.
- Messages that would overflow a message queue are discarded.

ATTACHMENT 8 NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

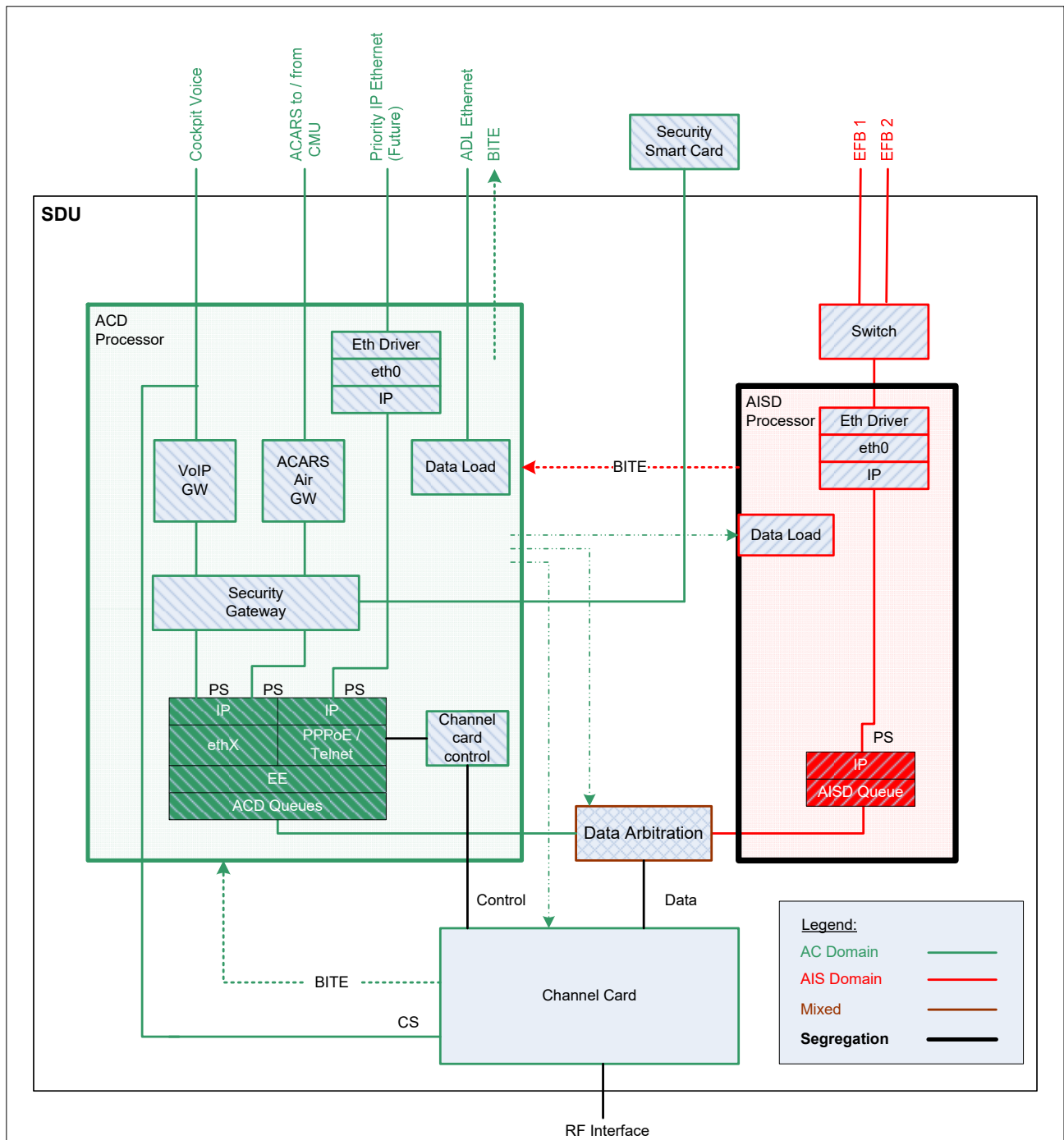


Figure 2 – Architecture for SB200-S Terminal

The key features of this architecture are described in the following subsections.

3.2.1 Data Arbitration Function

The data arbitration function enforces traffic priority and preemption, and maintains segregation of traffic between the AC and AIS domains up to the channel card interface. The required security assurance level of the data arbitration function should be determined per RTCA DO-326A and EUROCAE ED-202A.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

In the Air-To-Ground direction, the data arbitration function arbitrates between an AIS domain data queue and separate data queues for packet-switched (PS) voice (VoIP), ACARS, and Priority IP service. The ACD queues always have priority over the AISD queue. Should any queue overflow, the existing data in the queue is then discarded. The data queues should use separate memory spaces.

After connecting to the satellite network, the ACD processor automatically instructs the channel card to create a PDP context specifically to carry data from the AISD. The data arbitration function marks the data for transmission through this context based purely on the physical port from which it is received. This marking is achieved by adding a header identifying the context that the channel card should use for transmitting the data. The content of the data therefore cannot affect its routing.

The ACD processor similarly creates PDP contexts to be used for data packets carrying CS, ACARS, and Ethernet data.

The ACD processor adds headers to data packets from the ACD which enable the channel card to identify the data as Cockpit Voice, ACARS, or Priority IP service. These headers are added by the Ethernet Encapsulation (EE) function that is part of the networking protocol stack.

The mechanisms described above allow the channel to transmit data without ever examining the actual payload data. It only examines the headers to determine the PDP context to be used for transmission.

The parameters needed to establish the background context for the AISD are contained in the Owner Requirements Table (ORT). These context parameters include the Access Point Name (APN) and host name. The priority of this PDP context is fixed. Neither the EFB nor the AISD processors have any control over the PDP context and both should be agnostic to the characteristic or profile of the IP connection. The context parameters cannot, therefore, be manipulated via an attack from the EFB.

In the Ground-To-Air direction, the channel card sends data packets to the data arbitration function with headers identifying the context through which the data was received. The data arbitration function acts as a switch. It sends data to the AISD processor or the ACD processor depending on the PDP context it originated from. In the case of a data packet for the AISD, the data arbitration function removes the header containing the PDP context identifier before sending the packet to the AISD processor. In the case of packets for the ACD, the headers containing the PDP context identifiers are not removed, as the ACD processor needs them to distinguish between data packets for its different services.

To ensure that other hosts in the ACD cannot be made to inject malicious messages, the link between the SDU and the ACARS system (e.g., the Communications Management Unit (CMU) or Communications Management Function (CMF)) should provide network isolation equivalent to that of a point-to-point ARINC 429 connection.

One possible implementation of the data arbitration function is as part of a Field Programmable Gate Array (FPGA). Other methods may be possible (e.g., an ARINC 653 operating system providing segregation) but should achieve a similar level of segregation and robustness.

ATTACHMENT 8 NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

3.2.2 ACD (Aircraft Control Domain) Processor

As shown in Figure 2, the ACD processor provides all functions for the following cockpit communications services:

- A Circuit-Switched (CS) voice channel
- A Voice over IP channel (VoIP)
- An Aircraft Datalink Gateway (ADGW) for the carriage of ACARS messages, with an associated port connecting to the ACARS system (e.g., a CMU)
- An Ethernet interface for a Priority IP service (for unidentified future applications)

Functions shown in Figure 2 to provide the above services include:

- Hosting the Aircraft Security Gateway.
- Control of the channel card, including instructing the channel card to create separate PDP contexts to be used for the various ACD and AISD services.
- Data loading (discussed under a separate heading).
- Control of the terminal also resides in the ACD processor. This includes some functions not shown in Figure 2: Control of the antenna.
- Control of the HPA.
- ARINC 429 navigation data inputs for IRS, GNSS, and Aircraft ID information.
- ORT Interface to the Universal Integrated Circuit Card (UICC) (part of the SDU Configuration Module (SCM)).
- ACD processor provides partitioning to ensure segregation and non-bypassability of security functions. Partitioning can be implemented at the level of OS (such as a secure hypervisor) or enhanced secure OS, enforcing strict access control between partitions. Additionally, such a mechanism should ensure by design EICAS/FWS, ADL, CMC, MCDU cannot receive any data from the ground or AISD. Equivalent mechanisms may be possible.
- Ensure partition segregation by applying strict filtering between partitions.

3.2.3 AISD (Airline Information Services Domain) Processor

This processor is intended to provide connectivity to up to two EFBs. Because a default background class context is pre-established by the ACD processor, no support is provided for PPPoE or “Telnet” control of the channel card by the EFB or the AISD processor. There should also be no exchange of control information between the AISD and the ACD. Note that rather than being directly attached via Ethernet, EFBs may be connected through an Aircraft Interface Device (AID) that provides an additional layer of control over data transmission to and from the EFB units. **FAA Advisory Circular 20-173: Installation of Electronic Flight Bag (EFB) Components**, documents the regulatory requirements for EFB data interfaces.

The AISD functions should operate on a separate processor. It should not share physical memory with the ACD. Alternative methods of achieving separation may be possible, but alternative solutions should achieve a similar level of segregation and robustness as demonstrated by a security analysis.

3.2.4 Security Layer for ACD

To provide additional security controls, a VPN operates between the aircraft and the ground and tunnels over the majority of the Inmarsat network (satellite, RAN, and

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

CN). The VPN terminates within the AES on the aircraft and within a security gateway within the ground aero rack, which also houses the gateways for ACARS. The VPN ensure mutual authentication of the endpoints and integrity of data using IPsec. Access to ACD services, such as ACARS services, is controlled using a PKI system, which is responsible for enrolling aircraft and ground gateways onto the system and producing signed certificates to vouch for their authenticity. Due to the constantly changing population of aircraft, the enrollment process and distribution of certificates needs to be dynamic.

It is assumed within this standard that similar VPNs are required with each of the connecting ANSP/ACSP partners for delivery of ATS datalink traffic. These VPNs can be statically established.

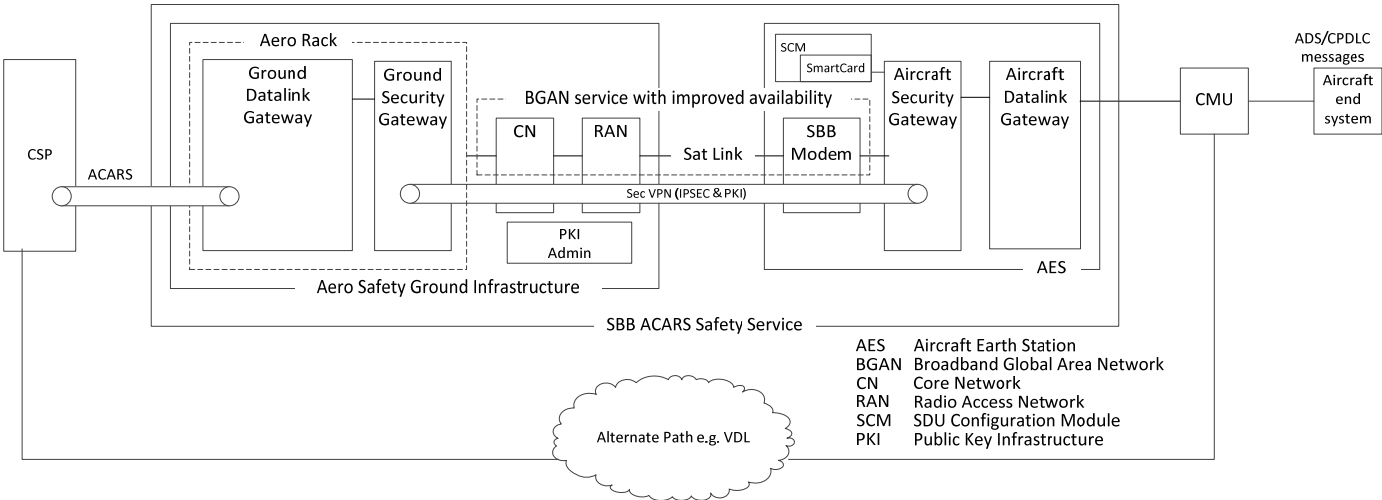


Figure 3 – SBB ACARS Service Architecture

The main components of the SBB ACARS Service architecture are:

ADGW	Aircraft Datalink Gateway. A functional block within the AES that is responsible for encapsulating ACARS messages in an IP wrapper to allow them to be sent via SBB and also de-encapsulates received ACARS IP messages for transmission to the aircraft CMU. The ADGW does not provide a guaranteed delivery of messages to (or from) the ground gateway. Rather, it is responsible for ensuring a communications link with the ground, where permitted by the AES resources and network availability. The ultimate responsibility for ensuring message delivery is at the ACARS or messaging layer.
Aero Rack	The Aero Rack is the collective name given to the GSGW and GDGW.
AES	Aircraft Earth Station. The equipment located on the aircraft that provides a communication link via satellite. The AES includes modems for the Inmarsat SBB network and optionally for the Classic Aero network.
ASGW	Aircraft Security Gateway. The ASGW is responsible for establishing the Secure VPN tunnel between the aircraft and its peer GSGW for the provision of an IPsec VPN for secure air-ground datalink communication.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

CMU	Communication Management Unit. The equipment located on the aircraft responsible for routing communications between aircraft and ground. The CMU manages communication across multiple sub-networks: VHF radio (Terrestrial) HF radio (Terrestrial) Inmarsat (satellite) Iridium (satellite)
GDGW	Ground Datalink Gateway. The GDGW supports delivery of ACARS traffic over the satellite link. It is the peer of the ADGW.
GSGW	Ground Security Gateway. The GSGW is the peer of the ASGW and terminates the IPsec secure VPN tunnel.

3.2.4.1 Aircraft Security Gateway

The Aircraft Security Gateway implements mutual authentication and data integrity protection features between the ground secure aero rack and the ACD domain; thus, the Aircraft Security Gateway is hosted on the ACD processor. The ACD processor will authenticate the data and check its integrity and will drop all non-authenticated data.

The Aircraft Security Gateway provides a layer of evidence that only data that is coming from Ground Security Gateway is allowed into the ACD. The overall security concept is based on a multi-hop mutual secure channel from the ANSP to the CSP, the CSP to Inmarsat secure aero rack, and from Inmarsat Ground Security Gateway to Aircraft Security Gateway. At each hop, security activities and evidences are assumed to be provided to guarantee that the data has not been tampered with or corrupted. The integration of the Aircraft Security Gateway in the ACD processor should demonstrate that no other flow, other than the authenticated flow, can be allowed to be forwarded into the CMU. In other words, the design of the ACD processor should ensure only data coming from ASGW can be sent to the ADGW, and from the ADGW to the CMU.

The Security Level (SL) of the ASGW should be assessed in accordance with RTCA DO-326A and EUROCAE ED-202A.

The credentials for setting up the IPSEC VPN are stored inside the Security Smartcard (which is physically hosted in the SCM) and should be protected against tampering, theft, and corruption during all operational phases.

The PKI concept uses digital certificates to provide the framework upon which the mutual authentication concept is established. Certificate usage and policy should be defined in compliance to ATA Spec 42 and ARINC Report 842.

PKI operations should be defined to minimize operator (airline) maintenance and administrative tasks while maintaining adequate security.

3.2.5 PDP Contexts

The SwiftBroadband system uses the well-established concept of PDP contexts as defined in the 3GPP system. A PDP context is a virtual bidirectional data pipe that is established by negotiation between the channel card in the AES and the BGAN core network. Multiple PDP contexts (up to 11) can be established over the same radio bearer. This mechanism allows transmission of separated streams of data over a single radio bearer.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

At the time of establishing a PDP context, a PDP context identifier is agreed between the AES and the core network. A header, which is added to transmitted data packets, contains this PDP context header allowing the data to be routed correctly at the receiving end. Each PDP context is associated with an Access Point Name (APN) on the ground. Each PDP context is also allocated a priority level. This association between a PDP context identifier and an APN and a priority level exists for the duration of the PDP context.

PDP contexts can be created, modified, or destroyed as required at any time. This is normally done by a controller instructing the channel card in the AES. The channel card then negotiates the PDP context with the ground and reports back.

In an AES terminal, the ACD processor should set up the required PDP contexts for the VPN (for the carriage of ACARS messages) and AISD IP data as soon as the channel card has connected to the SwiftBroadband network. The APN for the ACARS PDP context routes to the GSGW. The ACD processor also associates this PDP context with the ASGW internally. In this way, one PDP context with the correct priority level forms a virtual data pipe between the ASGW and GSGW. This association should remain for as long as the terminal is connected to the SwiftBroadband network for the purposes of providing safety services.

Similarly, a durable association with a PDP context is set up connecting the AISD processor to an appropriate APN which provides connectivity to the internet.

The primary (AMBE+2) voice channel is handled by special provision in the BGAN network without the need to set up a PDP context. A secondary voice channel uses VoIP, however, for which a special PDP context is created by the ACD processor.

For the sake of network security, the ACD processor should manage the setup, modification, and destruction of all PDP contexts on the channel card.

The control of the channel card, particularly the setup of PDP contexts, should be robust. A robust bi-directional link between the ACD processor and the channel card should be used for the purpose. The creation of a PDP context should be confirmed by the channel card. The PDP context identifier agreed between the channel card and the RAN (as described in the Inmarsat SDM) should be passed to the ACD processor. This identifier should be used in the headers to identify the context used for data packets in both directions. For this reason, the ACD processor should also notify the data arbitration function of the PDP context identifier for the AISD.

3.2.6 PPPoE/Telnet Control

External equipment using the priority IP Interface may be used to control the creation and properties of IP contexts by the channel card, utilizing the protocol described in Attachment 5. In the case of an SB200 safety services terminal, it is important that the PPPoE/Telnet messaging is handled in the ACD processor, and such messages are not passed to the channel card for interpretation. The ACD processor should then control the channel card, typically using a proprietary interface and protocol.

This mechanism allows the ACD processor to moderate the control of PDP contexts. In particular, the ACD processor should prevent the external equipment from affecting PDP contexts which the external equipment did not create, such as the context used for ACARS. In addition, only trusted equipment in the ACD should be allowed to have PPPoE/Telnet control over PDP contexts.

If the external equipment does not specifically require PPPoE/Telnet control over PDP contexts, the ACD processor may be configured to set up a background context

ATTACHMENT 8

NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

for the priority IP port automatically (as it does for the AISD). PPPoE/Telnet control may be disabled in this case. To make provision for different avionics equipment connected to the priority IP port, the following options should be configurable in the Secure ORT:

- Create a default background context for the priority IP port (enable/disable, and PDP context parameters).
- Allow PPPoE/Telnet control over the priority IP port (enable/disable).

3.2.7 Aircraft Datalink Gateway (ADGW)

This gateway receives one ACARS message at a time from the CMU/CMF. The ADGW wraps ACARS messages into UDP packets as described in the Inmarsat SDM. It exchanges packets directly with the GDGW, handling all the necessary protocol, including keep-alive messages and position reporting.

3.2.8 Data Loading

ARINC 615A data loading is performed only through a port of the ACD processor. Software part integrity is assumed to be assured by functions and processes external to the SDU (such as the central data loading computer verifying the software image before loading it to the SDU). All SDU subsystems, (e.g., ACD processor, AISD processor, data arbitration function, and channel card) should be individually or collectively data loaded through this interface. The ACD processor, in turn, loads other processors in the SDU.

To ensure that data loading can only happen while the aircraft is in maintenance mode and not during operation, data loading capability should be disabled under control of the ACD processor during normal operation. No data flows should, therefore, be possible over the data load lines while the system is in operation. While data loading, all other data flows to the AISD processor should be disabled by hardware logic based on the air-ground state and the data load enable discrete input.

Data loading from the ACD processor to the AISD processor should use one-way open-loop communication only. There should be no data path by which the AISD behavior can influence the ACD processor. The ACD should be robust to any type of data (including acknowledgement) sent from AISD to ACD in the context of dataloading. The AISD processor should not be able to influence the data loaded by the ACD processor.

One possible implementation is for the ACD processor to write directly to the program memory of the AISD processor with the AISD processor having read-only access to this memory.

Out-of-conformity conditions for the loaded software should be detectable and generate a fault when seen.

3.2.9 BITE

The ACD processor reports BITE information to the central maintenance function. For this purpose, the AISD processor reports discrete BITE signals to the ACD processor. The ACD processor reads these discrete signals by polling. No interrupts are involved; therefore, BITE from the AISD processor cannot affect ACD processor operation. In case the BITE information is not sent over discrete signal, the ACD processor should provide a security function to check the format of the BITE information received from the AISD processor in order to ensure that it does not

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

contain any malicious data. If BITE information is sent from other processors to ACD (e.g., channel card and PIESD), an equivalent level of filtering shall be implemented.

3.2.10 Channel Card

The channel card is considered to be a transparent modem. To maintain this transparency, it is required that:

- The channel card should not be able to be compromised by the content of payload data. The channel card should, therefore, not examine the content of payload data.
- There should be no mechanism (e.g., via addressing) by which the channel card can be made to pass data from the AISD processor to the ACD processor.
- The process of examination of packet headers to determine the PDP context of Air-To-Ground packets should be robust. A header, which is malformed or that does not match an established PDP context, should cause the packet to be discarded.
- While it is essential for the channel card to analyze many protocol layers of Ground-To-Air data to satisfy operation of the SBB system, the final payload IP data should not be analyzed by the channel card. Out-of-range or unexpected data within the PDP context identifier should not lead to malfunction of the channel card. Any error during PDP context analysis should lead to discarding of the data packet.
- The channel card should robustly implement the protocol described in the Inmarsat SDM to ensure that Ground-To-Air data received over one PDP context does not get passed on with an incorrect PDP context identifier resulting in the data being routed to the wrong destination by the data arbitration function.
- The channel card, in conjunction with the RAN, should enforce the traffic priority and preemption over the SBB air-interface as specified in the Inmarsat SDM.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

4.0 SECURITY ANALYSIS

After the reference architecture was developed, a condensed security analysis was performed based on the airworthiness security process defined in RTCA DO-326A and EUROCAE ED-202A. This process helps ensure that all potential security threats have been accounted for and that the threats are adequately mitigated when there is a potential safety impact due to a security failure.

An ARINC 811-based analysis was done to aid the system designer. This is published in Appendix B, Security Analysis of the Satcom Ethernet Interfaces. System designers should plan to conduct a full security analysis on their complete design as part of the overall development process.

The process defined in RTCA DO-326A is comprehensive and is intended to cover the end-to-end airplane design process from the airplane level down to the system and item levels. It is intended to align closely with SAE ARP4754A. Because ARINC 781 defines just one system, only a subset of the overall process was used.

At a high level, the analysis process consists of the following steps:

1. Identify the security scope to determine the points of entry to the system.
2. Identify the external threats that can attack those entry points and how they can impact the system.
3. Determine the overall security architecture of the system, including the potential vulnerabilities and any existing mitigations against the threats.
4. Determine security risks for the system, based on impact and likelihood of successful attacks.
5. Identify threat conditions with a non-trivial safety impact, and mitigations that reduce the risks to an acceptable level. Develop additional mitigations as needed to address any remaining unacceptable risks.
6. Identify any external dependencies that contribute to the overall security of the system including operational requirements.

Figure 4 shows the key questions to be answered as part of the security analysis.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

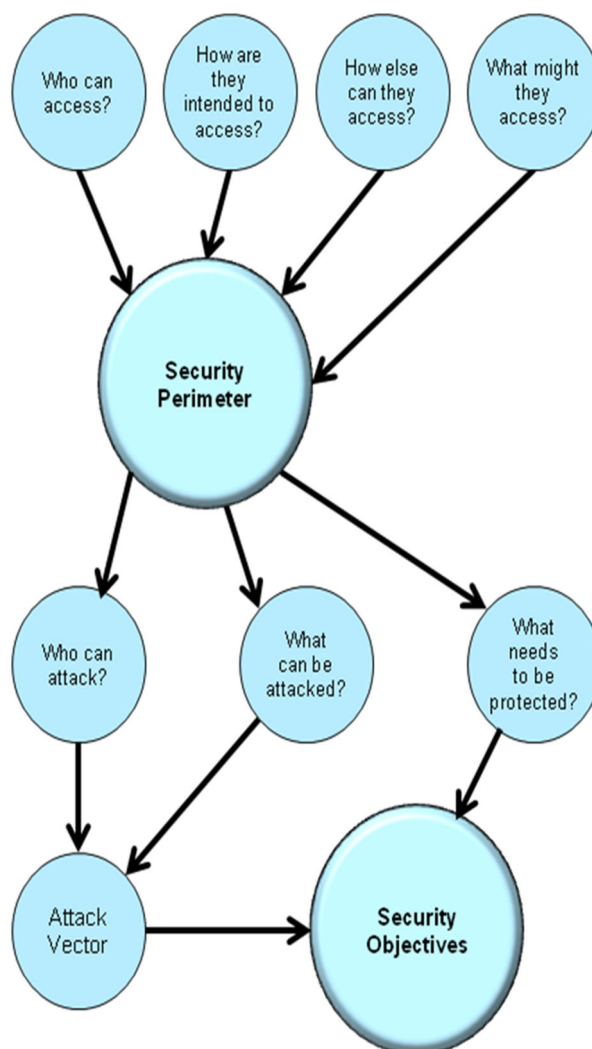


Figure 4 – Security Analysis Questions

The analysis was performed against the reference architecture for a compact SDU described previously in this characteristic.

4.1 Assumptions and Operational Requirements

The assessment is based on the following key operational requirements for the security environment. If these requirements are not met, the security assessment does not apply:

1. Maintenance personnel will follow approved procedures.
This includes MRO personnel.
 - a. The system designer, operator and regulator should agree on a characterization of the likelihood and severity of maintenance personnel errors; including the possibility that malware may be unknowingly carried to the airplane on a maintenance terminal.
2. Flight crews will follow approved procedures.
3. The system designer, operator, and regulator should agree on a characterization of the likelihood and severity of flight crew errors including

ATTACHMENT 8

NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

the possibility that malware may be unknowingly carried to the airplane on a portable crew device such as a tablet.

4. Interfaced systems at higher assurance levels will not serve as a launching point for attacks on the system.
 - a. Higher-assurance systems will not be corrupted by attackers.
 - b. Such systems may also not provide any protection to the SDU if attacks are simply passed through to the SDU, thus, enabling the attack vector. Any such dependencies should be evaluated for each installation.
5. System software is non-malicious and free of intentional flaws.
6. Physical access to the satcom systems controlled to the same degree as physical access to installed on-board electronic systems in general. That is, there are no special access physical control requirements, nor is access control requirements relaxed.
7. Airline procedures are adequate to record satcom maintenance actions.
8. The security requirements of the ground infrastructure and satellite network are outside the scope of this document.

4.2 Security Design Guidelines

The developer of the system should adhere to the following guidelines:

1. Ensure by design EICAS/FWS, ADL, CMC, and MCDU cannot receive any data from the ground
2. Ensure all traffic from EFB to ACD is blocked on the Data Arbitrator
3. Ensure EFB cannot send any traffic to ACD through any other management link like BITE or data loading link
4. Provide partitioning to ensure segregation and non-bypassability of security functions in ACD and non-ACD processors
5. Ensure partition segregation by applying strict filtering between partitions
6. Ensure only air-side is enabled to initiate the setup of communications at network level (PDP and VPN)
7. Provide network filtering on Data Arbitrator, as well as on ACD and non-ACD processors
8. Ensure protection against flooding attacks from an EFB and from the ground on the Data Arbitrator, as well as on ACD and non-ACD processors
9. Ensure the integrity of security files and binaries on Data Arbitrator, as well as on ACD and non-ACD domain processors
10. Provide a security function to filter all management flows from non-ACD to the ACD processors on an applicative level (e.g., BITE data)
11. Provide provision in terms of resources in order to support cryptographic algorithms updates throughout the aircraft lifecycle
12. Ensure a fail secure behavior
13. Ensure robustness to network malformed inputs
14. Ensure vulnerabilities are monitored throughout time and that their impact is assessed
15. Ensure critical vulnerabilities are patched as soon as possible
16. Protect all credentials used for Air-To-Ground integrity and authentication of data

ATTACHMENT 8 NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

17. Provide security logging capabilities
18. Ensure memory protection and space segregation (such as Memory Management Unit (MMU))
19. Avoid Direct Memory Access (DMA) from untrusted interfaces
20. Shutdown external interfaces during data loading mode
21. Least privilege principle on all security files
22. Forbid any writing on critical security binaries and files except during data loading mode
23. Ensure by design that no single vulnerability can lead to a bypass of the aforementioned security properties
24. Ensure by design that if the rear panel interface is used for data loading that data loading will not be possible from a front face plug interface
25. Ensure that the SDU Channel acts as much as possible as a transparent modem by robust PDP context processing to demonstrate that the channel card cannot be corrupted by any malformed/spurious PDP context information

4.3 Security Scope

The security scope of a system is defined by the security perimeter, hardware, software, data assets requiring protection, and the external dependencies that define additional security measures to be provided by external systems or entities. The security perimeter is comprised of the external network interfaces and data flows that may expose the system to attack.

For the CSDU, the security perimeter is enumerated below.

4.3.1 Interfaces

All interfaces on the SDU system should be treated as part of the security perimeter since they are potential attack vectors.

Network interfaces on CSDU:

1. Interface to cockpit phone
2. ARINC 429 or ARINC 664 interface to ACARS application system, e.g., CMU
3. Ethernet interface for Priority IP service (bandwidth management)
4. Ethernet or ARINC 429 data loading interfaces
5. Two Ethernet interfaces for EFBs
6. ARINC 429 interfaces to RF subsystems (HF and VHF)
7. Multiple read-only ARINC 429 bus inputs for ADIRS, WOW, etc.
8. BITE and data load paths are considered in the analysis
9. SDU Crosstalk Interface using Ethernet or ARINC 429 interfaces

Multi-channel SDUs will have additional Ethernet interfaces to cabin (AISD) and Passenger Information and Entertainment Services Domain (PIESD) systems. These interfaces should be included in the analysis. However, it is noted that it is not possible to attack ACD or AISD from PIESD via the normal data path since a channel card cannot be made to communicate with another channel card (via the RF splitter/combiner). Only the BITE and data load paths are considered in the analysis.

ATTACHMENT 8

NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

Also, if ARINC 664 (deterministic Ethernet) is used for any interfaces, it would likely be used instead of the standard Ethernet interfaces (i.e., an aircraft network would likely use either deterministic Ethernet or regular Ethernet, but not both side-by-side).

4.3.2 Assets

The assets characterize the system well enough to identify the potential targets of attack. Assets include functions, data, and resources that are associated with airworthiness or airworthiness security. These are the components of the system that, if attacked, will cause an adverse effect on aircraft safety. For purposes of this analysis, we are focused on the safety services to be carried over the SBB network as they are managed by the SDU system on the airplane.

1. ACARS messages containing ATS or Aeronautical Operational Communications (AOC) messages
2. Cockpit voice calls, either circuit-switched or packet-switched (VoIP)
3. IP data to or from the cockpit (*future use, not analyzed here*)
4. ORT-based configuration data for the SDU
5. System software
6. The data arbitration function (listed separately due to its importance to the security of the system)
7. Universal Subscriber Identity Module (USIM) (which operates on the UICC within the SCM)
8. Security Smart Card
9. PPPoE client software hosted on external system
10. Data loading functions and controls (e.g., WOW input, manual analog switch inputs)
11. BITE reporting
12. Security functions
13. Interfaces to systems, such as CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU

EFBs, other cabin systems, and passenger data are excluded from this analysis because, they are either under protection of systems external to the SDU, has no safety impact, or both. Also, specifically excluded are the ground systems communicating with the airborne equipment; ground systems are treated as external dependencies.

4.3.3 External Dependencies

External dependencies are elements, functions, systems, or processes that contribute to the overall security of the system under analysis but are outside the perimeter of the system. For the SDU, these include:

1. Inmarsat ground station systems

Ground station systems should adhere to aviation industry best practices for mission critical IT systems, for example, the U.S. National Institute of Standards and Technology (NIST) risk management framework, which is used by the FAA for security evaluation of Comm/Nav/Surveillance ground systems. Specific control measures should include, but are not limited to:

ATTACHMENT 8 NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

- Systems should be audited on a regular basis for adherence to a documented security policy.
- Firewall configurations should be audited regularly for correctness.
- Security monitoring systems should be used to provide real-time detection of malware and intrusion attempts.
- Unauthorized connections initiated from the ground to the airplane should be strictly controlled.
- User and administrative accounts should be regularly reviewed for correct authorizations.
- Workstations used for general Internet access should be network-segregated from the core critical systems supporting the airplanes.
- All logins should require strong authentication.

Identified deficiencies may require re-evaluation of the airborne side security analysis.

2. Data loaders and portable maintenance terminals

Airlines and MROs should have processes in place to ensure that data loaders and maintenance terminals do not become infected with malware and are access-restricted to authorized and licensed maintenance personnel only.

3. In-flight Entertainment (IFE) systems

In a multi-channel system providing passenger Internet access, the IFE system should provide packet filtering that limits attacks from PIEDS that are directed at the SDU.

4.4 Identification of Threats

This part of the analysis consists of developing the threat conditions, threat scenarios, and security objectives as part of the preliminary security risk assessment.

4.4.1 Threat Conditions

A threat condition results when safety of the aircraft is adversely affected due to a security failure (i.e., a successful attack executed by a threat). Four main threat conditions are identified for SBB safety services:

1. Undetected corruption of FANS messages (includes spoofing), i.e., loss of integrity
2. Loss of availability of FANS messages
3. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.)
4. Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)

In addition, the following threat condition should also be considered:

5. Loss of availability/integrity of AISD

4.4.2 Applicable Attack Path

Here below are some applicable attack types that needs to be considered in the context of the SDU security analysis:

ATTACHMENT 8 NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

1. ACARS masquerade attack (attack on integrity of ACARS data)
2. SDU vulnerability exploitation
3. Installation of specific malicious code on SDU
4. Installation of COTS malicious code on SDU
5. Denial of service attacks (includes flooding attacks)

4.4.3 Initial Threat Scenarios

The initial threat scenario assessment laid out all the elements necessary for an attack to be successful and cause an impact to aircraft safety. These scenarios involve threats to the ACD where safety services could be affected. Refer to Table 4-1 for references to the threats based on interfaces. These threats should be refined in discussions with the airframe manufacturers based on the specific system architecture.

The following figure illustrates the interfaces referenced in the threat scenarios.

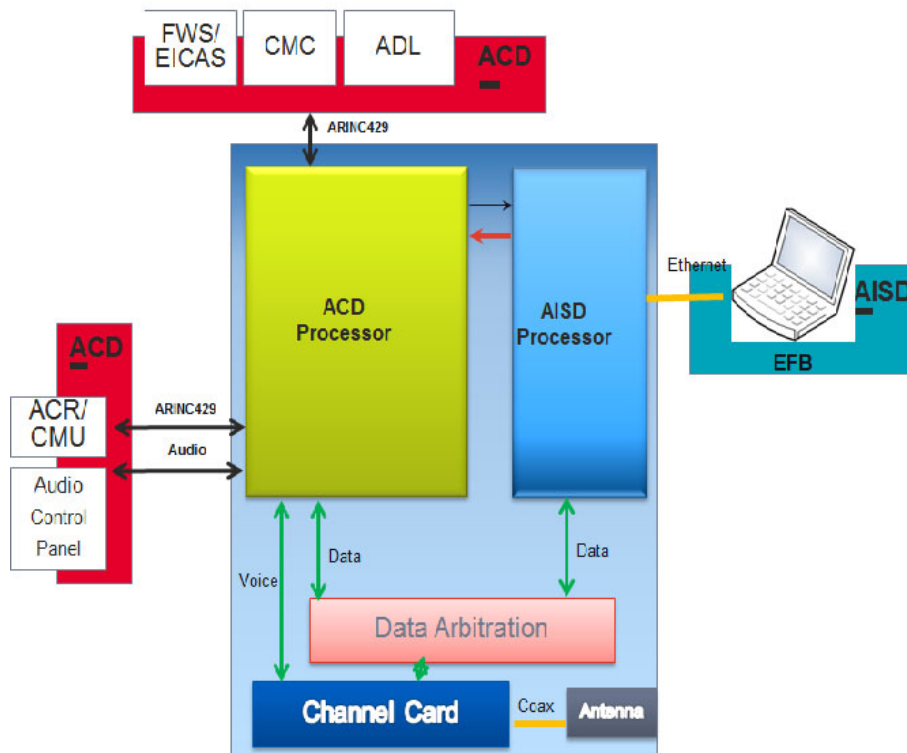


Figure 5 – Initial Reference Design

A security barrier, as defined in the table below, is a security function positioned between a threat source and an asset to protect the asset from being harmed by the threat source. A security barrier can consist of one or more security measures as defined in RTCA DO-326A/ED-202A.

1. Undetected corruption of FANS messages (includes spoofing), i.e., loss of integrity
2. Loss of availability of FANS messages

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

3. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.)
4. Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)

In addition, the following threat condition should also be considered:

5. Loss of availability/integrity of AISD

Table 4-1 – Initial Threat Scenarios

Scenario	Attack Path	Number of Required Security Barriers	Threat Condition(s)
Threat Scenario 1	Aircraft AISD to ACD CMU through satcom AISD and ACD parts	One	1. Undetected corruption of FANS messages (includes spoofing), i.e., loss of integrity 2. Loss of availability of FANS messages 3. Loss of availability of avionics assets (CMU) 4. Loss of integrity of avionics assets (CMU)
Threat Scenario 2	Aircraft AISD to ACD EICAS/FWS, ADL, CMC through satcom AISD and ACD parts	Two	1. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.) 2. Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)
Threat Scenario 3	Ground network to ACD ACR through satcom ACD part	One	1. Undetected corruption of FANS messages (includes spoofing), i.e., loss of integrity 2. Loss of availability of FANS messages 3. Loss of availability of avionics assets (CMU) 4. Loss of integrity of avionics assets (CMU)

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

Scenario	Attack Path	Number of Required Security Barriers	Threat Condition(s)
Threat Scenario 4	Ground network to ACD EICAS/FWS, ADL, CMC through satcom ACD part	Two	1. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.) 2. Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)
Threat Scenario 5	Ground network to ACD ACR through satcom AISD part	One	1. Undetected corruption of FANS messages (includes spoofing), i.e., loss of integrity 2. Loss of availability of FANS messages 3. Loss of availability of avionics assets (CMU) 4. Loss of integrity of avionics assets (CMU)
Threat Scenario 6	Ground network to ACD EICAS/FWS, ADL, CMC through satcom AISD part	Two	1. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.) 2. Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)
Threat Scenario 7	Aircraft AISD to ACD EICAS/FWS, ADL, CMC through satcom AISD part, Data arbitration and ACD parts	Two	1. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.) 2. Loss of integrity of avionics assets (CMU, EICAS/FWS,

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

Scenario	Attack Path	Number of Required Security Barriers	Threat Condition(s)
			ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)
Threat Scenario 8	Aircraft AISD to ACD AMU/ACR through satcom AISD part, Data arbitration and ACD parts	One	1. Undetected corruption of FANS messages (includes spoofing), i.e., loss of integrity 2. Loss of availability of FANS messages 3. Loss of availability of avionics assets (CMU) 4. Loss of integrity of avionics assets (CMU)
Threat Scenario 9	Aircraft AISD to ACD EICAS/FWS, ADL, CMC through satcom AISD part, Data arbitration, Channel Card and ACD parts	Two	1. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.) 2. Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)
Threat Scenario 10	Aircraft AISD to ACD AMU/ACR through satcom AISD part, Data arbitration, Channel Card and ACD parts	One	1. Undetected corruption of FANS messages (includes spoofing), i.e., loss of integrity 2. Loss of availability of FANS messages 3. Loss of availability of avionics assets (CMU) 4. Loss of integrity of avionics assets (CMU)

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

Scenario	Attack Path	Number of Required Security Barriers	Threat Condition(s)
Threat Scenario 11	From Radio Access Network through a rogue antenna to ACD EICAS/FWS, ADL, CMC through Inmarsat SBB satcom ACD part	Two	1. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.) 2. Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)
Threat Scenario 12	From Radio Access Network through a rogue antenna to ACD EICAS/FWS, ADL, CMC through Inmarsat SBB satcom AISD part	Two	1. Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDU, etc.) 2. Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, FMS/MCDUs, etc.)
Threat Scenario 13	From Radio Access Network through a rogue antenna to ACD EICAS/FWS, ADL, CMC through ACD ACR through Inmarsat SBB satcom ACD part	One	1. Undetected corruption of FANS messages (includes spoofing), i.e., loss of integrity 2. Loss of availability of FANS messages 3. Loss of availability of avionics assets (CMU) 4. Loss of integrity of avionics assets (CMU)

4.5 Validation of the Security Architecture

This step demonstrates that the design requirements (as expressed in the reference architecture in this document) will meet the security objectives. An adequate design will possess certain soundness properties that support its ability to meet the objectives. Each property below is followed by the architectural elements from the reference architecture that supports it. (excerpted from RTCA DO-326).

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

- The architecture does not allow its security countermeasures to be bypassed, and the countermeasures will always be invoked when they are intended to be invoked.
 - The data arbitration function resides in the main data path to control all data transmissions. It cannot be bypassed. For other design approaches (e.g., an ARINC 653-compliant operating system), the designer should ensure the same level of control is achieved.
- The architecture does not allow the security countermeasures to be tampered with.
 - The data arbitration function does not act on the contents of packets from the EFB/AISD side, and it is not network-addressable. Therefore, an attacker is not able to modify the operation of this function.
- The security countermeasures do not interfere with each other except as intended.
 - The primary countermeasures are distinct from each other and should not present interference issues in an implementation.
- The architecture provides restorative means for establishing (or re-establishing) the correct configuration of the architecture.
 - A requirement for software conformity-checking enables alerting of a mechanic to reload the SDU software.

4.6 Impact Classification of Threat Conditions

The impact of all applicable threat conditions should be evaluated under RTCA DO-326A/EUROCAE ED-202A to ensure that requirements are met based on the system architecture.

4.7 Likelihood Assessment

The likelihood of all applicable threat conditions should be evaluated under RTCA DO-326A/EUROCAE ED-202A to ensure that requirements are met based on the system architecture.

4.7.1 Risk Mitigation

Once the risk has been evaluated under RTCA DO-326A/EUROCAE ED-202A, the appropriate security measure should be proposed to mitigate the risk.

For multi-channel SDUs, including those providing passenger access off-board, physical channel card segregation provides the necessary partitioning and attack prevention. The IFE system is treated as an external dependency that provides some measure of packet filtering on passenger traffic to limit attacks on the SDU.

For Security measures, it is adequate to define the functional requirements needed to prevent the attacks in the threat source profiles, and then conduct verification and vulnerability testing against the actual implemented system to ensure that the requirements have been met. This should also include robustness testing against denial of service attacks.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

5.0 CONSIDERATIONS FOR MULTI-CHANNEL SWIFTBROADBAND SYSTEMS

In order to provide maximum leverage of the SB200 design work and reduce development costs, the reference design for a multi-channel system uses the core SB200 design and adds channel cards as needed to support additional lower-assurance cabin and passenger applications (e.g., in-flight Internet access).

For sake of completeness, three configurations of multi-channel AES equipment have been identified, and are described in the following paragraphs. These configurations are aimed at addressing network security concerns.

In all three configurations, the common resources (e.g., HPA and antenna) are controlled by the ACD processor. Priority should always be given to safety services in the allocation of these resources.

In all three configurations, the domains are segregated from each other by using separate processors for each domain, with no shared memory. Other methods may be possible (e.g., an ARINC 653 operating system providing segregation), but alternative solutions should achieve a similar level of segregation and robustness.

In addition, the safe BITE and data loading principles, as described for the SB200 system, should be used.

The configurations shown below assume the use of multiple channel cards, where each channel card provides a single SBB channel. Manufacturers may wish to employ channel cards which can provide multiple SBB channels, provided segregation is maintained where necessary. For example a multi-channel capable card may not need to meet any segregation requirement if all the channels are used for PIESD. If, however, a multi-channel card is to be used for data belonging to separate network domains (ACD/AISD/PIESD), it should provide segregation equivalent to that provided by using separate channels cards for each network domain.

Configuration 1:

Configuration 1, shown in Figure 6, uses a single-channel card for all cockpit communications (ACD and AISD) using the architecture described above for SB200. The other (one to three) channel cards may then be used for cabin communications services (PIES).

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

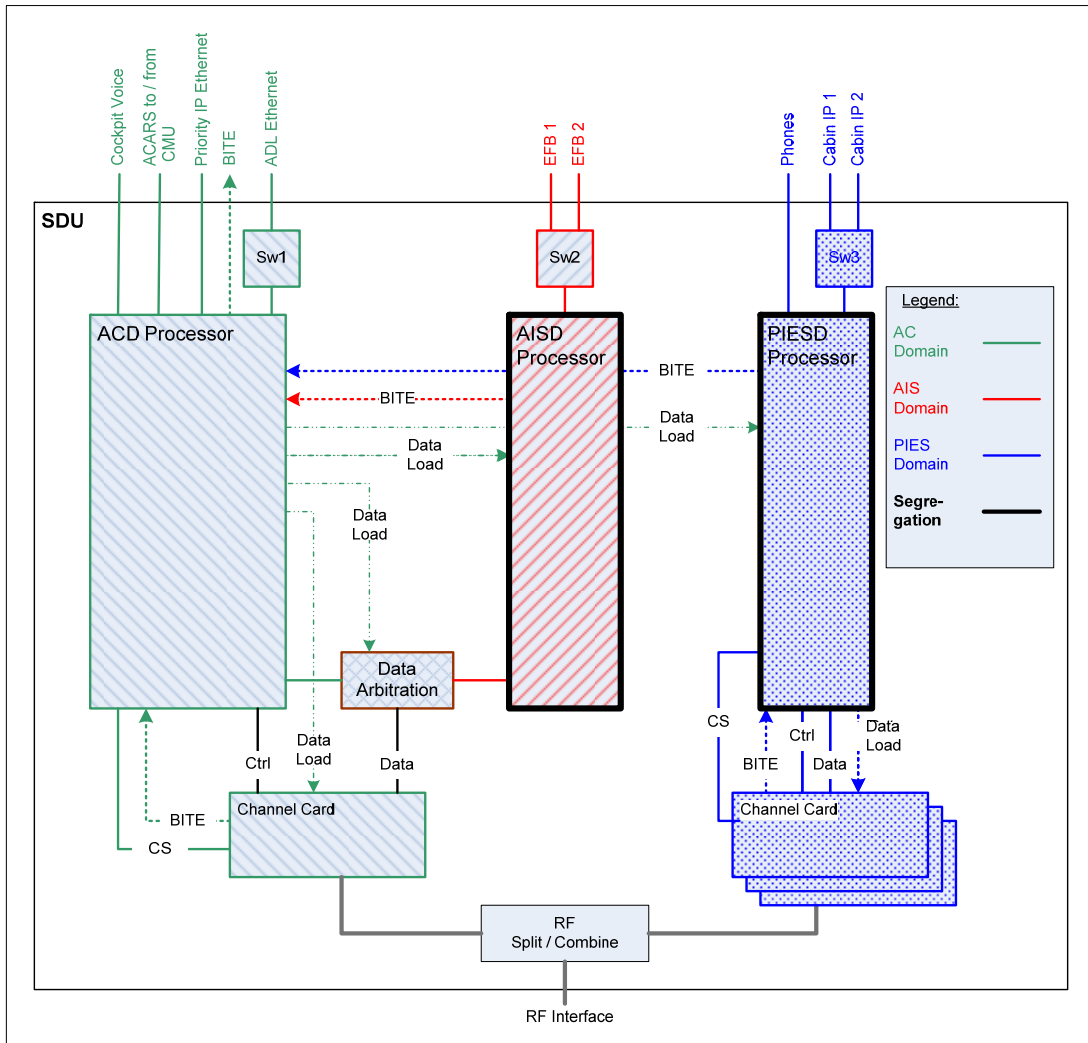


Figure 6 – Multi-Channel System Configuration 1

Configuration 2:

Configuration 2, shown in Figure 7, uses separate channel cards for each domain. The ACD uses one channel card, the AISD uses one channel card, and the PIESD uses the remaining one or two channel cards.

ATTACHMENT 8 NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

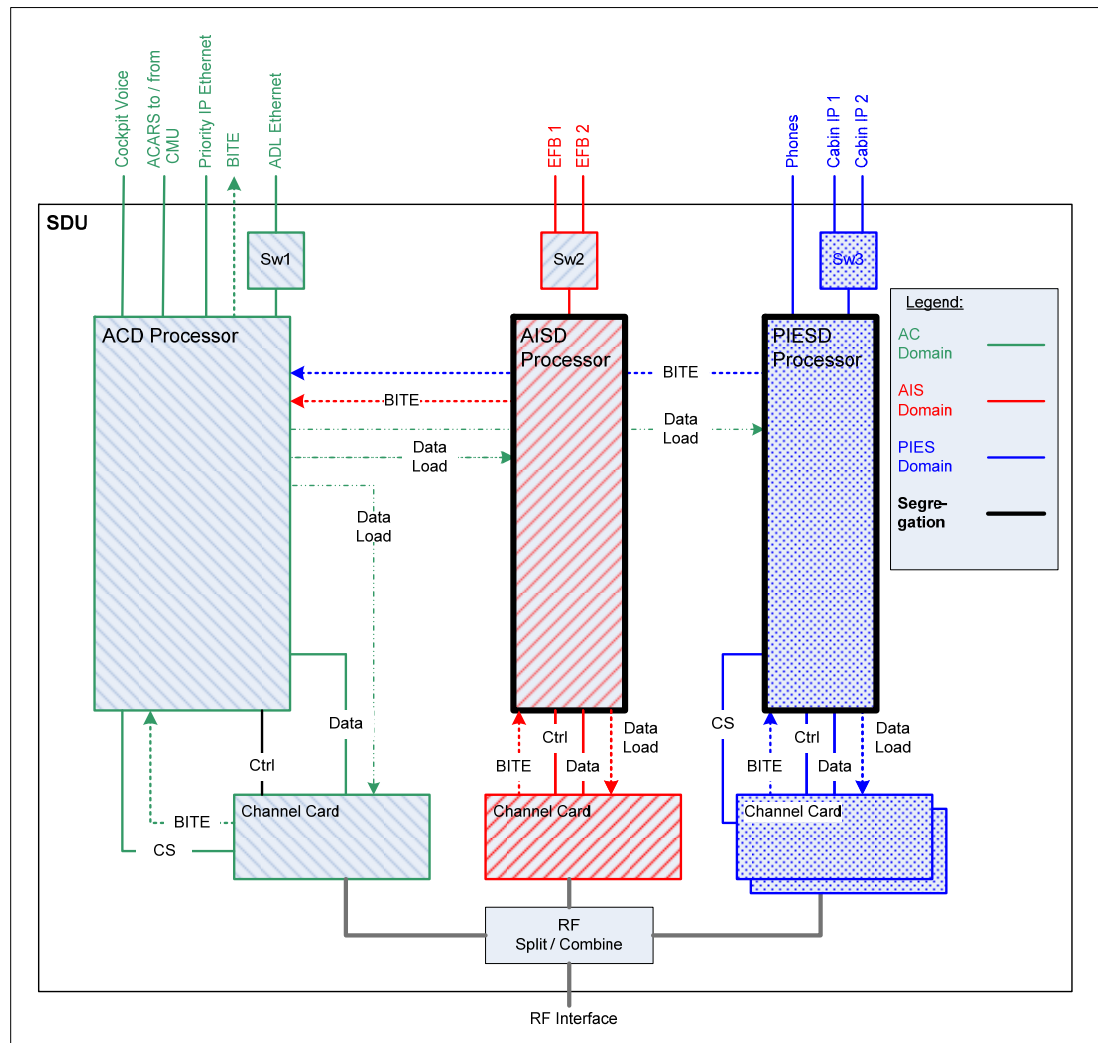


Figure 7 – Multi-Channel System Configuration 2

Configuration 3:

Configuration 3, shown in Figure 8, allocates one channel for ACD use and is segregated from the other two domains. The AISD and PIESD share the remaining channel cards. Segregation between the AISD and the PIESD is achieved by a specialized Ethernet switch designed to provide protection to the AISD, either internal or external to the SDU. The design of this switch is beyond the scope of this document.

ATTACHMENT 8
NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

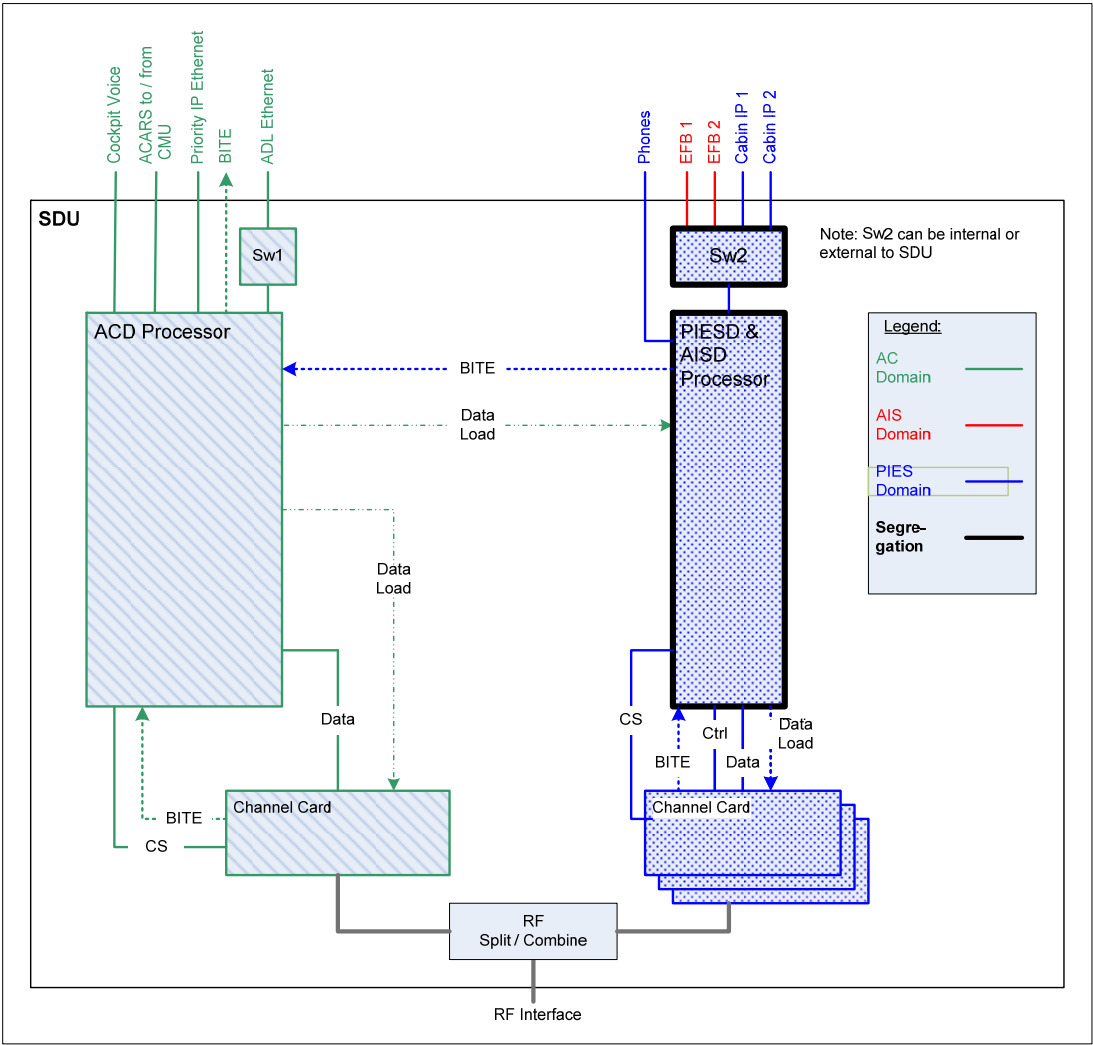


Figure 8 – Multi-Channel System Configuration 3

**ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA**

ATTACHMENT 9 ATCT AND LTE RESILIENT DLNA

9.1 Introduction

Additional interferers continue to be added to the spectrum environment that are expected to impact the functionality of the Inmarsat L Band Satcom System. These interferers are:

- Ancillary Terrestrial Component (ATCt) – In Band Interferer
- Long Term Evolution (LTE) Interferers below 1517 MHz – Out of Band Interferer (Note: alternative IMT technologies may be used in the future)

The purpose of this attachment is to define these interferers and to specify five DLNA solutions to protect both existing fielded Inmarsat L Band Satcom Systems as well as future installations.

A secondary purpose of this attachment is to provide guidance to installers on which DLNA should be selected for their application/installation.

9.1.1 Ancillary Terrestrial Component (ATCt)

In 2003, the Federal Communications Commission (FCC) authorized the use of spectrum in the ranges of 1525 to 1559 MHz and 1626.5 to 1660.5 MHz for Ancillary Terrestrial Component (ATCt), a wireless terrestrial service designed to operate in an integrated fashion with Mobile Satellite Services (MSS). This frequency band overlaps that used to provide both Classic Aero AMS(R)S/AMSS and SwiftBroadband-based AMS(R)S/AMSS, thereby creating the potential for co-channel and adjacent channel interference to these services in North American airspace.

The FCC set limits on ATCt to protect aeronautical communications. The FCC's ATCt licensee entered into a coordination agreement with Inmarsat that includes further limits on co-channel and adjacent channel operations. On December 31, 2015, the ATCt Licensee, Ligado, filed a new application to the FCC with a revised proposal for spectrum usage. This proposal limited the spectrum to the band of 1526 to 1536 MHz with additional reductions in total interferer power levels.

As of the publication of this standard, the FCC had yet to rule on this application, and consequently, ATCt services are not operational in the USA. Once the FCC rules, initial ATCt services could be rolled rapidly and hence cause interference to satcom terminals.

As of the publication of this standard, there are no immediate plans for ATCt deployment outside of the USA.

The calculated interferer power level that the DLNA is expected to protect against is -35.5 dBm based upon system level analysis performed in RTCA DO-343.

9.1.2 LTE Interferers below 1517 MHz

LTE is a mobile/cellular communications standard for high-speed wireless communication for mobile devices and data terminals. In this context, it is the mobile RF band 1452 to 1517 MHz which is immediately below the band used by Inmarsat satcom terminals.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

The International Telecommunication Union (ITU) WRC-15 assigned globally the band 1492 to 1518 MHz for use for IMT (LTE). In the USA, this band is used for aeronautical telemetry and hence LTE is unlikely to be deployed in the USA in this band. ITU-R instructed compatibility studies to be conducted between IMT/LTE operating below 1518 MHz and mobile satcom systems operating above 1518 MHz.

Within Europe, CEPT's ECC (Electronic Communications Committee) published ECC Report 263 on adjacent band compatibility of IMT operating in the frequency band 1492 to 1518 MHz and the MSS operating in the frequency band 1518 to 1525 MHz. The study concluded on the need for the minimum in-band blocking characteristic for land mobile earth station receivers operating above 1520 MHz from a 5 MHz broadband signal interferer (LTE) operating below 1517 MHz to be -30 dBm. ECC published report ECC 299 titled "Measures to Address Potential Blocking of MES Operating in Bands Adjacent to 1518 MHz (including 1525 to 1559 MHz) at Sea Ports and Airports." This report suggests LTE deployed near airports will initially have a lower RF power level that is compatible with existing aeronautical satcom installations. Then, after a transition period, a higher RF level compatible with new DLNAs described in this attachment will be deployed. The transition period is expected to be set on a country-by-country basis. In April 2018, the European Commission issued Implementing Decision 2018/661 to authorize this band within the European Union (EU).

Deployment in Europe and elsewhere in the world is expected in the early 2020s. Transition periods where lower RF power is used near airports are expected to be decided on a country by country basis by each country's spectrum regulator.

9.1.3 Overview of DLNA Options

Based on measurements, it is expected that some SDU/DLNA combinations will be sufficiently resilient to LTE only interference. For others, or if ATCt resilience is needed, new DLNAs will be required.

Based on the need to provide resilience to ATCt and LTE interferers, this attachment describes the following Diplexer/Low-Noise Amplifiers (DLNA) that provide resilience to high-power Long Term Evolution (LTE) and/or Ancillary Terrestrial Component (ATCt) interfering RF signals. Any of the DLNAs in this attachment should protect any legacy AES installation but prospective purchasers of DLNA should consult with their AES integrator for confirmation.

The appropriate DLNA depends on whether resilience is needed to LTE or to LTE and ATCt, and whether service is required for Classic Aero or SBB satcom operation.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

Key characteristics of each DLNA Type are shown in the Table 1 below:

Table 1 – Key DLNA Characteristics for the Protection of ATCt and LTE Interferers

DLNA Type	Resilient to LTE	Resilient to ATCt	Supports Classic Aero	Supports SBB	Tx Band (MHz)	Rx Band (MHz)	Form Factor
Existing DLNAs - for reference							
Type A			X		1626.5-1660.5	1530-1559	Type A
Modified Type A			X	X [1]	1626.5-1660.5	1525-1559	Mod Type A
Type F			X	X	1626.5-1660.5	1525-1559	Type F
New resilient DLNAs							
Type A-LTE	X		X		1626.5-1660.5	1530-1559	Type A
Modified Type A – LTE	X		X	X [1]	1626.5-1660.5	1525-1559	Mod Type A
Type F-LTE	X		X	X	1626.5-1660.5	1525-1559	Type F
Type H	X	X	X		1639.5-1660.5	1538-1559	Type F
Type J	X	X	X	X	1626.5-1660.5	1538-1559 & 1525-1559	Type F

Notes:

1. These DLNAs only support SBB if the associated HPA has sufficiently low intermodulation distortion levels to meet system requirements to protect Iridium satellites.
2. Only a handful of Type D DLNAs were produced and are therefore not included in the table.

Type F DLNAs are described in Section 2.2.4 of ARINC 781 together with a history of the development of DLNAs. Type A and Modified Type A are described in ARINC 741 Part 1. None of these DLNAs provide resilience to LTE or ATCt interference.

The Type A-LTE, Mod Type A-LTE, and Type F-LTE DLNAs have been defined specifically for legacy installations that may operate in the presence of LTE interferers but will not enter North American airspace when ATCt is deployed. These DLNA alternatives facilitate the removal of existing Type A, modified Type A, and Type F DLNAs for return to their manufacturer for upgrade to the ‘-LTE’ variants. Alternatively, if desirable, new DLNAs may be installed. Clear guidance should be provided to users that installing these DLNA variants will protect the satcom system against LTE interferers, but not ATCt interferers.

The Type H DLNA has a fixed filter and only supports a reduced bandwidth and hence is only suitable for Classic Aero installations.

The Type J DLNA has a switchable filter. Three mechanisms to control it are described in Section 9.3.5.3: Autosense, pulsed discrete, and ARINC 429 multi-control bus. On a particular aircraft, only one of these would be used.

All the new DLNAs above have the same fixing holes, connectors, and form factors as existing ARINC 741/781 DLNAs.

The pinouts of the DLNAs are the same as existing ARINC 741/781 DLNAs except that the Type J has, in addition, an ARINC 429 receive port.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

All the DLNAs use the existing wiring in aircraft (e.g., as for a Type A, modified Type A, or Type F), except for the Type J DLNA when “ARINC 429 multi-control bus” is used for commanding the DLNA filter. In this case, an additional ARINC 429 wire pair needs to be installed on the aircraft.

An accompanying SDU software change is only needed when a Type J is fitted and pulsed discrete or ARINC 429 multi-control bus is used. A Type J DLNA using Autosense does not require an SDU software change.

Consequently, LTE and ATCt resilience can be achieved on aircraft using existing DLNAs (Type A, Modified Type A, Type F as specified in ARINC Characteristic 741 and ARINC Characteristic 781) by installing a new DLNA without changing wiring or other equipment. The exception to this is rule is when the Type J DLNA is installed and Autosense is not used to control the DLNA.

9.2 Guidance to Airlines and Installers

General advice is provided herein. Airlines should consult with their airframer, satcom avionics, satcom antenna, satcom DLNA suppliers, service provider, and AES provider for specific advice on whether their installation requires changing, and if so, how, including provision of STCs or Service Bulletins.

For aircraft that do not use a Type A, Modified Type A, or Type F DLNA, please refer to your satcom avionics and antenna provider for guidance.

There are two interfering systems: ATCt (Ligado) and LTE. ATCt is an in-band interferer (1526 to 1536 MHz), whilst LTE is an out of band interferer (1452-1517 MHz).

LTE implementation is expected by the early 2020s, but licenses from spectrum regulators in many cases may provide a transition period where initially lower RF power levels are used near airports and these RF power levels are compatible with existing satcom installations.

LTE (in the 1452 to 1517 MHz band) is not expected to be deployed in the USA as the band is used for aeronautical telemetry.

ATCt deployment is dependent on authorization by the FCC. Ligado’s most recent proposals were made in mid-2018. As of the publication of this standard was published, the FCC has yet to rule on this proposal, and consequently, ATCt services are not operational in the USA. If the FCC approves, initial ATCt services could be rolled out rapidly and hence cause interference to satcom terminals.

Oceanic airspace is the only FAA-controlled airspace where satellite services are currently utilized for AMS(R)S. For applications where AMS(R)S or AMSS is used solely in oceanic airspace, no ATCt specific modifications are required.

As of the publication of this standard, there are no immediate plans for ATCt deployment outside of the USA.

LTE and ATCt interference is primarily, if not exclusively, an issue at airports, and the operations affected for the airline are pre-departure checks by flight crew and maintenance.

Hence, the airline needs to determine (1) what satcom capability is wanted at which airports for which aircraft and (2) what telecom licenses have been

**ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA**

issued at those airports, including if transition periods have been mandated and plans by network operators to deploy. This will determine what diplexer is most appropriate per aircraft and when they need to be fitted.

In existing aircraft, both the DLNA and SDU (and RFU if fitted) are likely to be affected by interference; however, the aircraft installation can be upgraded to be resilient to such interference by changing existing Type A, Modified Type A, Type D, or Type F DLNAs to the new DLNAs as described in this attachment. The SDU (and RFU if fitted) do not need to be modified.

There are a number of diplexer solutions and the choice of solution will primarily depend on whether protection is required for LTE, or LTE and ATCt, and whether only Classic Aero service is required or whether SBB service is required (either on its own or in conjunction with Classic Aero). Please refer to Table 1 of this attachment and the text below.

Where aircraft will not be entering North American airspace, the DLNA installed only requires LTE resilience. In these scenarios, it is possible to incorporate DLNA solutions with built in LTE resilience identified as the Type A – LTE, Modified Type A – LTE, and Type F – LTE.

For those operators who wish to ensure operations in an ATCt environment in North America when on the ground in close proximity to an ATCt base station and including carrying out radio checks at airports, it is recommended to install either a Type H or Type J DLNA, depending on which Inmarsat services are required.

In the case of aircraft installations offering only Aero H/H+ or Aero I service (i.e., no SwiftBroadband service used), a Type H DLNA provides a simple form, fit, and function upgrade path. This DLNA permanently has filtering to protect against ATCt and LTE interferers. No switching of filters or control of the DLNA is required, as the Aero H/H+ and Aero I services are expected to use a limited part of the band, which does not overlap with the interference bands. Such an aircraft with a Type H DLNA installed are suitable for operation anywhere in the world. No wiring or software changes are required.

The Type J DLNA offers the highest flexibility. The Type J DLNA contains an ATCt filter that can be turned on via multiple control mechanisms corresponding to the current planned ATCt deployment. This DLNA also has built in functionality to provide access to the full Inmarsat band when not in the presence of ATCt ground stations in North America by switching out the ATCt filter. The Type J DLNA may be used with any Inmarsat aeronautical service (e.g., Aero H/H+, Aero I, SwiftBroadband).

A Type J DLNA supports three mechanisms for filter selection between a 1525 to 1559 MHz passband and a 1538 to 1559 MHz passband being Autosense, pulsed discrete, and ARINC 429 multi-control bus. On a particular aircraft, only one of these would be used. It is expected that each aircraft installation will select the most appropriate method on a case-by-case basis. Such switching occurs dynamically in flight as the aircraft approaches and leaves areas of ATCt interference. SDU software changes and possibly wiring changes will be needed unless the Autosense control mechanism is used to switch the DLNA's receive band.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

9.3 DLNA Specifications

9.3.1 Type A – LTE DLNA Specification

All Type A – LTE DLNA characteristics remain unchanged from the Type A DLNA, in accordance with ARINC Characteristic 741, Section 2.2.4, except where modified as below.

9.3.1.1 Type A – LTE DLNA Antenna Port to Receive Port (DLNA Output)

The rejection from the antenna-port to the receive port (DLNA output) relative to the 1530 to 1559 MHz passband level when in standard bandwidth mode should be:

Frequency (MHz)			Required Rejection
0.0	to	1497	> 60 dB
1497	to	1512	> 35 dB
1497	to	1512	> 45 dB average [1]
1512	to	1517	> 20 dB
1512	to	1517	> 25 dB average [1]
1626.5	to	1660.5	> 120 dB
1660.5	to	18000.0	> 75 dB

Notes:

1. The requirement is an average rejection across the band where the averaging is applied in terms of linear power as opposed to dB. Both the absolute rejection and the average rejection requirements in a band should be met simultaneously.

9.3.1.2 Spectral Regrowth

For the following interferer cases with power measured at the DLNA antenna port:

Case 1: LTE 1512 to 1517, -30 dBm (source draft ETSI 301/473) with a 5 MHz LTE carrier.

Case 2: LTE 1492 to 1512, -20 dBm (based on 10 dB increase from Case 1) with a 20 MHz LTE carrier.

The Equivalent Noise Figure of the DLNA in any 200 kHz of the receive band should be no more than 2.6 dB in any 200 kHz of passband at 25 °C. At 70 °C, an additional allowance of 0.5 dB is allowed.

Equivalent Noise Figure is defined as $ENF = 10 \log (SNR_i / SINAD_o)$.

Where:

SNR_i is the signal to noise ratio at the input to the DLNA [S/N].

$SINAD_o$ is the signal to noise plus distortion ratio at the output of the DLNA [S/(N+D)].

D is the power of the distortion introduced by the DLNA.

9.3.2 Modified Type A – LTE DLNA Specification

All Modified Type A – LTE DLNA characteristics remain unchanged from the Modified Type A DLNA, in accordance with ARINC 741, Section 2.2.4, except where modified below.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

9.3.2.1 Modified Type A – LTE DLNA Antenna Port to Receive Port (DLNA Output)

The rejection from the antenna-port to the receive port (DLNA output) relative to the 1525 to 1559 MHz passband level when in standard bandwidth mode should be:

Frequency (MHz)			Required Rejection
0.0	to	1450.0	> 75 dB
1450	to	1492	> 65 dB
1492	to	1512	> 35 dB
1492	to	1512	> 45 dB average*
1512	to	1517	> 20 dB
1512	to	1517	> 25 dB average*
1626.5	to	1660.5	> 120 dB
1660.5	to	18000.0	> 75 dB

* The requirement is an average rejection across the band where the averaging is applied in terms of linear power as opposed to dB. Both the absolute rejection and the average rejection requirements in a band should be met simultaneously.

9.3.2.2 Spectral Regrowth

For the following interferer cases with power measured at the DLNA antenna port:

Case 1: LTE 1512-1517, -30 dBm (source draft ETSI 301/473) with a 5 MHz LTE carrier.

Case 2: LTE 1492-1512, -20 dBm (based on 10 dB increase from Case 1) with a 20 MHz LTE carrier.

The Equivalent Noise Figure of the DLNA in any 200 kHz of the receive band should be no more than 2.6 dB in any 200 kHz of passband at 25 °C. At 70 °C, an additional allowance of 0.5 dB is allowed.

Equivalent Noise Figure is defined as $ENF = 10 \log (SNR_i/SINAD_o)$.

Where:

SNR_i is the signal to noise ratio at the input to the DLNA [S/N].

$SINAD_o$ is the signal to noise plus distortion ratio at the output of the DLNA [S/(N+D)].

D is the power of the distortion introduced by the DLNA.

9.3.3 Type F – LTE DLNA Specification

All Type F – LTE DLNA characteristics remain unchanged from the Type F DLNA, in accordance with Section 2.2.4, except where modified below.

9.3.3.1 Type F – LTE DLNA Antenna Port to Receive Port (DLNA Output)

The rejection from the antenna-port to the receive port (DLNA output) relative to the 1525 to 1559 MHz passband level when in standard bandwidth mode should be:

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

Frequency (MHz)			Required Rejection
0.0	to	1450.0	> 75 dB
1450	to	1492	> 65 dB
1492	to	1512	> 35 dB
1492	to	1512	> 45 dB average*
1512	to	1517	> 20 dB
1512	to	1517	> 25 dB average*
1626.5	to	1660.5	> 120 dB
1660.5	to	18000.0	> 75 dB

* The requirement is an average rejection across the band where the averaging is applied in terms of linear power as opposed to dB. Both the absolute rejection and the average rejection requirements in a band should be met simultaneously.

9.3.3.2 Spectral Regrowth

For the following interferer cases with power measured at the DLNA antenna port:

Case 1: LTE 1512-1517, -30 dBm (source draft ETSI 301/473) with a 5 MHz LTE carrier.

Case 2: LTE 1492-1512, -20 dBm (based on 10 dB increase from Case 1) with a 20 MHz LTE carrier.

The Equivalent Noise Figure of the DLNA in any 200 kHz of the receive band should be no more than 2.2 dB in any 200 kHz of passband at 25 °C. At 70 °C an additional allowance of 0.5 dB is allowed.

Where:

SNR_i is the signal to noise ratio at the input to the DLNA [S/N].

SINAD_o is the signal to noise plus distortion ratio at the output of the DLNA [S/(N+D)].

D is the power of the distortion introduced by the diplexer.

9.3.4 Type H DLNA Specification

9.3.4.1 Type H DLNA RF Characteristics

9.3.4.1.1 Type H DLNA VSWR

The VSWR of the DLNAs antenna-port and transmit-port (Tx) should be 1.3:1 maximum. The DLNAs receive port (Rx) VSWR should be 1.5:1 maximum.

Note: In all DLNA performance measurements, any unused port should be terminated with its characteristic impedance.

9.3.4.1.2 Type H DLNA Receive Band Characteristics

9.3.4.1.2.1 Noise Figure

The DLNA noise figure should be less than 1.4 dB at temperatures below 25 °C. The noise figure may increase with temperature to a maximum of 1.8 dB at the maximum operating temperature (70 °C).

**ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA**

9.3.4.1.2.2 Gain

The gain at any frequency and any temperature should be between 53 and 60 dB under all operating conditions.

9.3.4.1.2.3 Gain Ripple

The gain ripple should be no more than 4.0 dB (peak to peak) over any 200 kHz passband.

9.3.4.1.2.4 Group Delay

The group delay variation should be less than 5 μ s in any 10 kHz of the passband.

9.3.4.1.3 Type H DLNA Antenna Port to Receive Port (DLNA Output)

9.3.4.1.3.1 Type H DLNA Antenna Port to Receive Port

The rejection from the antenna-port to the receive port (DLNA output) relative to the 1538 to 1559 MHz passband level should be:

Frequency (MHz)			Rejection
0.0	to	1450.0	> 75 dB
1450	to	1497	> 65 dB
1497	to	1507	> 60 dB
1507	to	1517	> 45 dB
1526	to	1534	> 40 dB
1526	to	1536 (sic)	> 40 dB average*
1639.5	to	1660.5	> 120 dB
1660.5	to	18000.0	> 75 dB

* The requirement is an average rejection across the band where the averaging is applied in terms of linear power as opposed to dB. Both the absolute rejection and the average rejection requirements should be met simultaneously.

9.3.4.1.3.2 Phase Noise

The DLNA contribution to the phase noise present on a received carrier measured at the receive port of the DLNA shall have a single sideband power density continuous spectrum not exceeding the limit mask defined below.

Frequency offset from actual received carrier frequency (Hz)	SSB phase noise density limit in 1 Hz bandwidth (dBc)
10	-37
100	-68
1000	-76
3000	-80
10000	-82
35000	-82

9.3.4.1.4 Type H DLNA Transmit Port to Antenna Port

The path from the transmit port to the antenna port should have the following characteristics:

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

Frequency (MHz)			Rejection
0.0	to	1525.0	> 80 dB
1525.0	to	1559.0	> 120 dB
1559.0	to	1585.0	> 111 dB
1585.0	to	1605.0	> 95 dB
1605.0	to	1610.0	> 62 dB
1610.0	to	1614.0	> 40 dB
1614.0	to	1620.0	> 30 dB
1620.0	to	1624.5	> 20 dB
1624.5	to	1625.5	> 10 dB
1625.5	to	1639.5	Decreases
1639.5	to	1660.5	Insertion loss < 0.8 dB
1660.5	to	1735.0	Increases
1735.0	to	1865.0	> 50 dB
1865.0	to	3250.0	> 20 dB
3250.0	to	3333.0	> 50 dB
3333.0	to	4000.0	> 40 dB
4000.0	to	12000.0	> 50 dB
12000.0	to	18000.0	> 15 dB

9.3.4.1.5 Type H DLNA – Transmit Port to Receive Port (DLNA Output)

The rejection from the transmit port to the receive port (DLNA output) relative to the passband level from the antenna port to the receive port should be as follows:

Frequency (MHz)			Rejection
1538.0	to	1559.0	> 120 dB
1639.5	to	1660.5	> 120 dB
1660.5	to	12000.0	> 50 dB

9.3.4.1.6 Type H DLNA Output Power

The output power capability of the DLNA receive output port should be +10 dBm minimum at the 1 dB gain compression point. This set of parameters establishes the linearity for the receive system and is directly related to its two-tone intermodulation performance.

COMMENTARY

This DLNA output should allow the system installer a maximum loss between the DLNA and the SDU as described in Section 2.3.5.3. Note also that the spectral regrowth requirement imposes further linearity constraints.

9.3.4.1.7 Type H DLNA Intermodulation

9.3.4.1.7.1 Type H – DLNA Intermodulation Products in Satcom Receive Band

With two CW carriers, each of power 10.2 dBW anywhere in the band 1639.5 to 1660.5 MHz, the 9th and higher intermodulation product should be less than -133 dBm in the band 1538 to 1559 MHz as measured at the receive port, but with the power level referenced to the antenna port.

**ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA**

COMMENTARY

The specification above is for Type F based on SBB but using 9th rather than 7th order since the DLNA will not pass a 7th order. Although Classic Aero has a lower spreading factor which would imply a tighter intermodulation requirement. The required order, assuming carriers constrained in the 10MHz AMS(R)S band, is 21st. It is assumed that if the DLNA meets the above spec for 9th order, then the 21st order will be significantly and adequately better.

9.3.4.1.7.2 Type H – DLNA Intermodulation Products in GNSS Band

With two CW carriers, each of power 10.2 dBW anywhere in the band 1626.5 to 1660.5 MHz, the 7th and higher intermodulation products should each be less than -100 dBm in the band 1555 to 1595.42 MHz as measured at the antenna port.

COMMENTARY

The spec above is the Type F spec based on SBB but using 7th rather than 5th order since the DLNA will not generate a 5th order in the GNSS band. Although Classic Aero has a lower spreading factor which would imply a tighter intermodulation requirement. The required order, assuming carriers constrained in the 10 MHz AMS(R)S band, is 15th. It is assumed that if the DLNA meets the above spec for 7th order, then the 15th order will be significantly and adequately better.

9.3.4.1.8 Stability

The DLNA is unconditionally stable with any load impedance (any magnitude and phase) on any port (0 to 18 GHz), with input levels specified.

9.3.4.1.9 Spectral Regrowth

For the following interferer cases with power measured at the DLNA antenna port:

Case 1: ATCt: -35.5 dBm (source RTCA DO343) with a 10 MHz LTE carrier.

Case 2: LTE 1512 to 1517, -30 dBm (source draft ETSI 301/473) with a 5 MHz LTE carrier.

Case 3: LTE 1492 to 1512, -20 dBm (based on 10dB increase from Case 2) with a 20 MHz LTE carrier.

The Equivalent Noise Figure of the DLNA in any 200 kHz of the receive band should be no more than 2.4 dB in any 200 kHz of passband at 25 °C. At 70 °C, an additional allowance of 0.5 dB is allowed.

Equivalent Noise Figure is defined as $ENF = 10 \log (SNR_i/SINAD_o)$.

Where:

SNR_i is the signal to noise ratio at the input to the DLNA [S/N].

SINAD_o is the signal to noise plus distortion ratio at the output of the DLNA [S/(N+D)].

D is the power of the distortion introduced by the diplexer.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

9.3.4.2 Type H DLNA Mechanical Characteristics

9.3.4.2.1 Type H DLNA Connectors

The DLNA should use the following connectors for its RF ports:

Port	Connector Type
Transmit Port (SDU or HPA)	N Jack (Female)
Receive Port (SDU)	TNC Jack (Female)
Antenna Port	TNC Jack (Female)

The DLNA should use a MIL-C-26482 Series 2 type connector for control and power interconnections. Shell size and insert arrangement as per Attachment 1, Section 1.8.

9.3.4.2.2 Type H DLNA Form Factor

See Attachment 1, Section 1.8 for the form factor of the DLNA.

Note: The form factor of the Type H DLNA will have the same mounting holes, connector locations, and maximum size as the Type F DLNA. Refer to manufacturer specific interface control drawings and models for exact form factor.

9.3.4.3 Type H DLNA Control Characteristics

9.3.4.3.1 Type H DLNA On/Off Control

Provisions are needed to switch the LNA on and off. Note 6 to the Standard Interwiring in Attachment 1, Section 1.4 of this characteristic describes the switching signal.

9.3.4.3.2 Type H DLNA BITE

Provisions are needed for the DLNA to provide BITE to the antenna. Note 5 to the Standard Interwiring in Attachment 1, Section 1.4 of this characteristic describes the switching signal.

9.3.5 Type J DLNA Specification

Note: The Type J DLNA switches between two filter settings being standard bandwidth (supporting a receive passband of 1525 to 1559 MHz) and reduced bandwidth (supporting a receive passband of 1538 to 1559MHz).

The DLNA has three control mechanisms to switch between standard bandwidth and reduced bandwidth:

1. Autosense
2. Pulsed Discrete Control
3. ARINC 429 Multicontrol Bus

If the Type J DLNA is controlled by Autosense or pulse discrete, then no change is needed to the existing wiring in aircraft (e.g., as for a Type A, modified Type A, or Type F). If the Type J DLNA is controlled by ARINC 429, multi-control bus an additional wire pair needs to be installed on the aircraft.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

An accompanying SDU software change is only needed when a Type J is fitted and pulsed discrete or ARINC 429 multi-control bus control is used. A Type J DLNA using Autosense does not require an SDU software change.

9.3.5.1 Type J DLNA RF Characteristics

9.3.5.1.1 Type J DLNA VSWR

The VSWR of the DLNAs antenna-port and transmit-port (Tx) should be 1.3:1 maximum. The DLNAs receive port (Rx) VSWR should be 1.5:1 maximum.

Note: In all DLNA performance measurements, any unused port should be terminated with its characteristic impedance.

9.3.5.1.2 Type J DLNA Receive Band Characteristics

9.3.5.1.2.1 Noise Figure

The DLNA noise figure should be less than 1.2 dB at temperatures below 25 °C. The noise figure may increase with temperature to a maximum of 1.8 dB at the maximum operating temperature (70 °C).

9.3.5.1.2.2 Gain

The gain at any frequency and any temperature should be between 53 and 60 dB under all operating conditions when backoff is 0 dB.

The gain can be reduced by ARINC 429 control in steps of 3 dB up to a reduction of 45 dB.

9.3.5.1.2.3 Gain Ripple

The gain ripple should be no more than 1.5 dB (peak to peak) over any 200 kHz passband.

9.3.5.1.2.4 Group Delay

The group delay variation should be less than 200 ns in any 200 kHz of the passband when in standard bandwidth mode.

The group delay variation should be less than 200 ns in any 200 kHz of the (reduced) passband when in reduced bandwidth mode.

9.3.5.1.3 Type J DLNA Antenna Port to Receive Port (DLNA Output)

9.3.5.1.3.1 Type J DLNA Antenna Port to Receive Port – Reduced Band

The rejection from the antenna-port to the receive port (DLNA output) relative to the 1538 to 1559 MHz passband level when in reduced bandwidth mode should be:

Frequency (MHz)			Rejection
0.0	to	1450.0	> 75 dB
1450	to	1507	> 65 dB
1507	to	1517	> 45 dB
1526	to	1534	> 40 dB
1526	to	1536 (sic)	> 40 dB average [1]
1626.5	to	1660.5	> 120 dB
1660.5	to	18000.0	> 75 dB

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

Notes:

1. The requirement is an average rejection across the band where the averaging is applied in terms of linear power as opposed to dB. Both the absolute rejection and the average rejection requirements in a band should be met simultaneously.

9.3.5.1.3.2 Type J DLNA Antenna Port to Receive Port – Standard Band

The rejection from the antenna-port to the receive port (DLNA output) relative to the 1525 to 1559 MHz passband level when in standard bandwidth mode should be:

Frequency (MHz)			Required Rejection
0.0	to	1450	> 75 dB
1450	to	1497	> 65 dB
1497	to	1512	> 40 dB
1497	to	1512	> 49 dB average [1]
1512	to	1517	> 25 dB
1512	to	1517	> 30 dB average [1]
1626.5	to	1660.5	> 120 dB
1660.5	to	18000.0	> 75 dB

Notes:

1. The requirement is an average rejection across the band where the averaging is applied in terms of linear power as opposed to dB. Both the absolute rejection and the average rejection requirements in a band should be met simultaneously.

9.3.5.1.3.3 Phase Noise

The DLNA contribution to the phase noise present on a received carrier measured at the receive port of the DLNA shall have a single sideband power density continuous spectrum not exceeding the limit mask defined below.

Frequency offset from actual received carrier frequency (Hz)	SSB phase noise density limit in 1 Hz bandwidth (dBc)
10	-42
30	-56
50	-56
100	-65
200	-68
500	-76
1000	-84
5000	-86
35000	-86
50000	-95
100000	-95

Note: The phase noise of the local oscillator at offsets of 1 to 10 MHz should be monitored closely. Tests indicate that phase noise exceeding -145 dBc/Hz in this frequency range will create images of the ATC interference in the DLNA passband.

**ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA**

9.3.5.1.4 Type J DLNA Transmit Port to Antenna Port

The path from the transmit port to the antenna port should have the following characteristics:

Frequency (MHz)			Rejection
0.0	to	1525.0	> 80 dB
1525.0	to	1559.0	> 120 dB
1559.0	to	1585.0	> 111 dB
1585.0	to	1605.0	> 95 dB
1605.0	to	1610.0	> 62 dB
1610.0	to	1614.0	> 40 dB
1614.0	to	1620.0	> 30 dB
1620.0	to	1624.5	> 20 dB
1624.5	to	1625.5	> 10 dB
1625.5	to	1626.5	Decreases
1626.5	to	1633.0	Insertion loss < 1.3 dB
1633.0	to	1660.5	Insertion loss < 0.8 dB
1660.5	to	1735.0	Increases
1735.0	to	1865.0	> 50 dB
1865.0	to	3250.0	> 20 dB
3250.0	to	3330.0	> 50 dB
3330.0	to	4000.0	> 40 dB
4000.0	to	12000.0	> 50 dB
12000.0	to	18000.0	> 15 dB

The above should be met over -55 °C to +55 °C.

Between +55 °C to +70 °C, the characteristics above may be degraded as follows:

Frequency (MHz)			Rejection
1625.0	to	1625.5	> 2.5 dB

9.3.5.1.5 Type J DLNA – Transmit Port to Receive Port (DLNA Output)

The rejection from the transmit port to the receive port (DLNA output) relative to the passband level from the antenna port to the receive port should be as follows:

Frequency (MHz)			Rejection
1525.0	to	1559.0	> 125 dB
1626.5	to	1660.5	> 135 dB
1660.5	to	12000.0	> 50 dB

9.3.5.1.6 Type J DLNA Output Power

The output power capability of the DLNA receive output port should be +10 dBm minimum at the 1 dB gain compression point. This set of parameters establishes the linearity for the receive system and is directly related to its two-tone intermodulation performance.

COMMENTARY

This DLNA output should allow the system installer a maximum loss between the DLNA and the SDU as described in

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

Section 2.3.5.3. Note also that the spectral regrowth requirement imposes further linearity constraints.

9.3.5.1.7 Type J DLNA Intermodulation

9.3.5.1.7.1 Type J – DLNA Intermodulation Products in Satcom Receive Band

With two CW carriers, each of power 10.2 dBW anywhere in the band 1626.5 to 1660.5 MHz, the 7th and higher intermodulation product should be less than -133 dBm in the band 1525 to 1559 MHz as measured at the receive port, but with the power level referenced to the antenna port.

COMMENTARY

The test carrier levels are based on the carrier power level for the IGA antenna spec level (Section 2.3.3.6.12.1) but increased by 0.8 dB for the DLNA transmit insertion loss and increased by 0.3 dB for the DLNA to antenna cable loss.

The required intermodulation level to protect the satcom receive band are based on a degradation of 6% to the system noise figure (i.e., $\Delta T/T=6\%$) which is equivalent to 0.25 dB. An interference bandwidth of 170 kHz is assumed, which is equivalent to a seventh order intermodulation product formed by SwiftBroadband (151.2 kSym/s) and Classic (10.5 kSym/s) bearers.

9.3.5.1.7.2 Type J – DLNA Intermodulation Products in GNSS Band

With two CW carriers, each of power 10.2 dBW anywhere in the band 1626.5 to 1660.5 MHz, the 5th and higher intermodulation products should each be less than -100 dBm in the band 1555 to 1595.42 MHz as measured at the antenna port.

COMMENTARY

The test carrier levels are the same as those used for the intermodulation products into the satcom receive band.

The intermodulation level is based on the IGA/HGA intermodulation level at the GPS carrier frequency (1575.42 MHz) but reduced by 40 dB to reflect the satcom to GNSS antenna isolation and reduced by approximately an additional 12 dB to partition the intermodulation budget between the various system components (antenna, cable, and DLNA). To ease DLNA test, the intermodulation level is not a function of frequency.

9.3.5.1.8 Stability

The Diplexer/LNA is unconditionally stable with any load impedance (any magnitude and phase) on any port (0 to 18 GHz), with input levels specified.

9.3.5.1.9 Spectral Regrowth

For the following interferer cases with power measured at the DLNA antenna port:

Case 1: ATCt: -35.5 dBm (source RTCA DO343) with a 10MHz LTE carrier

**ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA**

Case 2: LTE 1512-1517, -30 dBm (source draft ETSI 301/473) with a 5 MHz LTE carrier

Case 3: LTE 1492-1512, -20 dBm (based on 10dB increase in Case 2) with a 20 MHz LTE carrier

The Equivalent Noise Figure of the DLNA in any 200 kHz of the receive band should be no more than 2.2 dB in any 200kHz of passband at 25 °C. At 70 °C, an additional allowance of 0.5dB is permitted.

Equivalent Noise Figure is defined as $ENF = 10 \log (SNR_i/SINAD_o)$.

Where:

SNR_i is the signal to noise ratio at the input to the DLNA $[S/N]$.

$SINAD_o$ is the signal to noise plus distortion ratio at the output of the DLNA $[S/(N+D)]$.

D is the power of the distortion introduced by the diplexer.

9.3.5.2 Type J DLNA Mechanical Characteristics

9.3.5.2.1 Type J DLNA Connectors

The DLNA should use the following connectors for its RF ports:

Port	Connector Type
Transmit Port (SDU or HPA)	N Jack (Female)
Receive Port (SDU)	TNC Jack (Female)
Antenna Port	TNC Jack (Female)

The DLNA should use a MIL-C-26482 Series 2 type connector for control and power interconnections. Shell size and insert arrangement as per Attachment 1-8.

9.3.5.2.2 Type J DLNA Form Factor

See Attachment 1, Section 1.8 for the form factor of the DLNA.

Note: The form factor of the Type J DLNA will have the same mounting holes, connector locations, and maximum size as the Type F DLNA. Refer to manufacturer specific interface control drawings and models for exact form.

9.3.5.3 Type J DLNA Control Characteristics

9.3.5.3.1 Type J DLNA On/Off Control

Provisions are needed to switch the DLNA on and off. Note 6 to the Standard Interwiring in Attachment 1, Section 1.4 of this characteristic describes the switching signal.

9.3.5.3.2 Type J DLNA BITE

Provisions are needed for the DLNA to provide BITE to the antenna. Note 5 to the Standard Interwiring in Attachment 1, Section 1.4 of this characteristic describes the switching signal.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

9.3.5.3.3 Control of the Type J DLNA

The Type J DLNA switches between two filter settings:

- Standard bandwidth (supporting a receive passband of 1525-1559 MHz)
- Reduced bandwidth (supporting a receive passband of 1538-1559MHz)

The DLNA has three control mechanisms to switch between standard bandwidth and reduced bandwidth:

1. Autosense
2. Pulsed Discrete
3. ARINC 429 multi-control bus

A state machine (see Section 9.3.5.3.5) is implemented within the DLNA, which combines both the Autosense and Pulsed Discrete switching mechanism and the filter state (standard bandwidth or reduced bandwidth), as well as the state of LNA, off.

Consequently, the DLNA has two modes being State Machine Mode and ARINC 429 Mode.

The DLNA powers up in State Machine Mode.

The DLNA transitions to ARINC 429 mode on receipt of a valid ARINC 429 word where valid is defined in Section 9.3.5.3.3.3. In ARINC 429 mode the DLNA discrete control input and discrete BITE output operate in the conventional manner (i.e., Type F) except that the ARINC 429 word can modify the behavior of the discrete control input. The DLNA transitions from ARINC 429 mode to State Machine Mode when no valid ARINC 429 word has been received for 10 seconds. The DLNA continues to transition between the modes based on the received ARINC 429 words.

Based on an initial analysis, pulsed discrete control will not work with ARINC 741 side mount antennas using two DLNAs – either Autosense or ARINC 429 multi-control bus should be used.

9.3.5.3.3.1 Type J DLNA Autosense

The Type J DNLA includes an “Autosense” mechanism that when active applies additional filtering in the band 1526 to 1536 MHz when the power in that band measured with respect to the input exceeds a threshold.

The Type J DLNA supports the following filter settings where the numbers are aligned to the ARINC 429 command word:

0	Autosense
1	Standard Bandwidth
2	Reduced Bandwidth (additional filtering below 1538 MHz)
3~7	Reserved – DLNA uses standard bandwidth

The Type J DLNA Autosense mechanism can be active in either ARINC 429 Mode or in State Machine Mode – see those sections for a description of the behavior.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

There are two filter states within Autosense:

Power in band 1526 to 1536 MHz	Autosense state
Below threshold	Standard Bandwidth
Above threshold	Reduced Bandwidth

The Autosense mechanism should apply reduced bandwidth when the power in the band 1526 to 1536 MHz exceeds -75 dBm.

The Autosense mechanism should apply standard bandwidth when the power in the band 1526 to 1536 MHz is below -85 dBm.

Switching between Autosense filter settings should be minimized to stop phase discontinuities which may cause the SDU modems to lose synchronization. To prevent frequent filter setting transitions the following measures should be implemented:

- Averaging/filtering is applied to the power measurement. The averaging/filtering should be such that the switching threshold needs to be crossed for not less than two seconds and not more than four seconds.
- There should be hysteresis of at least 3 dB applied about the switching thresholds.
- Following a filter setting transition the DLNA shall dwell in the new filter setting for a minimum period of 10 seconds before performing another filter setting transition.

The DLNA should not apply reduced bandwidth when the following signals are applied to the DLNA.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

Frequency band	Level	Comment
Below 1100 MHz	+15 dBm	Secondary radar, 40 dB isolation
1100 to 1450 MHz	+3 dBm	RTCA DO210 & DO-262/EUROCAE ED-243 MOPS
1450 to 1518 MHz	+3 to -15 dBm	Edge band interference from IMT
1610 to 1626.5 MHz	+17 dBm	Iridium Certus, 40 dB isolation
1626.5 to 1660.5 MHz	+48 dBm	Inmarsat satcom transmitter
Above 1660.5 MHz	+3 dBm	RTCA DO210 & DO-262/EUROCAE ED-243 MOPS

In each case, the power limit applies to the composite power in any 10 MHz band.

9.3.5.3.3.2 Type J DLNA Pulsed Discrete Control

The existing discrete control and BITE lines are repurposed such that pulsing of the discrete control line is used to switch between standard bandwidth and reduced bandwidth. Similarly, pulsing of the discrete BITE line is used to indicate the state of the DLNA. The State Machine that implements this is described in Section 9.3.5.3.5.

9.3.5.3.3.3 Type J DLNA ARINC 429 Multi-Control Bus Control

ARINC 429 commands from the SDU's multi-control bus control the DLNA. There are insufficient pins on the DLNA to provide an ARINC 429 output.

The following should be noted:

1. The SDU can command the DLNA to use Autosense (as well as the two filter states).
2. The SDU can command the DLNA to have reduced gain.
3. The DLNA control input can be programmed to either be ignored or to control the RF output.
4. The RF output can be enabled or disabled either by the ARINC 429 word or the DLNA control input.
5. The ARINC 429 bus is high speed and connected to the SDU multi-control bus.
6. The SDU sends ARINC 429 words at a rate of 5-10 words per second. This implies that the interval between the start of two words with the same label number should always be between 100 and 200 ms.
7. To provide robustness, a CRC-4-ITU is used in the DLNA Control Word. The CRC polynomial is $G(x) = x^4 + x + 1$. The CRC register is initialized with 0xF, and the algorithm protects bits 11-25 of the DLNA Control Word. This CRC is used in the telecommunication world and is captured in the ITU-T and G.704 specification.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

8. The DLNA enters the ARINC 429 Mode on receipt of a valid ARINC 429 word – that is one with correct parity, correct label, correct CRC, SDI set to all call, SSM as normal operation, or functional test.
9. The DLNA exits the ARINC 429 Mode and transitions to State Machine Mode when it has not received a valid ARINC 429 word for 10 seconds.
10. There is no specific acknowledge of receipt of ARINC 429 word by the DLNA – rather, if one is not received, then the DLNA behavior is as above where the DLNA transitions to the State Machine Word.
11. The DLNA should go into self-test when it receives a valid ARINC 429 word with SSM set to functional test. If the DLNA receives a valid ARINC 429 word with SSM set to normal operation while the DLNA is undertaking self-test, it should exit self-test. While the SDU is sending self-test commands, it should not send other commands. During functional test, the DLNA BITE control line should indicate OK (≥ 15 V). The DLNA BITE should indicate failed if the result of the self-test is a fail (≤ 1 V).
12. The DLNA BITE line should indicate the current filter setting as in the table in Section 9.3.3.5.
13. If ARINC 429 is used to control two DLNAs in an ARINC 741 side mount antenna system, then the SDI should still be set to ALL CALL.

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

9.3.5.3.4 Type J DLNA – DLNA Control Word Definition

BIT	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Function	P	SSM		CRC [7]				Spare						RF Output	Requested Filter Mode	Gain				SDI		Label 157 [6]										
								0	0	0	0	0	0										0	0	1	1	1	1	0	1	1	0
																										7		5			1	

Sign/Status Matrix		
BITS		Coding
31	30	
0	0	Reserved (Failure Warning)
0	1	Reserved (No Computed Data)
1	0	Functional Test
1	1	Normal Operation

Requested DLNA Rx Gain	
BITS 14-11	Coding
0000	Max Gain
0001	3 dB below max gain
0010	6 dB below max gain
Etc.	Etc.
1111	45 dB below max gain

Requested DLNA Filter Setting	
BITS 17-15	Coding
000	Autosense
001	Standard BW (No ATCt)
010	Reduced BW (ATCt)
011-111	Reserved – DLNA goes to Standard BW (No ATC)

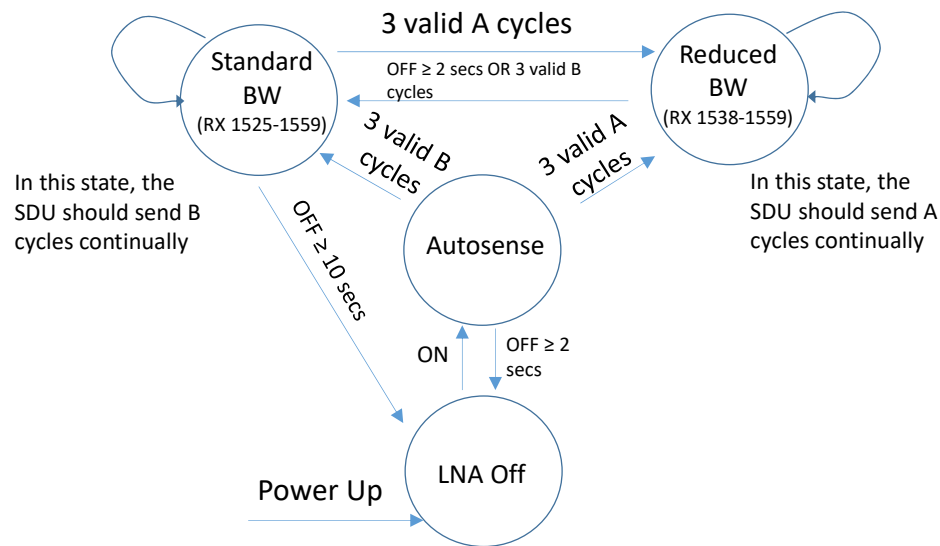
SDI Code [13]		
BITS		Coding
10	9	
0	0	All Call
0	1	Reserved
1	0	Reserved
1	1	Reserved

RF Output [3][4]		
BITS		Coding
19	18	
0	0	Disable (ignore discrete input)
0	1	Enable (ignore discrete input)
1	0	Use discrete input
1	1	Reserved – DLNA uses discrete input

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

9.3.5.3.5 Type J DLNA State Machine

The DLNA state machine is shown below:



The DLNA state machine operates as follows:

- The DLNA transitions between these states as shown in the state diagram based on the LNA/Control input which has two values ON ($\leq 1V$, i.e., ground) and OFF ($\geq 15V$). These voltage levels and polarity are the same as for a Type F.
- The DLNA senses a Valid A cycle if the LNA/Control input has an OFF level for between 0.5 and 1.5 seconds, followed by an ON level between 2 and 3 seconds. For multiple Valid A cycles, the next cycle must be contiguous.
- The DLNA senses a Valid B cycle if the LNA/Control input has an OFF level for between 0.5 and 1.5 seconds, followed by an ON level between 5 and 6 seconds. For multiple Valid B cycles, the next cycle must be contiguous.

The DLNA BITE line operates as follows to reflect the state of the state machine (Note the ARINC 429 bus between the antenna/BSU and the SDU is low-speed):

ATTACHMENT 9
ATCt AND LTE RESILIENT DLNA

State	DLNA BTE Line
Failed/LNA OFF	≤ 1 V continuous
Autosense	≥ 15 V continuous
Standard bandwidth	≤ 1 V between 0.8 and 1.2 seconds followed by ≥ 15 V between 2.3 and 2.7 seconds and then repeats cycle. (Note this is inverse of command sent on control line)
Reduced bandwidth	≤ 1 V between 0.8 and 1.2 seconds followed by ≥ 15 V between 5.3 and 5.7 seconds and then repeats cycle. (Note this is inverse of command sent on control line)

The DLNA/Control input is generated in the SDU as an ARINC 429 command and the antenna (ARINC 781) or BSU (ARINC 741) converts the ARINC 429 command to a discrete. The SDU behavior is:

- Valid A cycle is ARINC 429 Antenna Control Word (label 144) bit 11 value 0 between 0.8 and 1.2 seconds, followed by value 1 between 2.3 and 2.7 seconds (SDU transmits this continuously).
- Valid B cycle is ARINC 429 Antenna Control Word (label 144) bit 11 value 0 between 0.8 and 1.2 seconds, followed by value 1 between 5.3 and 5.7 seconds (SDU transmits this continuously).
- To transition between Reduced BW and Standard BW the SDU should set the Control Line to OFF for between 2.5 and 3.5 seconds.

**ATTACHMENT 10
ATTACHMENT REFERENCE GUIDE**

ATTACHMENT 10 ATTACHMENT REFERENCE GUIDE

Attachment Number	Description
1	Standard Interfaces
1.1A	General Configuration Overview – Single Satcom Installation
1.1B	General Configuration Overview – Dual Satcom Installation
1.2A	Satcom System Configuration – HPA Integrated in SDU
1.2B	Satcom System Configuration – Optional Flange Mounted HPA
1.3	Standard Interwiring
1.4	Notes Applicable to Standard Interwiring
1.4A	System Configuration Pins Definition and Interpretation
1.5	SDU Form Factor
1.5A	SDU Top Plug Connector Layout
1.5B	SDU Middle Plug Connector Layout
1.5C	SDU Bottom Plug Connector Layout
1.6	SDU Configuration Module Form Factor
1.6A	SDU Configuration Module Connector Layout
1.7A	Small Flange Mount HPA Form Factor
1.7B	Large Flange Mount HPA Form Factor
1.7C	Flange Mount HPA Connector Layout
1.8	Diplexer/Low-Noise Amplifier Form Factor
1.9	Antenna Coverage
1.10	High Gain and Intermediate Gain Antenna Footprint
1.10A	Antenna Coaxial Cable Interface
1.11	No Longer Used
1.12	High Gain and Intermediate Gain Top Mount Antenna Control Connector Layout
2	ARINC 429 Labels and Word Formats Used in the Aviation Satellite Communications System
2A	Antenna Configuration Data Reporting
2B	Bit-Oriented Fault Reporting Protocol
3	Cockpit Voice – SAT Phone State Machine for Normal Operation
4A	ARINC 781 SDU Functions Matrix
4B	ARINC 781 SDU Interfaces Matrix
5	Ethernet Interface
6	ARINC 781 HPA Output Power Use Cases
7	Compact Satcom Definition
8	Network Security for SwiftBroadband Safety Services
9	ATCt and LTE Resilient DLNA
10	Attachment Reference Guide

APPENDIX A ACRONYMS

APPENDIX A ACRONYMS

3D	Three Dimensions
3GPP	Third Generation Partnership Project
AAC	Airline Administrative Communications
AAGW	ACARS Aircraft Gateway
ac	alternating current
AC	Access Concentrator
ACARS	Aircraft Communications Addressing and Reporting System
ACD	Aircraft Control Domain
ACP	Audio Control Panel
ACR	Avionics Communication Router
ACU	Antenna Control Unit
ADIRS	Air Data Inertial Reference System
ADL	Airborne Data Loader
ADS-C	Automatic Dependent Surveillance – Contract
ADGW	Aircraft Datalink Gateway
ADSU	Automatic Dependent Surveillance Unit
AEEC	Airlines Electronic Engineering Committee
AES	Aircraft Earth Station
AGGW	ACARS Ground Gateway
AGC	Automatic Gain Control
AISD	Airline Information Services Domain
AM/PM	Amplitude Modulation/Phase Modulation
AMBE	Advanced Multi-Band Excitation (speech encoding algorithm)
AMCP	Aeronautical Mobile Communications Panel
AMM	Aircraft Maintenance Manual
AMS(R)S	Aeronautical Mobile-Satellite (Route) Service
AMS	Audio Management System
AMSS	Aeronautical Mobile Satellite Services
ANSP	Air Navigation Service Provider
ANT	Antenna
AOC	Aeronautical Operational Control
APC	Airline Passenger Communications
APM	Aircraft Personality Module
ASGW	Aircraft Security Gateway
APN	Access Point Name
AT	Attention
ATC	Air Traffic Control
ATCt	Ancillary Terrestrial Component
ATG	Air-To-Ground
ATE	Automatic Test Equipment

APPENDIX A ACRONYMS

ATLAS	Abbreviated Test Language for All Systems
ATS	Air Traffic Services
BABT	British Approvals Board for Telecommunications
BER	Bit Error Rate
BIT	Binary Digit
BITE	Built-In Test Equipment
BGAN	Broadband Global Area Network
BNR	Two's Complement Fractional Binary Notation
BP	Bottom Plug
bps	bits per second
BRI	Basic Rate Interface
BSS	Business Support System
BSU	Beam Steering Unit
C	Celsius
C/M	Carrier-to-Multipath Ratio
C/No	Carrier-to-Noise Density Ratio
CAIMS	Centralized Airplane Information Management System
CCDF	Complementary Cumulative Distribution Function
CCIR	International Consultative Committee for Radio
CCS	Cabin Communications System
CDM	Configuration Data Module
CDU	Control Display Unit
CEPT	European Conference of Postal and Telecommunications Administrations
CFDS	Centralized Fault Display System
CFR	Code of Federal Regulations
CLI	Command Line Interface
CMC	Central Maintenance Computer
CMF	Communications Management Function
CMU	Communications Management Unit
CN	Core Network
CODEC	Coder/Decoder
CPD	Cabin Packet Data
CPDF	Cabin Packet-mode Data Function
CPDLC	Controller/Pilot Data Link Communications
CR/LF	Carriage Return/Line Feed
CRC	Cyclic Redundancy Check
CS	Circuit Switched
CSDU	Compact SDU
CTU	Cabin Telecommunications Unit
CW	Continuous Waveform
DAL	Development Assurance Level
dB	Decibel

APPENDIX A
ACRONYMS

dB/K	Decibel per Kelvin
dBc	Decibel relative to carrier
dB _i	Decibel relative to isotropic
dB _c	Decibel relative to isotropic, circular polarization
dB _m	Decibel relative to one milliwatt
dBW	Decibel relative to one watt
dc	direct current
DCN	Data Communication Network
DHCP	Dynamic Host Configuration Protocol
DIP	Diplexer
DLNA	Diplexer/Low-Noise Amplifier
DMA	Direct Memory Access
DoS	Denial of Service
DP	Distribution Partner
DTMF	Dual Tone Multi-Frequency
DTX	Discontinuous Transmission
ECAM	Electronic Centralized Aircraft Monitoring
ECC	Electronic Communications Committee
EDU	Electronic Display Unit
EE	Ethernet Encapsulation
EFB	Electronic Flight Bag
EICAS	Engine Indication and Crew Alerting System
EIRP	Effective Isotropic Radiated Power
ELGA	Enhanced Low Gain Antenna
EMI	Electromagnetic Interference
EOT	End of Transmission
EQID	Equipment Identifier
ETX	End of Text
EU	European Union
EUROCAE	European Organization for Civil Aviation Equipment
EVM	Error Vector Magnitude
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FCC	Federal Communications Commission
FDE	Flight Deck Effect
FID	Forward Identification Number (for Swift64 services)
FMC	Flight Management Computer
FMHPA	Flange-Mount HPA
FNN	Fixed Network Node
FPGA	Field-Programmable Gate Array
FPLMTS	Future Public Land Mobile Telecommunications System
FT	Functional Test

APPENDIX A ACRONYMS

FW	Failure Warning
G/T	Gain to Noise Temperature Ratio
GDGW	Ground Datalink Gateway
GES	Ground Earth Station
GGSN	Gateway GPRS Support Node
GHz	Gigahertz (10 ⁹ Hz)
GLONASS	Global Navigation Satellite System
GND	Ground
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Services
GPS	Global Positioning System
GSDB	GES-Specific Data Broadcast
GSGW	Ground Security Gateway
GSM	Global System for Mobiles
GTA	Ground-To-Air
HDOP	Horizontal Dilution of Precision
HAE	Height above Ellipsoid
HF	High Frequency
HGA	High Gain Antenna
HLD	High-Power Amplifier/Low-Noise Amplifier/Diplexer
HMI	Human-Machine Interface
HPA	High-Power Amplifier
HPR	High-Power Relay
HSDU	High-Speed Data Unit
HSN	Harmonics, Spurious, and Noise
Hz	Hertz
I-2	Inmarsat-2 Satellite
I-3	Inmarsat 3 Satellite
I-4	Inmarsat 4 Satellite
I/Q	In-Phase and Quadrature (Modulation)
IAI-2	Inmarsat Air Interface-2
ICAO	International Civil Aviation Organization
ID	Identification
IF	Intermediate Frequency
IFE	In-Flight Entertainment
IGA	Intermediate Gain Antenna
IMEI	International Mobile Equipment Identifier
IMEISV	International Mobile Equipment Identifier Software Version
IMSI	International Mobile Subscriber Identity
IMT	International Mobile Telecommunications
IMT-2000	International Mobile Telecommunications 2000
INS	Inertial Navigation System

APPENDIX A

ACRONYMS

IP	Internet Protocol
IPSec	IP Security
IRS	Inertial Reference System
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ITU	International Telecommunication Union
kg/hr	kilogram per hour
kHz	kilohertz
kSym/s	kilo symbols per second
LAN	Local Area Network
L-band	Portion of the microwave band of the electromagnetic spectrum ranging approximately from 0.39 to 1.55 GHz
LED	Light Emitting Diode
LES	Land Earth Station
LESO	LES Operator
LGA	Low Gain Antenna
LNA	Low-Noise Amplifier
LPA	Low Power Amplifier
LRU	Line Replaceable Unit
LSB	Least Significant Bit
LTE	Long Term Evolution
mA	milliampere
MAC	Media Access Control (address)
MASPS	Minimum Aviation System Performance Standards
MBS	Multi-Bearer System
MCDU	Multi-Purpose Control and Display Unit
MCHPA	Multi Carrier High-Power Amplifier
MCU	Modular Concept Unit
MEO	Medium Earth Orbit
MFR	Manufacturer
MHz	Megahertz
MIL	Military
M-ISDN	Modular Integrated Services Digital Network
MMU	Memory Management Unit
MNN	Mobile Network Mode
MOPS	Minimum Operational Performance Standards
MP	Middle Plug
MPDS	Mobile Packet Data Service
MRO	Maintenance and Repair Organization
ms	millisecond
MSS	Mobile Satellite Services
MSB	Most Significant Bit

APPENDIX A ACRONYMS

MTSAT	Multifunction Transport Satellite
NCD	No Computed Data
NCP	Network-layer Control Protocol
NCS	Network Coordination Station
NIST	National Institute of Standards and Technology
NOC	Network Operations Center
NS	Non-Safety
NVM	Non-Volatile Memory
OEM	Original Equipment Manufacturer
ORT	Owner Requirements Table
PADI	PPPoE Active Discovery Initiation
PADO	PPPoE Active Discovery Offer
PADR	PPPoE Active Discovery Request
PADT	PPPoE Active Discovery Termination
PAPR	Peak-to-Average Power Ratio
PBX	Private Branch Exchange
PC	Public Call
PCM	Pulse Code Modulation
PCS	Payload Control System
PDP	Packet Data Protocol
PEP	Peak Envelope Power
PER	Packet Error Rate
PKI	Public Key Infrastructure
PIES	Passenger Information and Entertainment Services
PIESD	Passenger Information and Entertainment Services Domain
PIM	Passive Intermodulation
PIMBIT	Passive Intermodulation Built-In Test
PLMN	Public Land Mobile Network
POTS	Plain Old Telephone Service
PPP	Point-to-Point Protocol
PPPoE	Point-to-Point Protocol Over Ethernet
PS	Packet Switched
PSDN	Packet Switched Data Network
Psid	P-Channel used for satellite identification
PSTN	Public Switched Telephone Network
PTT	Push-to-Talk
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RAM	Random Access Memory
RAN	Radio Access Network
REN	Ringer Equivalent Number

**APPENDIX A
ACRONYMS**

RDI	Restricted Data Interface
RF	Radio Frequency
RFU	Radio Frequency Unit
RMP	Radio Management Panel
RMS	Root Mean Square
ROM	Read Only Memory
RTP	Real-time Transport Protocol
Rx	Receive
SAL	System Address Label
SARPs	Standards and Recommended Practices
SAS	Satellite Access Station
satcom	Satellite Communications
SBB	SwiftBroadband
SBS	Satellite Base Station
SCC	Satellite Control Center
SCDU	Satellite Control/Display Unit
SCM	SDU Configuration Module
SDI	Source/Destination Identifier
SDM	Inmarsat System Definition Manual
SDU	Satellite Data Unit
SELCAL	Selective Calling
SGSN	Supporting GPRS Support Node
SIP	Session Initiation Protocol
SL	Security Level
SLIC	Subscriber Line Interface Circuit
SMART	Standard Modular Avionics Repair and Test System
SMS	Short Message Service
SNMP	Simple Network Management Protocol
SSM	Sign/Status Matrix
STX	Start of Text
SU	Signal Unit
SYN	Synchronization
TBD	To Be Determined
TCAS	Traffic Collision Avoidance System
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	Time Division Multiplexed
TDMA	Time Division Multiple Access
TE	Terminal Equipment
TFT	Traffic Flow Template
TFTS	Terrestrial Flight Telecommunications System
TNC	Threaded Neill-Concelman (RF connector)
TP	Top Plug

**APPENDIX A
ACRONYMS**

TT&C	Telemetry Tracking & Control
Tx	Transmit
UDI	Unrestricted Data Interface
UMS	User Modifiable Software
UMTS	Universal Mobile Telephone System
USIM	UMTS Subscriber Identity Module
UT	User Terminal
UTC	Universal Time Coordinated
V	Volts
VA	Volt-Ampere
Vac	Volts, alternating current
Vdc	Volts, direct current
VHF	Very High Frequency
VoIP	Voice over IP
VPN	Virtual Private Network
VSWR	Voltage Standing Wave Ratio
W	Watts
WAN	Wide Area Network
WCDMA	Wide-band Code Division Multiple Access
WG	Working Group
WGS-84	World Geodetic System 1984
WRC-03	World Radio Communication Conference 2003
WOW	Weight On Wheels
WSC	Williamsburg SDU Controller
WSCI	Williamsburg SDU Controller Interface
XL Band	Extended L-band

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

APPENDIX B SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

B-1 Introduction and Background

The increasing use of and importance in new airplane designs of airborne networks based on standard Ethernet and IP protocols results in a significant new arena of information systems security risks that must be understood and adequately mitigated or controlled.

Readers of this appendix looking to jump ahead to specific design guidance are directed to the sections Step 2: Select and Implement Security Controls and Specific ARINC 781 Implementation Architectures.

COMMENTARY

This security analysis was produced in 2008 based on ARINC Report 811 methodology. As of 2012, the recommended methodology is EUROCAE ED-202/RTCA DO-326. This analysis has been retained here, as it contains much useful material, but users are cautioned that ARINC Report 811 is not the preferred security process methodology where there are potential impacts to safety.

B-2 Design Principles for Secure Airborne Networks

Certain guiding principles for design of secure and cost-effective airborne networks should be taken into account when developing industry standards specifications:

- Specifications must allow for a range of different network architectures with common interfaces that meet the needs of the respective manufacturers and their suppliers. These different architectures will reflect varying levels of integration and sharing of components and services across security domains and will provide varying levels of protection inherent in the network design.
- In an integrated airplane network architecture using shared resources, security considerations take on greater significance than in one that assumes physical isolation of domains.
- Cost savings may be realized when onboard resources are shared, while still meeting assurance requirements.
- Security must be designed into the network in multiple layers, reflecting a defense-in-depth approach. This means that security controls are designed into both the network design as a whole, and also into individual components.
- Airborne systems and networks whose failure do not impact safety of flight (“minor” or less) may nonetheless impact airline business operations if functioning in a degraded or non-working state. Such systems and networks may process airline or passenger data requiring security controls that maintain confidentiality, integrity, and/or availability.

This analysis is conducted in as objective a manner as possible using an ARINC standard framework and does not presuppose or limit itself to any specific airborne network architectures in order to remain applicable to a broad range of current and future implementations of the satcom Ethernet interface. However, after the analysis sections, some sample architectures are presented to illustrate the application of recommended security controls. The analysis methodology is presented in the next section.

APPENDIX B SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

B-3 Analysis Methodology

ARINC Report 811: *Commercial Aircraft Information Security Concepts of Operation and Process Framework*, defines a three step risk-based information security process framework which can be employed to develop secure aircraft information systems. It is intended to provide a high-level information security process that organizations can tailor to suit business/operational needs, integrate with existing operations, and apply in a consistent and repeatable manner across heterogeneous aircraft information systems, which may be acquired from multiple suppliers. The intended audience includes all organizations (e.g., airlines, aircraft and avionics suppliers, service providers, etc.) that specify, acquire, develop, implement, test, operate, and maintain secure aircraft information systems.

Note: The reader is encouraged to become familiar with the content of the ARINC Report 811.

This framework was first used when developing specifications for ACARS message security (AMS).

The high-level risk-based information security process consists of three steps and a review process (some text excerpted from ARINC Report 811).

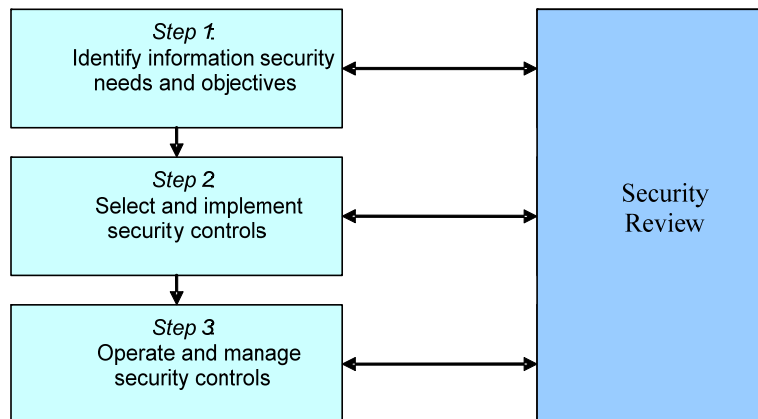


Figure 1

This analysis will also follow this framework, but will only focus on the activities of Step 1, and to a limited extent, Step 2.

Step 1: Identify information security needs and objectives – consists of performing the analysis necessary to enable determination of which security controls are most appropriate to the system under consideration.

This step involves activities like:

- Asset identification – what information will the system process?
- Security categorization – how sensitive is the information?
- Risk assessment – what threats exist to the system? How likely are they and how severe could their impact be?
- Policy identification – what policies, regulations, and laws must be taken into account during system design and operation?
- Physical environment and assumptions – what assumptions can be made that will affect the design of the security solution?

APPENDIX B SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

- Security objectives – what fundamental objectives – including business objectives as well as security objectives – drive the design of the security solution?

Step 2: Select and implement security controls – consists of selecting appropriate security controls, also referred to as safeguards or countermeasures, and implementing them based on considerations like cost and security using the security objectives and the results of the risk-based analysis performed in step 1.

Security controls include a set of management, operational, and technical controls, where:

- Management controls focus on processes that are performed by an airline to manage aircraft information system security to an acceptable level of risk. Examples include configuration management and contingency and recovery planning.
- Operational controls focus on processes that are performed by people. Examples include use of identification badges and training airline personnel in the proper operation of security systems.
- Technical controls include those mechanisms that are implemented primarily in hardware, software, and firmware. Examples include encryption (a cryptographic mechanism) and firewalls (a non-cryptographic mechanism).

When possible, priority should be given to automated technical controls over operational controls, allowing better security and reducing airline overhead to administer operational security.

The risk-based security process facilitates selection and implementation of the minimum set of security controls that support an airline organization in:

- Performing its mission (e.g., safe carriage of passengers/cargo, meeting financial objectives of stakeholders).
- Maintaining its business operating functions (e.g., dispatch, maintenance).
- Meeting its legal responsibilities (e.g., regulatory).
- Protecting individuals (e.g., crewmembers, passengers).
- Protecting its aircraft information systems consistent with airline security policy.

Step 3: Operate and manage security controls – concerns the ongoing work involved in maintaining the selected security controls once the system is in operation. The operation and management of security controls might be the most important step in the process to the airlines. This is especially true when steps one and two are provided by other companies.

Complementary to these three steps is the security review process. Security review consists of revisiting steps 1-3 to determine if the security needs and objectives have changed, if the security controls remain appropriate, and if the system is being operated securely and cost-effectively.

Refer to ARINC Report 811 for further decomposition and explanation of these steps.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

B-4 Security Analysis of Satcom Interfaces

This analysis is based on the characteristics of the information assets that will be transmitted via the Inmarsat services. A security failure of the SDU could result in exposure of confidential assets to unauthorized parties, compromise of the integrity of those assets, impersonation of privileged communications, and/or the inability to transmit those information assets to and from the ground. Security controls or functions of the SDU and its Ethernet interfaces should therefore enable resistance to such failures. Considering the mapping of user interfaces to compatible Inmarsat services (ARINC Characteristic 781, Table 3.3), the following analysis is extended to all interfaces (SBB, Swift64, and Classic Aero). Indeed, all services on SBB Ethernet are not available today and satcom should prevent security failure when used with other services such as Classic Aero regardless of the architecture of the aircraft.

The scope of the analysis is focused on the SDU and its neighbor systems, but takes into consideration some of the potential threat vectors such as attacks launched against the airplane from the ground.

Step 1: Identify information security needs and objectives

Step 1.1: Asset identification and security categorization

Although Inmarsat does not currently offer or support use of SwiftBroadband for safety services, the service is targeted for use by airlines for business operational communications that could have significant impact to airline operations if unavailable. Other uses of the service may be for passenger voice or data connectivity which, while not critical to airline operations, would tarnish the airline's reputation if passenger communications are compromised or become unavailable. Table 1 identifies at a high level the information assets carried by the SBB service including future safety of flight services. A more detailed breakdown into information sub-types is normally defined as part of the analysis, but is probably not needed for purposes of this document. ARINC Report 811 has a good example list of aircraft information types.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Table 1

Information Type	Description	Owner	Primary Domain
Airline operational data	Data such as aircraft position, or FOQA data used to maintain health and dispatchability of the aircraft.	Airline	Airline Information Services (AIS)
Engine monitoring data	Data collected by engine monitoring subsystem and transmitted to engine manufacturer and airline.	Airline	Aircraft Control (AC) (originates in ACD but transmitted by system in AIS domain)
Cabin crew application data	Data for applications such as duty free on board, cabin logbook. May include passenger personal data and credit card numbers.	Airline	AIS
Pilot comms	AOC-type messages	Airline	AC or AIS
Passenger comms	Voice over IP (VoIP) calls, email, web.	Passengers	Passenger Information and Entertainment Services (PIES)
SDU configuration	Configuration and session data essential for operation of the SDU.	Airline/service provider (Inmarsat Distribution Partner)	AIS or PIES (See note)
Safety services	Cockpit voice and data.	Airline	AC

Security categorization provides an initial estimate concerning the importance of the fundamental security services of confidentiality, integrity, and availability within the system.

Table 2 shows the security categorization of the data types in Table 1. The highest category is used when there are multiple sub-types of varying impact.

Note: The actual physical location of the interface may reside in either – it is dependent on the particular architecture chosen by the manufacturer. Due to the fact that it is an interface to lower integrity networks on the ground, it is often represented as being in the PIES domain.

Table 2

Information Type	Security Category		
	Confidentiality	Integrity	Availability
Airline operational data	High	Medium	Medium
Engine monitoring data	Medium	High	High
Cabin crew application data	High	Medium	Medium
Pilot communications	High	Medium	Medium
Passenger communications	Low	Low	Low
SDU control and configuration	High	High	Medium
SDU operational status	Low	Medium	Medium
Safety services	Medium	High	High

Notes:

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

1. Due to sensitivities to tracking of individual pilot actions, airline operational data such as FOQA must be kept highly confidential until it is processed and anonymized on the ground. Also, as airlines more fully integrate the data feeds coming off of the aircraft into their regular operations, they will rely on its availability for operations.
2. The effectiveness of onboard applications (e.g., aircraft health monitoring and prognostics functions) depends on the reliable collection and off-aircraft transmission of the associated data. Loss, corruption, alteration or reception of the data by unauthorized entities can compromise the integrity of the data and thus severely impact the effectiveness of the applications and their value to the airline.
3. Cabin crew application data ratings reflect the sensitivity of passenger personal and credit card data that might be present in a buy onboard application, and reliance on transmission of cabin logbook data to the ground to ensure quick turnaround at the arrival gate.
4. Passenger communications, while possibly important to the passenger, are rated Low to reflect the fact that an attack against any of the categories would have minimal impact to the airline, loss of goodwill chief among them.
5. A compromise of the SDU's own configuration data (e.g., ORT) would likely impact the other information types. Loss or non-availability of this data would mean that the SDU could not operate, and therefore no satcom service could be provided. Likewise if its integrity were compromised, although this could also have a financial impact as an attacker could manipulate the configuration to use a more expensive class or type of service. Adding the capability of the satcom to support safety services, the integrity of the configuration needs to be assured.

The primary domain mainly depends on the architecture of the Aircraft. The analysis should be based on the most restrictive use of the satcom devices.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

The connection between the different outputs identified in Table 3-3 and the different domains are identified in the following table (including future support):

User Interface		Inmarsat Service			Connected Domain
		SwiftBroadband	Swift64	Classic Aero	
Non-ATC Cockpit Voice	4-wire Analog + discrete	X		X	ACD
ATC Cockpit Voice	4-wire Analog + discrete	X		X	ACD
Cabin Voice	2-wire Analog POTS/SLIC	X	X	X	AISD/PIESD
	CEPT-E1	X	X	X	
	ISDN	X	X	X	
Non - ATC Cockpit Data	ARINC 429 Data-2/Data-3			X	ACD
	Ethernet/AFDX	X	X	X	
ATC Cockpit Data	ARINC 429 Data-2/Data-3			X	ACD
	Ethernet/AFDX	X		X	
Cabin Data (inc. Fax, Modem and Packet Data)	CEPT-E1	X	X	X	AISD/PIESD
	ISDN	X	X		
	Ethernet	X	X		
	2-wire Analog POTS/SLIC	X	X	X	

Step 1.2.1: Assess risk

The risk assessment step consists of threat identification and threat analysis. Table 3 identifies the system-specific threats. This table is focused on security of the SDU, and does not enumerate threats present in the ground infrastructure, e.g., Inmarsat Distribution Partner's network or airline's network, although security of the overall system will rely heavily on controls in place in the ground environment to restrict access to the forward link (see assumption A.DP). The threat analysis portion consists of estimating the likelihood and severity of each threat identified, and has been combined into the same table for easier reading. Because this document analyzes a specification rather than being based on operational experience with deployed ARINC 781 systems, the analysis takes a conservative yet concerned approach and is instead primarily based on the technical difficulty of carrying out the threat, and assumes a population of motivated attackers exists. It is certainly far more expensive to add/retrofit security controls to deployed systems than to specify them up front. Likelihood and Severity ratings for the parent threats (in bold type) represent the highest rating of the child threats.

It should also be stressed that there is little to no inherent security at layer 2 of the OSI model (the Media Access Control layer, typically implemented as Ethernet), so security controls to counter these threats must be implemented at higher layers as well as in the physical environment. Once an attacker has direct access to layer 2 of the network (i.e., plugging into the local segment), full compromise of the system is possible. Also, many network-based attacks would likely come from the cabin network (PIES domain) and attempt to reach the cockpit network (AC or AIS domain).

APPENDIX B

SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

The threats to each SDU interface should be identified. The following diagram shows a proposed worst case architecture. It identifies all the interface services with their domain of connection. The diagram does not present part segregation but some main functions of the SDU that are linked together. The Administration, Configuration, Control, Dataloading, Monitoring, etc., is a representation of all the commands that can be sent to the different parts of the satcom, for instance ORT, configuration of each channel card, RF power, priority, etc. The purpose of the links is only to indicate an exchange of data, without any consideration of the type of link for each kind.

COMMENTARY

The reader should note that some connection with AIS and PIES may be shared, which has to be monitored closely.

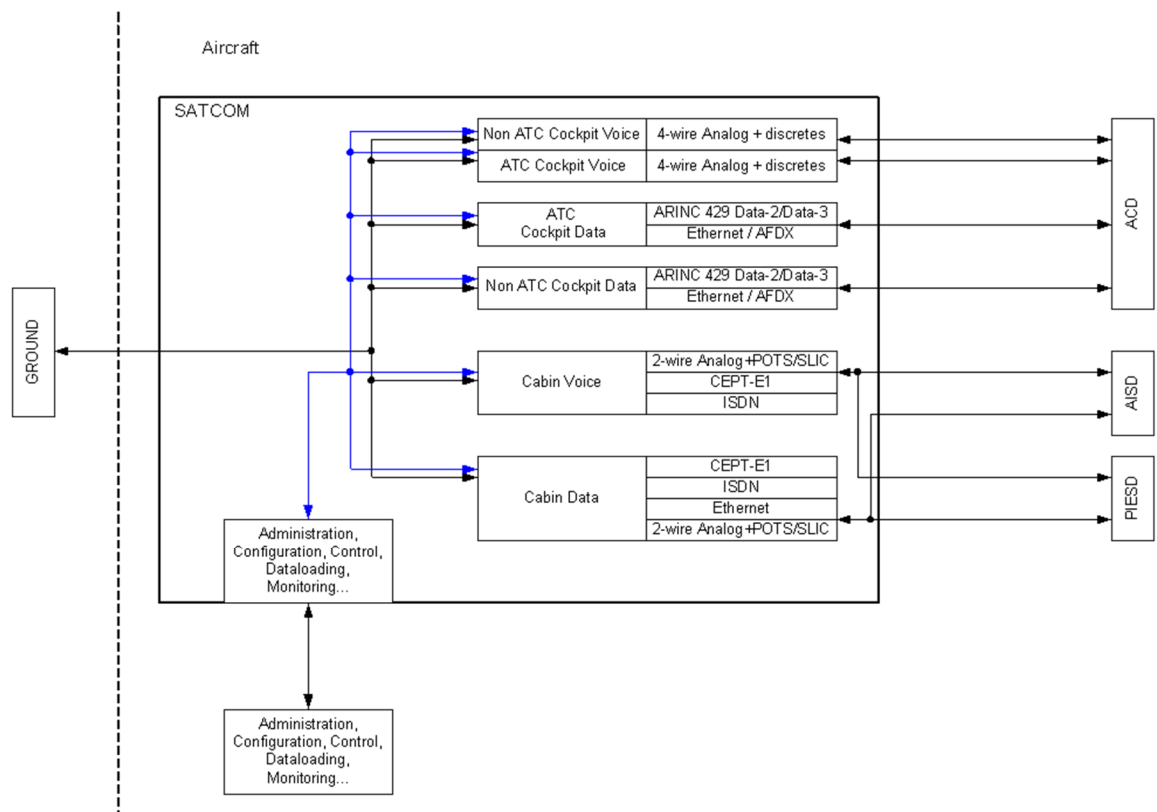


Figure 2

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Table 3

Threat Identifier	Threat Description	Likelihood	Severity
T.ACCESS	An authorized user may gain unauthorized access to the aircraft system or to information controlled by the aircraft system via user error, system error, or an attack for malicious or non-malicious purposes.	Likely	Medium
T.ACCESS.1	A disgruntled airline employee may eavesdrop on or interfere with proprietary or sensitive data on the airplane sent via the SBB service. Mitigated by use of application end-to-end encryption (A.APPLICATION SECURITY).	Unlikely	Medium
T.ACCESS.2	A malicious or curious passenger may access the system and interfere with its operation, cause increased cost to the airline due to unauthorized changes to classes or contexts, or obtain free offboard access.	Likely	Medium
T.ENTRY	An individual other than an authorized user may gain access to the aircraft system or to information controlled by the aircraft system via system error or an attack for malicious purposes.	Highly likely	Medium
T.ENTRY.1	Control messages to the SDU may be spoofed.	Highly likely	Medium
T.ENTRY.2	Session traffic from trusted hosts may be eavesdropped.	Likely	Low
T.ENTRY.3	Status messages from the SDU may be spoofed.	Highly likely	Medium
T.ENTRY.4	Satcom integrity may be compromised by attack from the outside of the aircraft or PIESD.	Highly likely	High
T.ENTRY.5	The ACD may be compromised by attack from the PIESD.	Highly likely	High
T.ENTRY.6	The ACD may be compromised by attack using the high-speed Satcom function (SBB or Swift 64) through the "Classic" Aero service.	Highly likely	High
T.ENTRY.7	Data exchanged between ground and ACD may be corrupted by an attacker from the PIESD.	Highly likely	High
T.ENTRY.8	Data exchanged between ground and ACD may be corrupted by an attacker from the PIESD.	Highly likely	High
T.DOS	The aircraft system resources may become exhausted due to system error, non-malicious user actions, or denial-of-service (DoS) attack.	Highly likely	High
T.DOS.1	An attacker may cause exhaustion of all 11 primary contexts by the generation of bogus PDP setup messages (PADI->PADS).	Highly likely	High

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Threat Identifier	Threat Description	Likelihood	Severity
T.DOS.2	An attacker or non-malicious user may generate bogus or spurious traffic that saturates the channel or specific contexts.	Highly likely	High
T.DOS.3	An attacker may inject bogus PADT control messages that cause shutdown of a context.	Likely	High
T.DOS.4	Communication between ACD and Ground may be denied by an attacker from the PIESD.	Highly likely	High
T.DOS.5	An attacker using the high-speed satcom function (SBB and Swift 64) may deny use of the Classic aero service.	Highly likely	High
T.DOS.6	An attacker from the PIESD may deny communication between the AISD and Ground.	Highly likely	Medium
T.DEVELOP	Security failures may occur as the result of problems introduced during implementation of the aircraft system.	likely	High
T.DEVELOP.1	An attacker may intentionally introduce security flaws during the development of the SDU software.	likely	High
T.DEVELOP.2	Software with security flaws may be introduced into the process after development but before implementation on the aircraft.	likely	High
T.FAILURE	The secure state of the aircraft system could be compromised in the event of a system failure.	Highly likely	High
T.FAILURE.1	An attacker could compromise overall security of the system by causing a failure in one component of that system.	Highly likely	High
T.FAILURE.2	In the event of hardware failure, the security of the aircraft may be compromised.	Highly likely	High
T.INSTALL	The aircraft system may be delivered or installed in a manner that undermines security.	Likely	Medium
T.INSTALL.1	An attacker may compromise a system that has been incorrectly configured at installation.	Likely	Medium
T.MAINTAIN	The security of the aircraft system may be reduced or defeated due to errors or omissions in the administration and maintenance of the security features of the aircraft system.	Highly likely	High
T.MAINTAIN.1	An authorized maintenance tech may introduce an obsolete software version in place of a newer one, exposing vulnerabilities that were previously fixed.	Likely	Medium
T.MAINTAIN.2	Security features may be disabled by a technician because they are preventing completion of work or dispatch of the aircraft.	Highly likely	High
T.OPERATE	Security failures may occur because of improper operation of the aircraft system.	Likely	High

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Threat Identifier	Threat Description	Likelihood	Severity
T.OPERATE.1	An authorized user of the system may intentionally force the operational system into an unsecure state.	Likely	High
T.OPERATE.2	An attacker may attempt compromise of the system during a less secure operating state.	Likely	High
T.PHYSICAL	Security-critical parts of the aircraft system may be subjected to a physical attack that may compromise security.	Unlikely	Medium
T.PHYSICAL.1	An attacker with physical access to the equipment may reconfigure the system to turn off security functions. Mitigated by existing aircraft physical access controls (A.AIRCRAFT-ACCESS).	Unlikely	Medium
T.PHYSICAL.2	An attacker may install a tapping device to capture network traffic. Mitigated by existing aircraft physical access controls (A.AIRCRAFT-ACCESS).	Unlikely	Medium
T.TRACEABLE	Security relevant events may not be traceable to the user or process associated with the event.	Highly likely	Low
T.TRACEABLE.1	An attacker may subvert the logging function of the SDU in order to conceal or destroy evidence of his activities.	Highly likely	Low
T.TRACEABLE.2	An attacker may assume another user's identity while performing malicious activity in order to conceal the source of the activity.	Highly likely	Low

The threats in Table 3 are shown in risk grid format below in Figure 3. Mitigation efforts and selection of security controls should of course focus first on the threats in the red areas, then on the ones in the yellow areas.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

L i k e l i h o o d	Highly Likely	T.TRACEABLE		T.MAINTAIN T.FAILURE T.DOS T.ENTRY
	Likely		T.INSTALL T.ACCESS	T.OPERATE T.DEVELOP
	Unlikely		T.PHYSICAL	
		Low	Medium	High
		Severity		

Figure 3

Step 1.2.2: Identify policies

This step identifies policies that may have an impact on the selection of security controls for aircraft systems. Policies are grouped into five major areas:

1. **Airline information security policies**
 Because airlines will have different information security policies, security specifications must remain flexible. But since networks on airplanes using open Internet standards are a new thing, most airlines' policies are only written to address their internal networks on the ground and have not yet been expanded to include networks operating onboard the aircraft in their fleet.
2. **National laws regarding import and export of cryptography**
 Designers of airplane systems that use cryptography must take into account the restrictions that some countries have in place on the import, use, and/or export of cryptography.
3. **Lawfully authorized electronic surveillance (LAES, aka lawful intercept)**
 Most governments around the world have laws that require communications service providers to provide information about communications or access to them for surveillance purposes, upon presentation of a court order by a law enforcement agency. These laws generally require that communication systems are designed and implemented specifically to facilitate such access.
4. **National and international laws regarding data privacy**
 Many countries have laws that govern how personally identifiable data is to

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

be protected in transit and in storage. This will primarily impact systems that carry passenger or crewmember information.

5. National and international regulations governing development and implementation of aircraft systems

These regulations govern how aircraft systems are to be designed and implemented for use on aircraft. Although references to security in these regulations are almost entirely focused on certification of security controls around systems that affect safety of flight, significant work is proceeding in various industry groups (e.g., EUROCAE WG72) to develop standards for security controls and assessment methodologies for non-safety-related yet operationally critical systems. Research is also being conducted under the auspices of various civil aviation authorities in this area.

Further discussion of these policy areas may be found in ARINC Report 811.

Table 4 details some of the relevant policies.

Table 4

Policy Identifier	Policy Description
P.AIRLINE	Airline information security policies
P.AIRLINE.1	Per requirements of many pilots unions, operational data (e.g., FOQA) that is identifiable to a specific pilot must be treated as highly sensitive and protected from disclosure.
P.AIRLINE.2	Passenger personal data will be protected from access by unauthorized parties.
P.AIRLINE.3	Passenger credit card information will be encrypted end-to-end to comply with credit card merchant requirements (ref. Payment Card Industry Data Security Standard (PCI DSS))
P.EXPORT	National and international laws regarding import and export of cryptography
P.EXPORT.1	Use of cryptography in ARINC 781 systems may require system developers, implementers, or owners to obtain licenses from countries in which an equipped aircraft may operate. This may include both landing and over flight situations. This requirement may be mitigated if encryption is used only for authentication and not for data transmission, or if the encryption function is built-in and not accessible to users.
P.LAES	Lawfully authorized electronic surveillance (aka lawful intercept).
P.LAES.1	Governments may require escrow or production to law enforcement of encryption keys used to encrypt data.
P.LAES.2	Communications service providers may be required by law to build facilities for electronic surveillance into their infrastructures to facilitate easy access by law enforcement agencies. <i>Note:</i> ETSI has published the most technical standards material for lawful intercept, ref. document 102-232, et al.
P.PRIVACY	National and international laws regarding data privacy.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Policy Identifier	Policy Description
P.PRIVACY.1	Personally identifiable information of passengers and crew members may be required to be specially protected from disclosure. (see also P.AIRLINE.1 above, as it deals with privacy of pilot-connected flight data.)
P.REGULATION	National and international regulations governing development and implementation of aircraft systems.
P.REGULATION.1	TBD

Step 1.2.3: Determine physical environment and assumptions

The third step in the risk assessment stage looks at the physical environment and other existing controls in place that mitigate the risk introduced by the threats listed in Table 3. The assumptions must be true regardless of the architecture and the airline operating it.

Table 5

Assumption ID	Assumption Description
A.AIRCRAFT-ACCESS	Existing aircraft access controls are assumed to be sufficient to prevent unauthorized persons from gaining physical access to the SDU.
A.DP	Inmarsat distribution partners must implement security controls on the ground segment to protect unauthorized access to the forward link to the aircraft, and to limit spurious traffic from the Internet.
A.SUPPLY-CHAIN-INTEGRITY	Existing mechanisms for digital signing, crating, and transmission of software parts are assumed to be sufficient to ensure integrity and authenticity (protect against malicious insertion of compromised software at some point in the supply chain (e.g., Trojans, back doors)).
A.DEVELOP	Satcom software is assumed to be provided free of intentional flaws or malicious code.
A.OOB-CONTROL	For flexibility of control, implementations will use an out-of-band control line between DTE and MT.
A.MAINTAIN	Airlines and maintenance personnel are considered to be authorized and trusted.
A.OPERATE	Airline and service provider personnel are assumed to be authorized and trusted.

A.MAINTAIN and A.OPERATE: As airlines and maintenance personnel are considered to be authorized and trusted, the threats identified T.MAINTAIN and T.OPERATE.1 are not considered in this analysis. Misuse is considered for some actions, but those are not supported by the satcom.

Those assumptions on the environment are used to define the threat scenarios to be considered for the design of a secure satcom. Compared to the threats identified in the Table 3, the remaining threats are:

- Provide integrity of the satcom from attack from the outside of the aircraft
- Provide integrity of the satcom from attack from the PIESD

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

- Protect the ACD from attack from AISD/PIESD
- Protect the ACD from attack from the high-speed satcom function (SBB and Swift64) through the “Classic” aero
- Provide integrity and availability of the data exchanged with ACD from attack from the PIESD
- Ensure integrity of communication between ground and ACD
- Ensure integrity of communication between ground and AISD
- Provide integrity and availability of the data exchanged with AISD from attack from the PIESD
- No satcom failure shall lead to a security breach
- No lack of security shall result from any given state of the system

Step 1.3: Characterize security objectives

Information security objectives are high-level goals that guide the selection of security controls. ARINC Report 811 defines 14 fundamental objectives that are common across most airplane cabin systems.

Table 6

Objective ID	Objective Description
O.COMMONCONTROLS	Aircraft systems should use common security controls for purposes of development cost reduction, simplicity, and centralized management.
O.COST	The overall cost of aircraft system security controls should be minimized. Cost factors to consider include both development costs and operation and maintenance costs.
O.DEFENSE-IN-DEPTH	Aircraft systems should employ multiple security controls to mitigate each significant threat.
O.EXISTING-LIFECYCLE	Development, operation, and maintenance of security controls for aircraft systems should fit within the existing aircraft lifecycle (e.g., not force changes in maintenance schedules).
O.EXISTING-SYSTEMS	Security solutions for new systems should require as few changes as possible to existing systems.
O.FLEXIBILITY	Security controls for aircraft systems should be flexible in order to permit a variety of different policies and procedures for their operation.
O.FUNCTION	Aircraft systems must provide effective operation to users performing authorized actions.
O.FUTURE-RESILIENCY	Aircraft systems should be designed to allow for regular adoption of new security controls and technology.
O.MINIMIZE-OVERHEAD	Security controls for aircraft systems should require minimal administrative and operational overhead.
O.MISSION-ACCOMPLISH	Security controls for aircraft systems should not inhibit airline mission accomplishment (i.e., delivery of passengers from point A to point B).
O.OPEN-STANDARDS	Security controls for aircraft systems should be based on open standards.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Objective ID	Objective Description
O.PUBLICPERCEPTION	Security controls for aircraft systems should protect airlines, manufacturers, and suppliers from threats that may affect their commercial image.
O.SAFETY	Security controls for aircraft systems should in no way compromise the safety of the aircraft.
O.SECURE	Security controls for aircraft systems should mitigate the risks to aircraft systems to a level that is acceptable based on airline business needs.

Step 2: Select and implement security controls

After the risk analysis has been completed per step 1, one can then begin to select security controls that mitigate the identified threats (table 3) while achieving the best balance in satisfying the stated security objectives (table 6). Selection of security controls for the satcom system should balance security needs with cost and supportability limitations. Controls may also include network design elements that provide isolation and segregation between domains onboard the aircraft.

ARINC Report 811 may be consulted for descriptions of the seventeen high-level control areas that guide the selection of system-specific controls. They are comprised of technical, operational, and management controls, which work together to achieve security objectives.

The threat consequences are corruption, denial of service, loss of data or disclosure. The controls implemented have to mitigate the risk of those consequences considering the different threats identified in Table 3 above and the assumptions in Table 5.

Table 7 shows the recommended security controls for ARINC 781 systems that address the major threats identified in Table 3 above.

Table 7

Control	Control Description and Suggested Implementation
Encrypt all control connections for transport of AT commands from DTE to MT. Satcom should provide integrity and authorization control of "Administration, Configuration, Control, Dataloading, Monitoring..."	Protect the internal control, monitoring, administration of the satcom. In particular, in case of channel card reconfiguration, it should be demonstrated that it cannot be disrupted by attack from ground or PIEDS. Use of secure shell (SSH) to carry commands to the MT instead of telnet mitigates risk from the following threats: T.ENTRY.1 T.ENTRY.3 T.ENTRY.4 T.DOS.3
The system should recover gracefully when failure of a security function is detected, and shut down if repeated abnormalities are seen.	Prevents operation of the system in an unsecure state. Attackers often attempt to disable security systems first so that activities can continue undetected. Mitigates risk defined by: T.FAILURE.1
The system should be safe secure.	In case of component failure, it should not create a security breach. T.FAILURE.2

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Control	Control Description and Suggested Implementation
The system should provide aircraft security during all states of the system (considering the different threats identified).	During all operational mode of the satcom (shutdown, transitory shutdown, configuration phase, initialization phase, operational mode, abnormal mode, downloading), the satcom should not enable a security breach of the aircraft. T.OPERATE.2
The system should generate a maintenance log entry when failure of a security function is detected.	Enables reactive detection of possible attacks against the system, i.e., does not directly prevent an attack but enables a response that may limit its severity or duration.
The satcom should support strict partitioning of traffic from AIS and PIES domains by physical or equivalent logical separation internal to the satcom, up to the RF module.	Use of separate physical communications paths (Ethernet interfaces, modems, and channel cards) minimizes the risk that an attacker can either subvert a shared component to gain access across the domain boundary, or flood a shared component to reduce resources available to the other domain (e.g., AIS, as attacker is most likely coming from PIES). Mitigates risk defined by: T.ACCESS.1 T.ENTRY.8 T.DOS T.FAILURE.
The satcom should support strict partitioning of traffic from ACD and AISD/PIESD by physical or equivalent logical separation internal to the satcom, up to the RF module.	Use of separate physical communications paths (Ethernet interfaces, modems, and channel cards) minimizes the risk that an attacker can either subvert a shared component to gain access across the domain boundary, or flood a shared component to reduce resources available to the other domain (e.g., as attacker is most likely coming from PIESD). Mitigates risk defined by: T.ACCESS.1 T.ENTRY.7 T.DOS T.FAILURE
The satcom should support strict partitioning of traffic between "Classic" Aero and SBB/S64 services.	Use of separate physical communications paths to prevent disturbance of ACD communication. (This segregation permits the previous control only when ACD use "Classic" Aero services, but in the future ACD may use also include SBB service). T.ENTRY.6 T.DOS
Satcom should support authenticated and encrypted communication between ground and AISD.	Satcom should allow an authenticated and encrypted communication to go through the satcom between the ground and the AISD (As suggested in the control deleted above, the satcom may not be an end point of such a communication). It protects communications from PIESD.
Satcom should support authenticated and encrypted communication between ground and ACD.	Satcom should allow an authenticated and encrypted communication to go through the satcom between the ground and the ACD (As suggested in the control deleted above, the satcom may not be an end point of such a communication). T.ENTRY.5

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Control	Control Description and Suggested Implementation
Satcom should support authenticated and encrypted communication between ground and PIESD.	Satcom should allow an authenticated and encrypted communication to go through the satcom between the ground and the PIESD

The justification of strict partitioning between ACD, AISD, and PIESD may not be easy, but it has to be achieved in order to reduce the vulnerabilities of attack from the PIESD.

Instead of having “SBB user sessions are authenticated and encrypted” considering the different architectures, it is more useful for the satcom to have authenticated and encrypted communications to go through satcom ACD or AISD. Moreover, satcom may not be the only standard IP communication means (as shown in Figure 6), and such authenticated and encrypted communication should be common for all those means. This is the reason for authenticated and encrypted communication to go through the satcom.

Satcom may also have to allow authenticated and encrypted communication between ground and PIESD to go through the satcom in case of secure communication for passenger is required by airlines/passenger.

According to Table 3-3 of Section 3.0, the cockpit data may be able to use SBB services instead of Classic Aero, provided that SBB will not present more vulnerabilities. To prevent this risk, a strict partitioning is required between Classic Aero and SBB/S64, so that Classic Aero can still be used as it is today.

The following drawings are illustrations of the different threats to illustrate the need of these security measures.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

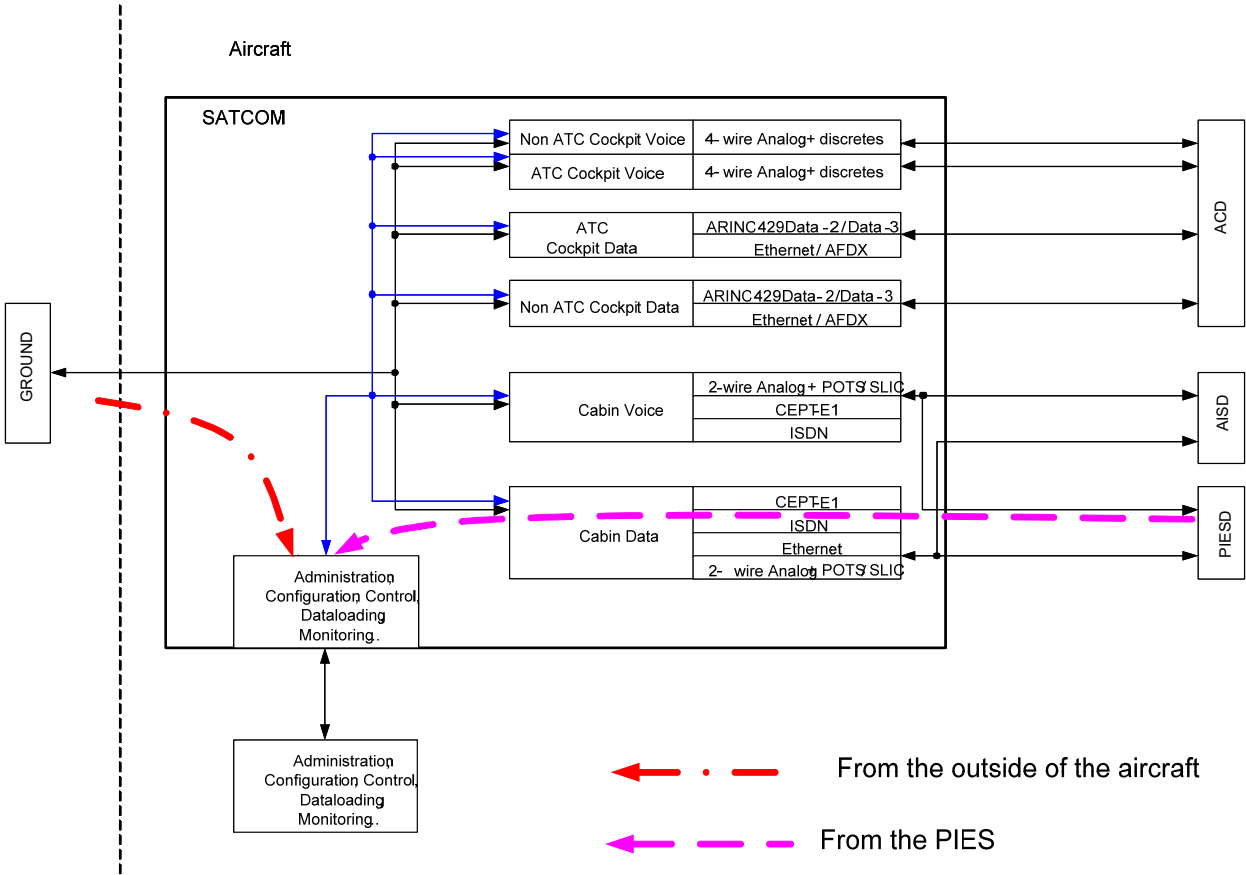


Figure 4 – Integrity

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

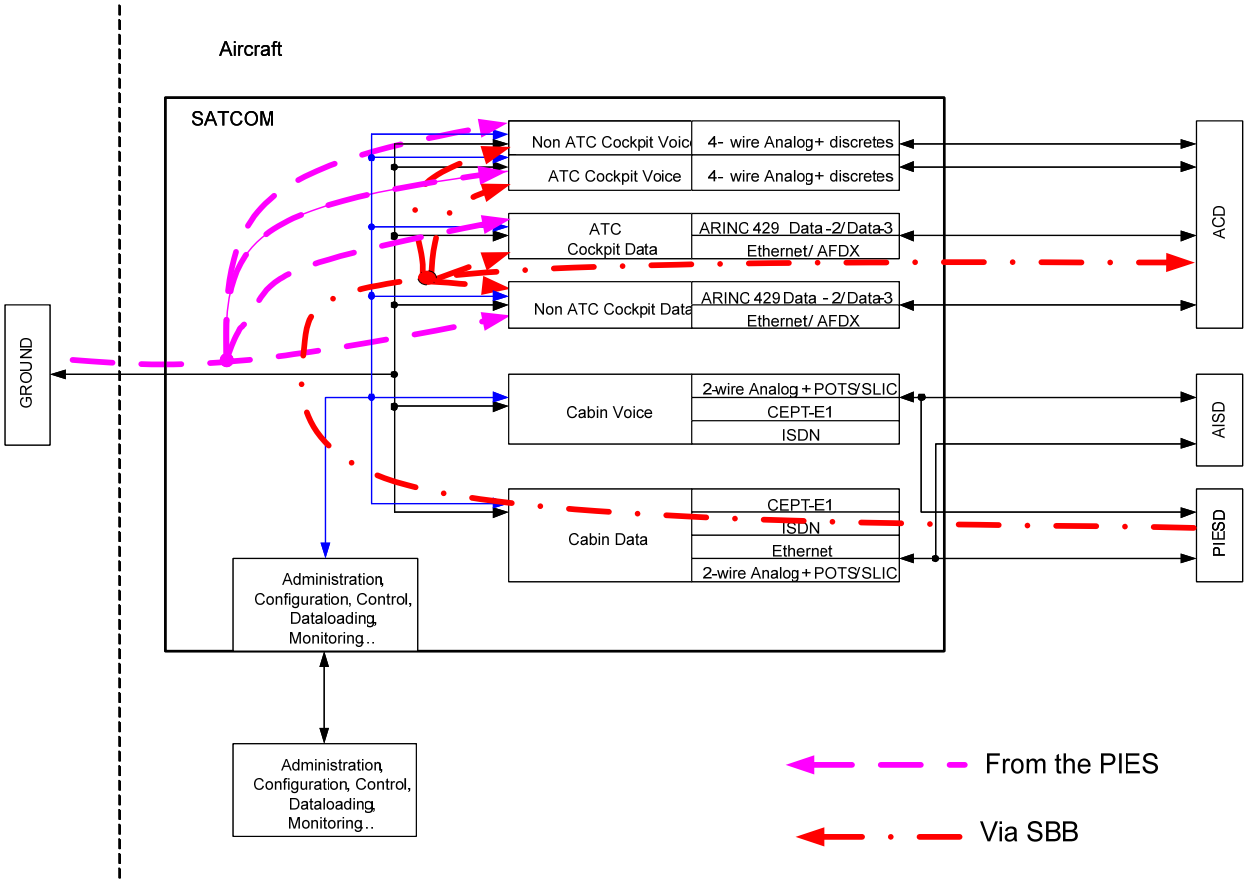


Figure 5 – Protection of the Aircraft Control Domain (ACD)

APPENDIX B SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

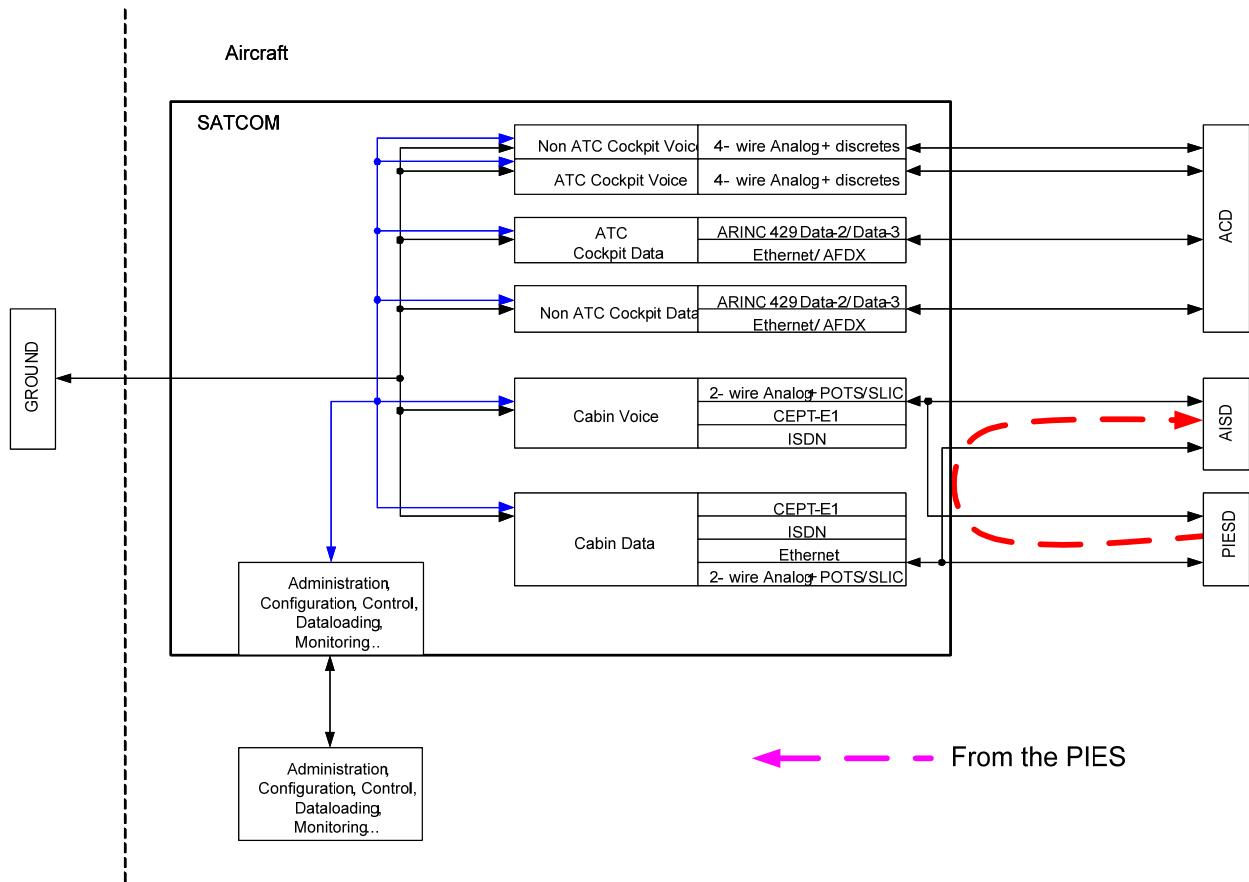


Figure 6 – Protection of the AISD

The following section, Specific ARINC 781 Implementation Architectures, illustrates some possible network designs and discusses the security profile and related considerations of each.

B-5 Specific ARINC 781 Implementation Architectures

Three possible network implementation designs were discussed in the Security subgroup meeting on January 29, 2007. The potential designs offer different levels of logical and physical separation of network traffic of varying protection requirements. Note also that the interface recommendations allow for setups as simple as a single laptop connected to the SDU (per Section 3.2.4.1 in the main document), so not all implementations will be of this higher complexity. Because the selected network design contributes significantly to the inherent security of an airborne system, careful consideration must be given to the pros and cons of each when making implementation decisions. Meeting the objective of defense-in-depth (see Step 1.3 above) helps ensure that network designs ranging in complexity from simple (single Terminal Equipment connected directly to SDU) to complex (multi-domain network) have adequate security implemented in each of the components actually in use. For example, this means that a simple setup with a single TE has an SDU that is reasonably protected from malicious software that may be running on the TE (laptop) without the user's knowledge.

Figure 7 below shows the major components of IFE, EFB, and Picocell all connecting to a network file server (NFS) or switch/router module, with a single connection to the satcom interface. These three components are of different

APPENDIX B

SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

assurance levels and reside in different domains of the aircraft network, yet share a common link to the satcom SDU. The NFS/switch/router would have to be able to differentiate traffic by source and destination, to protect the SDU from attack by unauthorized persons in the IFE (cabin) domain. Establishing separate VLANs by source of traffic would provide some security against basic threats, but should not be regarded as a complete solution as many switch implementations do not adequately resist attacks against them, and therefore may allow an attacker to inject traffic that jumps VLANs or cause the switch to fail into shared hub mode. Without additional security controls in the SDU, the NFS/switch/router is solely responsible for network defense of the SDU.

This design represents the likely most common implementation, and is made more secure by use of separate communication paths inside the satcom SDU with two Ethernet interfaces to receive connections from the switch from the AIS and PIES domains.

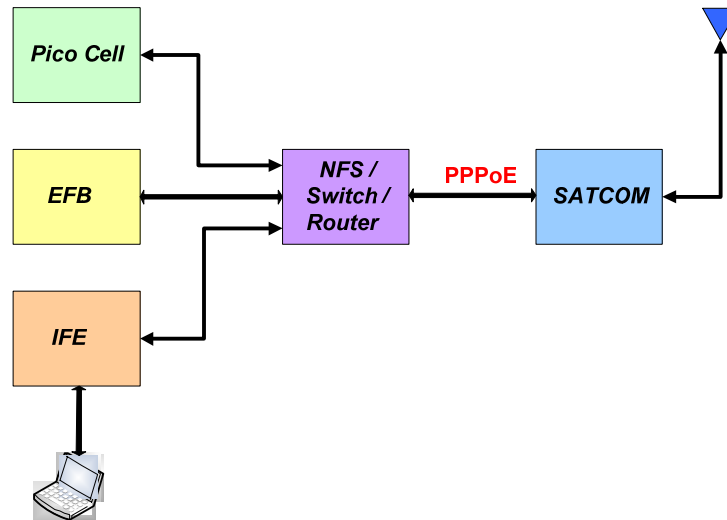


Figure 7

Figure 8 shows a design that establishes separate physical communication paths for cockpit applications like EFB, and for cabin-related applications. Note again that Cockpit as used here corresponds to the AIS domain, and Cabin refers to the PIES domain (ref. ARINC Specification 664). The SDU should therefore offer separate Ethernet interfaces that connect to separate modems and channel cards. However, the cost of deploying a second NFS/switch/router may make this design an unlikely proposition.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

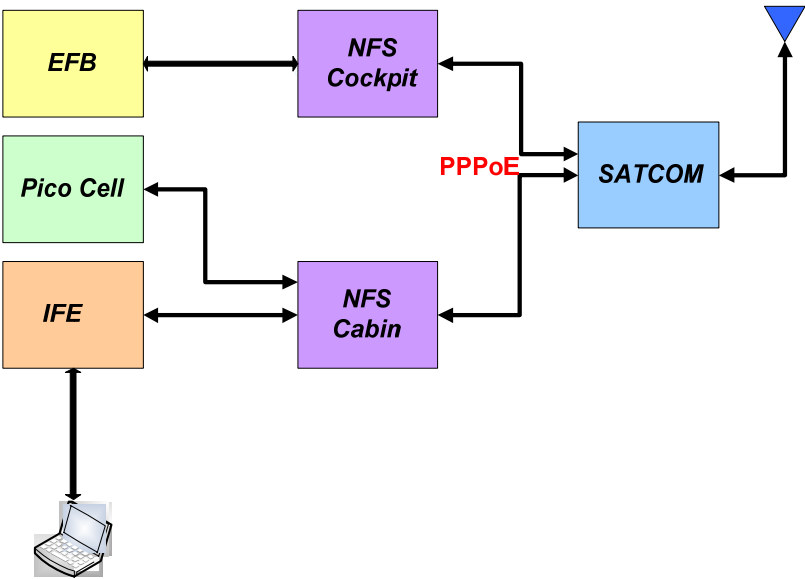


Figure 8

Figure 9 is similar in separation to the Figure 8 design, but uses two separate SDUs. This design would go even more strongly against cost and weight reduction objectives, while not achieving substantially lower risk than the design above. Despite this, some airlines are considering this design, believing it to offer redundancy that will enhance dispatchability of the aircraft.

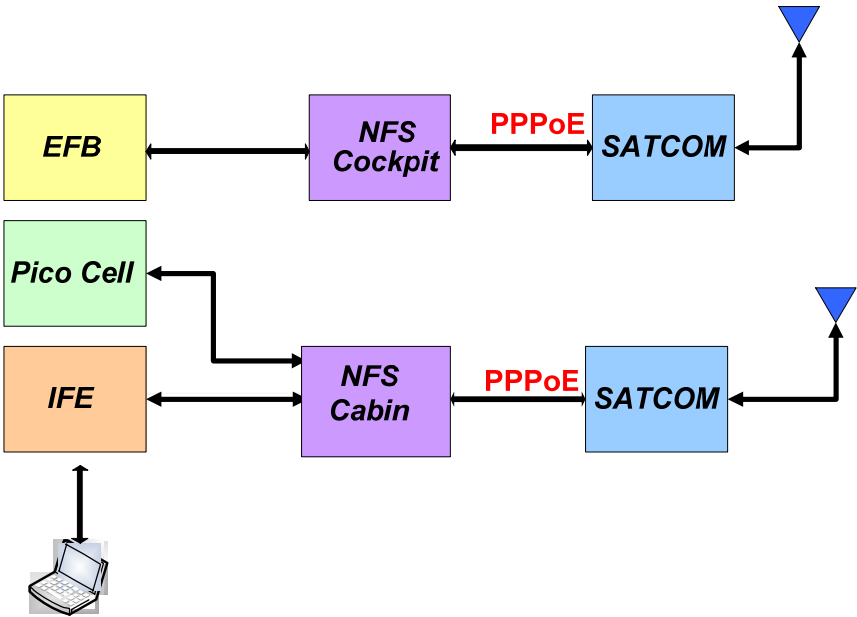


Figure 9

Absent additional security controls on the SDU Ethernet interface, the chief security concern with the preceding designs is a complete reliance on the security of the NFS/switch unit. This goes against the security objective of defense-in-depth (O.DEFENSE-IN-DEPTH).

Another area of potential interest regards use of a standard interface for all offboard links. Figure 10 below shows an example scenario for commercial aircraft where

APPENDIX B SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

multiple offboard links are present and routing intelligence is implemented to select a specific link depending on application, flight phase, and location requirements. All interfaces are via Internet standard layer 3 protocols (IP, ICMP).

This includes the communications manager function that is instantiated separately from the NFS/switch/router. It is responsible for securely managing and controlling all offboard links.

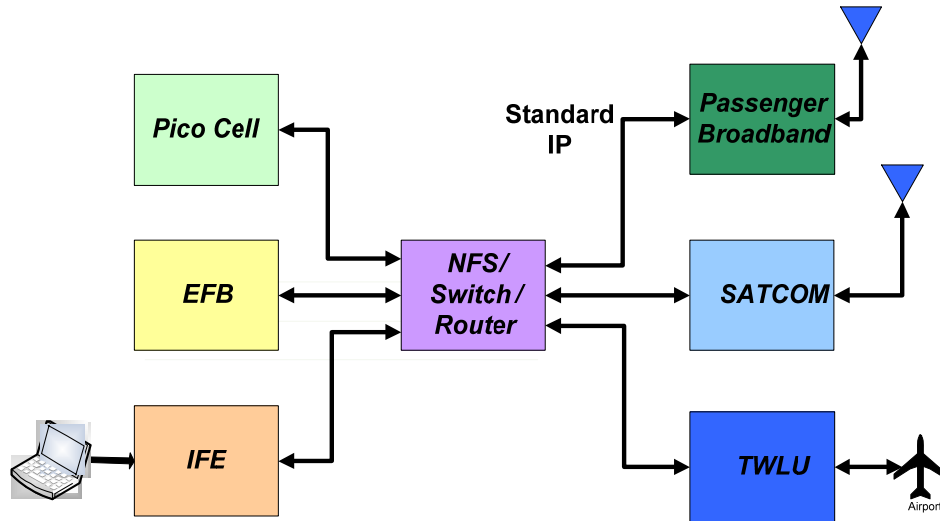


Figure 10

B-6 Summary

This security analysis has enumerated the threats that may be introduced when interfacing an ARINC 781 satcom SDU to an aircraft's onboard data network via an Ethernet interface, and lays out some recommended security controls to mitigate those threats. Adherence to defense-in-depth and traffic segregation principles means that a secure network design cannot rely on single points of control; rather each component in the network must contribute to overall security. For the satcom, this means that the Ethernet interface(s) must be segregated from the "Classic" Aero channel and must support authenticated and encrypted connections when needed for the different domains. It must ensure that malicious cabin network activities or ground activities cannot interfere with these higher sensitivity domains. Most importantly, the communication paths inside the satcom must be fully segregated through to the channel cards to ensure adequate separation of domain traffic.

B-7 Explanation of Terminology Used for Security Configuration

Security categorization provides an initial estimate concerning the importance of the fundamental security services of confidentiality, integrity, and availability within the system.

Here confidentiality, integrity, and availability are defined as follows:

- Confidentiality – protection against unauthorized disclosure of information.
- Integrity – protection against unauthorized modification or destruction of information.
- Availability – protection against disruption of access to, or use of, information.

Note that integrity and availability have established meanings in the aeronautical community, and their meaning in a security context is subtly different. Specifically

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

security integrity and security availability focus on the prevention of deliberate attacks, whereas the aeronautical community has traditionally focused on the prevention of accidental errors.

Security categorization looks at the potential impact of loss of each of the services for each identified information type within the system, and ranks the impact as either none, low, medium, or high.

Here none means that loss of the service would have no practical adverse effect on operations. Examples of impacts that would be categorized as none, include:

- Aircraft operation: No degradation in mission capability.
- Assets: No maintenance action, scheduled or unscheduled, required for airline assets.
- Financial: Negligible financial loss.
- Human: No discernible negative effect on passengers.
- Public perception: No negative effect on attitude of passengers in airline services.

Here low means that loss of the service would have only a limited adverse effect on operations. Examples of impacts that would be categorized as “low” impact include:

- Aircraft operation: Slight degradation in mission capability to an extent and duration that an airline is still able to perform its primary functions, but with somewhat reduced effectiveness – for example increased crew workload.
- Assets: Minor damage to airline assets.
- Financial: Minor financial loss.
- Human: Discomfort to passengers.
- Public perception: Distrust of service by airline customers.

Medium means that loss of the service could have a serious adverse effect on operations. Examples of impacts that would be categorized as medium impact include:

- Aircraft operation: Degradation in mission capability to an extent and duration that an airline is still able to perform its primary functions, but with noticeably reduced effectiveness – for example, heavy stress on crew or flight delays.
- Assets: Significant damage to airline assets.
- Financial: Significant financial loss.
- Human: Limited physical harm to individuals.
- Public perception: Serious distrust of some passengers in air traffic, disclosure of confidential airline operational data.

High means that loss of the service could have a severe or catastrophic effect on operations. Examples of impacts that would be categorized as high impact include:

- Aircraft operation: Serious degradation in or loss of mission capability so that an airline is not able to perform one or more of its primary functions for a period of time – for example flight interrupt or fleet re-route.
- Assets: Major damage to airline assets.
- Financial: Major financial loss.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

- Human: Serious or catastrophic physical harm to individuals.
- Public perception: Total loss of confidence in air traffic by passengers, disclosure of security information.

Note that in the above definitions, aircraft operation and human impacts are closely related to the traditional focus of safety analysis, whereas asset, financial, and public perception impacts are primarily airline business issues.

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SUPPLEMENT 1
TO
ARINC CHARACTERISTIC 781
MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEM

Published: November 22, 2006

Prepared by the AEEC

Adopted by the Airlines Electronic Engineering Executive Committee:

October 11, 2006

A. PURPOSE OF THIS DOCUMENT

This supplement primarily provides updates as follows:

- Added clarifications for interchangeability and connector contact arrangements.
- Added information concerning the external flange-mounted High Power Amplifier (HPA).
- For the Type D DLNA, changed the transmit port to antenna port and transmit port to receive port rejection.
- Added Section 3 SATCOM functions.
- Added Attachment 3 Cockpit Voice - Sat Phone State Machine for Normal Operation.
- Added Attachment 4-A, ARINC 781 SDU Functions Matrix.
- Added Attachment 4-B, ARINC 781 SDU Interfaces Matrix.
- Added Attachment 5 Ethernet Interface.

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document **blue bold** text is used to indicate those areas of text changed by the current supplement only.

C. CHANGES TO ARINC CHARACTERISTIC 781 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.1 Purpose of this Characteristic

The commentary has been deleted.

1.2 Relationship of This Document to Other ARINC Characteristics and Industry Documents

List of ARINC characteristics updated.

1.4 Function of Equipment

Added the transmit frequency range is likely to be limited by the DLNA transmit filter.

1.7.2 Receiver Equipment Performance

Clarification of G/T achievement conditions.

1.8 Interchangeability

Editorial changes and clarifications made concerning functional doublets versus matched pairs of equipment.

2.2.1.2 Connectors

SDU connectors' type clarified.

2.2.1.4.1 Frequency Range

Section created to define SDU frequency range. Subsequent section were renumbered.

2.2.1.5 RF Characteristics for SDU with External HPA

Commentary concerning the SDU RF characteristic added.

2.2.2 External Flange-Mounted High Power Amplifier (HPA)

Two subsections have been created.

2.2.2.1 General

Description of the external flange-mounted HPA updated.

2.2.2.2 RF Characteristic for External Flange-Mounted HPA

External Flange-mounted HPA RF characteristics defined.

2.2.4.3 Type D DLNA

This section and associated sub-sections have been updated regarding Type D DLNA characteristic change.

2.3 Antenna Specification

Adapter Plate role has been clarified.

2.3.1.2 Ideal Antenna Coverage Volume

Throughput has been replaced by Availability.

2.3.2.6.4 Gain

The gain value has been defined.

2.3.2.6.13.1 Antenna Intermodulation Products in Satcom Receive Band

The antenna Intermodulation Products in satcom Receive Band has been defined.

2.3.2.6.13.2 Antenna Intermodulation Products in GNSS Band

The antenna Intermodulation Products in GNSS Band has been defined.

2.3.3.6.4 Gain

The gain value has been defined.

2.3.3.6.12.1 Antenna Intermodulation Products in Satcom Receive Band

The antenna Intermodulation Products in satcom Receive Band has been defined.

2.3.3.6.12.2 Antenna Intermodulation Products in GNSS Band

The antenna Intermodulation Products in GNSS Band has been defined.

2.3.5.1 Loss Between SDU and External HPA

Coaxial cable loss value between SDU and external HPA has been changed from “19 to 25 dB” to “8 to 18 db.”

2.3.5.2 Polarization

Deleted commentary.

2.3.6 RF Installation Issues

New section added on RF installation concern.

2.5.1 Primary Power Input

External HPA power consumption defined.

2.6 System Functions and Signal Characteristics

A reference to Attachment 1-4 has been added.

2.8 Cooling

Added paragraph on cooling for non-ARINC 600 devices.

2.8.1 SDU

Clarifications were added on cooling loss in Emergency situations.

2.8.2 Flange Mounted HPA

External HPA cooling has been defined.

2.10 System ATE and BITE Design

The title of the section has been modified and the subsections were renumbered.

3.0 Satcom Functions

This new section on Satcom functions was added. The subsections include

- Inmarsat Radio; Inmarsat Services, Management of Radio Interfaces.
- User Interfaces; Pilot System Interfaces for Voice Communication, Cockpit Data, ISDN Interface, Ethernet, CEPT-E1, and POTS.
- Software Data Loader Interfaces.
- Miscellaneous; Dual, Configuration & Identification Data, and Security.
- Priority, Precedence, Preemption and Preference.
- Future Growth; AFDX, Fiber Optic, FANS/ATS over SwiftBroadband, and Multi Frequency Band.

ATTACHMENT 1-1A - GENERAL CONFIGURATION OVERVIEW - SINGLE SATCOM INSTALLATION

Revised diagram.

ATTACHMENT 1-1B - GENERAL CONFIGURATION OVERVIEW - DUAL SATCOM INSTALLATION

Revised diagram.

ATTACHMENT 1-3 - STANDARD INTERWIRING

Interwiring was updated.

ATTACHMENT 1-4 - NOTES APPLICABLE TO STANDARD INTERWIRING

Interwiring notes have been changed mainly to reference ORT parameters and the use of hybrid GPS/inertial data.

ATTACHMENT 1-4A - SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

This attachment has been changed to include the WOW logic select as multiplexed pin-programming and to rearrange some parameters. A typo has been corrected (WCSI became WSCI). This attachment has also been changed to mandate the use of the SDU number pin to differentiate between left and right satcoms.

ATTACHMENT 1-5 - SDU FORM FACTOR

Quadrax inserts have been modified.

ATTACHMENT 1-5A - SDU TOP PLUG CONNECTOR LAYOUT

For ISDN and Ethernet ports, this attachment has been modified to replace A/B by +/-.

TP06D is no longer a spare config pin.

ATTACHMENT 1-5B - SDU MIDDLE PLUG CONNECTOR LAYOUT

For Ethernet ports or Quadrax connectors, this attachment has been modified to clearly replace A/B by +/-.

CP has been changed to Cockpit.

MP07C has now become a spare discrete.

The Quadrax connectors pin-out has been corrected.

ATTACHMENT 1-5C - SDU BOTTOM PLUG CONNECTOR LAYOUT

The optic fiber inserts' attribute have been added.

ATTACHMENT 1-6A - SDU CONFIGURATION MODULE CONNECTOR LAYOUT

Editorial changes to SCM connector and pin-out have been made.

ATTACHMENT 1-7 - FLANGE MOUNT HPA FORM FACTOR

The HPA form factor has been changed.

ATTACHMENT 1-7A - FLANGE MOUNT HPA CONNECTOR LAYOUT

The HPA connector pin-out has been added.

ATTACHMENT 1-8A - DLNA POWER AND CONTROL CONNECTOR LAYOUT

The DLNA pin-out has been clarified.

ATTACHMENT 1-10 - HIGH GAIN AND INTERMEDIATE GAIN TOP MOUNT ANTENNA FOOTPRINT MAXIMUM DIMENSIONAL OUTLINE

The keep-away zone wording has been clarified.

ATTACHMENT 1-12 - HIGH GAIN AND INTERMEDIATE GAIN ANTENNA CONTROL CONNECTOR LAYOUT

SCRN has been replaced by Shield.

ATTACHMENT 2 - ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATION SYSTEM

The list of modifications is the following:

- Figures 1, 2, and 3 on HPA/SDU communication protocol and associated notes have been deleted.
- Notes # 1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 16, 28, 30, 31, 34, 37, 39, and 42 have been deleted and marked as unused.
- Notes 47, 48, 49, 50, 51, and 52 have been added and annotated on the appropriate figures.

Reserved labels for SDU to Antenna manufacturer specific communications have been defined and some minor editorial changes have been made.

ATTACHMENT 2A - ANTENNA CONFIGURATION DATA REPORTING

Updated the label fields in the ARINC 429 words. Specified that the ETX and EOT words must appear in bits 25-31 of the word. Revised Section 4, Configuration Data, to note that all data is transferred using a subset of the ISO 8859-5 alphabet plus addition of STX, ETX, EOT, and SYN as defined in ARINC Specification 429, Part 1, Attachment 5.

ATTACHMENT 3 - COCKPIT VOICE - SAT PHONE STATE MACHINE FOR NORMAL OPERATION

Added new attachment. The former Attachment 3, Attachment Reference Guide, is now in Attachment 6.

ATTACHMENT 4-A - ARINC 781 SDU FUNCTIONS MATRIX

A matrix listing SDU functions has been added.

ATTACHMENT 4-B - ARINC 781 SDU INTERFACES MATRIX

A matrix listing SDU interfaces has been added.

ATTACHMENT 5 - ETHERNET INTERFACE

This attachment has been added.

ATTACHMENT 6 - ATTACHMENT REFERENCE GUIDE

This attachment, formerly Attachment 3, was updated.

APPENDIX 1 - ACRONYMS

The acronyms list has been updated.

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SUPPLEMENT 2
TO
ARINC CHARACTERISTIC 781
MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEM

Published: November 15, 2007

Prepared by the AEEC

Adopted by the Airlines Electronic Engineering Executive Committee:

September 26, 2007

A. PURPOSE OF THIS DOCUMENT

This supplement primarily provides corrections or updates to:

- Transmit Frequency range of terminal is changed to 1626.5 to 1660.5 MHz.
- Definition of G/T for antenna
- DLNA: Addition of historical summary, improved noise figure
- Addition of Type F DLNA
- Addition of intermodulation requirements for the DLNA to antenna cable.
- Definition of the frequency range used by different Inmarsat services
- GNSS Frequency Check Algorithm
- Ethernet Interface
- ORT items and configuration pins including additions to determine if GNSS frequency management is required in SDU.
- Security requirements
- Attachment 1-3/1-5B – Addition of two I/O pins for SDU (previously spares)
- Attachment 1-4A – Addition of system configuration pins.
- Attachment 1-7A – External HPA connector type
- Attachment 1-8 – Addition of Type F DLNA Form factor
- Attachment 2A – Changes to antenna configuration data reporting.
- Attachment 5 – Ethernet Interface
- Attachment 6 – Addition of security analysis

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document **blue bold** text is used to indicate those areas of text changed by the current supplement only.

C. CHANGES TO ARINC CHARACTERISTIC 781 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.3 Inmarsat System Description

Deleted last sentence of fourth paragraph.

1.4 Function of Equipment

Deleted second paragraph.

1.6.4 Diplexer/Low Noise Amplifier (DLNA)

Added last sentence to first paragraph. Deleted last paragraph.

1.7.2 Receiver Equipment Performance

Changed method of determining G/T.

2.2.1.4.6 Harmonics, Discrete Spurious Emissions and Noise

Deleted 'Type D' before 'DLNA.'

2.2.2.2 RF Characteristic for External Flange Mounted HPA

Editorial correction.

2.2.4 Diplexer/Low-Noise Amplifier (DLNA)

Added commentary explaining use of Type D DLNA. Added historical development commentary.

2.2.4.2 Noise Figure/Gain

Changed noise figure for below 25 °C and 70 °C from 1.8 dB to 1.2 dB and 2.1 dB to 1.6 dB, respectively.

2.2.4.3 Insertion Loss and rejection

Changed title from Type D DLNA. Deleted commentary.

2.2.4.3.2.1 Type D - Transmit Port to Antenna Port

Added new section title and moved text from Section 2.2.4.3.2 here.

2.2.4.3.2.2 Type F - Transmit Port to Antenna Port

Added new section.

2.2.4.3.3.1 Type D - Transmit Port to Receive Port (DLNA Output)

Added new section title and moved text from Section 2.2.4.3.3 here.

2.2.4.3.3.2 Type F - Transmit Port to Receive Port (DLNA Output)

Added new section.

2.2.4.5 DLNA Intermodulation

Added new section and commentary. Section was called DLNA Connectors – this has been renumbered as Section 2.2.4.6.

2.2.4.5.1 Type F - DLNA Intermodulation Products in Satcom Receive Band

Added new section.

2.2.4.5.2 Type F - DLNA Intermodulation Products in GNSS Band

Added new section.

2.2.4.6 DLNA Connectors

Previously this was Section 2.2.4.5

2.2.4.7 DLNA Form Factor

Added note. Previously this was Section 2.2.4.6

2.3.2.5.4 Receiver System Figure of Merit (G/T)

Changed method of determining G/T.

2.3.2.6.13.1 Antenna Intermodulation Products in Satcom Receive Band

Changed 1629.5 to 1626.5 MHz. Changed requirement to be consistent with new method of determining G/T.

2.3.2.6.13.2 Antenna Intermodulation Products in GNSS Band

Changed 1629.5 to 1626.5 MHz.

2.3.3.5.4 Receiver System Figure of Merit (G/T)

Changed method of determining G/T.

2.3.3.6.12.1 Antenna Intermodulation Products in Satcom Receive Band

Changed 1629.5 to 1626.5 MHz.. Changed requirement to be consistent with new method of determining G/T.

2.3.3.6.12.2 Antenna Intermodulation Products in GNSS Band

Changed 1629.5 to 1626.5 MHz.

2.3.5.2 DLNA to Antenna Cable

Added new section. Added intermodulation requirements to this cable,

2.3.5.3 Total transmit Loss Between SDU or HPA and Antenna

Added note that total loss can increase at bottom of band due to DLNA insertion loss, Section renumbered.

2.3.5.4 Loss Between LNA and SDU

Section renumbered.

2.3.6 RF Installation Issues

In 2nd para, changed antenna to a reference.

3.1.1.4 SwiftBroadband

Comment added about supported streaming rates. Figure updated including deleting 256 kbps streaming.

3.1.2.4.2 Frequency Allocations by Ground Stations

Added the Classic frequency range. Revised the Swift64 category A and B allocations.

3.1.2.4.3 GNSS Frequency Management in the AES

Updated to explain use of ORT and configuration pins to control function. Added methodology to set the ORT and configuration pins.

3.1.2.4.4 Recommended Frequency Check Algorithm in SDU

Added behavior of SDU if frequency check fails. Added reference to previous para.

3.2.4 Ethernet

Added sentence and commentary.

3.2.4.1 Purpose and Requirements of the Interface

Re-formatted list of services and added text on retrieving status of the SDU and communications services/links and the interface should have adequate security for the intended applications.

3.2.4.2 Interface Components

Deleted circuit switched service and added use of PPPoE to set up Swift64 and SwiftBroadband Circuit Switched UDI data calls.

3.2.4.3 Interface Fundamentals

Revised the interface fundamentals for the “Routed Interface” and PPPoE.

3.2.4.4 Multiple Ethernet Interfaces

Added new sections.

3.4.2.1.3 ORT Contents

Extensive revisions to ORT Section C: Ethernet Ports Configuration. Added to ORT Section E: Item 5 GNSS frequency check algorithm and item 9 weight on wheels input configuration.

3.4.3 Security (and subsections)

Major revisions.

ATTACHMENT 1-3 – STANDARD INTERWIRING

Revised various pin assignments – key ones being: SDU MP01G, SDU MP02G, HPA pins renumbered to reflect change in connector type, renamed Ethernet pins.

ATTACHMENT 1-4 – NOTES APPLICABLE TO STANDARD INTERWIRING

Minor revisions to note 7 and added new notes 36 and 37.

ATTACHMENT 1-4A – SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

Redefined TP6E from spare to WOW input presence and GNSS frequency check. Removed DLNA Type from TP4F and TP4G and set codes 6, 7, and 9 to reserved for future.

ATTACHMENT 1-5B – SDU MIDDLE PLUG CONNECTOR LAYOUT

Revised to be consistent with changes to Attachment 1-3 Standard Interwiring.

ATTACHMENT 1-5C – SDU BOTTOM PLUG CONNECTOR LAYOUT

Revised to be consistent with changes to Attachment 1-3 Standard Interwiring.

ATTACHMENT 1-7A – FLANGE MOUNT HPA CONNECTOR LAYOUT

Changed connector type and renumbered pins.

ATTACHMENT 1-8 – DIPLEXER/LOW NOISE AMPLIFIER FORM FACTOR

Added figure for Type F.

ATTACHMENT 1-12 – HIGH GAIN AND INTERMEDIATE GAIN ANTENNA CONTROL CONNECTOR LAYOUT

Connector is now applicable to IGA as well as HGA.

ATTACHMENT 2A – ANTENNA CONFIGURATION DATA REPORTING

Revisions to all subsections.

ATTACHMENT 2B – BIT-ORIENTED FAULT REPORTING PROTOCOL

Revised Fault Summary Word #9 for satcom Ethernet ports.

ATTACHMENT 5 – ETHERNET INTERFACE

Major revisions were made to this section. All are not noted in this description of changes. Sections 5-7 contain all new material, but are not marked with track changes in order to improve readability. The former material in Section 6 (ORT Values Required for Ethernet Interface) has been moved and integrated into Section 3.2.4.1.

APPENDIX 2 – SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Added new appendix.

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SUPPLEMENT 3
TO
ARINC CHARACTERISTIC 781
MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEM

Published: February 9, 2009

Prepared by the AEEC

Adopted by the AEEC Executive Committee:

October 22, 2008

A. PURPOSE OF THIS DOCUMENT

This supplement provides corrections or updates to:

- Flange Mount HPA
- Security Analysis of the Satcom Ethernet Interface

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document **blue bold** text is used to indicate those areas of text changed by the current supplement only.

C. CHANGES TO ARINC CHARACTERISTIC 781 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.7.1 Transmitter Equipment Performance

The table and notes have been updated to reflect which services Inmarsat operate on each satellite generation Inmarsat 3 (I3) and Inmarsat 4 (I4).

2.2.1.4.2 RF Output Power

Updated to reference, Attachment 6 and values for HGA and IGA identified. The Note was changed.

2.2.2 External Flange Mount HPA and Subsections

Major rewrite which introduces two types of external flange mount HPA being small and large. Both are actively cooled although the large HPA has a loss of cooling mode. The output power ratings of the HPAs are 22-35 W, and 30-60 W respectively.

2.5.1 Primary Power Input

The table has been updated to define the input power of the external HPAs, as well as for the SDU in 'loss of cooling mode.'

2.8 Cooling

Reference to ARINC Specification 628 deleted and replaced by reference to Sections 2.2.2.2 and 2.2.2.3.

2.8.2 Flange Mounted HPA

The cooling for the small and large mounted HPAs is defined as 50 and 72 kg/hr of 60 °C (max) air with a 51 mm of water pressure drop. A loss of cooling mode is defined for the large HPA.

ATTACHMENT 1-2B – SATCOM CONFIGURATION – OPTIONAL FLANGE MOUNT HPA

'Cable' is changed to 'installation loss' in the note.

ATTACHMENT 1-6 – SDU CONFIGURATION MODULE FORM FACTOR

The position of the earth stud between the two views was contradictory. This has been corrected.

ATTACHMENT 1-7A – SMALL FLANGE MOUNT HPA FORM FACTOR

New form factor figure is provided.

ATTACHMENT 1-7B – LARGE FLANGE MOUNT HPA FORM FACTOR

New form factor figure is provided.

ATTACHMENT 1-7C – FLANGE MOUNT HPA CONNECTOR LAYOUT

The connector layout figure is renamed from Attachment 1-7A to Attachment 1-7C.

ATTACHMENT 6 – ARINC 781 HPA OUTPUT POWER USE CASES

This attachment is new and the old Attachment 6 has been renamed Attachment 7. This attachment defines 'HPA RF power use cases' which manufacturers may use to dimension the size (in RF output power) of their HPAs depending on expected applications.

APPENDIX B – SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

This appendix has been updated by Airbus so it now reflects security needs on both Boeing and Airbus aircraft. There are numerous changes that are not identified in this description of changes, but are marked in blue bold in the actual text.

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SUPPLEMENT 4
TO
ARINC CHARACTERISTIC 781
MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEM

Published: May 19, 2010

Prepared by the AEEC

Adopted by the AEEC Executive Committee:

March 31, 2010

A. PURPOSE OF THIS DOCUMENT

This supplement adds new material on Passive Intermodulation Built-In Test (PIMBIT) and RF installation issues. The following areas have also been updated:

- ORT contents
- Attachment 1-3 Standard Interwiring
- Attachment 1-4 Notes Applicable to Standard Interwiring
- Attachment 2B Bit-Oriented Fault reporting Protocol
- Attachment 5 Ethernet Interface.

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document **blue bold** text is used to indicate those areas of text changed by the current supplement only.

C. CHANGES TO ARINC CHARACTERISTIC 781 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

2.3.6 RF Installation Issues

Commentary was revised. Material was added on some best practices to obtain a low PIM installation of a SwiftBroadband satcom system and general maintenance guidelines for aluminum aircraft fuselages.

3.4.2.1.3 ORT Contents

Section B: Interfacing Systems Configuration was updated to include Data from GNSS to SDU.

Section E: Miscellaneous Configuration Settings was updated to include PIMBIT.

3.7 Passive Intermodulation Built-In Test (PIMBIT)

The new material in this section and its subsections is applicable to multi-channel system installations that support at least one SwiftBroadband channel. For the case of multiple system installations, each system can be treated independently of the others (in view of the assumed minimum propagation loss between the multiple systems' antennas).

ATTACHMENT 1-3 – STANDARD INTERWIRING

Changed MP06J and MP06K from “Spare ARINC 429 Input” to “Data from GNSS to SDU”.

ATTACHMENT 1-4 – NOTES APPLICABLE TO STANDARD INTERWIRING

Broke Note 15 into Notes 15 and 16 and renumbered all remaining notes.

Revised Note 15 extensively regarding the GNSS data to include deleting Label 370 GNSS Height (HAE) from the Hybrid Inertial/GNSS Data column.

Revised Note 16 regarding the circuit breaker size and wire size limits.

ATTACHMENT 1-5B

Pins MP6J and MP6K assigned to “Data from GNSS to SDU”.

ATTACHMENT 2B – BIT-ORIENTED FAULT REPORTING PROTOCOL

In Fault Summary Word #7 for satcom table, changed bit 20 from “Reserved” to “HGA Over Temperature.”

In Fault Summary Word #9 for satcom table, changed:

- Bit 21 to “Data from GNSS to SDU”
- Bit 22 to “Reserved for PIM Failure”
- Bits 23, 28 and 29 to “reserved”

ATTACHMENT 5 – ETHERNET INTERFACE

New and updated material.

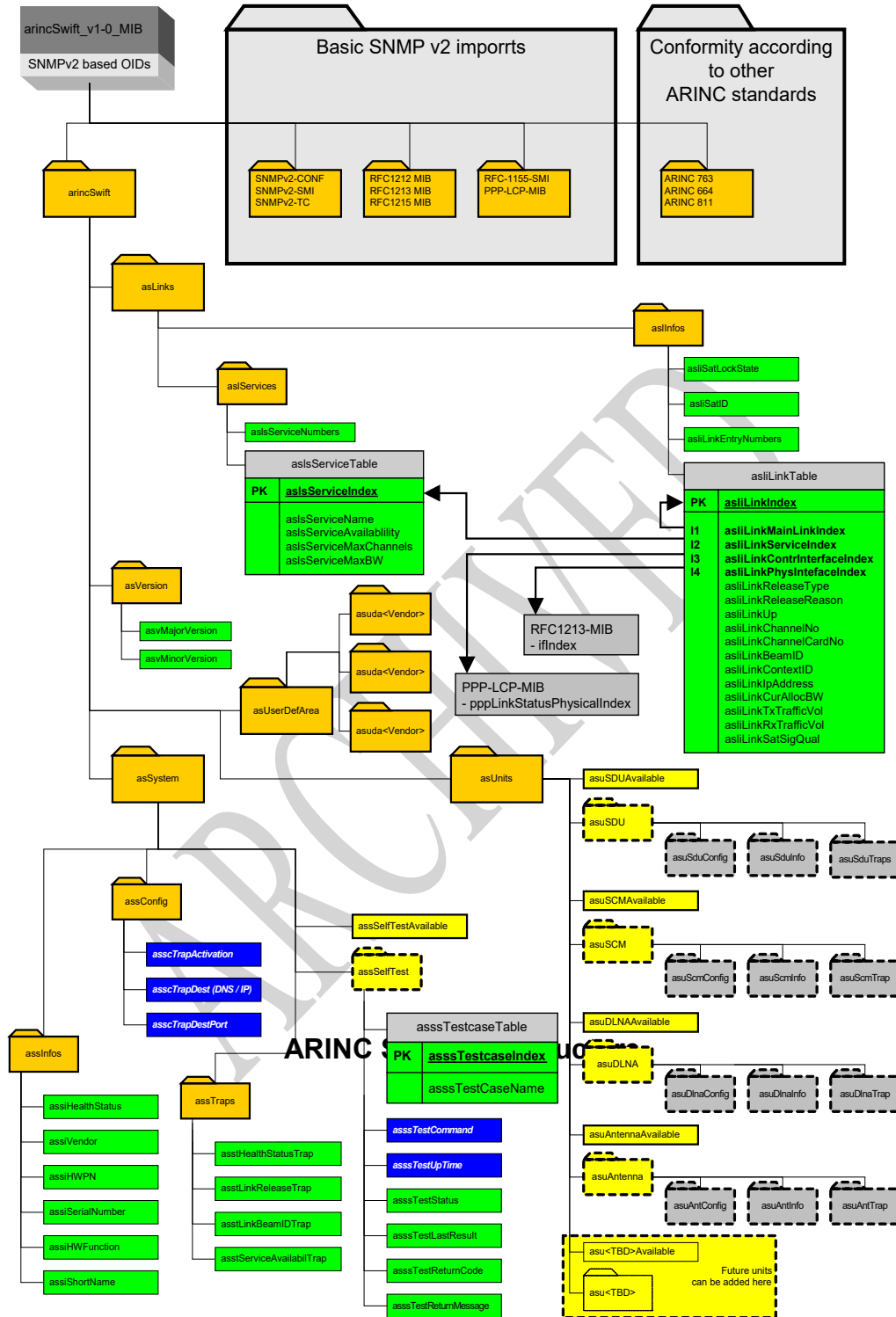
The following material is archived for future consideration and revision.

4.4.1.1 AT Command Timeouts

Activation and modification commands can take quite a while to execute over the air. A context activation (+CGACT) with maximum retries can take almost 3 minutes; context modification (+CGCMOD) can take 1 minute. In an environment where there are many processes sharing the same unit, commands by these other users may delay execution (that is, commands from all clients might be executed serially).

An application should tolerate a fairly long delay before declaring the connection as invalid (say, 5 minutes). The user application may decide to declare the operation has failed before that time, but should still give the side AT handler a chance to respond.

If an application gives up on a side AT command, it is recommended that it close the socket and connect a new one. Note that if the timeout is caused by too many commands having been queued up at the same time, opening a new connection and sending the command again will probably not result in a quick response.



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SUPPLEMENT 5
TO
ARINC CHARACTERISTIC 781
MARK 3 AVIATION SATELITE COMMUNICATION SYSTEM

Published: June 15, 2012

Prepared by the AEEC

Adopted by the AEEC Executive Committee:

May 02, 2012

A. PURPOSE OF THIS DOCUMENT

This supplement provides corrections or updates to:

- The definition of SwiftBroadband safety services
- The definition of SB200 (compact satcom system)
- Extended L band tuning range changes
- Tightening of HPA 7th order IM requirement
- Relaxation in Type F DLNA Tx to Rx port rejection
- Clarification of audio levels
- Additional HPA RF power use cases
- Cleanup to the definition of the Ethernet interface.
- Other miscellaneous changes

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document, **blue bold** text is used to indicate those areas of text changed by the current supplement only (with the exception of Attachment 7 (SB200)) which is a new attachment and is not marked.

C. CHANGES TO ARINC CHARACTERISTIC 781 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.1 Purpose of this Characteristic

Added paragraph indicating that this Characteristic specifies equipment operating in the L-band.

1.3 Inmarsat System Description

Added “L-band” terminology to distinguish the service being described from Ku-band and Ka-band services.

Added capabilities description of the Alphasat satellite.

Added description of the different SwiftBroadband classes.

Added commentary on anticipated future introduction of Extended L-band.

1.4 Function of Equipment

Changed frequency ranges to include Extended L-band.

Added paragraph to explain the need for equipment purchasers to specify the exact configuration of the ARINC 781 product required.

Added commentary cautioning against adding filters to protect Iridium.

1.5 Airborne Avionics Configuration

Added Enhanced Low GAIN Antenna to list of equipment defined in this Characteristic.

1.6.1 Satellite Data Unit (SDU)

Added explanation of 2 MCU and 6 MCU SDU form factors.

1.6.5 HPA LNA Diplexer (HLD)

Added new section.

1.6.6 Enhanced Low Gain Antenna (ELGA)

Added new section.

1.6.6 Intermediate Gain Antenna (IGA)

This section renumbered.

1.6.7 High Gain Antenna (HGA)

This section renumbered.

1.7.1 Transmitter Equipment Performance

Deleted LGA from Table 1-1.

Deleted Note 3 from Table 1-1.

Added EIRP for ELGA to Table 1-1.

Clarified the use of spot/regional beams for Classic Aero in Table 1-1, Note 1.

1.7.2 Receiver Equipment Performance

Added G/T requirement for ELGA.

2.1 Introduction

Added statement that interchangeability standards for the CSDU, ELGA, and HLD are defined in Attachment 7.

2.2 Form Factors, Connectors, and Pin Coding

This section expanded to refer to 6 MCU, SDU, and 2 MCU SDU.

2.2.1.4.5.1 Intermodulation Products

Tightened 7th order intermodulation specification for SwiftBroadband equipment.

2.2.4 Diplexer/Low-Noise Amplifier (DLNA)

Updated the commentary on the development history of the DLNA.

2.2.4.3.3.2 Type F - Transmit Port to Receive Port (DLNA Output)

Relaxed Type F DLNA TX to RX port rejection.

2.3.3.6.11 L-band System Physical Isolation

Added “L-band” to section title.

2.3.4 Enhanced Low Gain Antenna

Changed section title to “Enhanced Low Gain Antenna.”

Added reference to Attachment 7 for ELGA characteristics.

3.1.1.1 General

Refined the description of the extents of the Inmarsat radio function.

3.1.1.4 SwiftBroadband

Major update to reflect addition of SwiftBroadband safety, including a new service tree figure, an updated overall SwiftBroadband architecture figure, and an updated Table 3-2 (Forward and Return Bearer Types).

3.1.2.4.2 Frequency Allocations by Ground Stations

Deleted the commentary about a potential new Swift64 category as this is no longer being considered.

3.1.2.5 Mapping User Interfaces to Radio Interfaces

This section renumbered.

Updated Table 3-3 to reflect addition of SwiftBroadband safety.

3.1.2.6 Selection of Inmarsat Services, Satellites, and Ground Stations

This section renumbered.

Added “Alphasat” to the “satellite type in use” list.

3.2.1.1 Introduction

Added paragraph on the need for consistency between audio output levels of satellite voice services and that of VHF radio services.

Deleted references to SAT Radio.

3.2.1.2.1 MCDU

Reworded paragraph describing MCDU menus that are specified by the airframe manufacturers and when MCDU menus can be specified by the avionics equipment manufacturers.

3.2.1.2.3 AMS

Paragraph expanded and rewritten to clarify all audio input and output characteristics.

3.2.1.3 Call Annunciation

Added text describing caller line identification for SwiftBroadband safety voice operation.

3.2.1.7 SAT Phone using SwiftBroadband

Updated to reflect addition of SwiftBroadband safety.

3.2.1.8 SAT Radio

Added note that SAT Radio has not been implemented but that this section has been retained for reference.

3.2.2 Cockpit ACARS Data

“ACARS” added to title. Updated to reflect that the same interface is used for both Classic Aero and SwiftBroadband.

3.4.2.1.3 ORT Contents

ORT items added for:

Item C/17	Cockpit Ethernet Port
Item D/14	Cockpit Headset Audio Gain
Item D/15	Cockpit Headset Sidetone Gain
Item G/1	Safety Channel Identifier
Item G/2	Position Reporting Service
Item G/3	Safety Channel Access Class (0-15)
Item G/4	ACARS Data APN
Item G/5	Voice over IP APN

Item G/6	AGGW DNS Lookup Name
Item G/7	Aircraft Type

3.4.2.3 AES ID

Updated to reflect that SwiftBroadband safety uses this parameter as its primary addressing mechanism.

3.4.2.5 IMSI and IMEI(SV) (SwiftBroadband)

Updated to reflect that SwiftBroadband non-safety uses these parameters as its primary addressing mechanism.

3.4.2.6 Addressing for SwiftBroadband Safety Services

New section added.

3.4.2.7 Aircraft Type

This section renumbered.

3.6.3 FANS/ATS over SwiftBroadband

Commentary deleted and replaced by note stating that FANS/ATS over SwiftBroadband is now specified in the main body of this document.

3.6.4 Multi-Frequency Band

Section deleted.

3.7.3.1 Frequencies reserved for PIMBIT.

Added reference to Alphasat Satellite.

ATTACHMENT 1-3 STANDARD INTERWIRING

Modified SDU TP71 and SDU BP06 to accommodate SB200 interfaces.

ATTACHMENT 1-4A – SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

Added SwiftBroadband safety activation to TP6E.

ATTACHMENT 1-5A – SDU TOP PLUG CONNECTOR LAYOUT

Modified TP71 (coaxial contact) to accommodate SB200.

ATTACHMENT 1-5C – SDU BOTTOM PLUG CONNECTOR LAYOUT

Modified BP06 (coaxial contact) to accommodate SB200.

ATTACHMENT 2 – ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

Edited to remove references to Globalstar and ICO.

ATTACHMENT 5, Section 2.3.4, Streaming Class

Updated streaming data rates and added description of SBB X-stream mode.

ATTACHMENT 5, Section 3.3.11.3.1, Parameters Field for SBB

Deleted STREAM256K option name.

Added XSTREAM option name and sample AT string for SBB X-Stream service.

ATTACHMENT 5, Section 3.3.11.3.3, Parameter Field for ISDN

Changed MPDS to ISDN.

ATTACHMENT 5, Section 3.3.11.4, Paragraph Not Used

Added section title (was previously blank).

ATTACHMENT 5, Section 3.3.11.5, Hunt Group Syntax for Service Names

Changed STREAM256K to STREAM128K

ATTACHMENT 5, Section 4.2.4.2, Welcome Message

Added commentary that provisions should be included in the terminal to disable or modify the welcome message.

ATTACHMENT 5, Section 4.3.2.1, Additional Secondary Context

Figure updated: deleted PPPoE1.

ATTACHMENT 5, Section 4.3.2.2, Modify PDP Context

Figure updated: deleted “AT+CGEQREQ”.

ATTACHMENT 5, Section 4.4.1, AT Command Interface Support

+CMS ERROR changed from “M” to “O” in last column.

ATTACHMENT 5, Section 4.4.2.1.1, Set Command

Editorial change: “Session” corrected to “Session ID.”

ATTACHMENT 5, Section 5.3.2.2.1.2, Object Behavior

Added entry for SBB X-Stream.

ATTACHMENT 5, Section 5.3.2.2.2.1, Object Structure

Added range for Negotiated Bandwidth.

Added range for Beam ID.

Added note identifying values for expected maximum/ideal values for Link Signal Quality.

ATTACHMENT 5, Section 5.3.2.4.1.1, Information Sub Branch for the SDU Unit Related Objects

Corrected units for items 30, 31, and 32.

ATTACHMENT 5, Section 5.3.2.4.4.1, Information Sub Branch for the Antenna Unit Related Objects

Changed range for “.asuAntInfoGain(10) .” Added note that “-1” indicates invalid antenna gain for this object identifier.

ATTACHMENT 6 – HPA OUTPUT POWER USE CASES

Added explanation on how to calculate HPA output power with worked example.
Added commentary advising of the need to consider peak-to-average ratio.

ATTACHMENT 7 – COMPACT SATCOM DEFINITION (SB200)

Added new attachment describing a new compact SBB product.

ATTACHMENT 8 – Attachment Reference Guide

This attachment renumbered to make space for the new Attachment 7.

APPENDIX A – Acronyms

Updated acronym list.

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SUPPLEMENT 6
TO
ARINC CHARACTERISTIC 781
MARK 3 AVIATION SATELITE COMMUNICATION SYSTEMS

Published: December 5, 2012

Prepared by the AEEC

Adopted by the AEEC Executive Committee:

October 4, 2012

A. PURPOSE OF THIS DOCUMENT

This supplement provides new contents as follows:

- New Attachment 8, Security Recommendations for SwiftBroadband Safety Services
- Update to Section 3.4.3, Security
- Other miscellaneous changes

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document, **blue bold** text is used to indicate those areas of text changed by the current supplement. Attachment 8 is a new attachment added by Supplement 6. Bolding is omitted for readability.

C. CHANGES TO ARINC CHARACTERISTIC 781 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.2 Relationship of this Document to Other ARINC Standards and Industry Documents

Updated list of referenced documents.

3.2.4 Ethernet

Commentary added to stress that the Ethernet interface was designed for non-safety applications only, and that it has not been determined if this interface definition is suitable for the SBB Safety Priority IP service.

3.4.3 Security

This section is essentially being replaced by the new Attachment 8, Network Security Recommendations Analysis. This section is revised to include only high-level points on security, and includes references EUROCAE ED-202/RTCA DO-326 and Attachment 8.

Section 3.4.3 is based on ARINC Report 811, the content of which differs from EUROCAE ED-202/RTCA DO-326.

ATTACHMENT 5, SECTION 3.3 – PROTOCOL OPERATION FOR BGAN CONTEXT SETUP, PPPOE DISCOVERY

Corrected the table which delineates the PPPoE Discovery sequence so that it is consistent with RFC 2516.

ATTACHMENT 7, SECTION 4.1.3 – CSDU SERVICES AND FEATURES

Corrected the comments for “Cabin Data” and “Security” (added references Attachment 8).

ATTACHMENT 8 – NETWORK SECURITY ANALYSIS FOR SWIFTBROADBAND SAFETY SERVICES

This attachment added by Supplement 6.

ATTACHMENT 9 – ATTACHMENT REFERENCE GUIDE

This attachment renumbered to make space for the new Attachment 8.

APPENDIX A – ACRONYMS

Updated acronym list.

APPENDIX B – SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Added commentary at the end of Section B-1 that clarifies that the foundation of the security analysis in Appendix B is based on ARINC Report 811 methodology which does not address safety services. The current recommended methodology can be found in EUROCAE ED-202/RTCA DO-326.

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SUPPLEMENT 7
TO
ARINC CHARACTERISTIC 781
MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEMS

Published: August 9, 2017

Prepared by the AEEC

Adopted by the AEEC Executive Committee:

May 2, 2017

A. PURPOSE OF THIS DOCUMENT

Supplement 7 adds VPN for ACARS Service, expands SwiftBroadband network security, harmonizes interfaces (Ethernet and Fiber) with the SDU specified in ARINC Characteristic 771, and makes minor corrections and clarifications.

B. ORGANIZATION OF THIS SUPPLEMENT

In this document, **blue bold** text is used to indicate those areas of text changed by the current supplement only.

C. CHANGES TO ARINC CHARACTERISTIC 781 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.2 Referenced ARINC Standards and Industry Documents

Updated the list of referenced documents.

1.3 Inmarsat System Description

Deleted references to Inmarsat 2 satellites.

Removed statement that Alphasat was to be launched.

Added Alphasat Geostationary satellites to the list of components of the Inmarsat L-Band network.

Deleted reference to Integrated Services Digital Network (ISDN).

1.6.1 Satellite Data Unit (SDU)

Deleted reference to Cabin Integrated Services Digital Network (ISDN).

1.6.2 SDU Configuration Module (SCM)

Added Security Smart Card for Enhanced ACARS.

1.7.2 Receiver Equipment Performance

Added HLD characteristics to list of contributors to the receiver system performance.

2.2.1.2 Connectors

Note on ARINC 600 Configurations was added.

2.2.1.4.6 Harmonics, Discrete Spurious Emissions, and Noise

Added reference to RTCA DO-262 MOPS.

2.2.3.3 USIMs

Added Security Smart Card for Enhanced ACARS.

2.3.1.2 Achieved Antenna Coverage Volume

This section was revised. Class 4 required performance over at least 98% and IGA over at least 85% of the ideal coverage volume, were added.

3.1.1.4 SwiftBroadband

This section was expanded. Updates included:

- Enhanced ACARS service was added to Standard ACARS Service

- Enhanced ACARS service is supported by IPSEC VPN and PKI
- Addition of Reference to RTCA DO-343
- Figure 3-1, SwiftBroadband Services, was revised
- Figure 3-2, Overall SBB Architecture, was revised
- Figure 3-3, Enhanced ACARS End to End Architecture, was added

3.1.2.5 Mapping User Interfaces to Radio Interfaces

Table 3-3, Potential Mapping of User Interfaces to Compatible Inmarsat Services, was updated, including:

- Removed ISDN from the Cabin Voice and Non-Cabin Data Services rows
- Ethernet per ARINC 644, Part 2 was added for ATC and Non-ATC Cockpit Data

Note 3 was added, stating Ethernet ports are by default per ARINC 664, Part 2 and may be changed to ARINC 664, Part 7 by ORT.

3.1.2.6 Selection of Inmarsat Services, Satellites, and Ground Stations

Physical Interfaces were updated:

- Ethernet 1-12 was added
- ISDN was deleted

3.2.1.2.3 AMS

Replaced -22 dBm0 with -9.8 dBm0 in three places.

3.2.2 Cockpit ACARS Data

Added Label 271 – SDU to CMU Join/Leave information.

3.2.2.1 SDU to ACARS MU/CMU Join/Leave

This section, with information on ARINC 429 Label 271, was added.

3.2.3 ISDN Interface

This section was deleted in Supplement 7.

3.2.4 Ethernet

Commentary was thoroughly expanded to state that the Ethernet interface defined in this section, and in Attachment 5, was designed for non-safety applications. It has not yet been determined if this interface definition is suitable for the SBB Safety Priority IP service.

The following commentary was also added: Any reference to the Ethernet in the present document refers to Ethernet per ARINC Specification 664, Part 2.

3.4.1 Dual Satcom Installation

This section was revised and renamed “Dual Satcom Installation” from “Dual.” New information was added.

Some subsections were added, some were deleted.

3.4.1.1 Dual Satcom Configurations

This new section expands information contained in numerous previous sections. It includes definitions and notes for Table 3-4, Various Dual Satcom Configurations:

- Dual – Independent
- Dual – Cold Standby

- Dual – Warm Standby
- Dual – Hot Standby
- Dual – Cooperative (Master/Slave)

It was added that in a dual satcom installation with dissimilar terminals, each terminal may provide cockpit services via Inmarsat Classic, SwiftBroadband Iridium Block1, or Iridium Certus services.

The following key issues that determine the appropriate dual mode were added:

- Avionics Interfaces
- Interference between systems
- Switchover time between systems
- Startup behavior

3.4.1.2 Physical Interfaces for Dual Satcom

This new section, and its subsections, were added.

3.4.1.3 Standard Warm Standby Operation and Protocol

This new section, and its subsections, were added, including the definition of Crosstalk Label 273.

3.4.1.4 Interfaces between Terminals

This new section was added.

3.4.2.1.1 General

This section was expanded, including that:

- Secure ORT can be stored in one of three places:
 - Type 1: Within the SCM
 - Type 2: Within the SDU but can be changed independently of the software
 - Type 3: As an integral part of the SDU Software and hence cannot be changed without a software change
- User ORT can be stored in one of two places:
 - Type 4: Within the SCM
 - Type 5: Within the SDU but can be changed independently of the software

3.4.2.1.2 ORT Synchronization

This section was expanded, including Table 3-5, Operation of Type (1) and Type (4) ORTs.

3.4.2.1.3 ORT Contents

ORT Section A – Log-on Parameter Configuration

As part of Section A, ORT Items for Standard Warm Standby Operation, Items 5 through 11 were added.

ORT Section B – Interfacing Systems Configuration

ORT Section B – Interfacing Systems Configuration was revised to remove ISDN 1 and 2.

ORT Section C – Ethernet Ports Configuration

ORT Section C – Ethernet Ports Configuration was revised to add Ethernet Port 11 and 12 Configurations and a note on strapping TP-3G.

3.4.3 Security

This section was revised, including adding guidance on malware attacks and interception of communications by unauthorized parties.

ATTACHMENT 1 – Standard Interfaces

1.1A – General Configuration Overview – Single Satcom Installation

- Changed SCDU interface to MCDU

1.1B – General Configuration Overview – Dual Satcom Installation

- Changed SCDU interface to MCDU

1.3 – Standard Interwiring was updated.

1.4 – Notes Applicable to Standard Interwiring were updated, including adding Tables 1.4-3 – Fiber Port Interwiring and 1.4-4 – Ethernet Port Interwiring.

1.4A – System Configuration Pins Definition and Interpretation was updated:

- Mandatory Configuration Pins:
 - Added that these pins are considered mandatory for the aircraft but not for the SDU.
 - Added that Pin TP6D should be used to define sense of WOW input, rather than using an ORT item. Implementing this function in ORT could lead to inability to correct a mistake in the ORT while the aircraft is on the ground.
 - Added Simplified Implementation of Mandatory Configuration Pins.
 - Added Ethernet # 11 and 12 to the TP5F programming pin.

1.5A and 1.5B – SDU Form Factor, SDU Top Plug Connector Layout, and SDU Middle Plug Connector Layout: pin names were revised.

ATTACHMENT 2B – Bit Oriented Fault Reporting Protocol

Label 350, Note 5: Added Enhanced Low Gain Antenna (ELGA) with or without a DLNA or HLD (either standalone or incorporated in the antenna).

Label 357: Added Notes 2 and 3.

Added Note 2 to Bits 15, 16, 25, and 26.

Added Note 3 to Bits 20, 21, 22, and 24.

Label 360: Added Note 4.

Added Note 4 to Bits 27 and 28.

Label 361: Removed Reserved and added Ethernet 11 and 12 to Bits 28 and 29.

ATTACHMENT 4A – ARINC 781 SDU Function Matrix

Cabin ISDN information was removed from Section 3.1.2.5.

ATTACHMENT 4B – ARINC 781 SDU Interfaces Matrix

User Interfaces and 10/100BaseT Cockpit and Cabin (Example) columns were changed from “2” to “5”. ISDN was removed.

ATTACHMENT 7 – Compact Satcom Systems

This attachment was thoroughly revised and restructured, included renaming the attachment from Compact Satcom Definition (SB200) to Compact Satcom Systems. The previous 7 sections were reduced to 3.

Section 1.0 – Introduction

It was added that two variants of the compact systems are defined in Attachment 7: Class 4 compact system and compact Class 6 or 7 systems.

In Section 3 of this attachment, a Multicarrier High-Power Amplifier (MHPA) LRU was defined.

Section 2.0 – Class 4 Safety Service Overview

Class 4 was added to the section name.

Class 4 information was added to subsections.

It was added that manufacturers may wish to provide a multi-channel SDU in the 2 MCU form factor. A multi-channel 2 MCU SDU can operate with an IGA or HGA.

Previous Sections 2 through 7 were made subsections of Section 2.

Section 3.0 – Compact Safety Service Systems (Class 6 and 7) Overview

This new section and subsequent subsections were added, including Figure 12 – Compact Satcom System Configurations of Class 6 and 7.

ATTACHMENT 8 – Network Security for SwiftBroadband Safety Services

This attachment was thoroughly expanded.

Section 1.0 – Introduction

It was added that adequate mitigation must be considered to ensure the protection of certain assets (e.g., CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, MCDU, etc.).

Reference to RTCA DO-326A was added.

It was noted that physical processor segregation is not the only segregation solution.

Information on Enhanced ACARS, ACARS using VPN, was added.

2.0 Objectives

The objective that a SDU channel card should act as a transparent modem was added. It was also added that to reach this objective, the PDP context processing should be robust in the SDU channel card to ensure that it cannot be corrupted by any malformed/spurious PDP context commands.

3.1 End-to-End ACARS System Architecture

Figure 1, End-to-End Architecture, was renamed and extensively modified.

ACARS gateways acronyms, ADGW and GDGW, were updated.

It was stated that appropriate ground security level analysis was outside the scope of this standard.

3.2 Compact SDU (CSDU) Reference System Architecture

Key CSDU Security features were expanded.

References to RTCA DO-254, DO-178, DO-326A, and EUROCAE ED202A were revised or added.

A VPN between the SDU ACD and the secure ground aero rack for ACARS messages was added.

A Voice Over IP (VOIP) gateway is being studied for future service.

Figure 2, Architecture for SB200-S Terminal, was replaced.

3.2.1 Data Arbitration Function

It was added that the required security assurance level is per RTCA DO-326A and EUROCAE ED-202A.

3.2.2 ACD (Aircraft Control Domain) Processor

Acronym ADGW for Aircraft Datalink Security Gateway replaced previous acronym ACARS Airborne Gateway (AAGW).

The following ACD Processor functions, not shown in Figure 2, were added:

- Partitioning to ensure segregation and non-bypassability of security functions. Partitioning can be implemented at the level of OS (such as a secure hypervisor) or enhanced secure OS enforcing strict access control between partitions.
- It should be ensured that assets (e.g., EICAS/FWS, ADL, CMC, MCDU) cannot receive any data from the ground or AISD.
- Ensure partition segregation by applying strict filtering between partitions.

3.2.3 AISD (Airline Information Services Domain) Processor

It was added that alternative methods of achieving separation may be possible, but alternative solutions should achieve a similar level of segregation and robustness as demonstrated by a security analysis.

3.2.4 Network Layer for ACD

This new VPN security section and subsections were added, including Figure 3 – SBB ACARS Service Architecture.

3.2.5 PDP Contexts

VPN information for the carriage of ACARS messages was added.

Previous acronym AAGW was changed to ADGW.

3.2.7 Aircraft Datalink Gateway (ADGW)

This section was renamed from ACARS Airborne Gateway (AAGW).

Previous acronym AAGW was changed to ADGW.

3.2.8 Data Loading

It was added that the ACD should be robust to any type of data (including acknowledgement) sent from AISD to ACD when data loading.

3.2.9 BITE

It was added that the ACD processor should check BITE information received from the AISD processor to ensure it does not contain malicious data. If BITE information is sent from other processors to ACD (e.g., channel card and PIESD), an equivalent level of filtering shall be implemented.

4.0 Security Analysis

References to RTCA DO-326A and EUROCAE ED202A were added.

4.2 Security Design Guidelines

This section with security guidelines was added.

4.3.1 Interfaces

The following were added as new interfaces:

- BITE and data load paths are considered in the analysis
- SDU Cross-Talk Interface using Ethernet or ARINC 429 interfaces

4.3.2 Assets

The following were added as new assets to protect:

- Security Smart Card
- Interfaces to systems, such as CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, MCDU

4.4.1 Threat Conditions

The following were added as new threat conditions:

- Loss of availability of FANS messages
- Loss of availability of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, MCDU, etc.)
- Loss of integrity of avionics assets (CMU, EICAS/FWS, ADL, CMC, Aircraft Security Log Repository, MCDUS, etc.)

The following threat condition should also be considered:

- Loss of availability/integrity of AISD

4.4.2 Applicable Attack Path

This section was added.

4.4.3 Initial Threat Scenario Applicable Attack Path

This new section, with Figure 5, Initial Reference Diagram, and the 13 Threat Scenario table, replaces the previous threat scenario section.

4.6 Impact Classification of Threat Conditions

This new section states that the impact of all threat conditions should be evaluated under RTCA DO-326A/EUROCAE ED-202A, and replaces the previous section.

4.7 Likelihood Assessment

This section, stating that the likelihood of all applicable threat conditions should be evaluated under RTCA DO-326A/EUROCAE ED-202A to ensure that requirements are met based on the system architecture, was added.

4.7.1 Risk Mitigation

References to RTCA DO-326A and EUROCAE ED-202A were added.

APPENDIX A – ACRONYMS

The Acronyms List was updated.

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SUPPLEMENT 8
TO
ARINC CHARACTERISTIC 781
MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEMS

Published: September 10, 2019

Prepared by the AEEC

Adopted by the AEEC Executive Committee:

April 30, 2019

A. PURPOSE OF THIS DOCUMENT

Supplement 8 adds interference protection to the ARINC 781 airborne L-Band geostationary satellite communication (satcom) equipment from possible LTE and ATCt (Ligado) service interference. The supplement expands dual satcom operation and switching logic sections allowing for installation of dissimilar SDU suppliers and networks, e.g., Inmarsat (Classic or Aero) on one side and Iridium (Block 1 or NEXT/Certus) on the other. Safety ACARS Voice over Internet Protocol (VoIP) service is also specified.

B. ORGANIZATION OF THIS SUPPLEMENT

In this document, **blue bold** text is used to indicate those areas of text changed by the current supplement only.

C. CHANGES TO ARINC CHARACTERISTIC 781 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.1 Purpose of this Characteristic

Added reference to ARINC Characteristic 792.

Added reference to ITU-R G.703 and ITU-R G.704.

1.2 Referenced ARINC Standards and Industry Documents

Added reference to ARINC Characteristic 792.

1.6.2 SDU Configuration Module (SCM)

Enhanced Voice over IP (VoIP) information is added.

2.2.4 Diplexer/Low-Noise Amplifier (DLNA)

A commentary is added stating that new DLNAs are included in Attachment 9. These DLNAs are designed to suppress the threat of interference from Long Term Evolution (LTE) and Ancillary Terrestrial Component (ATCt) service.

The historical development of DLNAs for Inmarsat Classic and SwiftBroadband (SBB) equipment is thoroughly revised.

3.1.1.4 SwiftBroadband

VPN for Enhanced VoIP within the SBB network service is added.

Figure 3-1, SwiftBroadband Services, is replaced.

Figure 3-2, Overall SwiftBroadband Architecture, is replaced.

3.2.1.7 SAT Phone using SwiftBroadband

VPN for Enhanced Secure ACARS service is added as a fourth option to the existing voice services offered by SBB.

3.4.1.3 Standard Warm Standby Operation and Protocol

It was deleted that the ARINC 429 dual crosstalk bus should be operated at high baud rate.

3.4.1.3.1 General Dual Operating Principles

It was clarified that only one SDU can be active, but both can be in Standby concurrently, and that in case of SDU failure, the other SDU shall become active if it is not at fault and has coverage.

3.4.1.3.3 Power-Up Sequence for Dual Satcom

It was added that whenever the Satcom Disable discrete is asserted, the SDU shall be in Standby mode.

3.4.1.3.6 Crosstalk Protocol

This section was thoroughly revised, including deleting references to ARINC 429 Label 271 and ARINC Characteristic 741 for information on Label 270.

It was added that ARINC 429 Label 270 is described in Attachment 2, Section 2.2.

Information on ARINC 429 Label 270, Bit 28 was deleted.

Table 3-5, Crosstalk Protocol Bit Functions, was added.

3.4.1.3.7 Crosstalk Label 273 Definition

Dual Satcom Parameter table.

ARINC 429 Label 273: Bit 23 (Coverage Validity) information was added. Reference to Note 9 was added.

Note 9 was added stating that ARINC 429 Label 273 indicates that the SDU believes it is within coverage and should be able to provide service.

3.4.1.2.1.3 ORT Contents

ORT Section G: SwiftBroadband Safety Services Configuration

- Revised Item 7 to: Aircraft Type in ICAO DOC 8643 format (e.g., B747-400, B747-800, A319, and A320)
- Item 8 – Safety Service, was added

ORT Section H: ORT Items for Warm Standby Dual Satcom Operation, was added.

ATTACHMENT 1 – STANDARD INTERFACES

1.4A Systems Configuration and Interpretation

1.1 – Pins Used for Programming

- Simplified Implementation of Mandatory Configuration Pins
 - TP3F: was reworded to “Grounded or open so that the number of all configuration pins (excluding the Service Availability Pins) which are grounded (or connected to TP3D), including the parity pin itself, is odd.”
 - TP4D: was clarified to “when left unconnected, it indicates SDU#1, when Ground, it indicates SDU#2.”
 - Weight on Wheels (WOW) Input Table was added for TP6D and MP7D information.

1.2 – Functions Implemented by Pin Programming

- TP4D – SDU Position Number: It was clarified that SDU Position Number identifies whether the SDU is installed as SDU#1 or SDU#2 onboard the aircraft.

4.0 – TP3G, TP4D, TP4E, TP4F, TP4G, TP5D, TP5E, TP5F, TP5G, TP6D, AND TP6E: VARIOUS FUNCTIONS

- Note 1 was added to TP4D stating that if Spare 1 and Spare 2 are not defined for TP4D, TP4D should either not be connected (SDU #1) or connected to MP12F (SDU#2).

1.8 Diplexer/Low Noise Amplifier Form Factor

Figure 2 – Type F, H, J DLNA Outline

- Type H and Type J DLNA Outlines were added to Figure Header

DLNA Connector: It was added that previously spare Pins C and D, are for Type J DLNA.

ATTACHMENT 2 – ARINC 429 LABELS AND FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

Label 172 – Satellite Service Definition was thoroughly revised.

Options for Inmarsat SBB and Iridium Certus were added to existing Inmarsat Aero Classic and Iridium Block 1 services.

Note 52 was revised.

Label 261 – Flight Number, was corrected from “251.”

ATTACHMENT 2B – BIT-ORIENTED FAULT REPORTING PROTOCOL

Label 357 – Fault Summary Word #7 for Satcom

- Bit 20 – Antenna over temperature, name was changed from “HGA over Temperature”.

Label 362 – Fault Summary Word #10 for Satcom, this new ARINC 429 maintenance word was added.

ATTACHMENT 5 – ETHERNET INTERFACE

The Table of Contents was removed.

3.3.11.3.1 Parameter Field for SBB

- Stream was added to the SBB Option Table.

3.3.11.3.1.1 SBB Options (Optional)

- UP tag was added to the SBB Options Tag Table for upstream speed.
- Down tag was added to the SBB Options Tag Table for downstream speed.
- HCOMP was added to the SBB Options Tag Table for header compression.

5.3.2.2.2.1 Object Structure

Table 16 – Link Information Table Related Object Details

- Object Identifier (9) was revised.
- Object Identifier (25) was added.
- Object Identifier (26) was added.
- Object Identifier (27) was added.
- Object Identifier (28) was added.
- Object Identifier (29) was added.
- Object Identifier (30) was added.

5.3.2.2.2.2 Object Behavior

The main MIB table “.asliActLinkTable (5)” was corrected from “.asliActLinkTable (4) .

ATTACHMENT 8 – NETWORK SECURITY FOR SWIFTBROADBAND SAFETY SERVICES

It was added that Supplement 8 extends the use of the VPN for the PS Voice Service. PS Voice using a VPN is known as Enhanced PS voice while PS Voice without the VPN is known as Standard PS voice.

3.1 End-to-End ACARS System Architecture

Figure 1 – End-to-End Architecture, was replaced with a new diagram that includes VoIP.

3.2 Compact SDU Reference System Architecture

VoIP was added as a key security features of the Compact SDU system architecture.

Figure 2 – Architecture for SB200-S Terminal, was replaced with a new figure that includes VoIP using the Security Gateway in the ACD. A switch for EFBs 1 and 2 was added to the SBB terminal architecture in the AISD.

ATTACHMENT 9 – ATCt and LTE Resilient DLNA

This Attachment, with the definition of the new DLNAs for ATCt and LTE resilience, was added.

APPENDIX A – ACRONYMS

The acronym list was updated.

ARINC Standard – Errata Report

1. Document Title

(Insert the number, supplement level, date of publication, and title of the document with the error)

2. Reference

Page Number: _____ Section Number: _____ Date of Submission: _____

3. Error

(Reproduce the material in error, as it appears in the standard.)

4. Recommended Correction

(Reproduce the correction as it would appear in the corrected version of the material.)

5. Reason for Correction (Optional)

(State why the correction is necessary.)

6. Submitter (Optional)

(Name, organization, contact information, e.g., phone, email address.)

Please return comments to standards@sae-itc.org

Note: Items 2-5 may be repeated for additional errata. All recommendations will be evaluated by the staff. Any substantive changes will require submission to the relevant subcommittee for incorporation into a subsequent Supplement.

[To be completed by IA Staff]

Errata Report Identifier: _____ **Engineer Assigned:** _____

Review Status: _____

ARINC Project Initiation/Modification (APIM)

1.0 Name of Proposed Project **APIM #:** _____
(Insert name of proposed project.)

1.1 Name of Originator and/or Organization
(Insert name of individual and/or the organization that initiated the APIM)

2.0 Subcommittee Assignment and Project Support

2.1 Suggested AEEC Group and Chairman
(Identify an existing or new AEEC group.)

2.2 Support for the activity (as verified)
Airlines: (Identify each company by name.)
Airframe Manufacturers:
Suppliers:
Others:

2.3 Commitment for Drafting and Meeting Participation (as verified)
Airlines:
Airframe Manufacturers:
Suppliers:
Others:

2.4 Recommended Coordination with other groups
(List other AEEC subcommittees or other groups.)

3.0 Project Scope (why and when standard is needed)

3.1 Description
(Insert description of the scope of the project.)

3.2 Planned usage of the envisioned specification

Note: New airplane programs must be confirmed by manufacturer prior to completing this section.

New aircraft developments planned to use this specification yes ☐ no ☐

Airbus: (aircraft & date)

Boeing: (aircraft & date)

Other: (manufacturer, aircraft & date)

Modification/retrofit requirement yes ☐ no ☐

Specify: (aircraft & date)

Needed for airframe manufacturer or airline project yes ☐ no ☐

Specify: (aircraft & date)

Mandate/regulatory requirement yes ☐ no ☐
 Program and date: (program & date)
 Is the activity defining/changing an infrastructure standard? yes ☐ no ☐
 Specify (e.g., ARINC 429)
 When is the ARINC standard required?
 _____(month/year)_____
 What is driving this date? _____(state reason)_____
 Are 18 months (min) available for standardization work? yes ☐ no ☐
 If NO please specify solution: _____
 Are Patent(s) involved? yes ☐ no ☐
 If YES please describe, identify patent holder: _____

3.3 **Issues to be worked**

(Describe the major issues to be addressed.)

4.0 **Benefits**

4.1 **Basic benefits**

Operational enhancements yes ☐ no ☐
 For equipment standards:
 (a) Is this a hardware characteristic? yes ☐ no ☐
 (b) Is this a software characteristic? yes ☐ no ☐
 (c) Interchangeable interface definition? yes ☐ no ☐
 (d) Interchangeable function definition? yes ☐ no ☐
 If not fully interchangeable, please explain: _____
 Is this a software interface and protocol standard? yes ☐ no ☐
 Specify: _____
 Product offered by more than one supplier yes ☐ no ☐
 Identify: (company name)

4.2 **Specific project benefits (Describe overall project benefits.)**

4.2.1 **Benefits for Airlines**

(Describe any benefits unique to the airline point of view.)

4.2.2 **Benefits for Airframe Manufacturers**

(Describe any benefits unique to the airframe manufacturer's point of view.)

4.2.3 **Benefits for Avionics Equipment Suppliers**

(Describe any benefits unique to the equipment supplier's point of view.)

5.0 **Documents to be Produced and Date of Expected Result**

Identify Project Papers expected to be completed per the table in the following section.

5.1 Meetings and Expected Document Completion

The following table identifies the number of meetings and proposed meeting days needed to produce the documents described above.

Activity	Mtgs	Mtg-Days (Total)	Expected Start Date	Expected Completion Date
<i>Document a</i>	<i># of mtgs</i>	<i># of mtg days</i>	<i>mm/yyyy</i>	<i>mm/yyyy</i>
<i>Document b</i>	<i># of mtgs</i>	<i># of mtg days</i>	<i>mm/yyyy</i>	<i>mm/yyyy</i>

Please note the number of meetings, the number of meeting days, and the frequency of web conferences to be supported by the IA Staff.

6.0 Comments

(Insert any other information deemed useful to the committee for managing this work.)

6.1 Expiration Date for the APIM

April/October 20XX

Completed forms should be submitted to the AEEC Executive Secretary.