MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEMS

ARINC CHARACTERISTIC 781-5

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Supplement	Adoption Date	Published
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

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

FOREWORD

Aeronautical Radio, Inc., the AEEC, and ARINC Standards

ARINC 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 ARINC 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 or ARINC 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 volume:

> 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.

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ATTACHMENTS

1.0 INTRODUCTION AND DESCRIPTION

1.1 Purpose of this Characteristic

This document sets forth the desired characteristics of the Mark III Aviation Satellite Communication (satcom) System avionics 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.

1.2 Relationship of this Document to Other 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 (ACARS, MCDU, CFDS, etc.) are progressing to 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 429: *Mark 33 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 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 Avionics End Systems*

ARINC Specification 620: *Data link Ground System Standard and Interface*

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

ARINC Report 624: *Design Guidance for Onboard Maintenance System (OMS)*

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

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

1.0 INTRODUCTION AND DESCRIPTION

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

ARINC Characteristic 746: *Cabin Communications System*

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

ARINC Specification 801: *Fiber Optic Connectors*

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 Procedures*

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

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

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

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

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

1.3 Inmarsat System Description

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

Inmarsat L-band network consists of: a space segment formed by the Inmarsat-2 (I-2), Inmarsat-3 (I-3), Inmarsat-4 (I-4)**, and Alphasat (due for launch in 2013)** 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 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 only 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 SARPs published by ICAO to support air traffic control and distress communications via voice and data link.

The Inmarsat Swift64 service supports two types of data communications: Mobile ISDN and an IP-based Mobile Packet Data Service (MPDS). A single 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 and e-mail 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 and ISDN data. 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.
- Data services (i.e., file transfer, messaging, e-mail, Fax over IP, etc.).
- Video conferencing services.
- Internet access (i.e., web browsing, e-commerce, etc.).
- Intranet access (i.e., corporate WAN access via secure Virtual Private Network (VPN) connection).
- **ACARS-based and voice FANS ATS services.**

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 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 will be the first Inmarsat satellite to exploit this additional spectrum allocation. 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. Once equipment is being designed**

for Extended L-band capability, the relevant sections of this Characteristic will 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 (15**18** 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)
- Aeronautical Administrative Communications (AAC)
- Aeronautical Passenger Correspondence (APC)

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

- Classic Aero (e.g., Aero H, Aero I, Aero H+)
- 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 left to the individual manufacturers based on their response to market needs.

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

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 1-1. A more detailed block diagram (including alternate configurations) is shown in Attachment 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 Characteristic 724B ACARS Management Unit or an ARINC Characteristic 758 Communications Management Unit)
- Cockpit Ethernet
- Cabin voice and data via CEPT E1
- Cabin voice via 2-wire analog audio
- Cabin ISDN
- Cabin Ethernet, which may support data services as well as voice via pico cells
- **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 and the Universal Mobile Telecommunications Service (UMTS) Subscriber Identity Modules (USIMs). 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 (ORTs) (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. Diplexer/Low Noise Amplifier (DLNA)

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).

1.7 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)

		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 steering control signals to the antenna should be provided through an ARINC 429 bus from the SDU.

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, 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	**-21dB/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/m^2 the receiver system performance is intended to provide a bit error rate (BER) of 1x10^{-5} or better for classic Aero packet-mode data and 1x10^{-3} or better for classic Aero circuit-mode voice.

The receiver system performance is intended to provide a packet error rate (PER) of 1x10^{-3} or better for SwiftBroadband packet-switched services and 1x10^{-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, as defined in Section 2.0 of **ARINC Report 403**: *Guidance for Designers of Airborne Electronic Equipment* is desired by the users for each of the major subsystems and unit interchangeability, also defined in the above-referenced ARINC standards, 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 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.

COMMENTARY

Minimum Operational Performance Standards (MOPS) are prepared by Special Committees of RTCA Inc. 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 Inc. 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 vs. non-safety) by any particular system or avionics implementation.

2.0 INTERCHANGEABILITY STANDARDS

2.1 Introduction

This Chapter 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 LGA (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 1-5). 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 Signal sockets).

- 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 Signal sockets).
- Insert arrangement 12F5C2 receptacle in accordance with ARINC Specification 600, Attachment 19, Figure 19-49.19, for the bottom insert (Size 12 Electrical pins, Size 16 Electrical 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.

2.2.1.3 Form Factor

See Attachment 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 (receive) and 1626.5 to 1660.5 (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

<u>SwiftBroadband</u>

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.

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^o/dB and at a rate not exceeding 30^o/2 ms when the output level is adjusted by up to 4 dB in any 80 ms period.

Note: This applies to Classic Aeronautical and Swift64 Services.

2.2.1.4.5 Linearity

2.2.1.4.5.1 Intermodulation Products

Table 2-1 – Intermodulation Products

	Classic and Swift64 Services[1]		SwiftBroadband Services[2]	
Intermodulation Products	**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 System Definition Module (SDM).

2.2.1.4.5.2 EVM^2

The mean (Error Vector Magnitude)^2 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 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 SwiftBroadband 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 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.

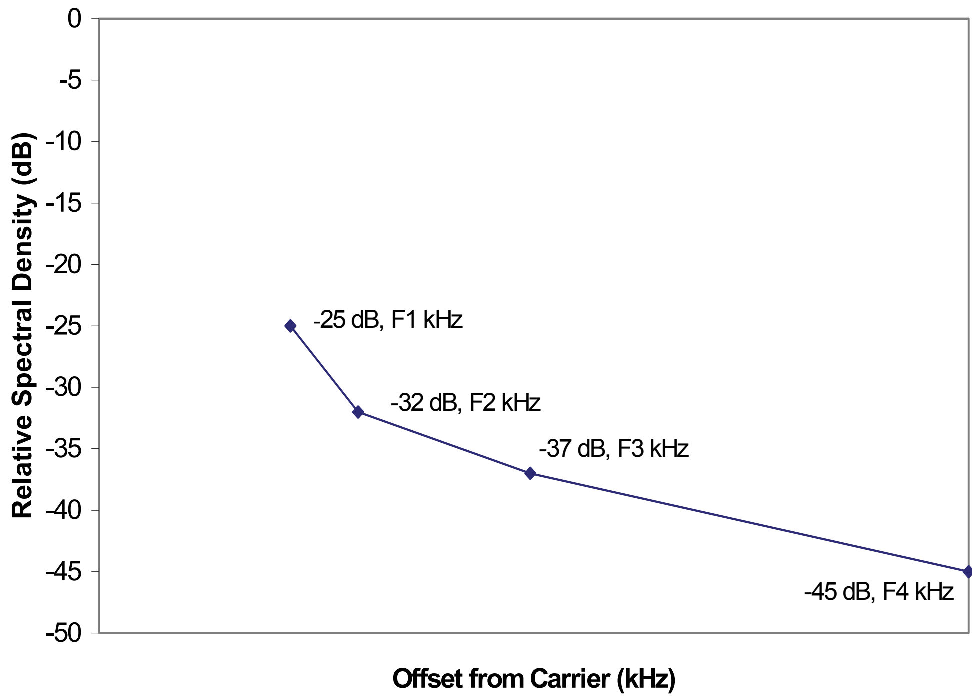


Figure 2-1 – Spectral Regrowth Envelope

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-210D 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 1-4, 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.

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 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 nominaly +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 internal HPA within the SDU on installations where the SDU is, in general, greater than 1.4 dB (approx 35 feet) away from the DLNA. The design of this HPA should be a functional doublet with the SDU as the gain stages between the internal HPA within 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.

The form factor and connector pin-out arrangement are shown in Attachment 1-7. 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 1-7A 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 1-7B 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 1-7A 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 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 should comply with Attachment 1-6.

2.2.3.2 Connectors

The SCM should be provided with a 15 pin D-type male connector and locking screws. The connector layout is defined in Attachment 1-6A.

2.2.3.3 USIMs

The SCM should be able to accommodate at least 4 USIMs.

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

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 781 document since a few units have been built and installed on aircraft for use with Classic Aero and Swift64 service.

COMMENTARY

HISTORICAL DEVELOPMENT OF THE DIPLEXER

The overall AES transmitter system Harmonics, Spurious, and Noise (HSN) and Intermodulation (IM) Product requirements are predicated on performance characteristics of the transmit filter in the diplexer that is described in ARINC Characteristics 741, 761, and 781 for AES system configurations and on the HSN and IM levels that are allowed to be output as byproducts of the signal generation and amplification processes, i.e., primarily the HSN and IM generated in the SDU and HPA.

Since the development of the first versions of the RTCA DO-210 MOPS and ARINC Characteristic 741, several different diplexer specifications have been developed. Historically, at this point in time, there have been six versions of diplexer filter specifications developed. These are known as "Type A", "Modified Type A", "Type B", "Type C" (initially called by the nickname "Jane" when first introduced), “Type D”, and “Type F”. The “Type E” nomenclature has been applied to a different diplexer application and that nomenclature is not being used for an Inmarsat system diplexer in order to avoid confusion with the diplexer used in the other application.

The “Type A” and “modified Type A” diplexers have been installed in numerous Inmarsat satcom installations in aircraft.

The "Type B" diplexer, a proposed pre-HPA filter, and the "Type C" diplexer were never commercially developed, qualified, or installed in aircraft. **The “Type D” and “Type F” diplexers are more recent developments with a few “Type D” diplexers having been developed and installed.**

These different diplexer designs were developed over time to meet changing requirements (1) to protect other services that operate outside, but nearby and adjacent to, the allocated Inmarsat satcom transmit band, i.e., 1626.5 to 1660.5 MHz and (2) to support different parts of the Inmarsat band – specifically some of the diplexers do not support the bottom part of the Inmarsat transmit and/or receive band. Diplexers for SwiftBroadband operation are required to support the full receive (1525 to 1559 MHz) and full transmit band (1626.5 to 1660.5 MHz). The services to be protected initially included GPS, GLONASS, Radio Astronomy, and Iridium. More recently the need for protection has been more completely recognized as applying to GNSS in general which also now includes the Galileo system.

The original diplexer design was the “Type A” model and it offered sufficient protection only for GPS. The following “Modified Type A” diplexer design was developed to give more protection to GLONASS as well as protecting GPS, thus covering the entire allocated GNSS frequency band.

At about the same time that the “Modified Type A” diplexer specification was being developed, there was concern about protection for the TFTS system. TFTS operated in the spectrum immediately above the Inmarsat satcom transmit band. The "Type B" diplexer design specification was developed for ARINC Characteristic 741 to offer protection to GPS, GLONASS, and TFTS. The "Type B" diplexer specifications were not involved in derivation of the specifications in any of the various RTCA DO-210() MOPS versions or any of the Changes to the MOPS.

The "Type C" diplexer specification was developed to provide additional protection for AMS(R)S services operating in the 1610 MHz to 1626.5 MHz bands. It did not address TFTS. In particular it was developed to provide an additional 10 dB of protection for the Iridium system at 1624.5 MHz and below. Along with the "Type C" diplexer design, a pre-HPA filter was designed to further reduce any broadband noise and spurious signals in the Iridium frequency band that might originate prior to the HPA in the AES system. Although the "Type C" diplexer could have been used in conjunction with the pre-HPA filter to provide additional HSN out-of-band filtering, the pre-HPA filter would not have provided significant additional attenuation of intermodulation products because intermodulation products originate primarily in the HPA which follows the pre-HPA filter in the system configuration. At the time the “Type C” diplexer design was introduced, Inmarsat committed to not using transmit frequencies below 1631.5 MHz for Classic Aero and Swift64 services in order to provide a “guard band” in which the “Type C” diplexer filter rejection response could “roll off” to the 10 dB rejection level commencing at 1624.5 MHz and below.

More recently Inmarsat found it has developed a need for increased operating spectrum in order to service the higher speed (hence, wider bandwidth) communications channels used in SwiftBroadband. To add to its available spectrum, Inmarsat chose to extend its operational aeronautical frequencies for SwiftBroadband below 1631.5 MHz, lowering their operating lower band edge down to 1628.5 MHz. To this end the “Type D” diplexer was developed and a few units were installed. The “Type D” diplexer design rejection “roll off” was designed to begin at 1628.5 MHz and provide significant rejection to frequencies below 1626.5 MHz, thus protecting against unwanted emissions affecting the other services below 1626.5 MHz. Specifically, the “Type D” diplexer provides at least 10 dB rejection at and below 1625.5 MHz to protect the Iridium spectrum at the Iridium satellite receivers in orbit (but potentially not providing sufficient protection for aircraft-installed Iridium receivers that are on the same aircraft along with an Inmarsat system to allow interference-free, simultaneous operation of both systems on the same aircraft).

After a relatively short time since the “Type D” diplexer was developed, Inmarsat found that they have a need for even more spectrum for their SwiftBroadband service than the “Type D” diplexer allows. Hence, a “Type F” diplexer design **was developed** to allow Inmarsat operation down to the bottom end of the allocated Inmarsat satcom transmit frequency band, i.e., providing sufficiently low transmission insertion loss all the way down to 1626.5 MHz while providing at least 10 dB rejection at 1625.5 MHz and below to protect the Iridium spectrum at the Iridium satellite receivers similar to the “Type D” diplexer (like the “Type D” diplexer, the “Type F” diplexer potentially does not provide sufficient protection for on-board Iridium receivers that are on the same aircraft as an Inmarsat system to allow interference-free, simultaneous operation of both systems).

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
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	> 2.5dB

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.

2.2.4.5 DLNA Intermodulation

COMMENTARY

D/LNA 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 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 intermod level is based on the IGA/HGA intermod 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 intermod budget between the various system components (antenna, cable, and DLNA). To ease DLNA test, the intermod 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.

Shell size and insert arrangement as per Attachment 1-8A.

2.2.4.7 DLNA Form Factor

See Attachment 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 1-4 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 1-4 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 range of 5° to 90° and an azimuth range of 360°. This ideal coverage volume is illustrated in Attachment 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 IGA subsystem should achieve the required performance 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) ±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] ±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 1-12.

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 1-10.

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 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.

2.3.2.5 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.

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 percent of all combinations of adjacent beams.
2. Twelve degrees for a minimum of 99 percent 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.

2.3.2.5.11 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.

2.3.2.6.9 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 percent of all combinations of adjacent beams.
2. Twelve degrees for a minimum of 99 percent 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 vs. physical separation of an HGA (12 dBi) and a GPS antenna mounted on 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
B-777 970 inches	52 dB Top HGA to GPS
B-767 400 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., Inmarsat 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 to 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.

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 figure C-1 and C-2 of RTCA DO-229C using the curve for “Terminal area, enroute & 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 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 1-12.

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 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 1-10.

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 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 (IGA) 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.

2.3.3.5.5 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 3 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.

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 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 Physical 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.

2.3.3.6.12.2 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 figure C-1 and C-2 of RTCA DO-229C using the curve for “Terminal area, enroute & 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 intermod 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).

2.3.5.3 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 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 (PIM) built-in 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

   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.

b. 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.
c. 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.
d. 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 the dust caps left 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 PIMBIT test be executed to ensure proper operation of the satcom system.
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 1-3 with the applicable notes in Attachment

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 Characteristics. 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 1-4.

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 1-4.

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 for 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 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 1-3).

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.

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

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.

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

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 Swift 64

The service capability is described in Section 1.3 and consists of a circuit switched service known as Mobile ISDN and a 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).

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 (SBS) 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:

	APC	AAC	AOC	ATS
Non-safety	✓	✓	✓	
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. ORT item G/1 determines if SwiftBroadband safety service is activated in the AES and, if so, what SBB channel supports it. The primary voice channel is implemented on the air interface as circuit switched, whereas for a second voice channel (for both air-to-ground and ground-to-air) VoIP is used – in both cases, the voice appears as circuit switched when delivered into the ground networks and aircraft. For both ACARS and safety voice, the 24-bit AES ID is used as the addressing mechanism.

The detailed requirements and implementation of SwiftBroadband safety are not described in this document. Further details are described in RTCA DO-xxx which is being produced by RTCA SC-222. 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

3.0 SATCOM FUNCTIONS

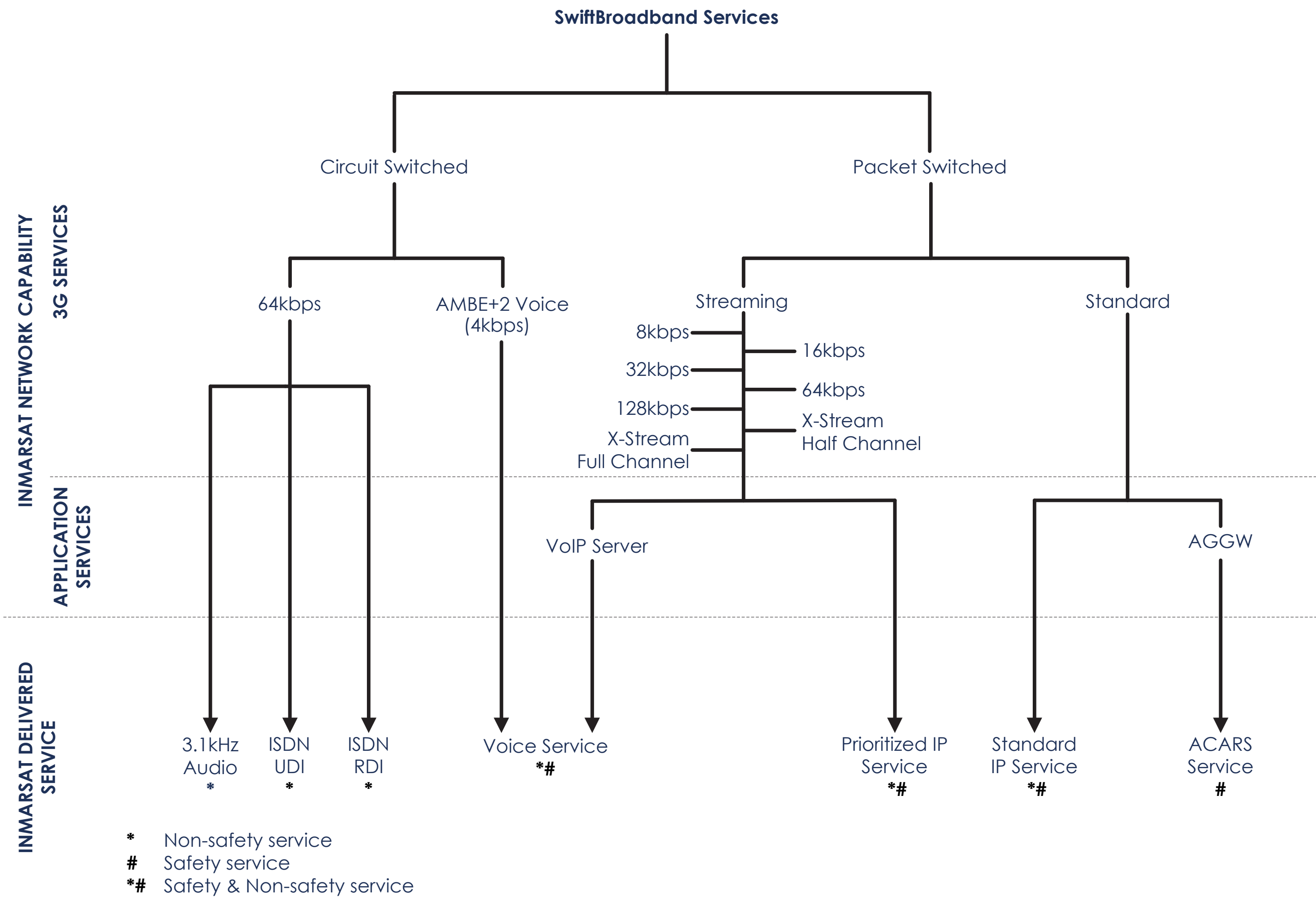


Figure 3-1 – SwiftBroadband Services

Gateway 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.

COMMENTARY

The IP safety service interface is being developed.

The above voice service using VoIP 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 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 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 below). 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.

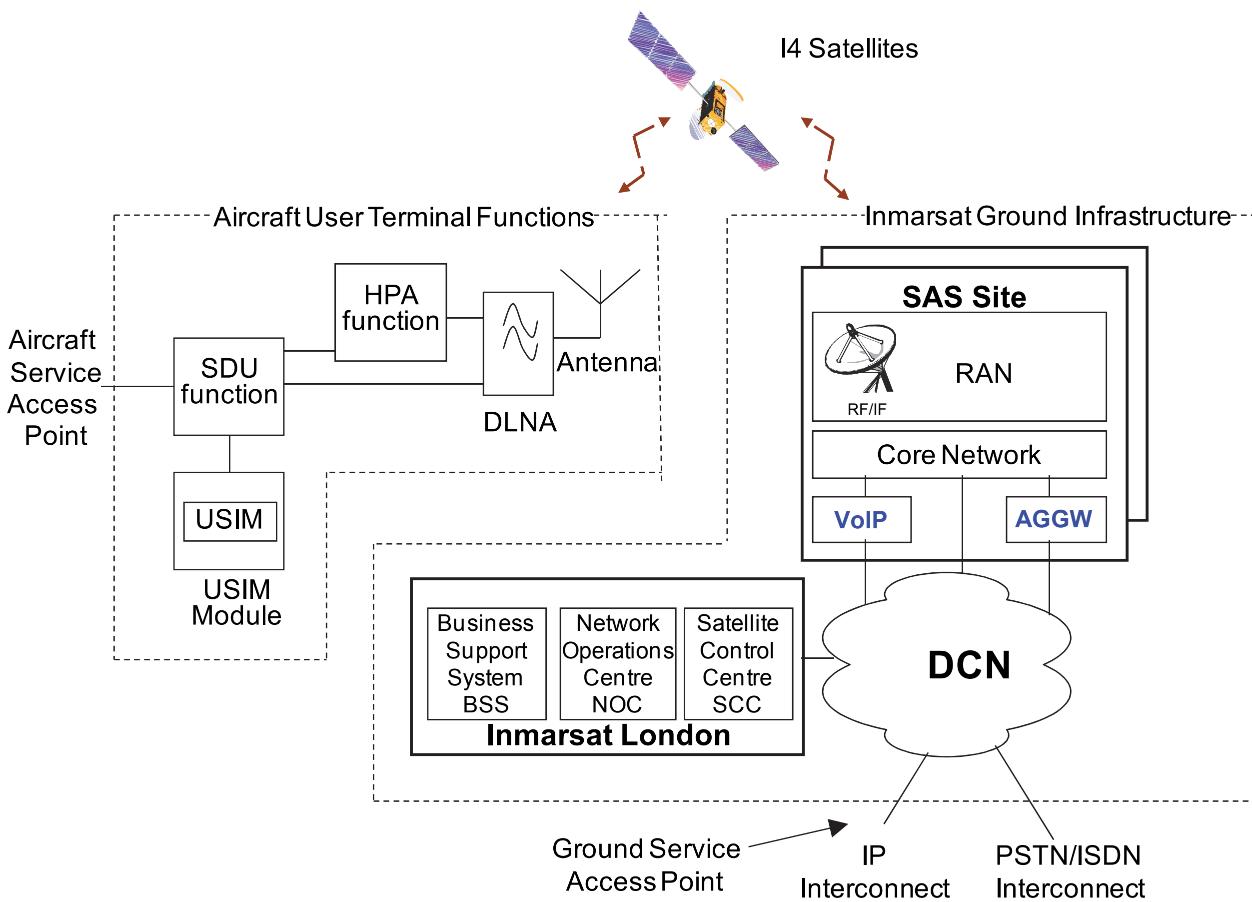


Figure 3-2 – Overall SwiftBroadband Architecture

SwiftBroadband RF bearers in the forward (to aircraft) direction are a continuous transmission of time division multiplexed (TDM) carriers shared between a number of users. RF bearers in the return direction (from aircraft) are based on time division multiple access (TDMA) between a number of users.

Power efficient QPSK (Quadrature Phase Shift Keying) and bandwidth efficient 16 QAM (Quadrature Amplitude Modulation) 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.

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).

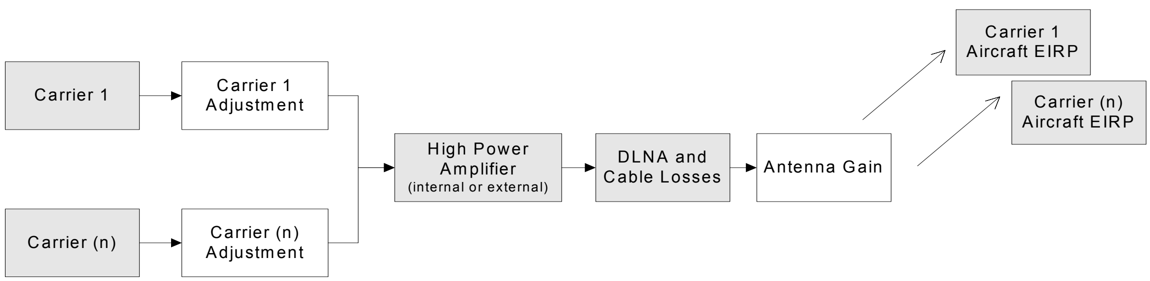


Figure 3-3 – RF Carrier Adjustment

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 is 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 ±120 μs 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 μs (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 WGS-84.

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

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 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 Swift 64, 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 Swift 64, R, T and C channels do not produce 3rd and 5th order intermodulation products at frequencies below 1610 MHz.

3.1.2.4.3 GNSS Frequency Management in the AES

ORT item E/5 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 airframer, 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 flimit 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 > flimit then the new frequency assignment is accepted by the SDU.

If $3F_L$ - 2FH ≤ flimit 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 $3F_L - 2F_H > f_{limit}$. 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 previous paragraph.

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 + discretes		Y[3]	Y[1, 3]	Y[5, 3]				Y[2, 3]	
ATC Cockpit Voice	4-wire Analog + discretes		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	
	ISDN		Y				Y		Y	
Non – ATC Cockpit Data	ARINC 429 ACARS				Y[3]					Y[2, 3]
	ARINC 429 Data-3									Y[3]
	ARINC 664/ Ethernet	Y		Y	Y	Y		Y		F
ATC Cockpit Data	ARINC 429 ACARS				Y[3]					Y[2, 3]
	ARINC 429 Data-3									
	ARINC 664/ Ethernet	F		F	F					F
Cabin Data (incl. Fax, Modem & Packet Data)	CEPT-E1	Y		F	F	Y		F	Y	Y
	ISDN	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.

"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 system**.
3. Expected combination for **cockpit SBB and Classic system**.
4. Expected combination for (digital) cabin voice (e.g., GSM) and data (wired or Wi-Fi).
5. **For voice signaling.**

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 H, Aero H+, Aero I, Aero L
  - For Swift64: 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 & 3B, 2B & 2B
- Physical interface: Ethernet 1-10, ISDN 1-2, POTS 1-2, Cabin CEPT-E1
- 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: AOR-W, AOR-E, IOR, POR, 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, ACP and 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 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.

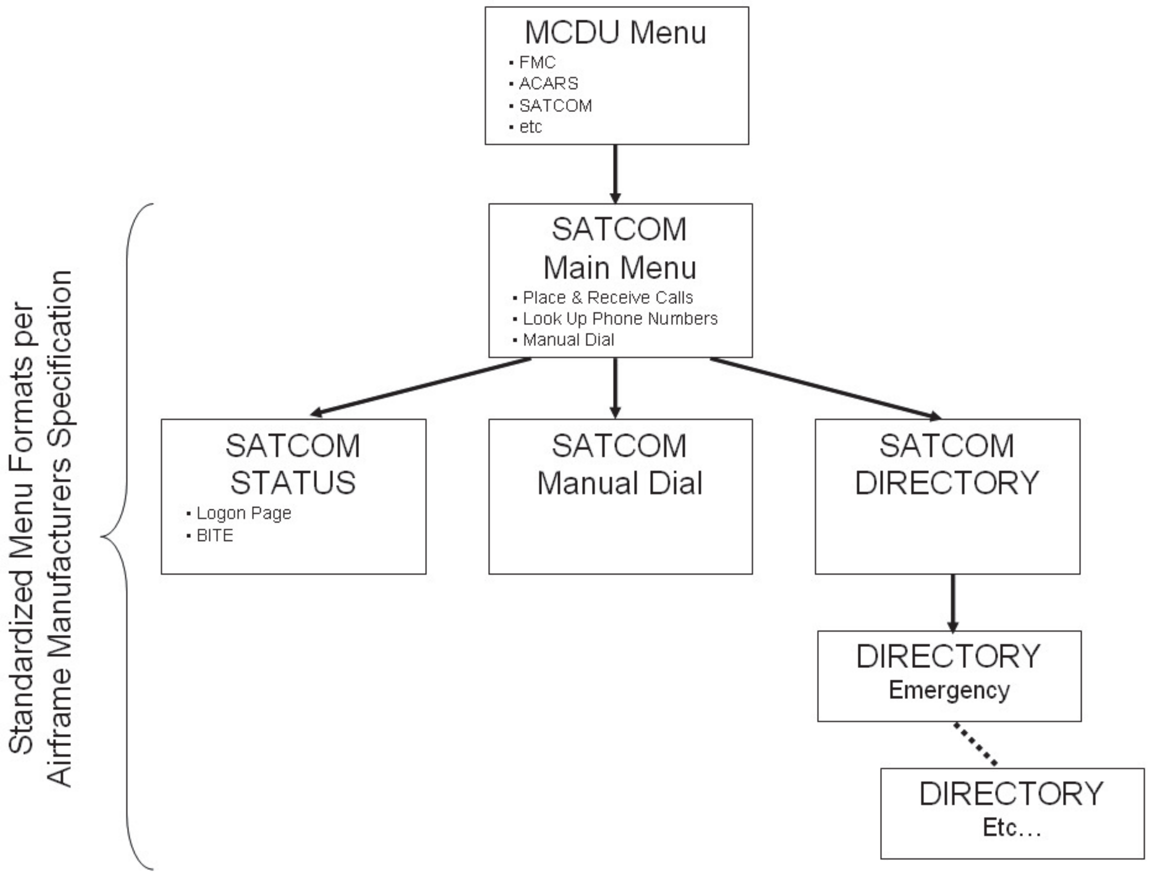


Figure 3-4 – Menus Expected to Have Airframe Manufacturer-specific Definitions

3.2.1.2.2 ACP

The Audio Control Panel provides a “CALL” light indication when a GTA call is detected or an 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 press-to-talk (PTT) signals (reference Section 3.4.2.1.3 Item D7).
- Cockpit Voice Call Light Output #1 and #2 (i.e., one per audio channel).
- 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 1-4.

The Cockpit Voice MIC On inputs can operate in one of two modes as defined by an ORT setting 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 ohm circuit at a nominal output level of 10mW RMS for a digital voice level of -22dBm0.**
2. **Be adjustable over at least the range 5mW to 40mW (-3dB to +6dB), via the ORT, for a digital voice level of -22dBm0.**
3. **Be capable of driving an unbalanced load.**

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

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.

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 -22 dBm0 into an A-law 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 EICAS, SELCAL & chimes should be provided for. Call status information should be provided to the EICAS/ECAM/EDU or equivalent as described in ARINC 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 (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 SCDU.

3.2.1.6.2 Air-to-Ground Call

<u>Call Initiation State</u>

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.

<u>Ground-to-Air Connected State</u>

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 ORT item D7 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. A "End Call" button selected on the SCDU provided an ORT item D7 (Section 3.4.2.1.3), is set to the "Switched PTT" option.
b. The Cockpit Voice Mic On Input (channel #1 or #2, as appropriate) is open circuit provided an ORT item D7 (Section 3.4.2.1.3), 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 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 an ORT setting (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 three 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 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.**

The pilot input method for placing **all three 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 SwiftBroadband 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 pre-empt 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.

Below is a concept diagram of how the system could be implemented.

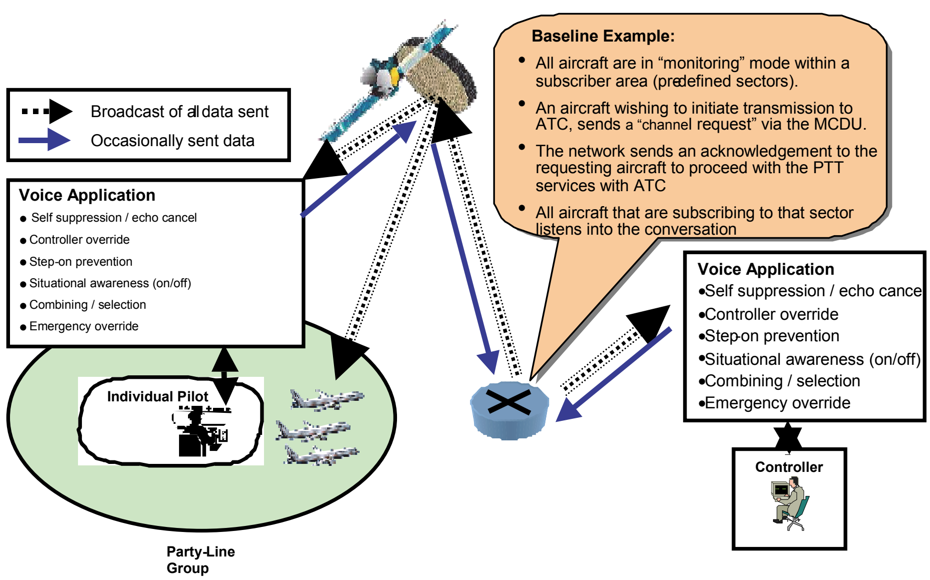


Figure 3-5 – Baseline Operational Concept for SAT Radio

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 airplane 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 of which concept will be up for evaluation, is required to be undertaken, but is not expected to be finalized in time for this specification.

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 1-4A 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 the full 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. This parameter is set as an ORT item B9 (Section 3.4.2.1.3) rather than configuration pin strapping.

3.2.3 ISDN Interface

The SDU should accommodate two BRI interfaces for use of Swift64 and SwiftBroadband circuit-switched services.

The signaling protocols used on the interfaces are ITU Q.921 and ITU Q.931 for layer 2 and 3 of the signaling link, respectively. The SDU acts as the NT device.

Both (the aircraft user and the ground user) can terminate an established call by using the signaling protocols on the ITU Q.921 and ITU Q.931 for layers 2 and 3 of the signaling link.

For an M-ISDN call initiated from one of the two ISDN BRIs interfaces, when appropriate, a Q.850 error code should be generated by the SDU as specified in Inmarsat mini-M SDM Section A Annex10 Table A10-7.1.5.1.2.

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. Other uses of the Ethernet ports (e.g., CFDS) may be described in future supplements (see Sections 3.6.1 and 3.6.2)

COMMENTARY

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.

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 of 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.
  - SDUs that host one or many SwiftBroadband channels.
- A SwiftBroadband channel may support up to 11 simultaneous packet data services (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, & transfer of packet data using SwiftBroadband packet data service. With control equating to set up, modify & terminate primary contexts and set-up, modify & 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 & transfer of packet data using Swift64 (packet & 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 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/TCPIP/Ethernet. Out of band means independent of the PPPoE session carrying the user data.

and/or

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 UDI data calls by using service names in PPPoE frames.

and (if required)

6. 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 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.

3.2.4.4 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 industry standard ARINC 665.

3.4 Miscellaneous

3.4.1 Dual

Dual satcom can be implemented in a variety of ways as shown in the table below. The main reason for this is due to the nature of how Classic Aero and SwiftBroadband/Swift64 services are provided. Classic Aero channels are dependent on a single AES ID (ICAO Code) and sharing of those channels has been extensively explored and described in ARINC Characteristic 741. The combined services of Classic Aero and SwiftBroadband/Swift64 into the one LRU has complicated the original definition of dual satcom, but has also provided some additional operational benefits or advantages in the simplification of controlling Classic Aero channels.

It should be noted that the different functional components of the SDU could at a particular instance provide different types of dual functionality. For example the Classic component could be operating in dual co-operative, while the SwiftBroadband component could be operating in dual independent.

It is further noted, that an SDU implementation may support many dual modes and the SDU could transition from one mode to another depending on, for example, the dual status discretes.

Table 3-4 – Various Dual Satcom Implementations

Generic Name	Key Characteristics	Notes
Dual – Independent	No or minimal interaction between the two systems. Two systems can have different functions and come from different suppliers.	For Classic Aero the airplane would require two ICAO codes.
Dual – Cold Standby	Standby system is powered off until needed. A "control function" is required to power up the system.	
Dual – Warm Standby	Standby system is powered on. No interaction between the radio functions of two systems (e.g., log on context is not passed between systems). A dual control function is required (but could be external). The radio function of the standby does not modulate or demodulate signals.	
Dual – Hot Standby	Standby system is powered on. The context (e.g., log on info, SwiftBroadband spot beam maps) is passed from one system to the other to allow "fast recovery" after a switchover. The radio function of the standby does not modulate or demodulate signals.	
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 radio functions of the two systems are interacting – e.g., the radio control channel of the slave unit is being provided by the master unit.	Defined per ARINC Characteristic 741. Channel units in the standby system are active and controlled by the Master unit.

Each of the dual satcom implementations can be separated into the definition of key functions:

- Radio Function
- Interface Function
- BITE Function
- Control Function

Interface functions in a dual system are described in sections below of this document. The Radio and Control functions are dependent on the degree of desired dual operation and are described in relation to each of the services being provided, i.e., Classic Aero and or SwiftBroadband/Swift64 operations.

3.4.1.1 Classic Aero Operations

3.4.1.1.1 General

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.

There are three key issues that determine the appropriate dual mode.

Firstly, at each power up cycle, both SDUs should perform a self-test of itself and if no BITE errors are detected, the SDUs should each attempt to perform a logon to verify correct operation. If any of the SDUs at power up in a dual installation (other than Cooperative Mode) fails to logon in a valid manner, the SDU that failed to log on should declare itself inoperative and require manual intervention.

Secondly the interface between the AMS and satcom must be considered. If an AMS can support four satcom voice inputs then the complexity in the SDU can be reduced and for example Dual-Hot Standby can be used. However if the AMS can only support two voice channels and it is required that (1) in normal operation the aircraft has two voice channels and (2) on failure of either SDU, some voice functionality is required (e.g., support for one voice channel), then only the Dual-Cooperative mode may be appropriate.

Thirdly, only one ICAO address can normally be allocated to an aircraft. Hence in this case dual independent mode is not appropriate.

Based on the above considerations, classic aero could be implemented as “dual-warm standby”, “dual-hot standby”, or “dual-cooperative” depending on the aircraft installation.

3.4.1.1.2 Interface Between SDUs

The Control & Interface Function that is implemented by the Cold/Warm/Hot Standby/Dual Cooperative implementations use signaling that must be performed via the dual satcom crosstalk buses (9C, 9D & 9G, 9H). This interface should be used to provide an indication of the health between each system with the protocol and interface definition being manufacturer specific.

3.4.1.1.3 Cold and Warm Standby

In the case of Cold and Warm Standby implementations, each SDU need not be aware of what state the other SDU is in. Switching between each system is achieved manually, either by software or a physical switch. In the case of Hot Standby implementations, each SDU should monitor the health or the log on status of the other SDU. Only one system is logged on to the Classic Aero services at any one time, outputting valid indications to such systems such as the CMUs and MCDUs. For the CMU, the standby SDU sets bit 11 of label 270 to indicate that it is not available for the CMU to use. For the MCDU the ARINC Characteristic 739 data would still be sent, but when the LSK is pressed for <SAT-R or <SAT-2 or equivalent, then the satcom menu should show that the voice channels are not available.

In normal operations, where both SDUs receive valid inputs from each other, the SDU that is program pinned to be SDU number 1 should log on and SDU number 2 should remain logged off. If SDU number 2 receives an indication that SDU number 1 reports a failure (and is logged off), then SDU number 2 should proceed to log on.

If an SDU does not receive a valid input from the other system, then that SDU should not attempt to log on or continue to be active. This could result in both SDUs being in the standby mode. In this scenario, the situation requires pilot intervention and a manual log on of the system that is deemed healthy.

3.4.1.1.4 Cooperative Mode

In the case of Cooperative Mode, the channel units in the Slave system are controlled and can modulate as determined by the Master. The complete definition of this cooperative operation is described in ARINC Characteristic 741.

3.4.1.2 SwiftBroadband & Swift64 Operations

It is expected that Dual Independent mode is most appropriate for SwiftBroadband/Swift64 operations. The SwiftBroadband/Swift64 channel units that are installed in each of the SDUs can operate completely independently of each other as determined by the onboard router.

3.4.2 Configuration & 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 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 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 1-4A) 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 overall 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 can not know whether its ORT is correct or not, since this can be only be determined by manually comparing the part number of an ORT that an SDU is using with the approved/certified 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 compare the just read SCM ORT with its “local copy” ORT. Normally they will be 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 can not 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 & same	Normal Operation	Normal Operation
b	Both ORTs valid but different	Use SCM ORT & transfer SCM ORT --> SDU Local Copy. Keep operating. No failures raised.	Same as for type (1).
c	Only SCM ORT valid	Use SCM ORT & 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 with data loader.	Same as for type (1).
e	Neither ORT valid	Raise failure. Do not operate. Failure cleared by uploading new secure ORT with data loader	Use default User ORT. Do not transfer to SCM. Raise failure. Keep operating. Failure cleared by uploading new user ORT with data loader.

3.4.2.1.3 ORT Contents

This table may accommodate the following items. It is left to the terminal manufacturer to 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.

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

    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.

    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.”

    GES/LES station identifications should be enterable in octal format.
3. 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.

4. 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 Section B: Interfacing Systems Configuration

1. ICAO code source (Reference Attachment 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 1-4 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 1-4 Notes 1 and 27)
   a. GPS position data present
   b. GPS position data not present
5. Primary IRS Input (Reference Attachment 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 1-4 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 1-4A.

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 1-4A.

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
    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 1-4A.

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 1-4A.

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 1-4A.

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 1-4A.

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 1-4A.

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 1-4A.

17. CCS type
    a. ITU Standard
    b. ARINC 746
18. SCM
    a. Connected
    b. Not connected

    Note: This ORT item is not applicable if strap pin TP3G indicates to use other strap pins per Attachment 1-4A.

19. ISDN 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 1-4A.

20. ISDN 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 1-4A.

21. Data from GNSS to SDU
    a. Connected
    b. Not connected

<u>ORT Section C: Ethernet Ports Configuration</u>

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 1-4A, 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 1-4A, then this ORT item only applies for the Ethernet bus speed.

3. Ethernet port 3 (Quadrax) 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 1-4A, then this ORT item only applies for the type of Ethernet/ARINC 664.

4. Ethernet port 4 (Quadrax) 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 1-4A, 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)
   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

1. Enabled
2. 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.

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 (see 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.

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

   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
4. 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.

5. Cockpit air-to-ground call camp-on timer

   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.

6. Noise insertion

   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

7. Cockpit hookswitch signaling method

   a. Switched PTT and/or SCDU line switch(es)
   b. Latched Audio Control Panel (ACP) satcom Mic-Switch

8. Telephone number pre-select

   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

9. SCDU line select key prompts for cockpit air-to-ground call

   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

10. Chime for cockpit air-to-ground call

    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

11. Placement of Cockpit Call using Place/End Call Discretes

    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.

    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.

    If ORT item D7 is set to Switched ‘PTT, the Place/End Call discretes are interpreted as Place Cockpit Call when exercised with the call light off.

    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

12. Dual satcom cockpit voice channel mapping to AMS/ACP

    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

13. Manual dial of number not in directory

    a. Enabled
    b. Disabled (except for short codes)

14. **Cockpit Headset Audio Gain**

    This item determines the headset audio level (both operational audio and test tone) with respect to the nominal level of 10mW.

    a. -3dB
    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**

15. **Cockpit Headset Sidetone Gain**

    This item determines the headset sidetone level, with respect to the microphone input audio level.

    a. **0 dB**
    b. **-3 dB**
    c. **-6 dB**
    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

    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
4. Antenna configuration
    a. ARINC 781 HGA
    b. ARINC 781 IGA
    c. LGA + LGA HPA
    d. ARINC 741 Top 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 1-4A.

5. GNSS Frequency Check Algorithm
    a. Not required
    b. Required with f_{limit} = 1585 MHz
    c. Required with f_{limit} = 1605 MHz
6. Position reporting
    a. Enabled
    b. Disabled
7. Reserved
8. Minimum initial EIRP for Swift64

9. 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 1-4A. Reference Attachment 1-4 Note 19.

10. 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.
11. 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.

12. 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.
13. 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**
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 (e.g., 747-400, 747-8, 330-500, 737-NG, 737-MAX)**

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 1-4A.

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 1-4, 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 airplane 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.

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 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 OEMs, 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

3.4.3.1 Introduction

Because the satcom system will support communication from airplane systems residing in the Airline Information Services (AIS) Domain and cabin systems in the Passenger Information and Entertainment Services (PIES) Domain, there is a need to demonstrate that the functions (shared or independent) contained within the SDU can provide adequate segregation of traffic and withstand potential threats that are introduced by its use in an open network environment. The security risks associated with the satcom system include (1) interruption or loss of satellite communications (2) interception of communications by unauthorized parties, and (3) subversion of authorization by impersonation of messages to the cockpit. 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. This section is focused on the security risks of the airborne system and the considerations and mitigations necessary for any ARINC 781 implementation.

The security analysis methodology defined in Attachment 3 of **ARINC Report 811:** *Commercial Aircraft Information Security Concepts of Operation and Process Framework* lays out three high level steps to be performed in order to achieve an adequately secure system:

Step 1: Identify information security needs and objectives.

Step 2: Select and implement security controls.

Step 3: Operate and manage security controls.

Step 1 of the process includes multiple sub-steps to determine what security controls will be necessary to secure the Ethernet interface of the SDU:

- Perform asset identification and security categorization
- Assess risk
- Identify policies
- Determine physical environment and assumptions
- Characterize security objectives

To support the recommendation of specific security controls for the satcom Ethernet interface, a detailed security analysis was performed in April 2007 using the ARINC 811 methodology and is available in Appendix B.

For detailed explanation of the security analysis steps, refer to ARINC Report 811. Additional guidance on analysis and implementation of secure airborne Ethernet networks should be sought in other applicable regulations and in documentation from airframe manufacturers and equipment suppliers.

3.4.3.2 Identification of Threats

Examples of threats are impersonation, malicious software and denial of service. Each of these has its own manifestations and levels of severity to consider. Other threats could exist, but these three are specifically identified for guidance purposes.

Impersonation

This threat can manifest itself in various ways, from the alteration of MAC (Layer 2) & IP (Layer 3) addresses, subversion of an application and spoofing of messages to the cockpit, or insertion of complete and valid source code that does more than just operate the SDU normally, e.g., Trojan horse or backdoor programs (see “Malicious Software”).

Malicious Software

This threat could lead to unpredictable behavior of the satcom system, including the generation of misleading or erroneous information, or the “crowding out” of legitimate uses (see “Denial of Service”).

Denial of Service

The cabin function portion of satcom could be commanded to be in exclusive use and prevent cockpit functions from operating correctly, or generation of spurious traffic could saturate the available bandwidth and prevent higher priority traffic from getting through.

3.4.3.3 Plan for Mitigation Criteria

In all cases, the SDU must provide enough design assurance to be able to satisfy mitigation criteria. The exact method to accomplish this is left up to each avionics manufacturer, but general guidance and possibilities are provided here.

Impersonation

Provide by demonstration or analysis that the IP/MAC addresses can only be altered physically or that the SDU has the facility to cross-reference these items via another source. Use of the SDU configuration module (SCM) for cross-referencing is an example of being able to vote on whether there is an unexpected mismatch of the key identification addresses. On some aircraft, identification addresses can be obtained via a centralized data source, and that is yet another valid form of mitigation. The ability to mask or keep from view these address to unauthorized sources is also a possible means of preventing the realization of this threat. Depending on what services are being offered, impersonation could also extend to the traditional AES ID (ICAO address) of the aircraft.

COMMENTARY

As of mid-2007, the Air Transport Association of America (ATA) has been requested to begin researching ways to attach a permanent and universally recognized identity to an airframe that stays the same for its full in-service lifetime and is also electronically available to any authorized system on or off-board the aircraft (similar in concept to a VIN on an automobile).

Malicious Software

The SDU must be capable of at least two means of mitigation to this threat. One way is to select system software that is inherently a less likely target of malicious software (“malware”), a second is to prevent malware from entering the SDU in the first place; a third is to be able to detect and address anomalous behavior that is indicative of malware in the system. The suggested implementation methods are described in the proceeding sections; however, the main examples to consider are the inadvertent execution of mobile code that could perform a variety of unintended effects within the SDU or other systems to which it interfaces. If the SDU cannot process such mobile code, then this would be the disposition based upon analysis.

Considerations that do not only pertain to software solutions can also include procedural-based solutions such as physical processes and controls. Mitigation of this threat can include the fact that the aircraft on which the SDU is being installed can provide a human-based procedure that prevents software intrusion or controls and audits the software on or off the aircraft. If this is the chosen method to disposition the first means, then it is an example of an acceptable overall approach.

For the case of malicious dataload, the SDU should cross check existing inputs such as weight-on-wheels inputs, airspeed inputs and cyclic redundancy code (CRC) checking. If necessary, incorporate resident hardware and software compatibility and revision history matrices.

Denial of Service

The mitigation plans to address this threat should consist of the ability to ensure that the cockpit services are not impeded in cases where the cabin network segment is being flooded by spurious or malicious traffic, e.g., if a cabin user is under attack. Such a condition could consume HPA and system processor resources, and the necessary protection methods are to ensure that cockpit services can preempt as necessary to ensure timely and successful delivery of communications to the ground. Shut-down of those functions that are exhibiting unintended overuse should be implemented. The ability to detect these conditions could be in concert with a suitable router (either internal or external to the SDU). Examples of being able to detect this condition could be a periodic request from a port or a function assigned to a cockpit service to determine if the function can be successfully executed. Priority and preemption capability of cabin services should always be included in the SDU design. Use of specific bits in packet headers to identify source and type of service is one way to achieve this.

3.4.3.4 Implementation of Functional Segregation

Functional segregation is a means to show equivalence to systems that serve isolated functions that are physically separated on the aircraft and have no effect on functions that interface with the control of the aircraft.

Aircraft having two satcom systems in which one is a cabin-only (PIES domain) system and the second is cockpit-only (AIS domain) is an example of functional segregation based purely on physical separation and the former having no interfaces to the cockpit systems. A two-satcom implementation can be costly, however. For shared satcom systems that provide both cockpit and cabin services, there is also a need to show an equivalent logical separation, albeit within the one enclosure.

COMMENTARY

> It must be noted that satcom systems for the past 10-15 years have also served in this dual-use capacity, allowing such services as SMS and PC data, albeit at very low data rates.

A “partition” is the facility to delineate circuitry or software code and claim valid equivalence to separation within the same enclosure. Examples can include a channel card being dedicated solely for cabin use, but being contained within the same SDU enclosure. The software controlling this individual card is then partitioned off. The partitions in this case would be the domain that affects the control of the airplane or SDU and domains that affect the operation of the airplane or SDU. A third partition would be an interface domain that covers the physical ports of the SDU which shows separation for the required functions.

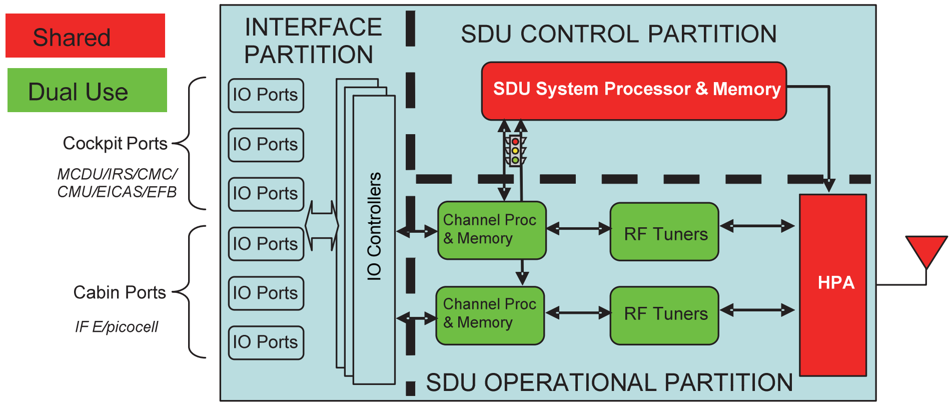


Figure 3-6 – Identification of Partitions that are Internal to the SDU Enclosure

Figure 3 shows a conceptual design of the SDU that is split into the above three partitions and attempts to satisfy the equivalence of physical separation as long as the shared resources incorporate the necessary mitigation methods described in the previous section.

Shared elements are components within the SDU that are used by all services, both cockpit and cabin. There are special requirements for these components to demonstrate their integrity. Dual-use items are components that can be configured for cabin use only or cockpit use only or a combination of both, due to the fact that if one of these components fail or exhibit abnormal behavior, it can be shut down.

3.4.3.4.1 Control Partition

The SDU Control Partition separates out the shared resources that control the SDU functions, allocating processor capacity, priority and preemption of cabin services by the cockpit. The processors and memory devices must be robust enough not to be accessible to any applications that are not native to the SDU operating system. A responsibility of this domain include functions for the MCDU, CMCF, Antenna control, audio control, etc., and represents the top-level system software level classification for the entire LRU.

The SDU Control Partition must remain operational at all times during threat conditions in order to support the mitigation plans for each of the identified threats. This can include the reboot and reload of functions that are contained in the Operational Partition. For the instance of denial of service attacks, this partition (perhaps in concert with the router) should limit the throughput requests for any individual IP address that is exhibiting abnormal activity.

3.4.3.4.2 Operational Partition

The SDU Operational Partition contains both shared and dual-use resources. In this case, the shared resource is the HPA and the control of its capabilities should be governed by the SDU Control Partition. Its access, however, is open to any of the dual - use components, which in this case consists of the channel cards and RF tuners. Since there is usually redundancy provided in these components, threats to these components could be realized in one set of channel & RF tuners, but should not affect both. It is acceptable to have this partition subject to reasonable reboot or reload to recover from the threat.

3.4.3.4.3 Interface Partition

The SDU Interface Partition is provided to comply with the physical separation requirements. Each port and I/O controller is redundant and separate such that threats being realized on one port or controller do not affect the operation of ports allocated to cockpit services. This partition should be equivalent to having two separate satcom systems installed on the aircraft.

3.4.3.5 Security Objectives

In a dual-use satcom system, the main functions to be protected are the various cockpit services from threats identified in the previous sections. Loss of cockpit voice and data both contribute to the hazard assessment level of the system. At a device level, the cockpit functions would be comprised of the system processor and memory, I/O Ports and certain channel cards.

At the time of this writing, all hazards to the satcom system are being considered to be “minor,” such that the categorization of the protection of these cockpit functions falls in the one category.

The physical environments for these cockpit functions are being referred to as individual partitions within the design of the SDU. The devices within these partitions can either be used as shared, dual-use, or independent. In the “Interface Partition,” the physical environment is that the I/O ports are independent and are separated from the I/O ports serving the cabin equipment. In the “Operational Partition,” the physical environment is that the channel cards are dual-use and can fail or succumb to threats, so long as the other remaining channel cards are automatically isolated for cockpit use only. In the “Control Partition,” the physical environment is that the system processor and memory are shared resources and must be shown not to succumb to or be adequately protected from any threats.

The security objectives are to ensure that the devices in the Control Partition retain full and proper function to shut down errant behavior in any device identified in the Interface and Operational partitions. Cessation of functionality in the non-cockpit I/O ports and the isolation of the remaining “good” channel card(s) would be examples of security objectives that need to be implemented.

3.4.3.6 Security Summary

The successful achievement of security objectives involves exercising the security analysis process in an iterative process of proposal and review, along with the orchestration of designing the SDU with partitions to show adequate separation of functions. The ability to mitigate the impending threats by a combination of robust software techniques both internal and external to the SDU is key to the successful management of security requirements and guidelines.

It is necessary for avionics manufacturers to consult with airframe manufacturers prior to completing the design of any potential dual-use satcom system. There are specific and perhaps differing views and levels of acceptability at each airframe manufacturer.

3.5 Priority, Precedence, Preemption, and Preference

Priority, precedence and preemption are defined for Classic 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 Attachments 1-3 and 1-4 specify the two Quadrax and five fiber ports.

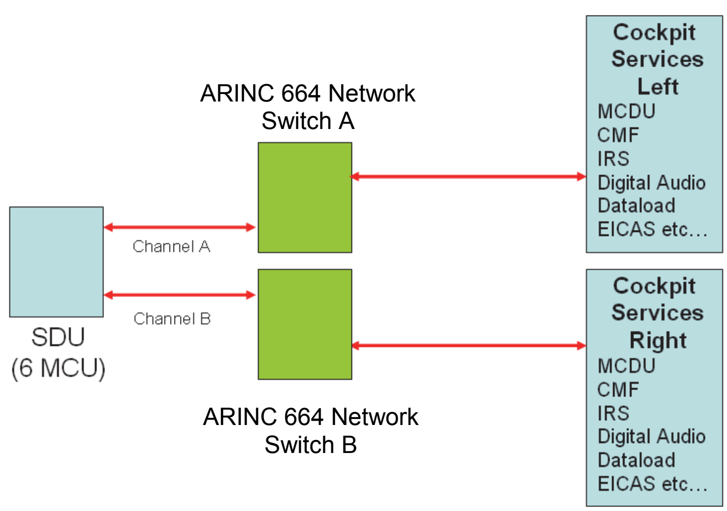


Figure 3-7 – ARINC 664 Interface Topology

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 document.

3.6.4 Multi-Frequency Band

This section 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 (IM) 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. (P)IM 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 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 data link 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 frequencies are chosen such that the receive frequency corresponds to the nth-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 vs. 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 the PIMBIT items in Section 3.4.2.1.3-E.

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 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 Section 3.4.2.1.3-E ORT Item 11 for the angles to be used, and Item 12 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 <u>without</u> 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:

- $10 \log_{10}(T2/T) = 10 \log_{10}((T + \Delta T)/T) = 10 \log_{10}(1 + \Delta T/T)$.
- 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 level (assumed to be PIM) when the two CW test signals are transmitting vs. the noise floor when no test signals are transmitting. For the recommended discard ratio, reference Section 3.4.2.1.3-E for ORT Item 13.

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.

3.7.3.10 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 Section 3.4.2.1.3-E for ORT Item 13.

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 7^{th}, 11^{th}, etc. products, even though the assigned frequencies were intended to allow for measurement of the 9^{th} 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 OEMs. 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/ACU, interconnections (RF coax, discretes, ARINC 429, etc.), having the satcom system frequency reference being within its specified operating temperature range, etc.).

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 45^{th} 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 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 & 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.

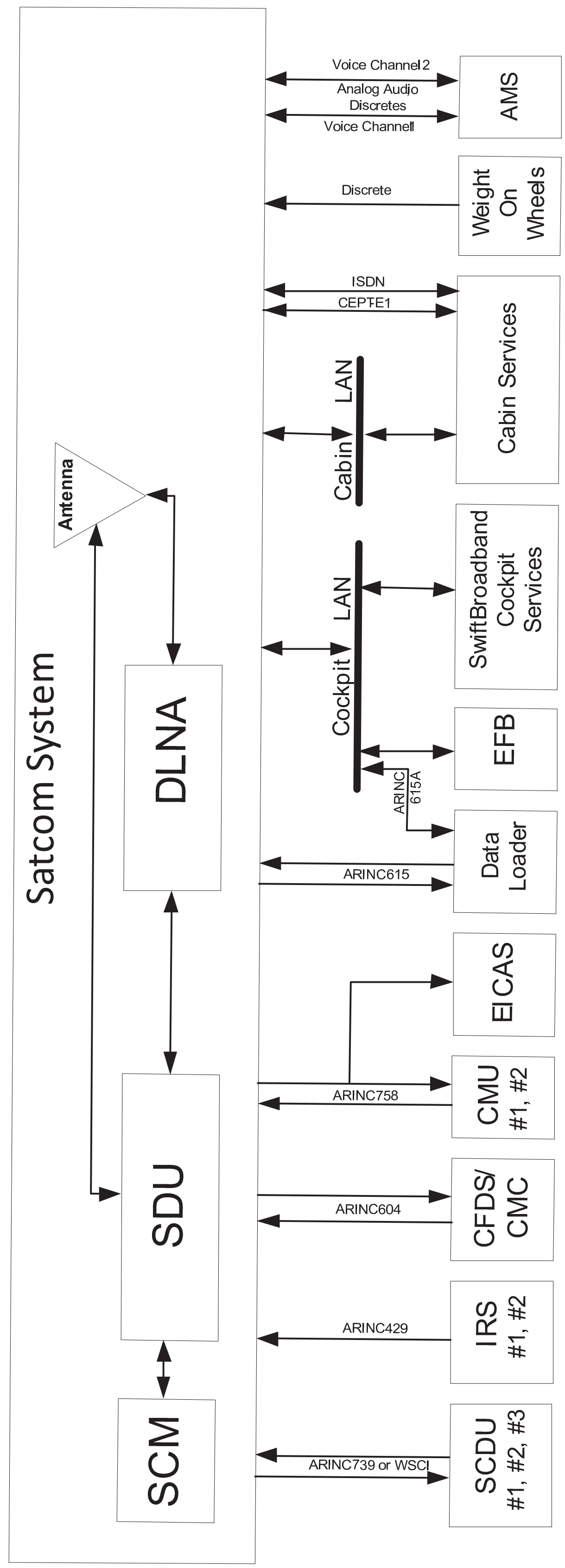
- Replace the DLNA-to-antenna coaxial cable assembly.

Additional actions that may be taken by OEM and/or equipment provider engineering personnel for fault isolation include but are not limited to the following:

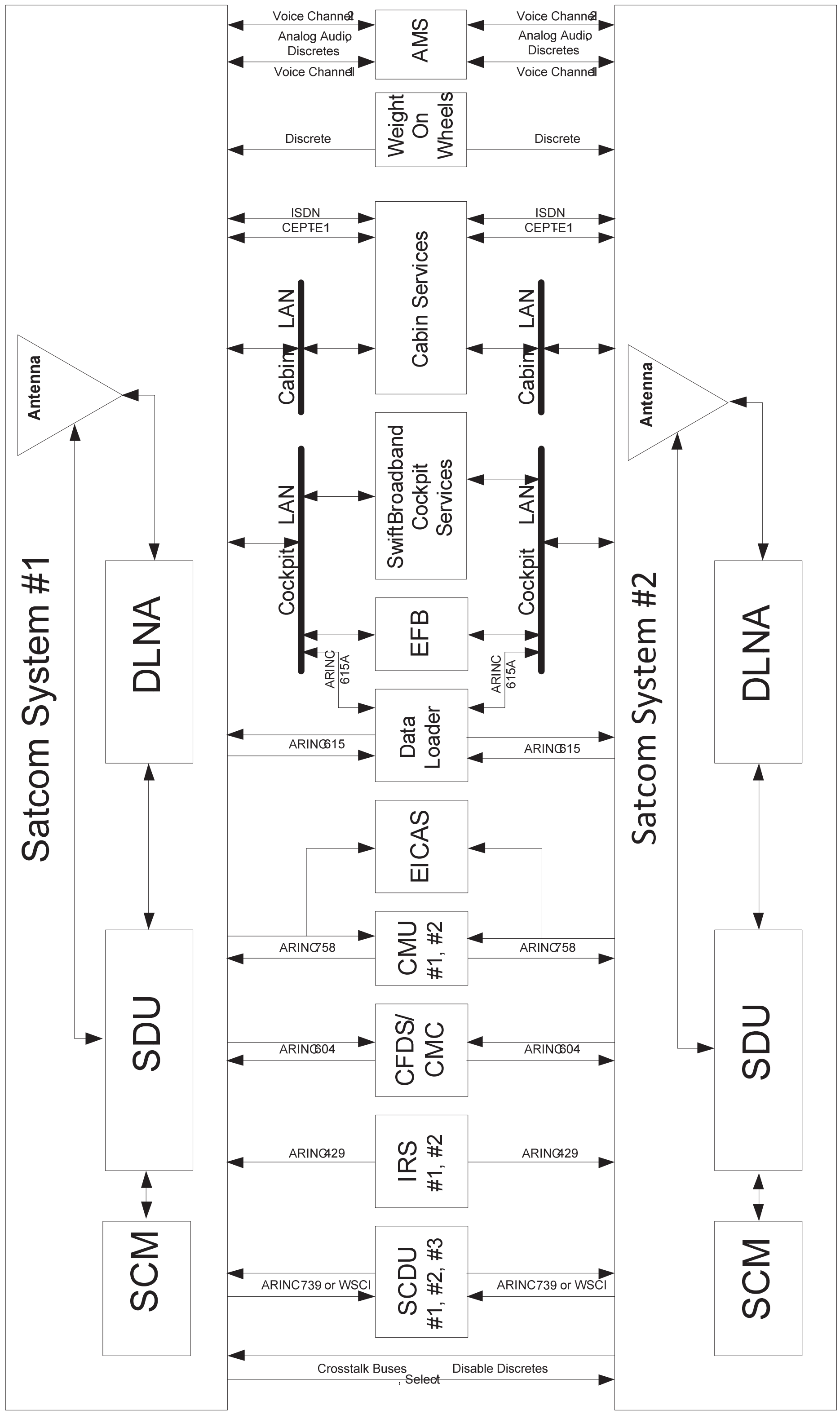
- Affix a low-PIM dummy load at the antenna port of the DLNA and repeat the PIM test.
- Affix a low-PIM dummy load at the antenna end of the DLNA-to-antenna coaxial cable assembly.
- Launch the PIMBIT while the aircraft is in-flight using special engineering test interfaces/modes.

The maximum recommended azimuth and elevation angle settings for the ORT items should be specified, based on the characteristics of the installed antenna.

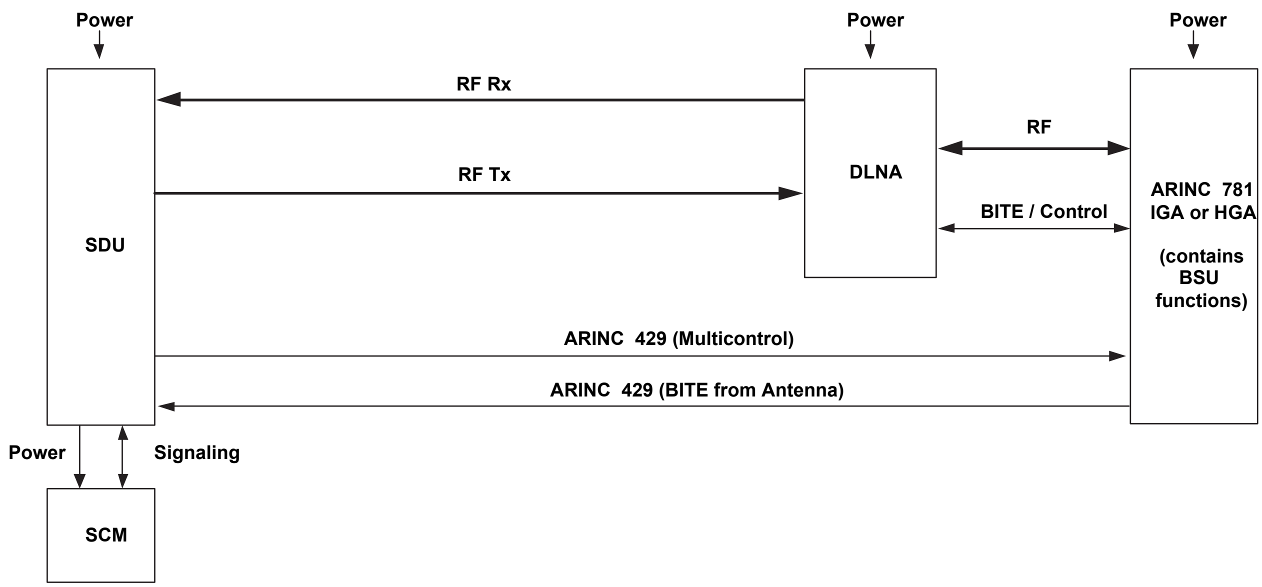
ATTACHMENT 1-1A
GENERAL CONFIGURATION OVERVIEW – SINGLE SATCOM INSTALLATION



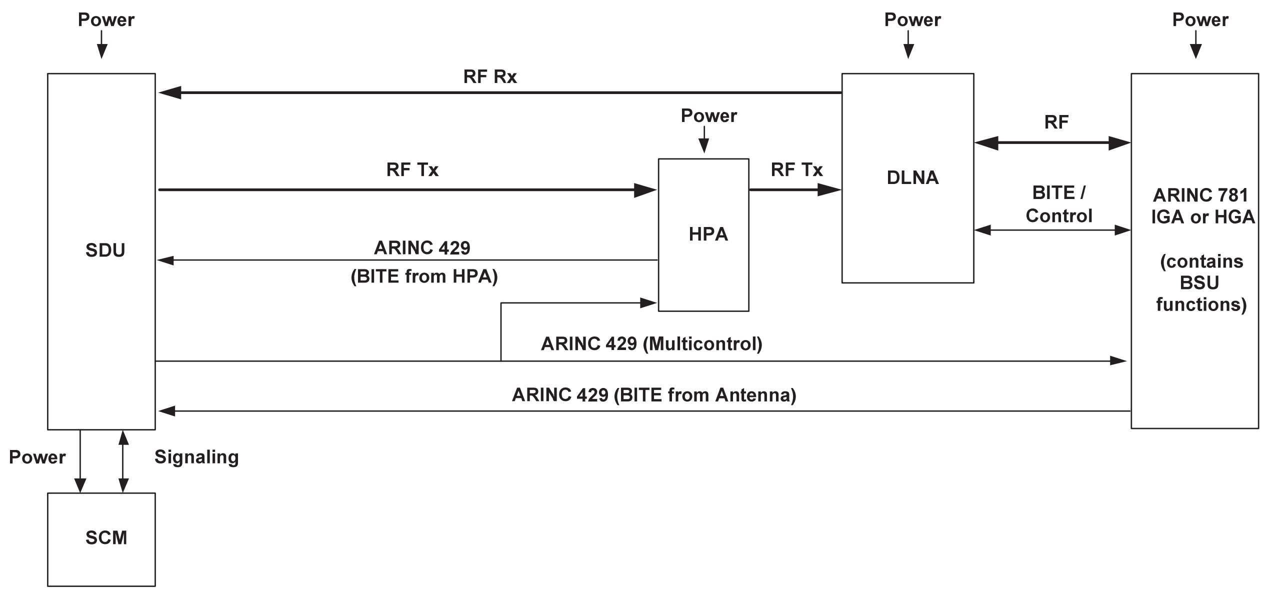
ATTACHMENT 1-1B
GENERAL CONFIGURATION OVERVIEW – DUAL SATCOM INSTALLATION



ATTACHMENT 1-2A
SATCOM SYSTEM CONFIGURATION – HPA INTEGRATED IN SDU



ATTACHMENT 1-2B
SATCOM CONFIGURATION – OPTIONAL FLANGE MOUNTED HPA



Note: This configuration is expected to be used on those few aircraft where the installation losses between the SDU and antenna does not meet the 2.5 dB loss requirement.

ATTACHMENT 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)**		TP**71**	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			
ATE Pins		TP02A			
ATE Pins		TP02B			
ATE Pins		TP02C			
ATE Pins		TP02D			
ATE Pins		TP02E			
ATE Pins		TP02F			
ATE Pins		TP02G			
ATE Pins		TP02H			
ATE Pins		TP02J			
ATE Pins		TP02K			
Ethernet 1 from SDU to User	+	TP03A	100BASE-TX		37
Ethernet 1 from User to SDU	+	TP03B	100BASE-TX		37
Ethernet Empty Cavity		TP03C	100BASE-TX		
Config Pin 1		TP03D	0V common		17
Config Pin 2		TP03E	Discrete		17
Config Pin 3		TP03F	Discrete		17
Config Pin 4		TP03G	Discrete		17
Spare		TP03H			
ISDN 1 from SDU to User	+	TP03J	ISDN		
ISDN 1 from User to SDU	+	TP03K	ISDN		
Ethernet 1 from User to SDU	-	TP04A	100BASE-TX		37
Ethernet 1 from SDU to User	-	TP04B	100BASE-TX		37
Ethernet Empty Cavity		TP04C	100BASE-TX		
Config Pin 5		TP04D	Discrete		17
Config Pin 6		TP04E	Discrete		17
Config Pin 7		TP04F	Discrete		17
Config Pin 8		TP04G	Discrete		17
Spare		TP04H			
ISDN 1 from User to SDU	-	TP04J	ISDN		
ISDN 1 from SDU to User	-	TP04K	ISDN		
Ethernet Empty Cavity		TP05A	100BASE-TX		
Ethernet Empty Cavity		TP05B	100BASE-TX		
Ethernet Empty Cavity		TP05C	100BASE-TX		
Config Pin 9		TP05D	Discrete		17
Config Pin 10		TP05E	Discrete		17
Config Pin 11		TP05F	Discrete		17
Config Pin 12		TP05G	Discrete		17
Spare		TP05H			
Spare		TP05J			
Spare		TP05K			

ATTACHMENT 1-3
STANDARD INTERWIRING

SDU SIGNAL NAME		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Ethernet 2 from SDU to User	+	TP06A	100BASE-TX		37
Ethernet 2 from User to SDU	+	TP06B	100BASE-TX		37
Ethernet Empty Cavity		TP06C	100BASE-TX		
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
Spare		TP06H			
ISDN 2 from SDU to User	+	TP06J	ISDN		
ISDN 2 from User to SDU	+	TP06K	ISDN		
Ethernet 2 from User to SDU	-	TP07A	100BASE-TX		37
Ethernet 2 from SDU to User	-	TP07B	100BASE-TX		37
Ethernet Empty Cavity		TP07C	100BASE-TX		
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
Spare		TP07H			
ISDN 2 from User to SDU	-	TP07J	ISDN		
ISDN 2 from SDU to User	-	TP07K	ISDN		
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 15V)		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

ATTACHMENT 1-3
STANDARD INTERWIRING

SDU SIGNAL NAME		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
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
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 (Spare) from SDU to User	+	MP06E	10BaseT		
Ethernet 5 (Spare)from SDU to User	-	MP06F	10BaseT		
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 & 2	A	MP07J	A429		2, 24, 25
Data to CMU 1 & 2	B	MP07K	A429		2, 24, 25

ATTACHMENT 1-3
STANDARD INTERWIRING

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 1-3
STANDARD INTERWIRING

SDU SIGNAL NAME		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Ethernet 3 from SDU to User	+	MP1T1	Quadrax		
Ethernet 3 from SDU to User	-	MP1T3	Quadrax		
Ethernet 3 from User to SDU	+	MP1T2	Quadrax		
Ethernet 3 from User to SDU	-	MP1T4	Quadrax		
Ethernet 4 from SDU to User	+	MP2T1	Quadrax		
Ethernet 4 from SDU to User	-	MP2T3	Quadrax		
Ethernet 4 from User to SDU	+	MP2T2	Quadrax		
Ethernet 4 from User to SDU	-	MP2T4	Quadrax		
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
Ethernet 6 (Channel A)		BP08	Fiber		34
Ethernet 7 (Channel B)		BP09	Fiber		34
Ethernet 8 (Spare)		BP10	Fiber		34
Ethernet 9 (Spare)		BP11	Fiber		34
Ethernet 10 (Spare)		BP12	Fiber		34

DLNA SIGNAL NAME	PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Antenna Port	J1	50 Ohm Coax	HGA or IGA	11
LNA Control	B	Discrete	HGA/11 or IGA/11	35
LNA BITE	H	Discrete	HGA/9 or IGA/9	35
LNA BITE Ground	J		HGA/10 or IGA/10	35
Chassis Ground	A			
115 Vac Cold	E			16
115 Vac Hot	F			
+28 Vdc Hot	G			
+28 Vdc Return	K			
See also coaxial cable from SDU or from HPA and to SDU				

HGA or IGA SIGNAL NAME	PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
+28 Vdc Hot	1			
+28 Vdc Return	2			
115 Vac Hot	18			16
115 Vac Return	19			
Chassis Ground	22			
See also ARINC 429 wires to/from SDU and coaxial cable from/to DLNA and discrete wires from the DLNA				

ATTACHMENT 1-3
STANDARD INTERWIRING

HPA SIGNAL NAME	PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
RF Out	J3	50 Ohm Coax	DLNA/J3	11
115 Vac Hot	X			16
115 Vac Return	Y			
Chassis Ground	J			
See also ARINC 429 wires to/from SDU and Coax from SDU				

SCM SIGNAL NAME	PIN	SIGNAL TYPE	SOURCE/SINK	NOTES

SCM Signals are shown in SDU section.

ATTACHMENT 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 Owner Requirements Table (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 777 airplane.

   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 data links 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 ± 3V dc, 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 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

7. The SDU should sense the closure of an external switch to dc ground. The resistance to airframe dc ground, defined as 0 ± 3V dc, 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 POTS (plain old telephone service) 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 vendors 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. ARINC Report 412 provides more information on audio system installation and shield grounding. Although interwiring is desired for two cockpit audio channels, the SDU need provide the electronics for only one.

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 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

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 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 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

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 3 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.

Owner Requirements Table (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 or 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 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

17. The System Configuration Pins definition and interpretation details are shown in Attachment 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 Owner Requirements Table (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 Discretes 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 Discretes. 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 1-4A or Owner Requirements Table (ORT) setting 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 defined in CCITT G.703 and G.704 and ARINC 746.

    The SDU designer should be aware that some aircraft will use for this interface 100 ohm star quad cable rather than 120 ohm shielded twisted pair.

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 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

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 & 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 1-4A.
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 ORed with either SDU’s Dual System Disable Select and this switch closure should disable that SDU and hence the other SDU becomes master.
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. Fiber Optic contacts are bi-directional.
35. Screen twisted triple.
36. The electrical characteristics should be as in Note 30. The functionality is manufacturer specific.
37. Reference ORT Section C Items 1 & 2 regarding actual operating speed of these interfaces.

ATTACHMENT 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 discretes or left 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 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

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.

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).

Optional Configuration Pins

All other configurations pins are optional and will not be used by the SDU if TP3G is connected appropriately.

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.

ATTACHMENT 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

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 Number – Identifies the SDU number installed 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.

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 ATT.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

- ISDN #1 Presence – Identifies whether or not this port is wired.
- ISDN #2 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.

ATTACHMENT 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

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.
- Swift Broadband Activation – Enables the Swift Broadband functionality.

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)
- **Swift Broadband Safety Activation – Enables the SwiftBroadband Safety functionality. (Note: Swift Broadband must already be activated (TP6D).)**

TP6F, 6G, 7D, 7E, 7F, 7G

- These pins are spares.

ATTACHMENT 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

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 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

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	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 installed Spare 2 Not installed	This is SDU1 Spare 1 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 installed Spare 2 Not installed	This is SDU2 Spare 1 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	ISDN #1 Not Wired	ISDN #1 Not Wired	ISDN #1 Not Wired	ISDN #1 Not Wired	ISDN #1 Wired	ISDN #1 Wired	ISDN #1 Wired	ISDN #1 Wired
	ISDN #2 Not Wired	ISDN #2 Not Wired	ISDN #2 Wired	ISDN #2 Wired	ISDN #2 Not Wired	ISDN #2 Not Wired	ISDN #2 Wired	ISDN #2 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 Not 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
	Swift Broadband Disabled	Swift Broadband Enabled	Swift Broadband Disabled	Swift Broadband Enabled	Swift Broadband Disabled	Swift Broadband Enabled	Swift Broadband Disabled	Swift Broadband 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} =1585MHz	GNSS frequency check with f_{limit} =1605MHz	**GNSS frequency check with f_{limit} =1585MHz**	No GNSS frequency check	GNSS frequency check with f_{limit} =1585MHz	GNSS frequency check with f_{limit} =1605MHz	**GNSS frequency check with f_{limit} =1585MHz**
	Swift Broadband Safety Disabled	**Swift Broadband Safety Enabled**	**Swift Broadband Safety Disabled**	**Swift Broadband Safety Enabled**	**Swift Broadband Safety Disabled**	**Swift Broadband Safety Enabled**	**Swift Broadband Safety Disabled**	**Swift Broadband Safety Enabled**

ATTACHMENT 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

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 TP 4F to:	Connect TP 4G 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	Open	MP13E
7	Reserved for future	Open	MP13F
8	Reserved for MFR	Open	MP14E
9	Reserved for future	MP11E	Open
10	Reserved for future	MP11E	MP11E
11	Reserved for future	MP11E	MP11F
12	Reserved for future	MP11E	MP12E
13	Reserved for future	MP11E	MP12F
14	Reserved for future	MP11E	MP13E
15	Reserved for future	MP11E	MP13F
16	Reserved for future	MP11E	MP14E
17	Reserved for future	MP11F	Open
18	Reserved for future	MP11F	MP11E
19	Reserved for future	MP11F	MP11F
20	Reserved for future	MP11F	MP12E
21	Reserved for future	MP11F	MP12F
22	Reserved for future	MP11F	MP13E
23	Reserved for future	MP11F	MP13F
24	Reserved for future	MP11F	MP14E
25	Reserved for future	MP12E	Open
26	Reserved for future	MP12E	MP11E
27	Reserved for future	MP12E	MP11F
28	Reserved for future	MP12E	MP12E
29	Reserved for future	MP12E	MP12F
30	Reserved for future	MP12E	MP13E
31	Reserved for future	MP12E	MP13F
32	Reserved for future	MP12E	MP14E
33	Reserved for future	MP12F	Open
34	Reserved for future	MP12F	MP11E
35	Reserved for future	MP12F	MP11F
36	Reserved for future	MP12F	MP12E
37	Reserved for future	MP12F	MP12F
38	Reserved for future	MP12F	MP13E
39	Reserved for future	MP12F	MP13F
40	Reserved for future	MP12F	MP14E
41	Reserved for future	MP13E	Open
42	Reserved for future	MP13E	MP11E
43	Reserved for future	MP13E	MP11F
44	Reserved for future	MP13E	MP12E

ATTACHMENT 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

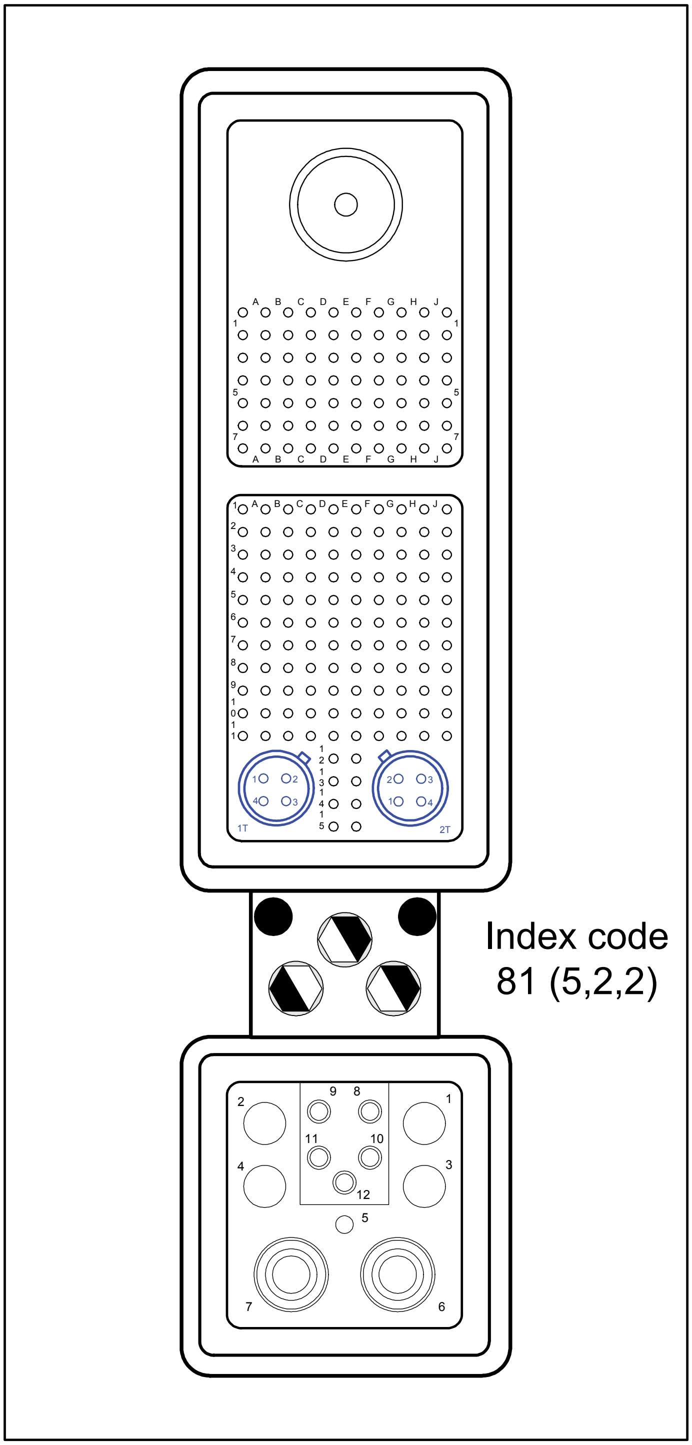
Configuration Number	Antenna Subsystem Configuration	Connect TP 4F to:	Connect TP 4G to:
45	Reserved for future	MP13E	MP12F
46	Reserved for future	MP13E	MP13E
47	Reserved for future	MP13E	MP13F
48	Reserved for future	MP13E	MP14E
49	Reserved for future	MP13F	Open
50	Reserved for future	MP13F	MP11E
51	Reserved for future	MP13F	MP11F
52	Reserved for future	MP13F	MP12E
53	Reserved for future	MP13F	MP12F
54	Reserved for future	MP13F	MP13E
55	Reserved for future	MP13F	MP13F
56	Reserved for future	MP13F	MP14E
57	Reserved for future	MP14E	Open
58	Reserved for future	MP14E	MP11E
59	Reserved for future	MP14E	MP11F
60	Reserved for future	MP14E	MP12E
61	Reserved for future	MP14E	MP12F
62	Reserved for future	MP14E	MP13E
63	Reserved for future	MP14E	MP13F
64	Reserved for future	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.

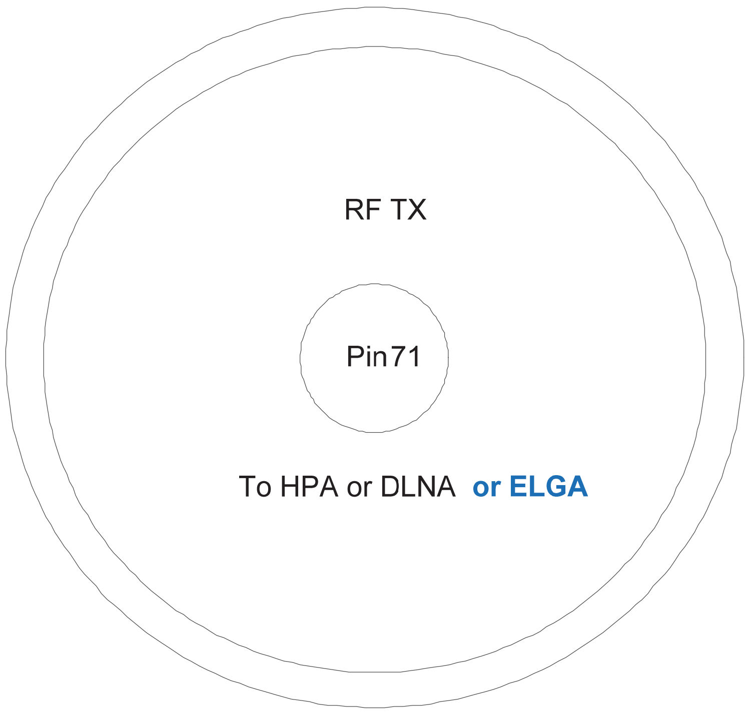
ATTACHMENT 1-5
SDU FORM FACTOR

SIZE 6 MCU
#2 Shell Connector



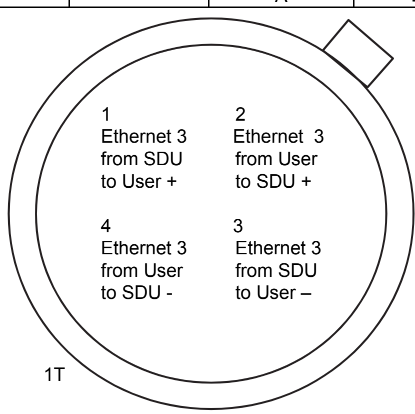
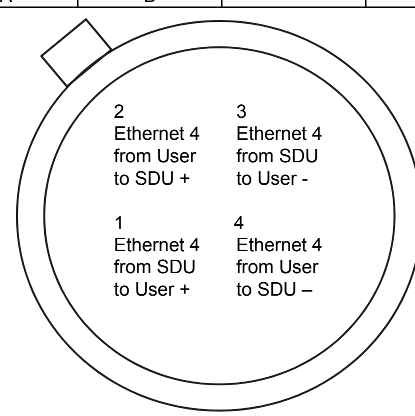
For the index code pins above, the dark color represents the post.

ATTACHMENT 1-5A
SDU TOP PLUG CONNECTOR LAYOUT

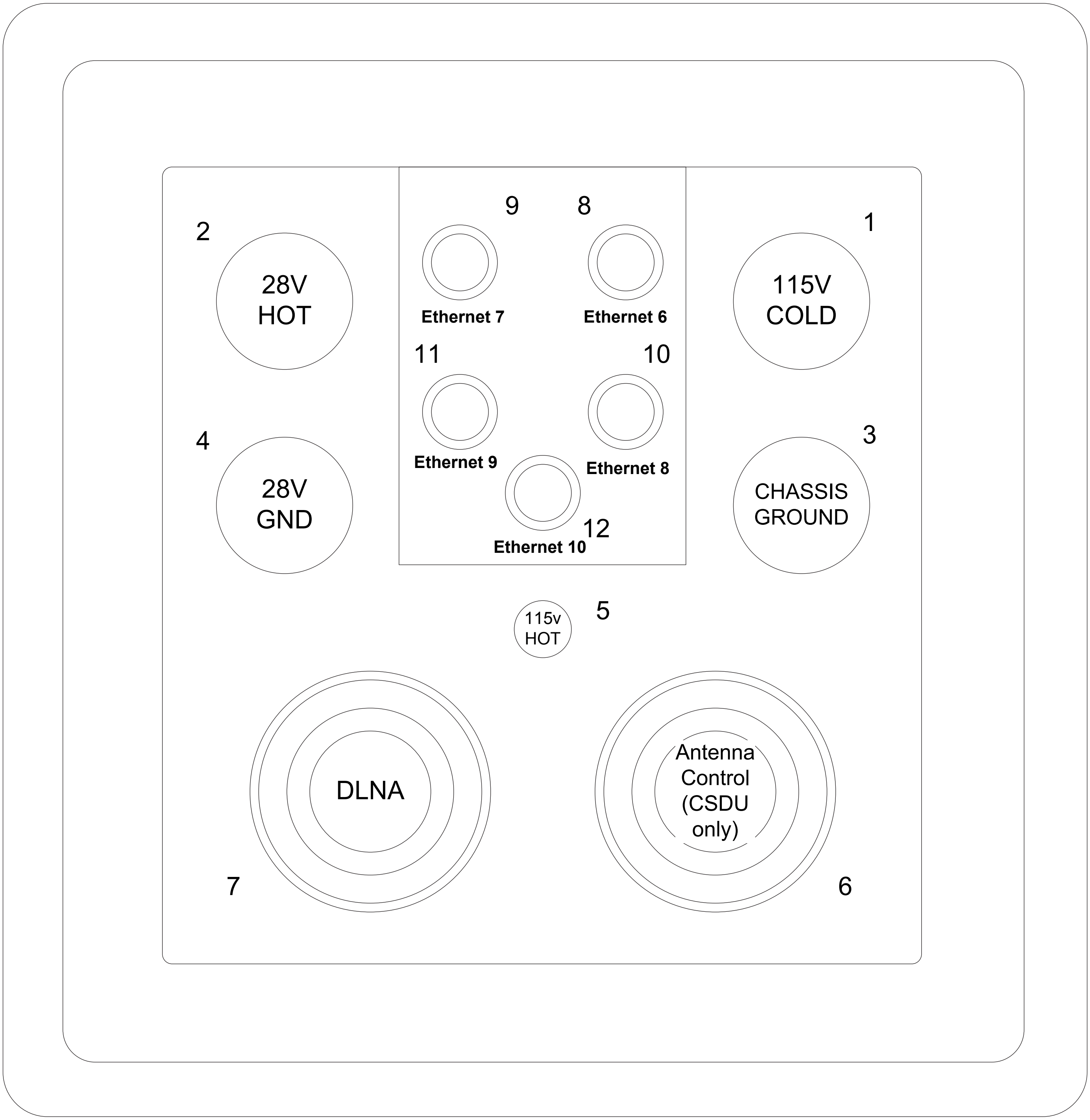


	A	B	C	D	E	F	G	H	J	K
1	ATE Pin 1	ATE Pin 2	ATE Pin 3	ATE Pin 4	ATE Pin 5	ATE Pin 6	ATE Pin 7	ATE Pin 8	ATE Pin 9	ATE Pin 10
2	ATE Pin 11	ATE Pin1 2	ATE Pin 13	ATE Pin 14	ATE Pin 15	ATE Pin 16	ATE Pin 17	ATE Pin 18	ATE Pin 19	ATE Pin 20
3	Ethernet 1 from SDU to User +	Ethernet 1 from User to SDU +	Empty Cavity	Config Pin 1	Config Pin 2	Config Pin 3	Config Pin 4	SPARE	ISDN 1 from SDU To User +	ISDN 1 from User to SDU +
4	Ethernet 1 from User to SDU -	Ethernet 1 from SDU to User -	Empty Cavity	Config Pin 5	Config Pin 6	Config Pin 7	Config Pin 8	SPARE	ISDN 1 from User To SDU -	ISDN 1 from SDU to User -
5	Empty Cavity	Empty Cavity	Empty Cavity	Config Pin 9	Config Pin 10	Config Pin 11	Config Pin 12	SPARE	SPARE	SPARE
6	Ethernet 2 from SDU to User +	Ethernet 2 from User to SDU +	Empty Cavity	Config Pin 13 [SPARE]	Config Pin 14 [SPARE]	Config Pin 15 [SPARE]	Config Pin 16 [SPARE]	SPARE	ISDN 2 from SDU to User +	ISDN 2 from User to SDU +
7	Ethernet 2 from User to SDU -	Ethernet 2 from SDU to User -	Empty Cavity	Config Pin 17 [SPARE]	Config Pin 18 [SPARE]	Config Pin 19 [SPARE]	Config Pin 20 [SPARE]	SPARE	ISDN 2 from User to SDU -	ISDN 2 from SDU to User -

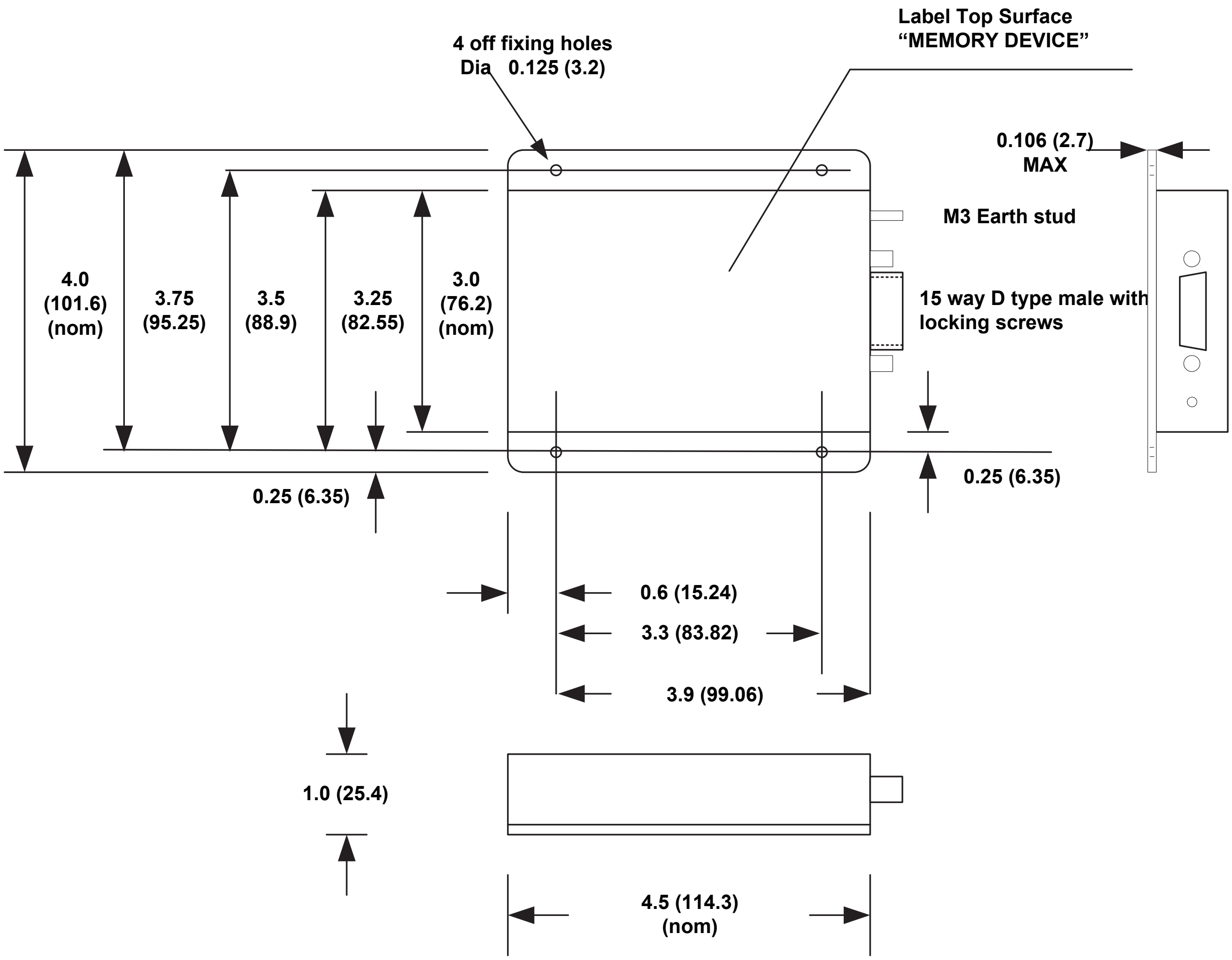
ATTACHMENT 1-5B
SDU MIDDLE PLUG CONNECTOR LAYOUT

	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 +15V	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 0V	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 10 Ethernet T (Spare) from SDU to User+	Ethernet 5 10 Ethernet T (Spare) 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 10 Ethernet T (Spare) from User to SDU+	Ethernet 5 10 Ethernet T (Spare) from User to SDU-	Spare ARINC 429 Output A	Spare ARINC 429 Output B	Data to CMU 1 & 2 A	Data to CMU 1 & 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 Discretes 1	Service Availability Discretes 2	Cabin CEPT-E1 Data input A	Cabin CEPT-E1 Data Input B	POTS 2 A	POTS 2 B
12					Service Availability Discretes 3	Service Availability Discretes 4				
13					Service Availability Discretes 5	Service Availability Discretes 6				
14					Service Availability Discretes 7	Service Availability Discretes 8				
15					Service Availability Discretes 9	Service Availability Discretes 10				2T

ATTACHMENT 1-5C
SDU BOTTOM PLUG CONNECTOR LAYOUT



ATTACHMENT 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 1-6A
SDU CONFIGURATION MODULE CONNECTOR LAYOUT

SCM Connector is 15 way D type male.

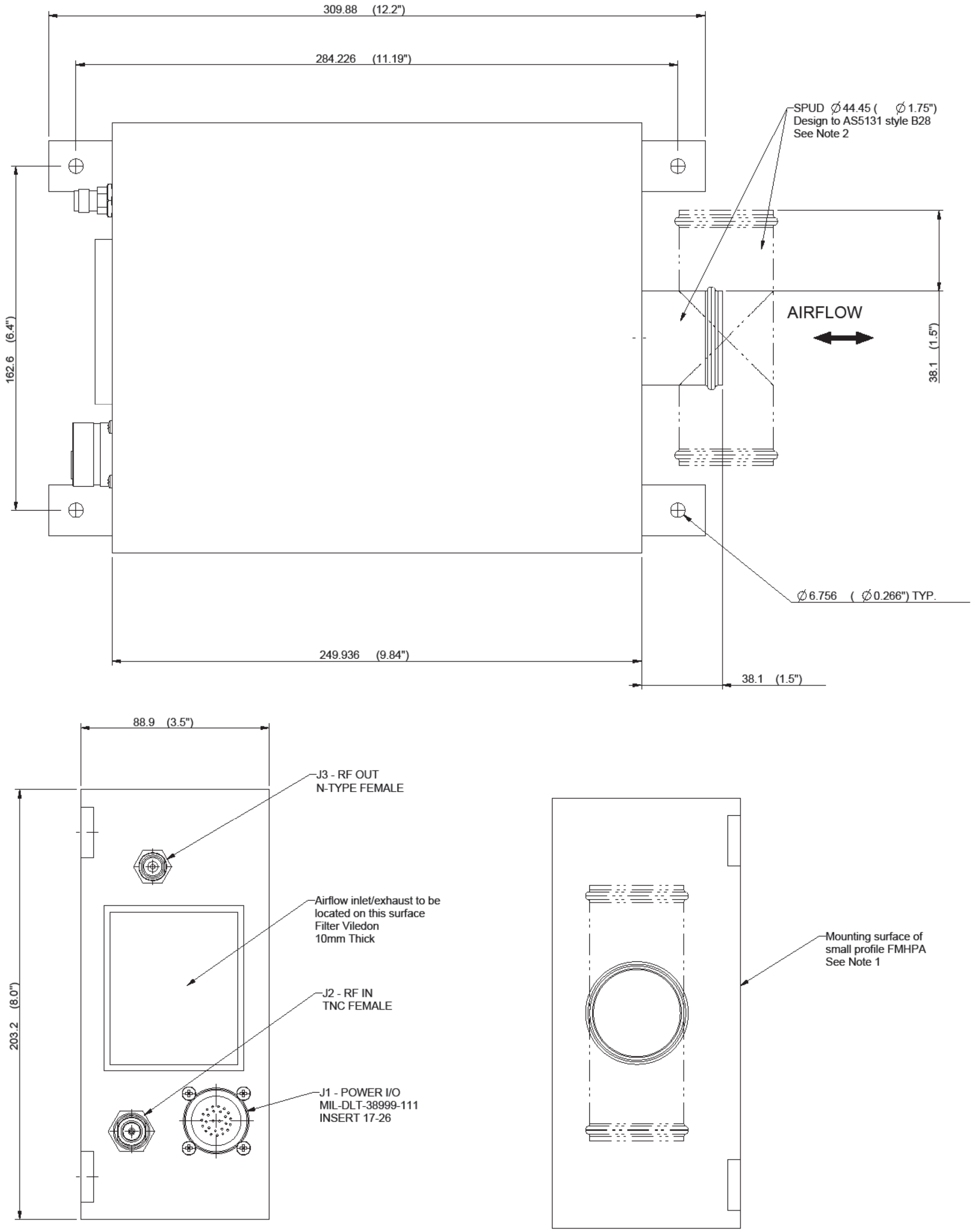
Data to SDU A 1	Data to SDU B	Data from SDU A	Data from SDU B	Reserved RS232 Gnd	Spare	Chassis Ground	Power Input +8 to +15V 8

Reserved Enable RS232 9	Reserved 0V strap output	Spare	Reserved RS232 Tx	Reserved RS232 Rx	Spare	Power Return 0V 15

- 1 Data to SDU A (RS422)
- 2 Data to SDU B (RS422)
- 3 Data from SDU A (RS422)
- 4 Data from SDU B (RS422)
- 5 Reserved - RS232 Gnd Used for shop loading
- 6 Spare
- 7 Chassis Ground
- 8 Power Input +8 to +15V
- 9 Reserved - Enable RS232* Used for shop loading
- 10 Reserved - 0V strap output Used for shop loading
- 11 Spare
- 12 Reserved - RS232 Tx Used for shop loading
- 13 Reserved - RS232 Rx Used for shop loading
- 14 Spare
- 15 Power Return 0V

*To be used for shop loading of ORT (open = normal operation, connect to pin 10 = shop load and allow use of RS232 port)

ATTACHMENT 1-7A
SMALL FLANGE MOUNT HPA FORM FACTOR

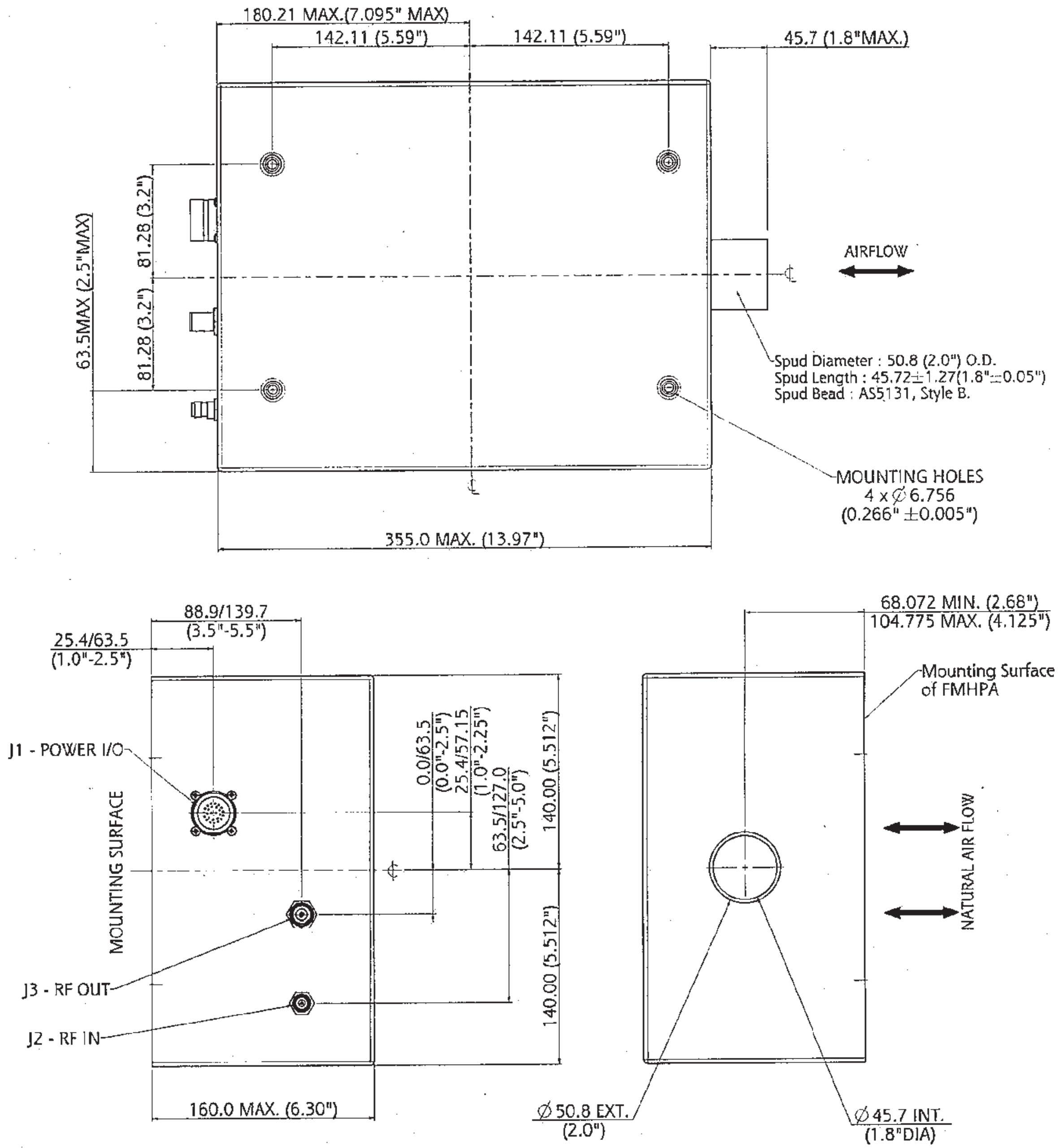


ATTACHMENT 1-7A
SMALL FLANGE MOUNT HPA FORM FACTOR

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 3 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 1-7B
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.

ATTACHMENT 1-7B
LARGE FLANGE MOUNT HPA FORM FACTOR

2. Key features are the 4 mounting holes and the locations of the connectors and airflow adaptor. Clear and unobstructed access to 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” 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 3 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 1-7C
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 1-8
DIPLEXER/LOW NOISE AMPLIFIER FORM FACTOR

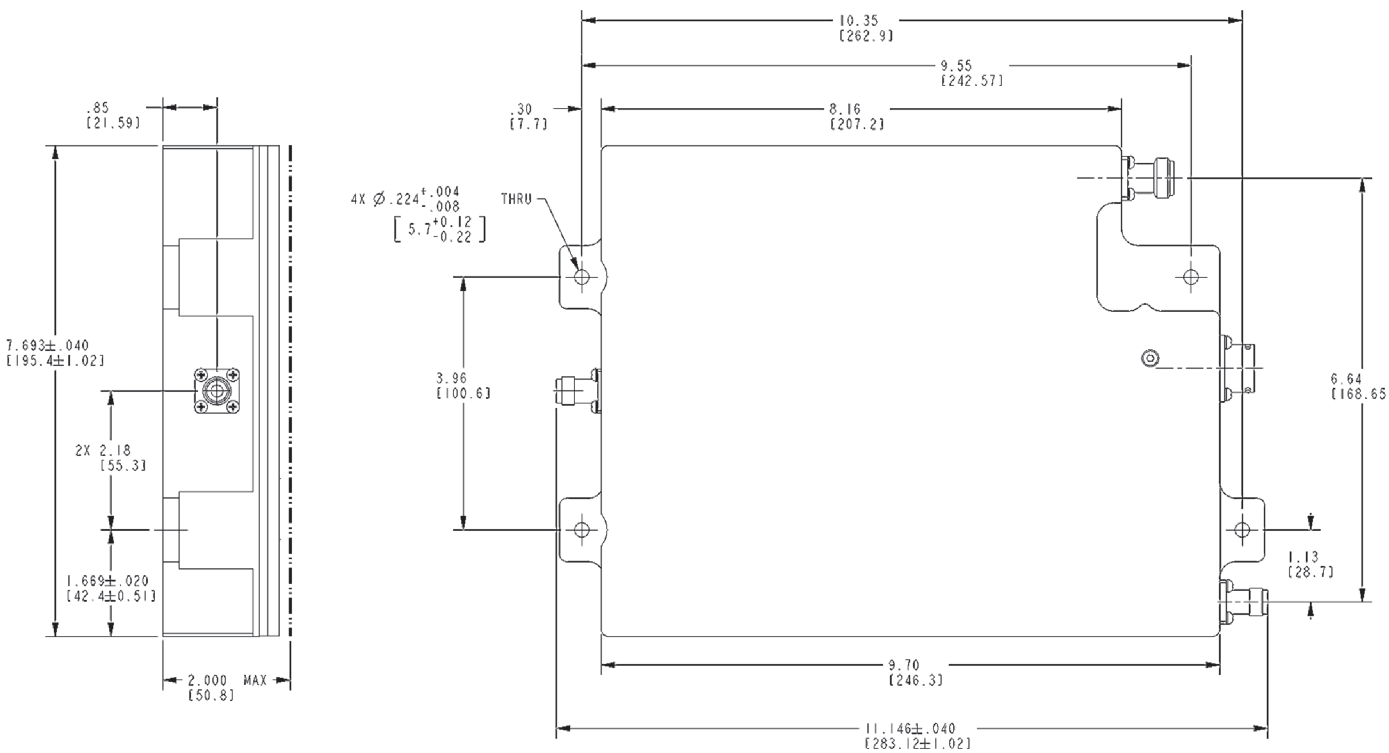


Figure 1 – Type D – Modified Type A DLNA Outline

ATTACHMENT 1-8
DIPLEXER/LOW NOISE AMPLIFIER FORM FACTOR

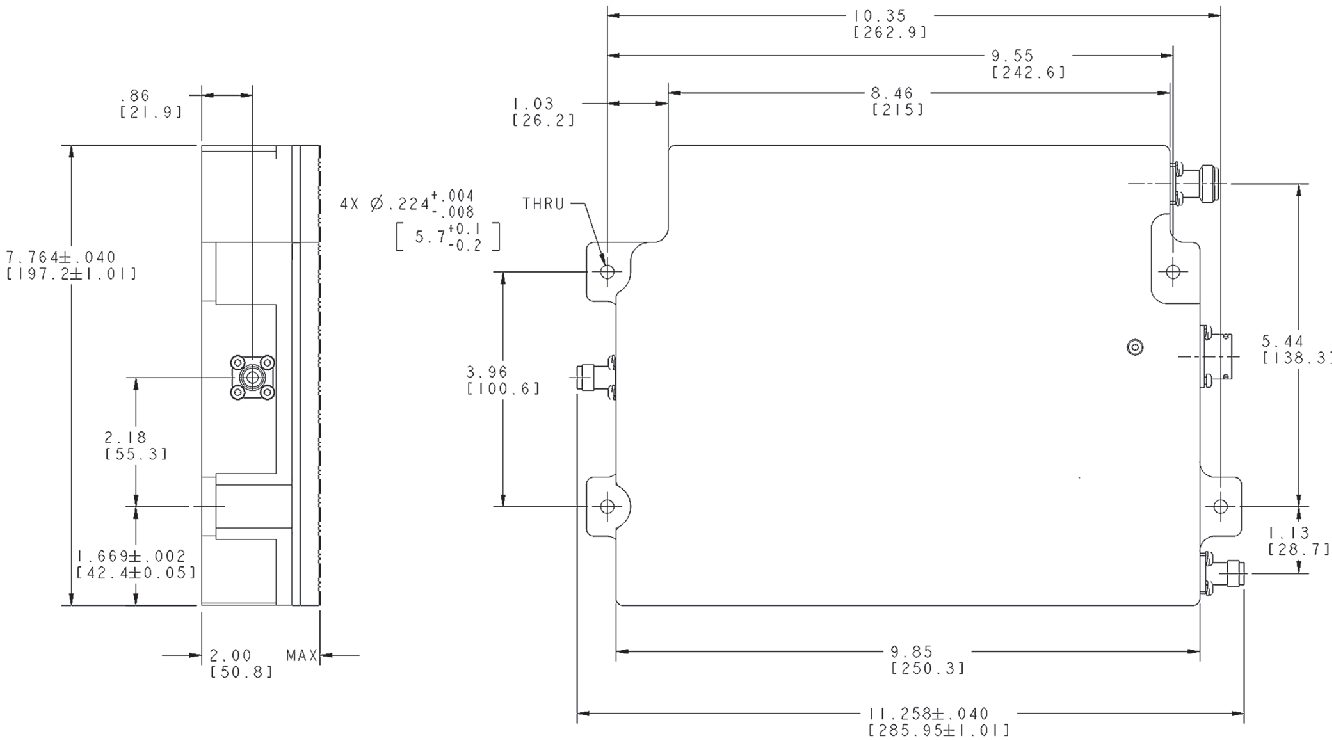
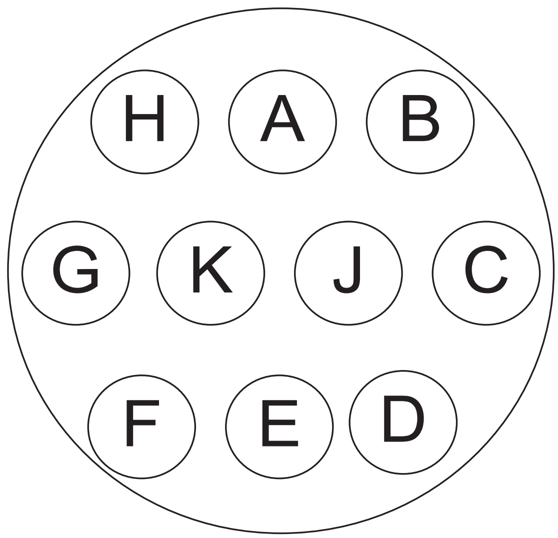


Figure 2 – Type F DLNA Outline

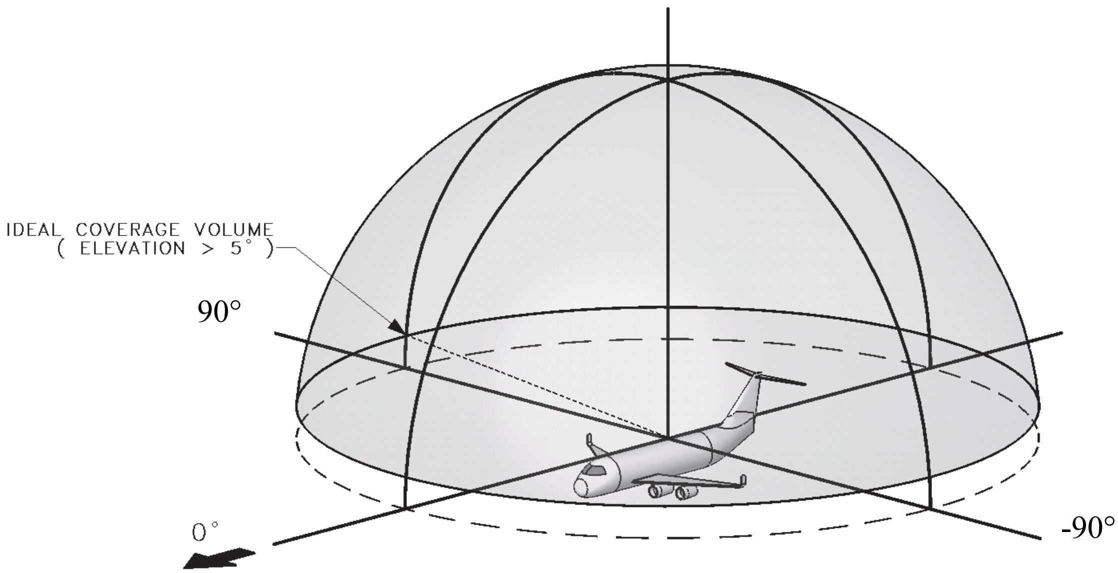
ATTACHMENT 1-8
DIPLEXER/LOW NOISE AMPLIFIER FORM FACTOR

Pin	Description
Pin A	Chassis Ground
Pin B	LNA Control
Pin C	Future Spare
Pin D	Future Spare
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

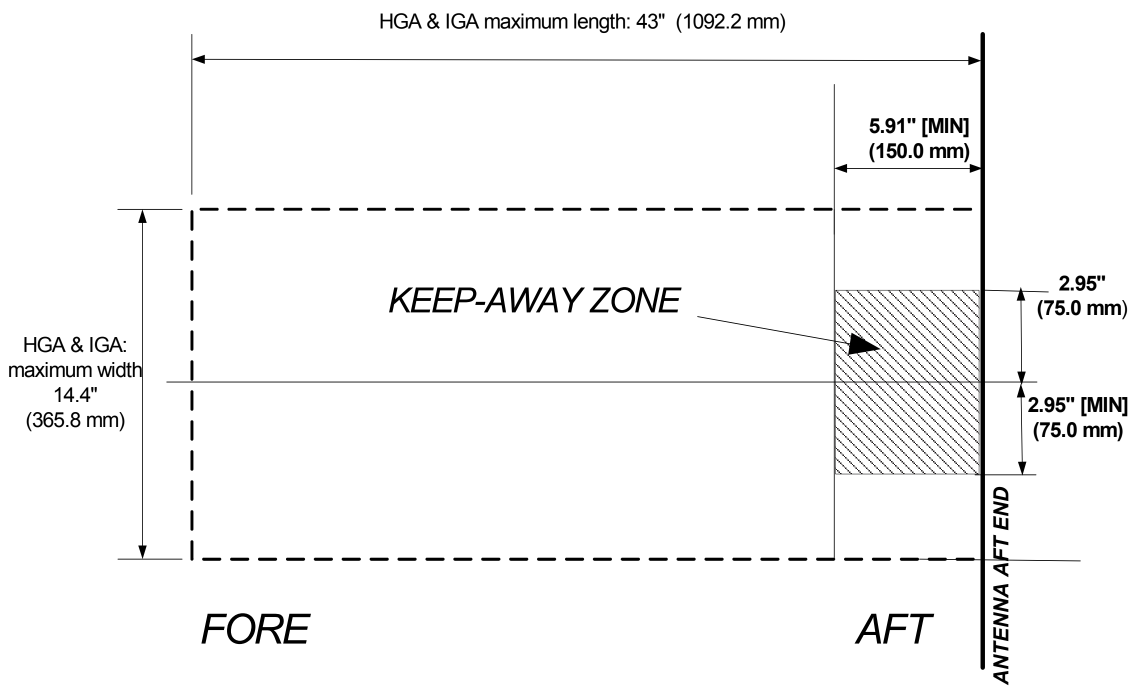


The DLNA Connector is MS3470L1210P or equivalent, which mates with MS3476L1210S or equivalent on the cable.

ATTACHMENT 1-9
ANTENNA COVERAGE



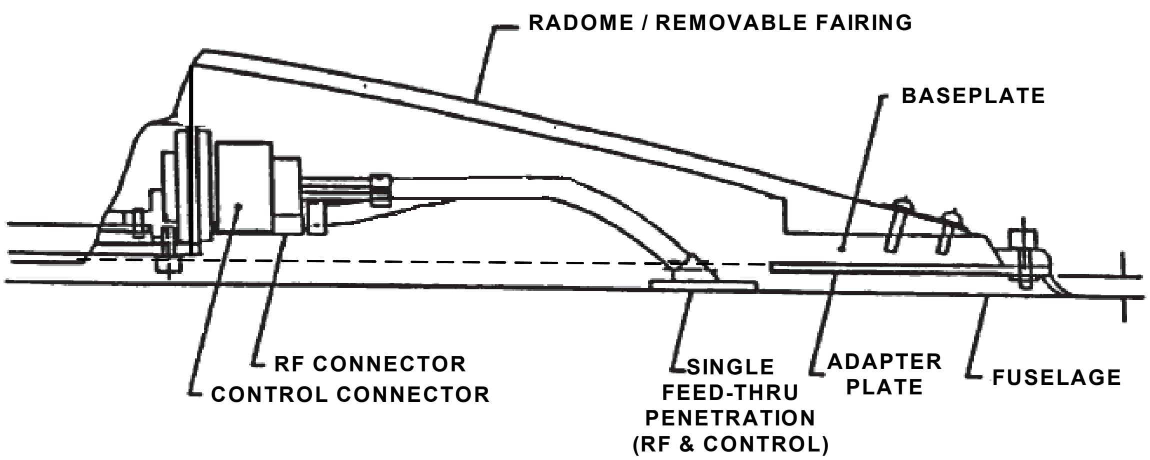
ATTACHMENT 1-10
HIGH GAIN AND INTERMEDIATE GAIN TOP MOUNT ANTENNA FOOTPRINT
MAXIMUM DIMENSIONAL OUTLINE



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."
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.

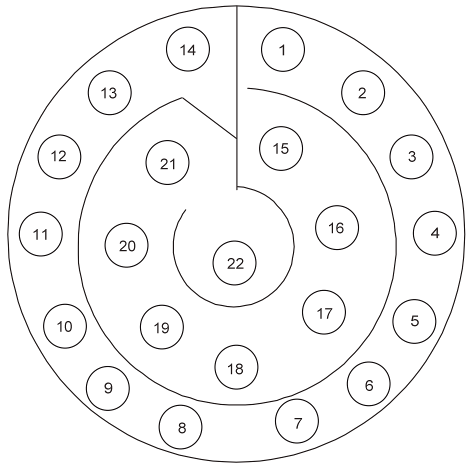
ATTACHMENT 1-10A
ANTENNA COAXIAL CABLE INTERFACE



ATTACHMENT 1-11
NO LONGER USED

This section deleted by Supplement 5

ATTACHMENT 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	RS422 RXD A[1]	Serial data to antenna +
14	RS422 RXD B[1]	Serial data to antenna -
15	RS422 TXD A[1]	Serial data from antenna +
16	RS422 TXD 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 1: 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

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	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

Discretes [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		EQID[43]	Gain	Spare		Discretes										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

Discretes		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			Discretes															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

Discretes [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 A741 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 [25] (LSB)	(MSB) Elevation [24] (LSB)	Label 152 [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	.	2	0	
3	.		0	
4	.		1	
5	.	2	0	
6	.		0	
7	.		0	
8	Label	0	0	
9	PAD			47
10	.			47
11	.			47
12	.			47
13	PAD			47
14	Inmarsat 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	Inmarsat 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.

Bit		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

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 LSB												Octal Label 221 [50]							
																								1	0	0	0	1	0	0	1

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	Inmarsat 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	Inmarsat 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.

Bit		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	dddcccxbbbaaaa	xx	xxx xxx xx

Where:

- aaaa = Minor Model (e.g., -400, -800, -500).
- xbbb = Major Model (e.g., 787, 777).
- ccc = Airframe Manufacturer Specific.
- ddd = Airframe Manufacturer Specific.

The following xbbb have been reserved by Boeing:

x	bbb	Aircraft Type
0	000	Boeing A/C #1
0	001	Boeing A/C #2
0	010	Boeing A/C #3
0	011	Boeing A/C #4
0	100	Boeing A/C #5
0	101	Boeing A/C #6
0	110	Boeing A/C #7
0	111	Boeing A/C #8
1	000	RSV
1	---	RSV
1	111	RSV

Sign Status Matrix (SSM) Definition per ARINC Specification 429 for discrete data words.

Bit		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	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	Spare		Satellite System Type													SDU SAL								Label 172							
	X	0	0	0	0	0	0	0	0	0	0	0	X	X	X	1	X	X	X	X	X	X	X	X	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 Aero	1
18	Spare	0
19	Iridium	X
20	**Spare**	**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	X

See Note 52 for 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.

0. 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.
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

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

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.
29. Reserved.
30. Not used.
31. Not used.

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

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 Discretes failure bit indications in the Maintenance Word. Failure Warning and respective DISCRETES 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:
    - Labels 145 to 149
    - Label 153

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

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
251	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 429 characteristic) and the external HPA equipment ID is 241 (as defined in ARINC 429 characteristic)

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)

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. 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 Inmarsat Swift64 Forward ID is structured and 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.

ATTACHMENT 2
ARINC 429 LABELS AND WORD FORMATS USED IN THE AVIATION SATELLITE COMMUNICATIONS SYSTEM

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												221							
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. For full 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, or Inmarsat and Globalstar). 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 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 758 has similar unique definitions for some of the bits in its label 172 output to the SDU and other air/ground data link 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 to indicate support of Inmarsat Aero service, and may also set other bits in the Satellite System Type field as applicable to the specific SDU design.

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

1 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:

- Name of the LRU
- Part number of the LRU
- Serial Number of LRU
- Name of software application
- Software part number
- Optional additional undefined configuration data

2 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). The STX word should be initiated no later than two seconds after either (1) the antenna sets its Label 350 word bit 29 to 1; or, if it is required by the

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

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 739(A) 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 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 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 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	YYYYYYYYYYYY	00	00	11101001

Function Select

000 0000 (0_{10}) = Null
000 0001 (1_{10}) = Reserved for future use
000 0010 (2_{10}) = Configuration Data
000 0011 (3_{10}) = Manufacturer-specific (see Section 2)
000 0100 (4_{10}) through 000 1100 (12_{10}) = Reserved for future use
000 1101 (13_{10}) through 111 1111 (127_{10}) = 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

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

word. If the SDI code is not equal to 'All Call' or 'Top', the antenna does not respond.

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)
16	Unused
17 - 23	Total Number of Data Pages Available (normally 1 – see Section 2)
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	1ST 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. 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)

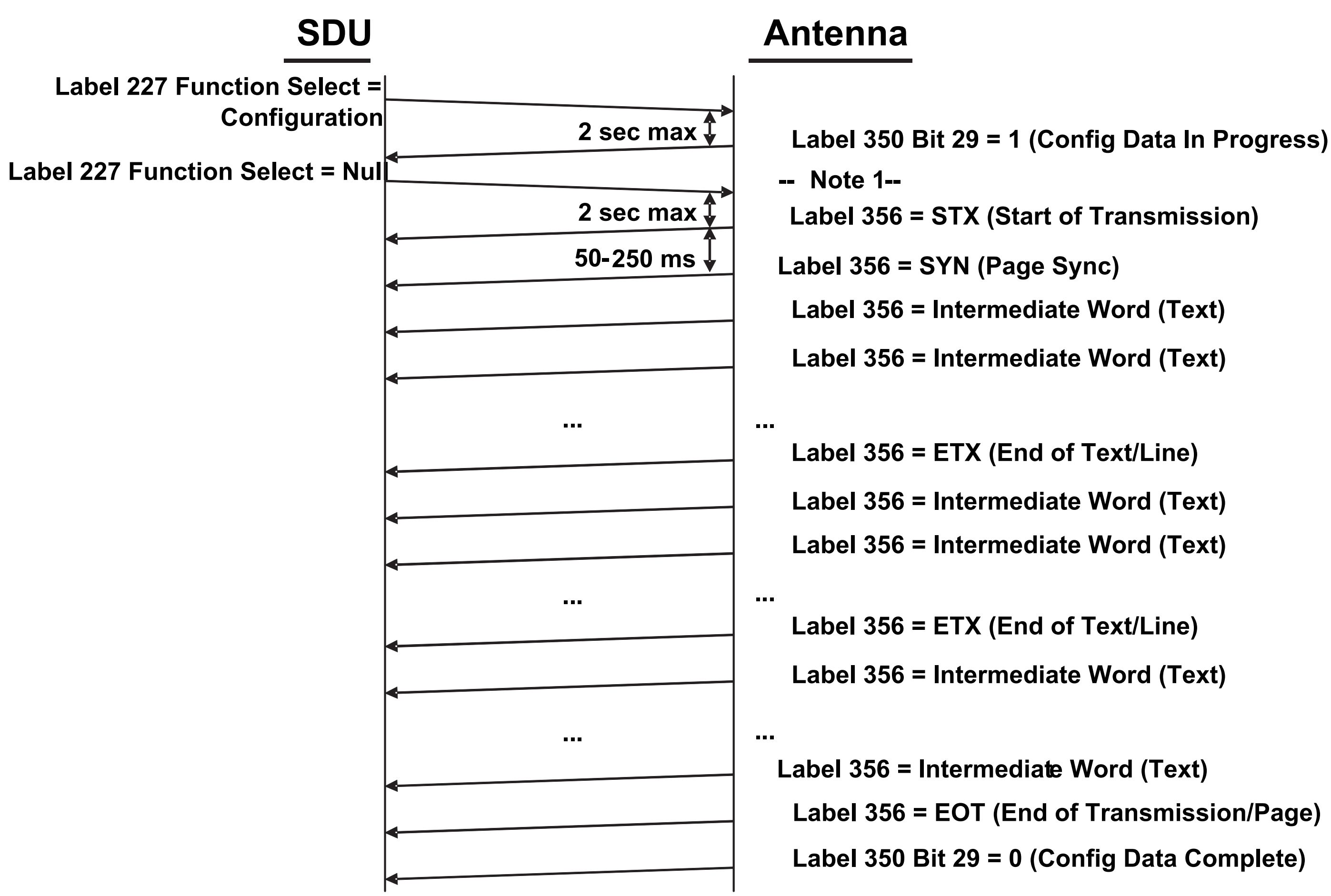
CONFIGURATION DATA LABEL 356						
32	31 → 25	24	23 → 17	16	15 → 09	08 → 01
P	EOT	PAD	CHAR or NUL	PAD	CHAR or NUL	LABEL
PAR	0000100	0	XXXXXXX	0	XXXXXXX	01110111

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



Note :

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 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 [semi]standard (single “page”) configuration data provided by the antenna is as follows:

Row	Data Type	Characters (max.)
1	Name of the LRU	11
2	Part number of the LRU	15
3	Serial Number of LRU	15
4	Name of software application	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

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	Bit Status 0
1 2 3 4 5 6 7 8	Label 350 (Octal)		
9 10	SDI		
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 HSDU1 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 31	SSM		
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 781 to preserve compatibility with Central Maintenance Computers designed per ARINC 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.
5. Applicable to a top mount high gain or intermediate gain 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 2 3 4 5 6 7 8	Label 351 (Octal)		
9 10	SDI		
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 31	SSM		
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.
3. Bits reserved in ARINC 781 to preserve compatibility with Central Maintenance Computers designed per ARINC 741.
4. Implementation required if the SDU is designed to interface with ARINC 741 antenna systems.

ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #3 for satcom

BIT ERROR RATE WORD Label 352				
PAR odd	SSM	SPARE	BIT ERROR RATE	LABEL 352
			MSB LSB	
32	30 31	29 25	24 9	8 1
p	x x	00000	bbbbbbbbbbbbbbbb	01010111

Note: The use of this word is optional. The format is being defined only to document the word. The field "Bit Error Rate" indicates the number of raw bit errors detected since the last report was generated. The report should be generated every 3000 channel bits, at a 600 bps P-channel rate, this would be a new word every 5 seconds. The data will be in binary format (positive only), and range from 0 to 3000 maximum.

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 2 3 4 5 6 7 8	Label 353 (Octal)		
9 10	SDI		
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 31	SSM		
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 781 to preserve compatibility with Central Maintenance Computers designed per ARINC 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 busses 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 781 to preserve compatibility with Central Maintenance Computers designed per ARINC 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 2 3 4 5 6 7 8	Label 355 (Octal)		
9 10	SDI		
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 (Note 3 and 4)	Failed	OK
30 31	SSM		
32	Parity (Odd)		

Notes:

1. “OK” status should always be indicated for equipment not installed or busses 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 781 to preserve compatibility with Central Maintenance Computers designed per ARINC 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 2 3 4 5 6 7 8	Label 357 (Octal)		
9 10	SDI		
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	Failed	OK
16	External ARINC 781 HPA to Antenna VSWR	Failed	OK
17	Reserved	Inactive	OK
18	Reserved	Inactive	OK
19	Reserved	Inactive	OK
20	HGA Over Temperature	Over Temp	OK
21	ARINC 781 Antenna to SDU Data Bus	Inactive	OK
22	SDU to ARINC 781 Antenna Data Bus	Inactive	OK
23	SDU Over Temperature	Over Temp	OK
24	SDU to Antenna VSWR	Failed	OK
25	SDU to External ARINC 781 HPA Tx Path	Failed	OK
26	SDU to External ARINC 781 HPA Data Bus	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 31	SSM		
32	Parity (Odd)		

Notes:

1. “OK” status should always be indicated for equipment not installed or busses 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 #8 for satcom

Bit No.	Function	Bit Status	
		1	0
1 2 3 4 5 6 7 8	Label 360 (Octal)		
9 10	SDI		
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	Inactive	OK
28	External ARINC 781 HPA Over Temperature	Over Temp	OK
29	Reserved for ARINC 741 RFU HSDU APM/CDM (Notes 2 and 3)	Failed	OK
30 31	SSM		
32	Parity (Odd)		

Notes:

1. “OK” status should always be indicated for equipment not installed or busses 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. Bits reserved in ARINC 781 to preserve compatibility with Central Maintenance Computers designed per ARINC 741.

ATTACHMENT 2B
BIT-ORIENTED FAULT REPORTING PROTOCOL

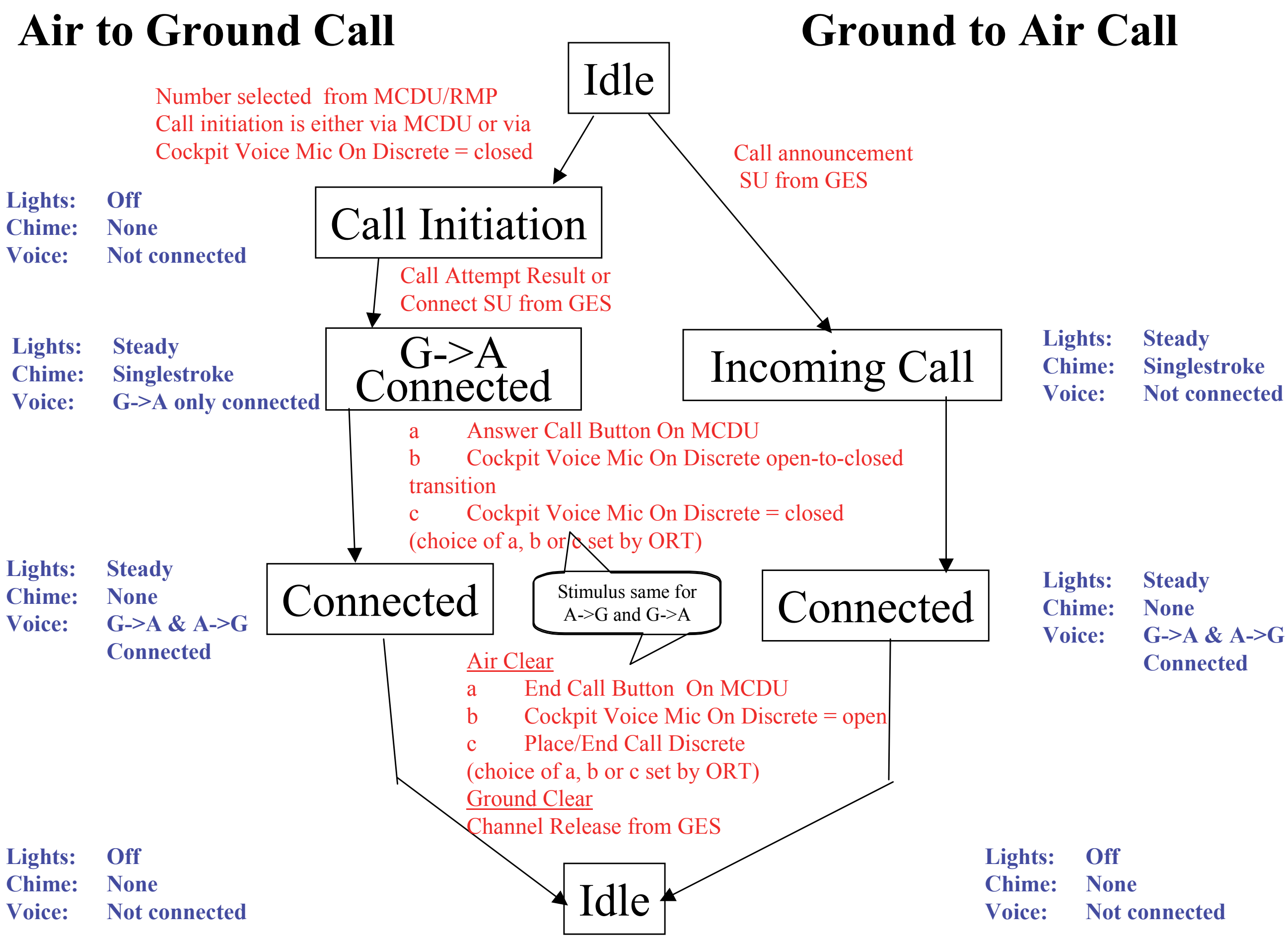
BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #9 for satcom

Bit No.	Function	Bit Status	
		1	0
1 2 3 4 5 6 7 8	Label 361 (Octal)		
9 10	SDI		
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	Reserved	Failed	OK
29	Reserved	Failed	OK
30 31	SSM		
32	Parity (Odd)		

Notes:

1. “OK” status should always be indicated for equipment not installed or busses not used, as determined by the Satellite Data Unit system configuration pins or its design.

ATTACHMENT 3
COCKPIT VOICE – SAT PHONE STATE MACHINE FOR NORMAL OPERATION



ATTACHMENT 4-A
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 specifications 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	Cockpit & 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, ISDN, 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	4kbps 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 Dataloader	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

ATTACHMENT 4-A
ARINC 781 SDU FUNCTIONS MATRIX

Section	Feature/Function	Options	Cockpit & Cabin SATCOM (Example)	Cabin Only SATCOM (Example)
3.4.1.2	SwiftBroadband & Swift64 Operations	Independent, Cold Standby, Warm Standby, Hot Standby, Cooperative	Independent, Cooperative	Independent, Cooperative
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 different channels is supported.

ATTACHMENT 4-B
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 specifications 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 & 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		2	2
10/100BaseT on size 22 pins		2	2
10/100BaseT (Cockpit data) on quadrax		No	No
ARINC 664 Copper (Cockpit voice & data)		No	No
ARINC 664 Fiber (Cockpit voice & data)		No	No
ISDN		2	2
CEPT-E1		No	No
(C)MU		2	No
Cockpit Voice (4-wire & discretes)		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 discretes		Yes	Yes
ATE pins		Yes	Yes
Misc Interfaces			
AES ID (429)		Yes	No
IRS/GNSS		2	2
Config. Straps		Yes	No
WOW		Yes	Yes
Tx Mute		No	No

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ETHERNET INTERFACE

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ATTACHMENT 5
ETHERNET INTERFACE

1.0 INTRODUCTION

1.1 Purpose and Scope

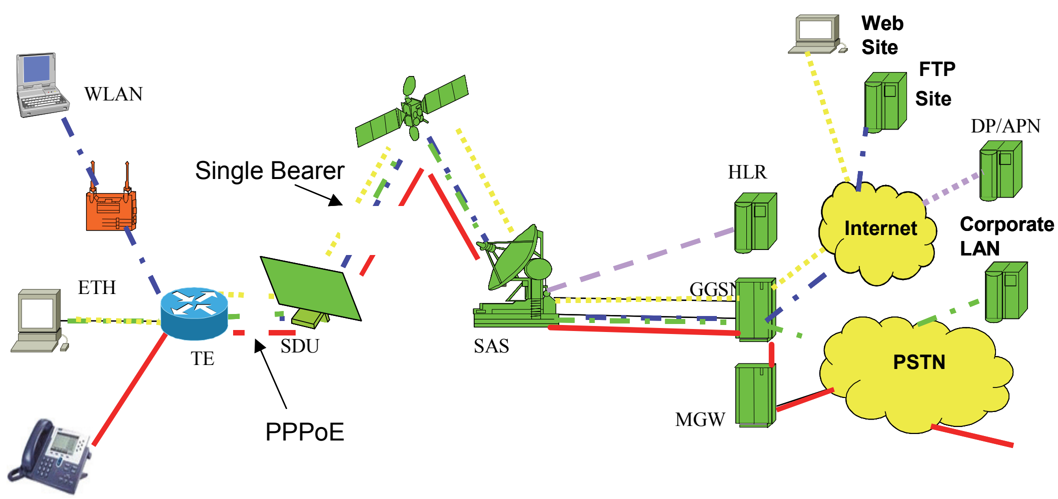
This attachment describes how an SDU should set up, control, terminate and transfer packet data using the BGAN/SwiftBroadband packet data service via an IEEE 802.3 Ethernet interface(s) to Terminal Equipment. Services offered by the Terminal Equipment are out of scope of this document. Other uses of 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.



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).

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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 set up, termination and transfer of packet data using Swift64 (packet & circuit switched service)

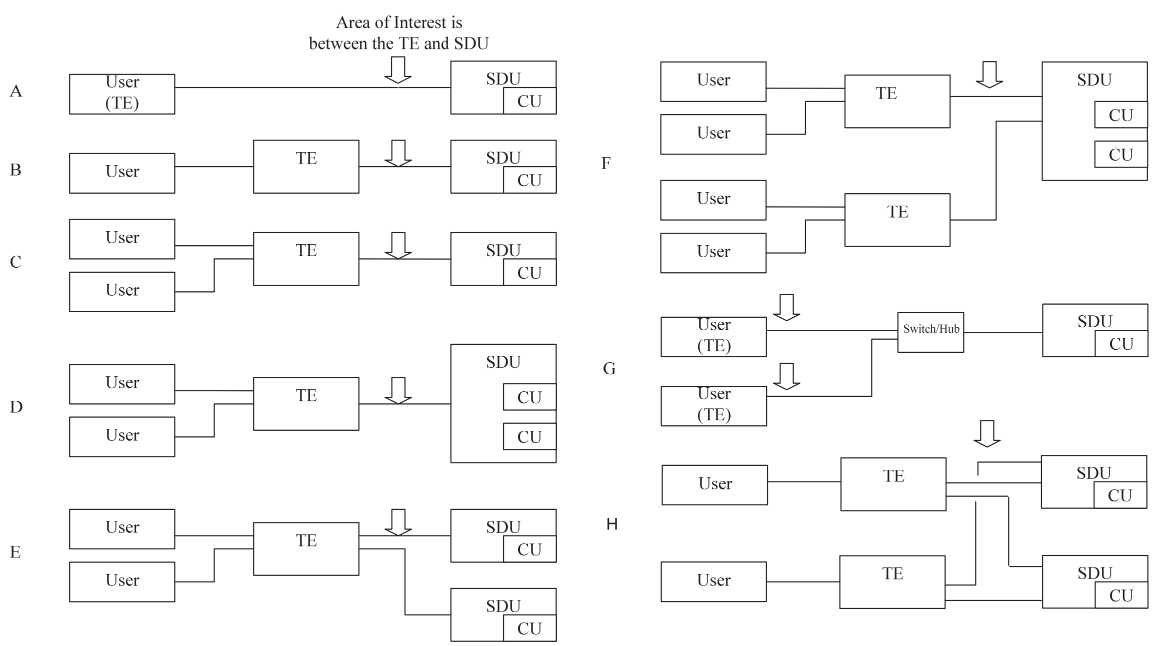
Suitable for use with Terminal End Points containing unmodified COTS protocol stacks

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



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.

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.

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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.

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 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.

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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.

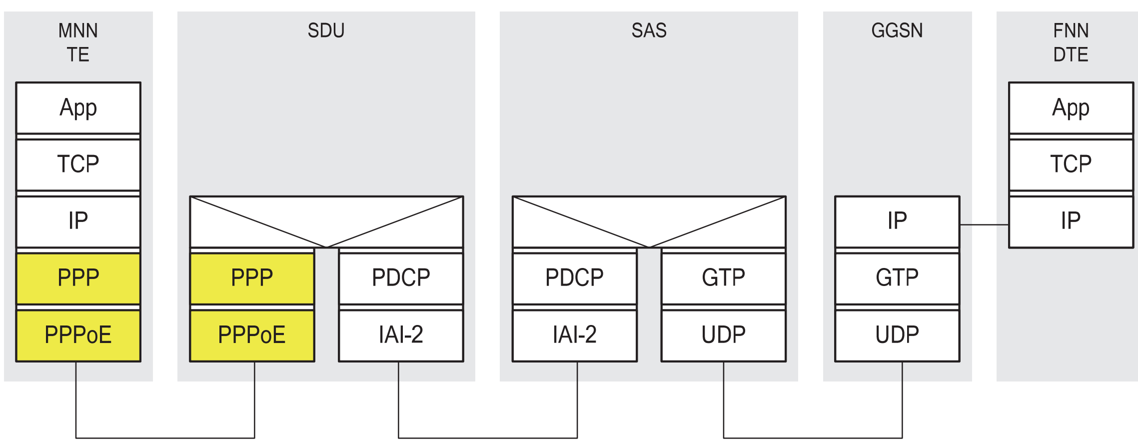
3.2 Protocol Layering

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 TE and Fixed Network Node (FNN) TE.



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.

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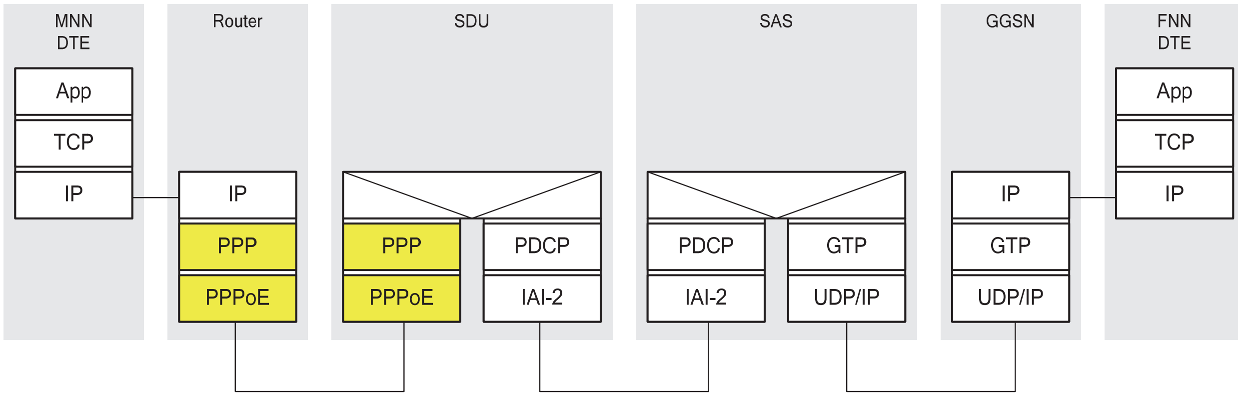
3.2.2 Layer 3 (Routed) Model - IP Presentation at TE



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).

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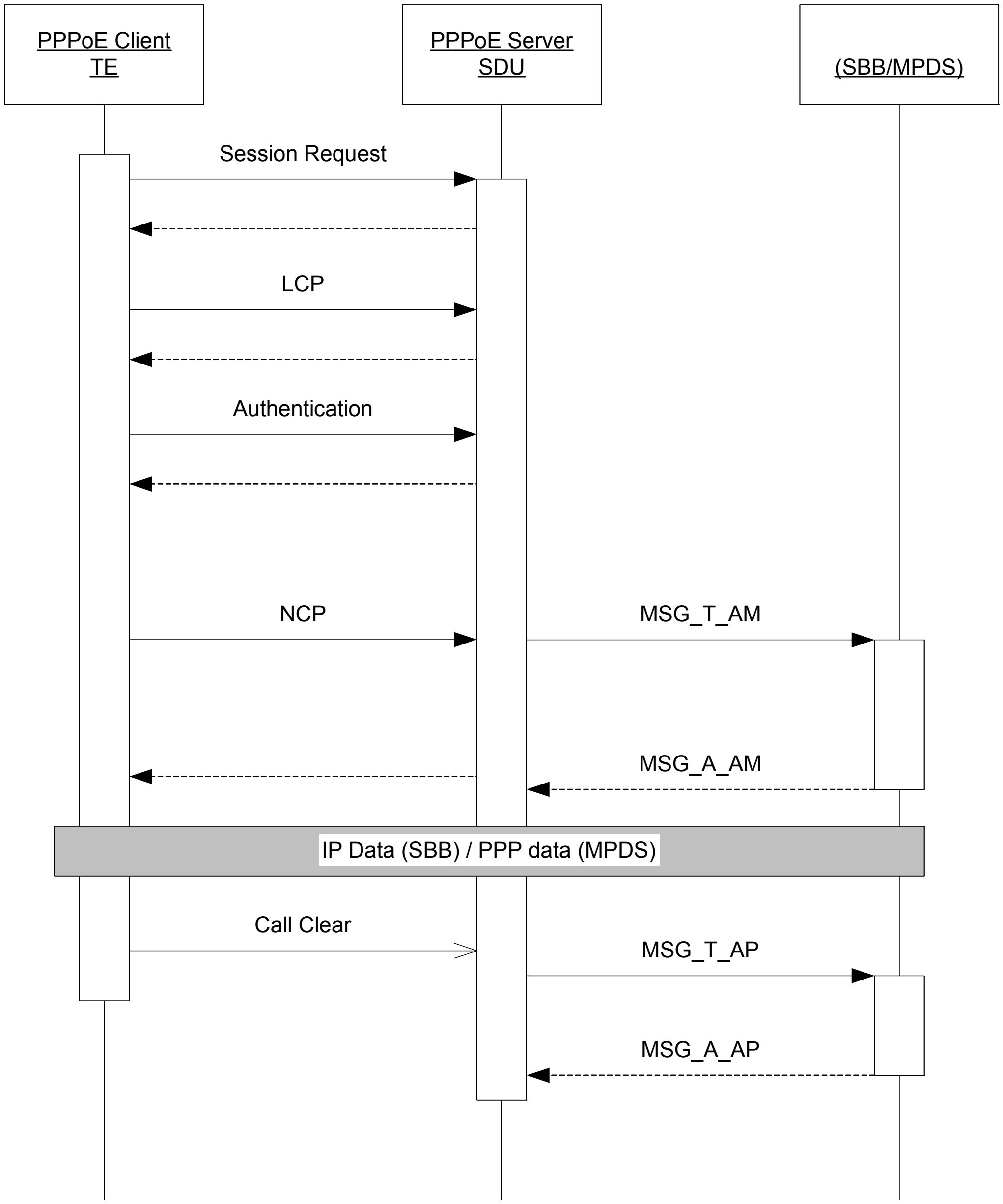

PPPoE IP Call

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.

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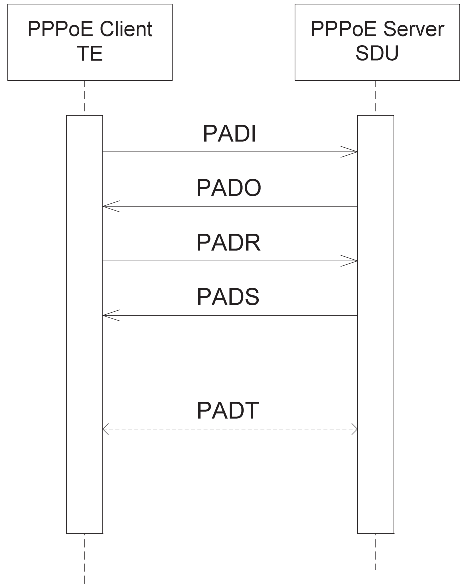

PPPoE Discovery

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. If the SDU cannot service the request for any reason then it will not reply.
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.

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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.

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 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
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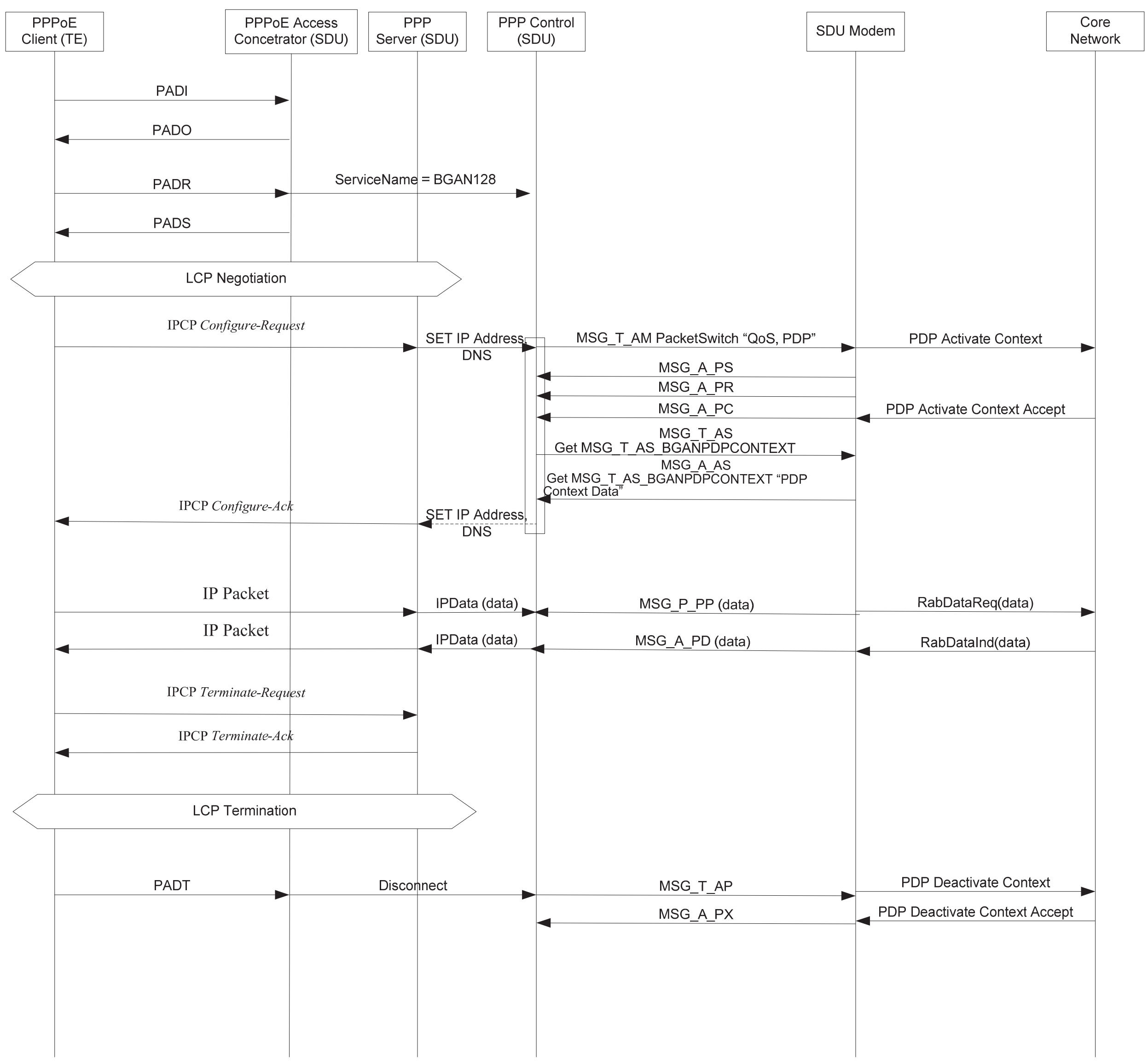
3.3.10 PPPoE to Core SBB Network



Message Sequencing Chart

ATTACHMENT 5
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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

ATTACHMENT 5
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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

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 dependant 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**
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**

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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*:

Tag	Value
USER	User Name
PASS	Password
APN	Access Point Name

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: {?}.

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.

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4.0 PDP CONTEXT CONTROL

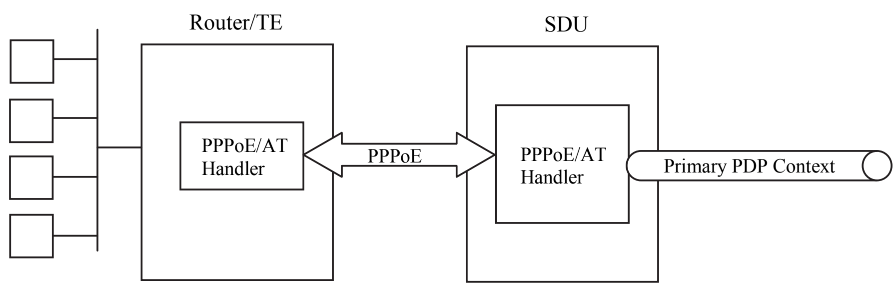
The following describes three options for interfacing a TE to a BGAN SDU utilizing PPPoE.

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

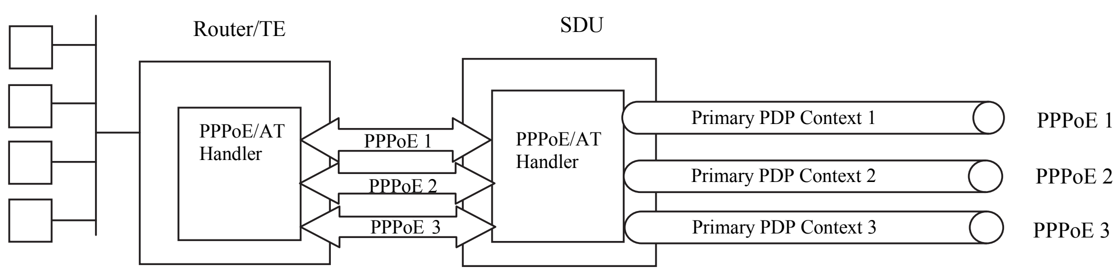
This section documents the relationship between a single TE and a SDU, where the TE does not employ a control line. The PDP context can be set up and initiated either by the use of ORT profiles stored at the SDU, or by placing a full context definition AT string in the PADR PPPoE message.



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.



Stage 1, No Control Line, Multiple PPPoE Sessions

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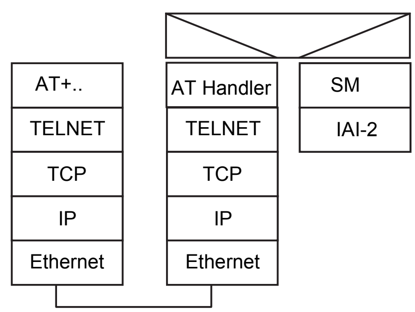
4.2 Out of Band Control Line

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.

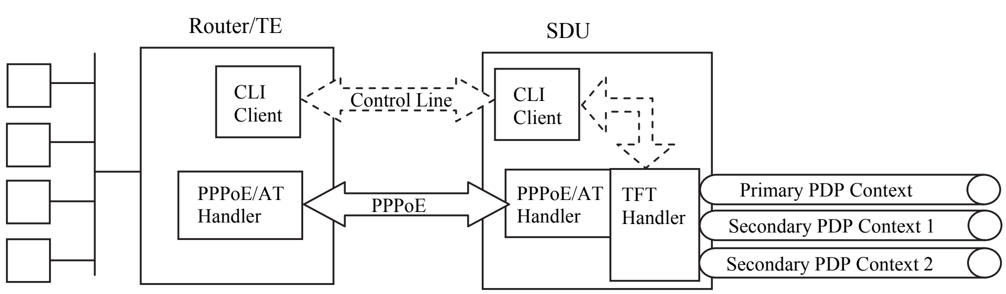
Using PPPoE as an interface mechanism between a TE and a SDU does have limitations. The PDP context definition, QoS and activation AT command strings have to be presented together via the PADR tag during the initial PPPoE Active Discovery Phase. Once this phase is complete, then no further transport mechanism 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.



Protocol Stack for a TE to SDU Control Line

4.2.2 Interface Stage 2 Implementation (With Control Line)



Stage 2, Control Line Added, Single PPPoE Session

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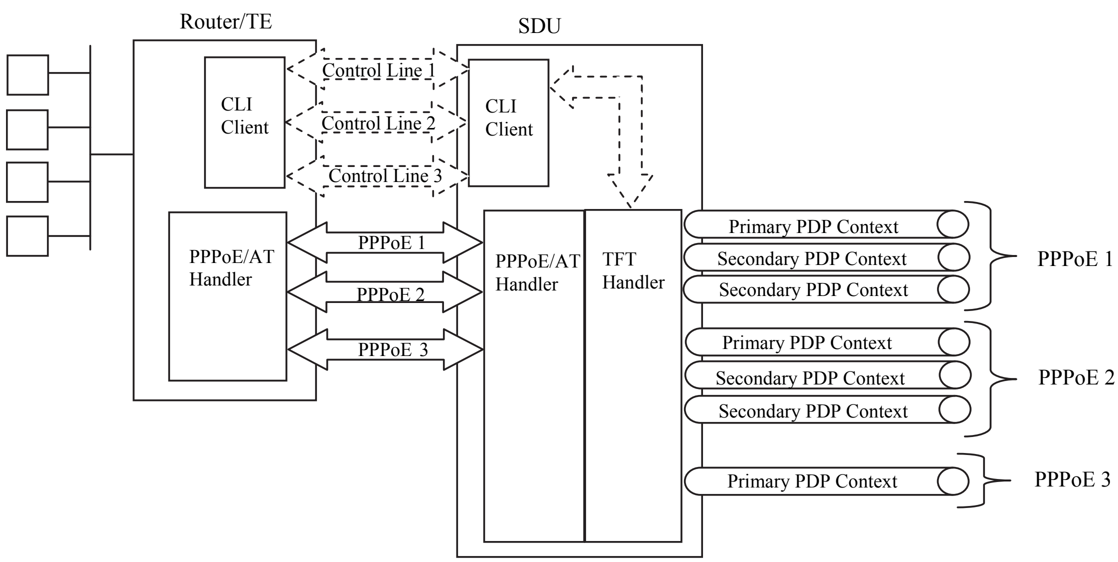
In addition to the standard PPPoE handler, a Command Line Interface (CLI) client is required on both the TE and SDU, as is a TFT handler. The CLI handler, via the command line, is used to pass further 'AT' commands to the SDU. As previously discussed, this facilitates PDP context modification and also 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.



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.

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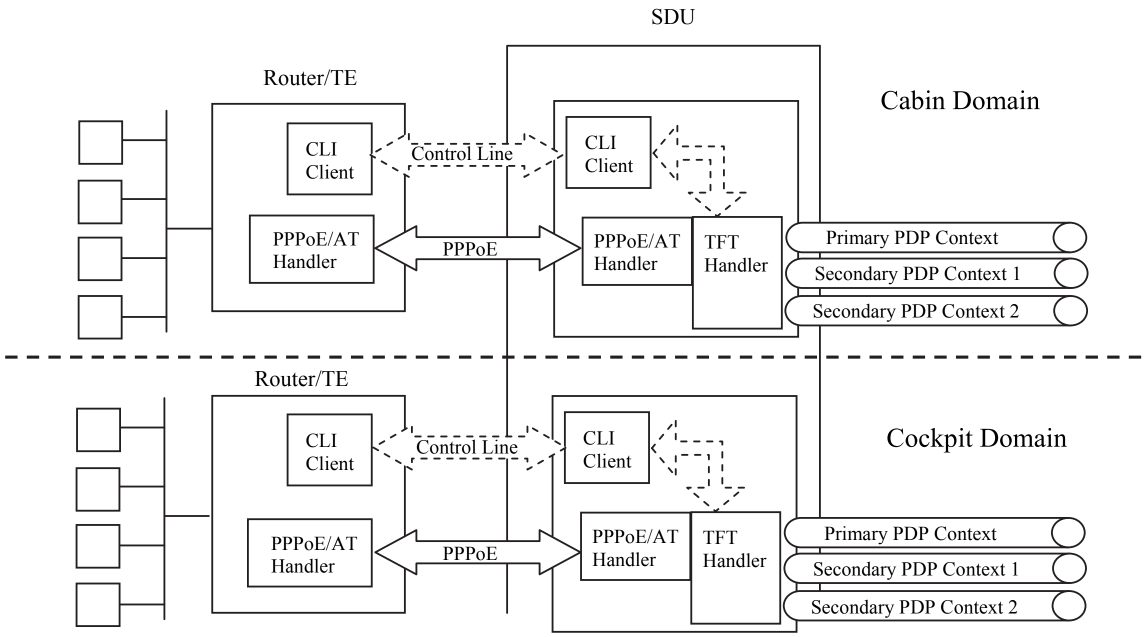
4.2.3 Stage 3 Implementation

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/TE's. The diagram below shows such a configuration.



Stage 3, Multiple Router/TE's With a Single SDU

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.

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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.

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. <u>Replacing</u> a primary context with a new primary context
2. <u>Adding</u> an additional <u>primary</u>
3. Adding an additional <u>secondary</u>
4. <u>Modifying an existing primary or secondary context</u>

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.

---

[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).

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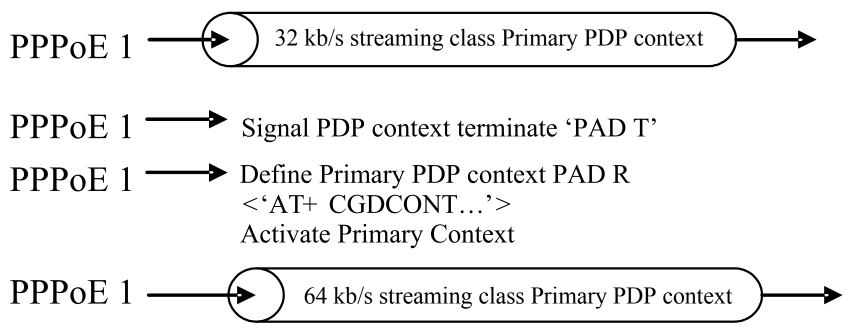
4.3.1 Scaling a PDP Context without a Control Line

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.

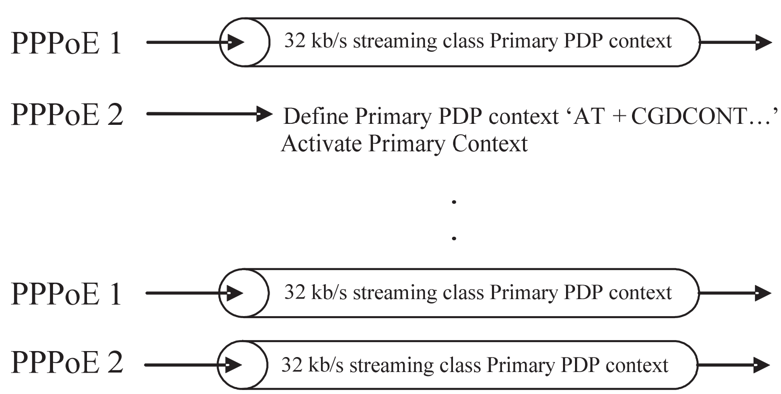
Here, the current PDP context is terminated and a new higher bandwidth context is defined and activated. Though this is a valid method of scaling up the bandwidth available, it does require that the controlling server handling IP traffic have the ability to buffer the IP traffic in order to suspend the 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.



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.



Scaling with Additional Primary Context

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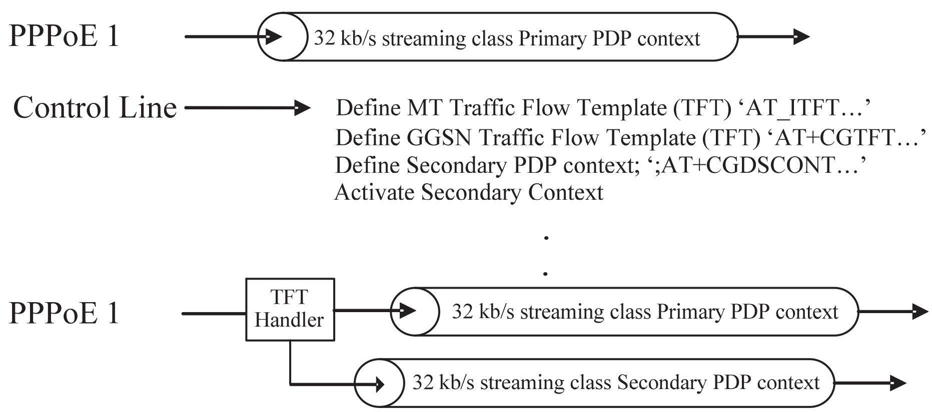
4.3.2 Scaling a PDP Context with a Control Line

4.3.2.1 Additional Secondary Context

This next example shows a secondary context being attached to the initial primary context. Though the two contexts will share the same IP address, the necessity for a Traffic Flow Template (TFT) may be problematic. The TFT specifies a method of IP traffic separation and routing across the two contexts. So, if it is a single application that requires the larger scaled up bandwidth, and then enforced traffic separation, by port address for example, is not desirable.

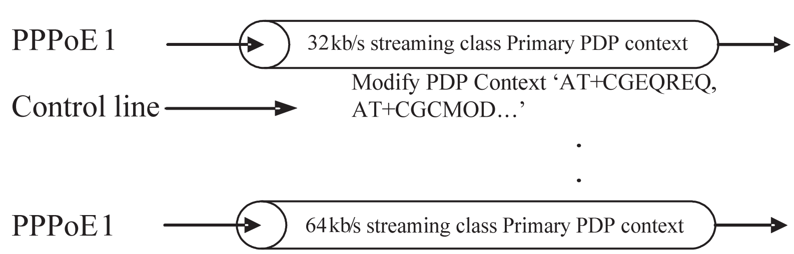


Scaling with Additional Secondary Context

4.3.2.2 Modify PDP Context

With a control line available, it is possible to signal to 'Modify' the current PDP context by using the +CGCMOD command and hence scale up the available bandwidth.

As the mobile essentially maintains the same Primary context there is no change of IP address that may necessitate more complex routing schemes in order to maintain user data continuity.



Scaling By Modifying the Primary Context

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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
+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

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3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
+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
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

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3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
+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
+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

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3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
+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
_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

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3 GPP AT Command	Description	Inmarsat BGAN UT-TE Interface Spec	ARINC 781 Attachment 5
_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		
_IPDPS[2]	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> _IPDPS=PPPoE_Session_ID	OK 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 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 lost of ownership through at spontaneous _IPDPS:0,0.0.0.0 message.

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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.

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.

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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

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5.0 Editor's Comment

This chapter 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 RFC's

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

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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

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:

```
.iso(1)
 └─ .org(3)
     └─ .dod(6)
         └─ .internet(1)
             ├─ .mgmt(2)
             │   └─ .mib-2(1)
             │       ├─ .system(1)
             │       │   └─ ... (as defined in RFC1213-MIB)
             │       ├─ .interfaces(2)
             │       │   └─ ... (as defined in RFC1213-MIB)
             │       ├─ .ip(4)
             │       │   └─ ... (as defined in RFC1213-MIB)
             │       ├─ .icmp(5)
             │       │   └─ ... (as defined in RFC1213-MIB)
             │       ├─ .tcp(6)
             │       │   └─ ... (as defined in RFC1213-MIB)
             │       ├─ .udp(7)
             │       │   └─ ... (as defined in RFC1213-MIB)
             │       ├─ .transmission(10)
             │       │   └─ .ppp(23)
             │       │       └─ ... (as defined in PPP-LCP-MIB as defined in RFC1471)
             │       └─ .snmp(11)
             │           └─ ... (as defined in RFC1213-MIB)
             └─ .private(4)
                 └─ .enterprises(1)
                     └─ .aeec(13712)
```

Basic Used SNMP MIB Structure

The enterprise OID for all ARINC 781 related MIB's 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 left unresolved (left up to the vendor).

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5.2.2 MIB Entry Point

The level 1 OID's 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)
                    └─ .aeec(13712)
                        └─ .arincSwift(781)
                            └─ ...
```

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 shall be defined as shown in the following figure:

Figure to be defined in a future supplement

ARINC Swift MIB Structure

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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).

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:

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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.

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 a 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

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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

5.3.2 Mandatory Branches

The Structure is divided into five mandatory main branches, which are shown in the following figure:

```
.arincSwift(781)
 ├─ .asVersion(1)
 ├─ .asLinks(2)
 ├─ .asSystem(3)
 ├─ .asUnits(4)
 └─ .asUserDefArea(5)
```

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:

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Table 12 - Version Object Details

Object Identifier	Type	Range	Description
.asvMajor(1)	`Integer32`		This object defines the major version of the arincSwift MIB definition. The current major version number is 1.
.asvMinor(2)	`Integer32`	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.

```
.arincSwift(781)
 ├─ ....
 └─ .asLinks(2)
     ├─ .aslServices(1)
     └─ .aslInfos(2)
```

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 - Service Related Object Details**.

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.

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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)`	`Interger32`	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 Behavior

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:

Table 14 - Example Link Service Table Content[3]

Row	.aslsIndex(1)	.aslsName(2)	.aslsAvailabile(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

---

[3] In practice, there will be many more entries than this. There will be separate entries for each streaming class, and seperate 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.

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Row	.aslsIndex(1)	.aslsName(2)	.aslsAvailabile(4)	.aslsMaxChannels(5)	.aslsMaxBW(7)
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.

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 – Link Information Table Related Object Details**. 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.

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Table 16 - Link Information Table Related Object Details

Object Identifier	Type	Range	Unit	Description
.asliActLinkIndex(1) .asliHistLinkIndex(1)	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).
.asliActLinkReleaseType(2) .asliHistLinkReleaseType(2)	Integer32		none	This object shows the release type of the current link as numeric codes as described in Attachment 5, Section 6.
.asliActLinkReleaseReason(3) .asliHistLinkReleaseReason(3)	DisplayString	0..128	none	This object shows the reason for the release type in a displayable form.
.asliActLinkStatus(4) .asliHistLinkStatus(4)	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.
.asliActLinkChanNo(5) .asliHistLinkChanNo(5)	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.
.asliActLinkContextID(6) .asliHistLinkContextID(6)	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.
.asliActLinkActualContextID(7) .asliHistLinkActualContextID(7)	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).

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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) are best-effort connections and do not have specifically negotiated, fixed, symmetric bandwidth.
.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 to “Example Link Service Table Content“, 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.

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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.**

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

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75 dBHz Swift64 (Spot/Regional Beam)
65 dBHz Swift64 NCS (Global beam)

5.3.2.2.2.2 Object Behavior

The `.asliActLinkTable(4)` 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 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	.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

The following table shows a content example of the history table:

Table 18 - Example 1 of History Link Table Content

Table Row	.asliActLink…					
	…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.

5.3.2.2.2.2.1 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

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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:

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

5.3.2.2.2.2.2 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.

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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.

5.3.2.2.2.2.3 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 – System Subfolders and Objects**.

```
.arincSwift(781)
 ├─ ....
 └─ .asSystem(3)
     ├─ .assConfig(1)
     ├─ .assInfos(2)
     ├─ .assTraps(3)
     ├─ .assSelfTestAvailable(4)
     └─ .assSelfTest(5)
```

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.

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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 vendor.
`.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**.

```
.arincSwift(781)
 ├─ ....
 └─ .asSystem(3)
     ├─ ....
     ├─ .assSelfTestAvailable(4)
     └─ .assSelfTest(5)
         └─ .asssTestcaseTable(2)
```

.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 a 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).

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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 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 subchapter 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 vendor 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.

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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 vendor.
.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 vendor specific fault code of latest system error.
.asuSduInfoFailureReason(12)	DisplayString	0..255	Human readable vendor 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.
.asuSduInfoIntHPAState(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.

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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 means that its 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 d**B**.
`.asuSduInfoOutputFwdPower(31)`	`Integer32`		The output forward power in d**B**.
`.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 sub section 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)
```

.asuSDU Configuration Sub Structure

These objects have to be implemented if a vendor 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 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 sub section 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 subchapter 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 sub section 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:

```
...
├─ .asuSCMAvailable(3)
└─ .asuSCM(4)
    ├─ .asuScmInfo(1)
        ├─ .asuScmInfoTableNumbers(1)
        └─ .asuScmInfoTable(2)
```

SCU Info Sub Structure

These objects have to be implemented, if a vendor decides to support the optional **`.asuSCM(4)`** sub branch by setting the **`.asuSCMAvailable(3)`** object to “True”.

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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 vendor.
.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 then 1 SIMS are installed this parameter has to 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 then 2 SIMS are installed this parameter has to 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 then 3 SIMS are installed this parameter has to 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 then 4 SIMS are installed this parameter has to 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 sub section 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 sub section is a placeholder for future updates and can be used to insert trap objects in the **.asuSCMTraps(3)** subfolder.

5.3.2.4.3 DLNA Unit Related Objects

This subchapter contains all objects related to the DLNA. They are grouped in tables to cover that the unit can be available multiple times.

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ETHERNET INTERFACE

5.3.2.4.3.1 Information Sub Branch for the DLNA Unit Related Objects

This sub section 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)
```

DLNA Info Sub Structure

These objects have to be implemented, if a vendor 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 vendor.
.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 sub section is a placeholder for future updates and can be used to insert configuration objects in the **.asuDlnaConfig(2)** subfolder.

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 sub section is a placeholder for future updates and can be used to insert trap objects in the **.asuDlnaTraps(3)** subfolder.

ATTACHMENT 5
ETHERNET INTERFACE

5.3.2.4.4 Antenna Unit Related Objects

This subchapter 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 sub section 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)
```

Antenna Info Sub Structure

These objects have to be implemented, if a vendor 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.

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 vendor 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**).

ATTACHMENT 5
ETHERNET INTERFACE

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 sub section 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 sub section 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 vendor 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.

Table 37 - User Defined Area Vendor OID's

Vendor Name	<Vendor>	Vendor sub OID	complete Vendor 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 vendor needs its own place for user defined and vendor specific information (and is not covered by the table above), he has to request a entry ID for its own objects from Air/Ground Communication Systems Subcommittee to avoid OID conflicts within the whole structure.

Each of the vendor sub OID's 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 - **Vendor Related Version Objects**

Object Identifier	Type	Range	Description
.asuda<*VENDOR*>VersMajor(1)	`Integer32`		This object defines the major version of the vendor 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 vendor 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 SDU[5] 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 & 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.

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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
    7and 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

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 brought up for discussion during finalization of the specification, and were deemed to be useful, but to be added in a future revision. 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, …), over-the-air compression control, over-the-air crypto control.

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 1-1 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:

1. 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

$$= \frac{\mathrm{CL_{factor}}}{\mathrm{AG_{factor}}}\left[(\#\mathrm{channels})(\mathrm{UseCase_{watts}})\right]$$

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):

$$\begin{aligned} &\text{Total HPA Output Power (watts)} \\ &\quad = \frac{1.78\ \mathrm{CL_{factor}}}{15.85\ \mathrm{AG_{factor}}}[(2\ \text{channels})(70.79\ \text{watts Aero C 8.4 kbps}) \\ &\quad + (4\ \text{channels})(100\ \text{watts SBB Class 6}) \\ &\quad + (1\ \text{channel})(109.65\ \text{watts Aero RT 10.5 kbps})] \end{aligned}$$

= 73.13 watts

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 π/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 , Padstrow, Corrwall Great Britain for Agilent Technologies by John Wiley & Sons, Ltd, 2009**

ATTACHMENT 7
COMPACT SATCOM DEFINITION (SB200)

1.0 INTRODUCTION

This attachment describes a Compact Satcom System. It is intended as a small form-factor lower-cost alternative configuration, aimed primarily at delivering safety services to the cockpit.

The Compact Satcom System is particularly suited to deliver the Inmarsat SwiftBroadband SB200 Evolution service, operating in Class 4 over the Inmarsat I4 and Alphasat satellites. A Class 4 is by definition a single-channel system, allowing reduced size, power dissipation and cost. The Compact System is therefore not suitable for providing multi-channel services such as Classic Aero.

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, perhaps more suitable for non-airline applications. 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 SB200 EVOLUTION SAFETY SERVICE (CLASS 4) OVERVIEW

The Inmarsat Class 4 service is designed to enable compact airborne equipment, particularly the antenna. The main characteristics are:

- Service down to 5 degree elevation (The SB200 Class 15 service provides coverage only above 20 degree elevation.)
- Provided over I4 satellites and Alphasat
- ACARS messaging service
- Dual voice channels, for safety or non-safety services
- IP data connection, up to 200 kb/s. Safety or non-safety use.
- Streaming service up to 32kb/s to support multivoice services
- Priority and pre-emption of safety voice and data services
- Small antenna (e.g. a blade antenna)

3.0 AIRBORNE TERMINAL CONFIGURATIONS

Despite the desire to standardize one configuration of the 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 1-6), and may optionally include an internal SCM. The three configurations are shown in section 7. Configurations 1 and 2 have baseline and alternate aircraft wiring defined, whilst Configuration 3 has only one aircraft wiring defined. The equipment manufacturer should be consulted to determine which configurations and/or wiring is appropriate.

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COMPACT SATCOM DEFINITION (SB200)

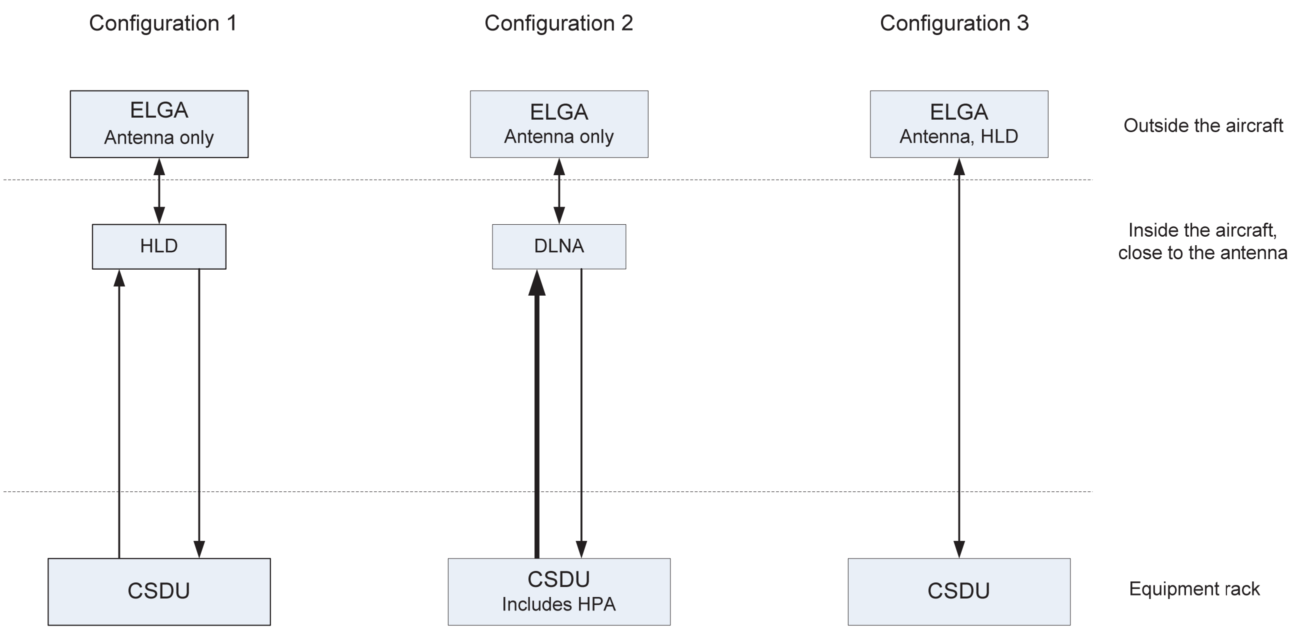

Figure 1 – Compact Satcom System Configurations

4.0 LRU DEFINITIONS

4.1 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)
- It provides one channel of service only

The connector definition of the CSDU is identical to that on the 6 MCU (full-sized) SDU.

Like the full-sized SDU, the 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.

4.1.1 CSDU Form Factor

The SDU should comply with the dimensional standards in ARINC Specification 600 for the 2 MCU size.

4.1.2 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 CSDU. Other interfaces are considered optional.

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COMPACT SATCOM DEFINITION (SB200)

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 1 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 & data)	No	
ARINC 664 fiber (Cockpit voice & data)	No	
ISDN	No	
CEPT-E1	No	
(C)MU	Yes - 2	Two for B777. Two ACR in A350 / 380
Cockpit Voice (4-wire & discretes)	Yes – 2 sets	
MCDU	Yes - 3	
POTS/SLIC	No	
BITE/Maintenance Interfaces		
CFDS / CMC on ARINC 429	Yes	
ADL (ARINC 615/429)	Ethernet & ARINC 429	For Ethernet: Quadrax Ethernet 3 preferred
Service Availability Status discrete	No	Optional. Desirable for some business jet applications
ATE pins ARINC 664 copper or fiber	No 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 ARINC 664 copper or fiber	Yes No	 ARINC 664 copper desirable for A350 / 380

ATTACHMENT 7
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4.1.3 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.

Section	Feature/Function	Required for SB200 safety system?	Comments
2.10	BITE (CFDS interface)	Yes. (1 x A429) Rx/Tx	Used on some 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 & 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	Cabin domain in terms of priority & pre-emption. Same domain as cockpit in terms of security. Provide external security (firewall) as needed. Probably not used by airliners.
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 & VOIP)	Some require DTMF dialing.
3.2.1.8	SAT Radio – SwiftBroadband	No	Not defined to date.
3.2.1.9	Williamsburg SDU (WSCI) Controller	No	Used on some aircraft (A380, A350, Dassault).
3.2.4	Ethernet	Yes, all	
3.3	Software Dataloader	Both. S/W & 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 & Swift64 Operations	N/A	
3.4.3	Security	No PIES support required.	All Ethernet ports in one network domain.
3.5	Future Growth		
3.5.1	ARINC 664	No	
3.5.4	Multi-Frequency Band	No	

4.1.4 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 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.

4.1.5 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.

4.2 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.

4.3 HLD

4.3.1 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 aimed at 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.

4.3.2 HLD Form Factor

The HLD form factor is shown in Figure 2.

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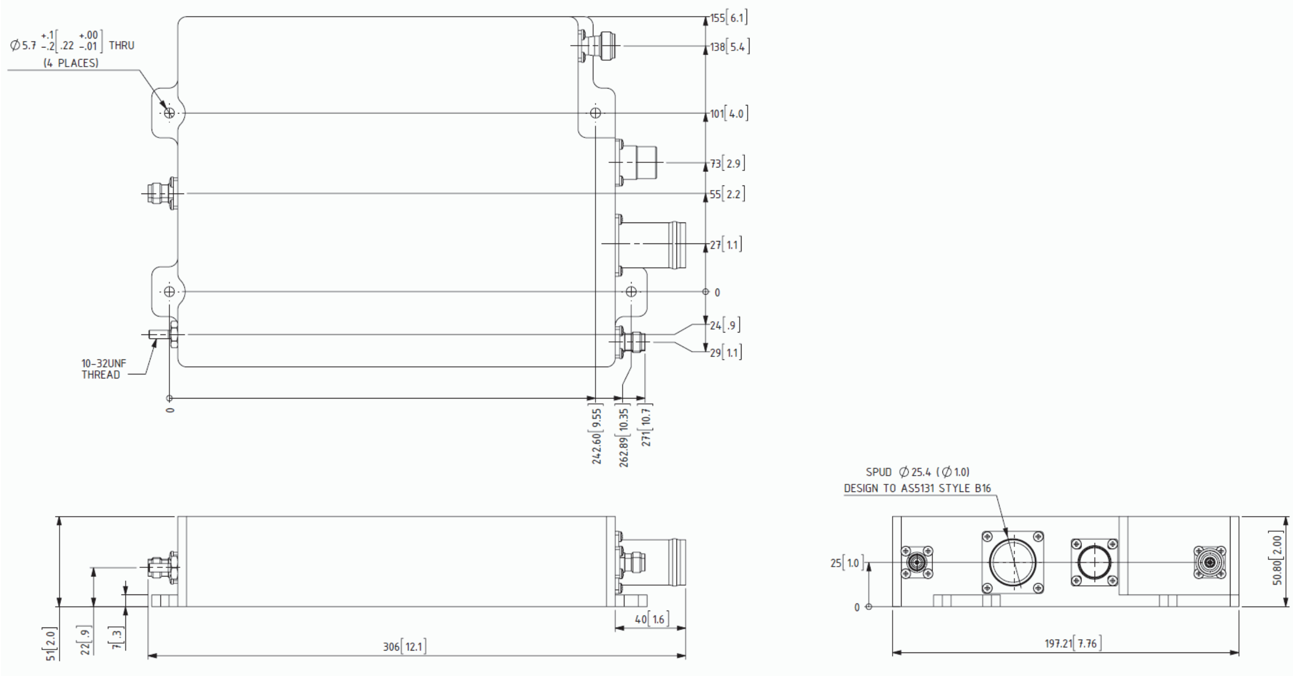
The outline resembles that of a Type F DLNA, but it uses a different multi-pin connector. The position of the connectors and cooling spigot may be positioned in the area defined.



NOTE: Baseline drawing – Consult manufacturer to confirm outline.

Figure 2 – HLD outline

4.3.3 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 in the table below.

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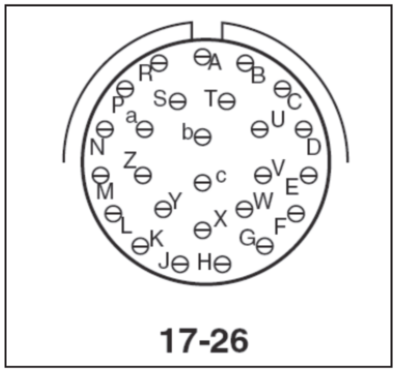

Figure 3 – HLD Multi-pin Connector Insert Arrangement

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		RS232 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

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4.3.4 HLD Cooling

A spigot for cooling air should be provided on the HLD. The cooling air flow rate should be 25 kg/hr at 60°C (max) air (inlet temperature), and the pressure drop through the HLD should be 51 ± 5 mm of water at this rate.

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 and will inform the SDU of it being in such a mode. The system will then operate at a reduced services mode.

A minimum clearance of 1-inch beyond the envelope defined in Figure 2 should be provided to facilitate the passively cooled nature of this design when in 'loss of cooling mode'.

4.3.5 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.

4.3.6 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.

4.4 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 given in Attachment 1-8.

4.5 ELGA (Enhanced Low Gain Antenna)

4.5.1 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.

4.5.2 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 741. The ELGA is shorter, however, and does not use the rear pair of mounting screw holes.

4.5.3 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.

4.5.4 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 the HGA in section 2.3.2.2 and attachment 1-12. If the ELGA contains two TNC connectors, then they should be color coded.

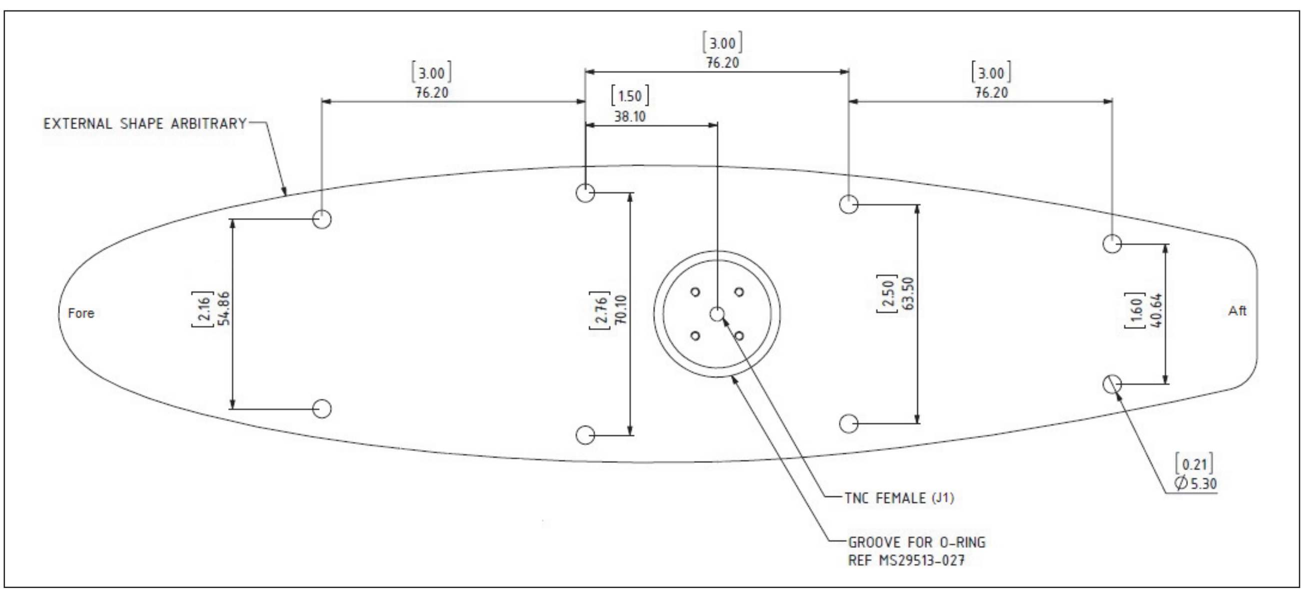

Figure 4 – ELGA with single TNC female connector

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COMPACT SATCOM DEFINITION (SB200)

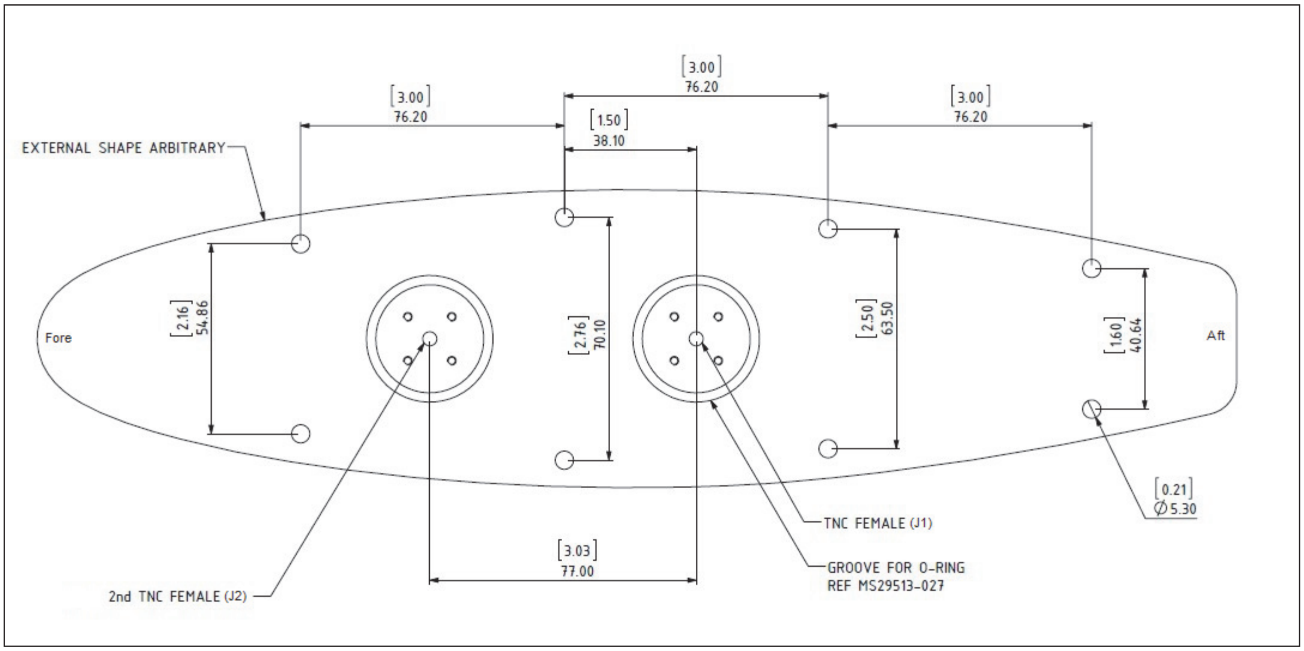

Figure 5 – ELGA Footprint, with 2nd TNC connector

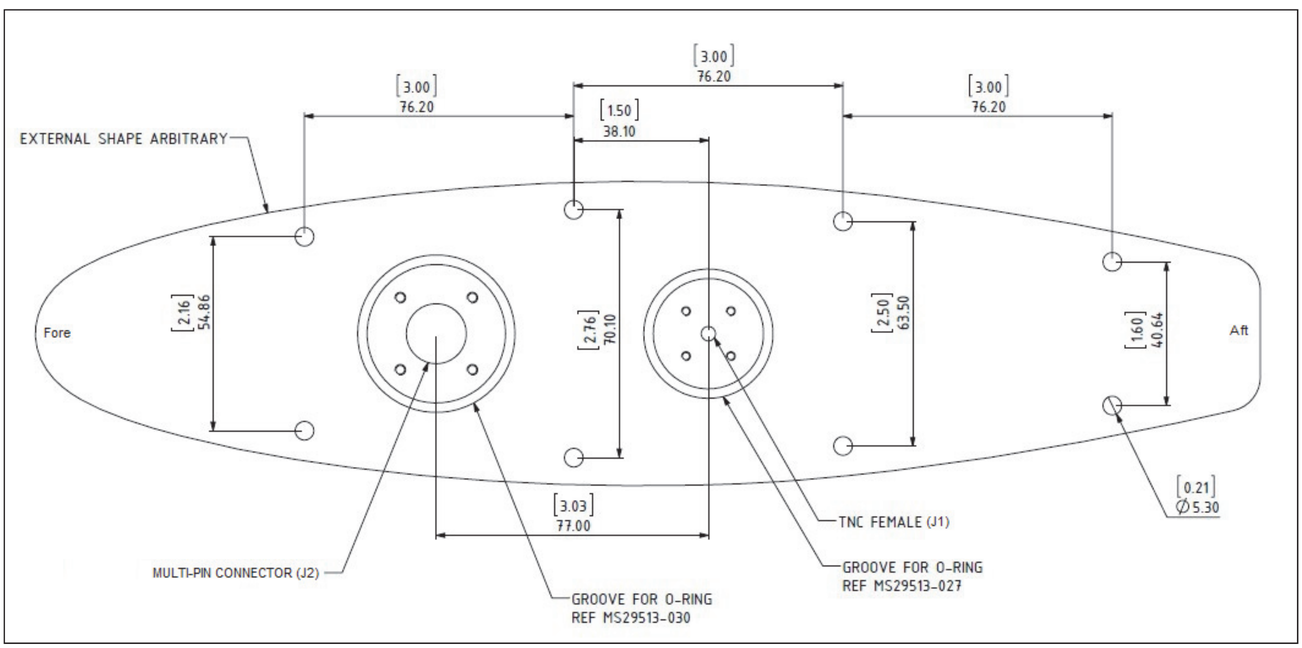

Figure 6 – ELGA footprint, with multi-pin connector

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4.6 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.

5.0 INTERCHANGEABILITY

The 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 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 1-8. The optional power/control connector of the HLD is the same as the Flange Mount HPA except a different keying is used.

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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).

6.0 PERFORMANCE CRITERIA

The 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.

6.1 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	dBW
Ant Gain (min)	1	dB
Ant-DLNA Cable Loss	0.5	dB
DLNA Insertion Loss	0.8	dB
CSDU-DLNA Tx Cable Loss	3	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 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.

6.2 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.)

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The receiver system performance is intended to provide a packet error rate (PER) of $1x10^{-3}$ or better for SwiftBroadband packet-switched services and $1x10^{-2}$ 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.

7.0 INTERWIRING

This section deals specifically with wiring between the 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 section 4.1.3 of this attachment as well as Attachment 1-3 and Attachment 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 1-5c).

7.1 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 4.6 of this attachment. A weight saving can be achieved this way.

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.

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COMPACT SATCOM DEFINITION (SB200)

7.2 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 section 4.6. 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.

7.3 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 4.6 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.

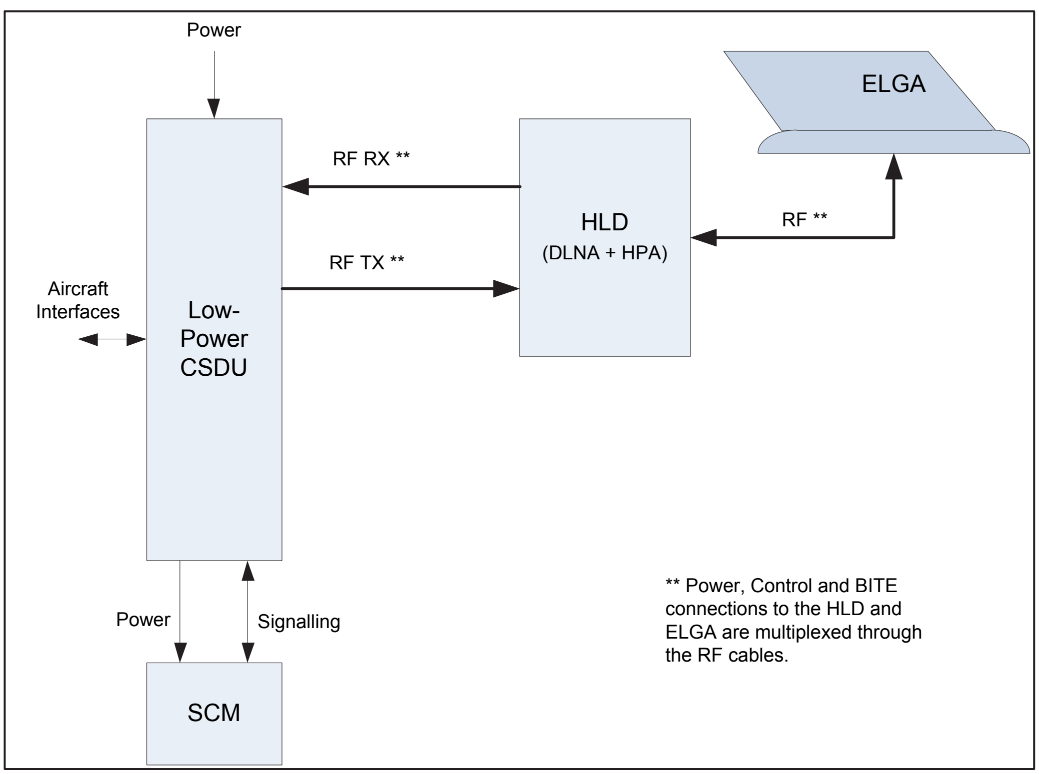

Figure 7 – Compact Satcom System - Configuration 1 - Baseline wiring

ATTACHMENT 7
COMPACT SATCOM DEFINITION (SB200)

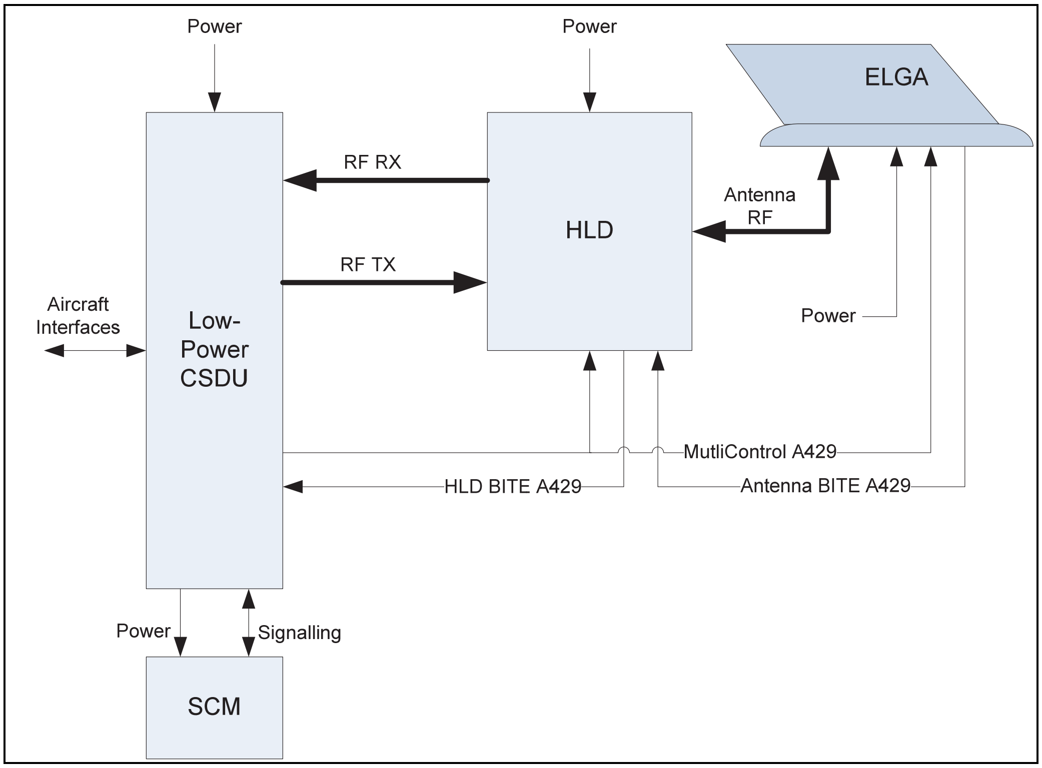

Figure 8 – Compact Satcom System - Configuration 1 - Alternate wiring

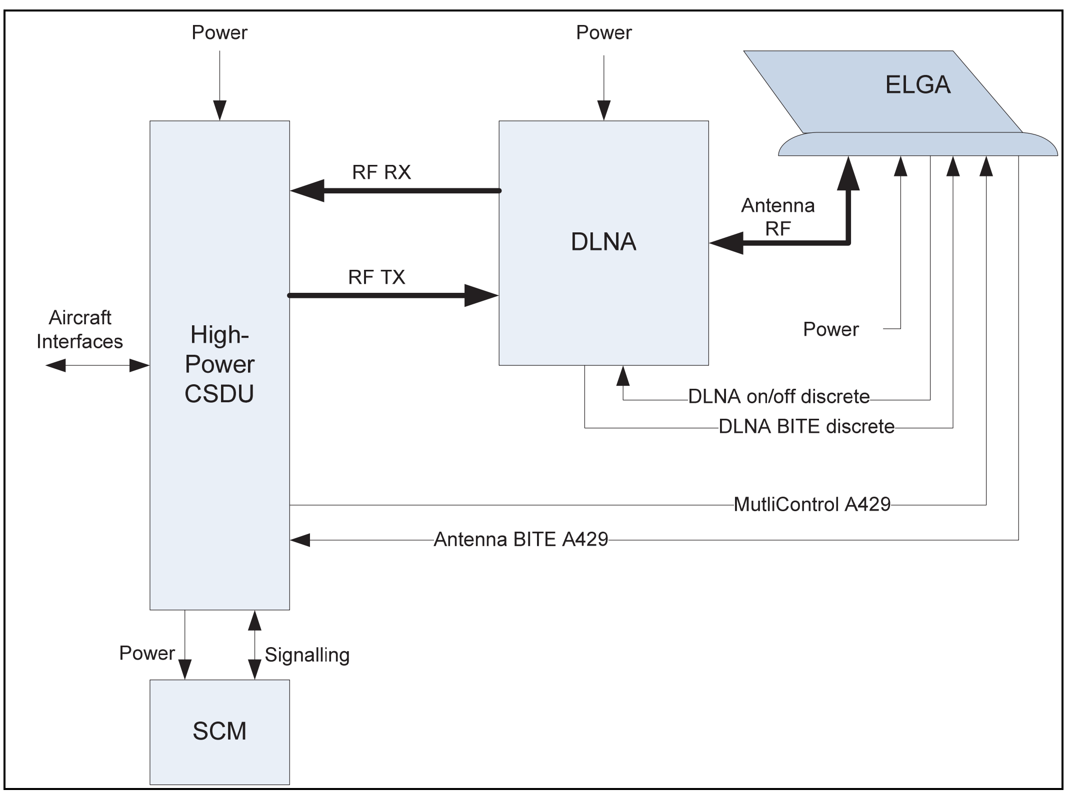

Figure 9 – Compact Satcom System – Configuration 2 – Baseline wiring

ATTACHMENT 7
COMPACT SATCOM DEFINITION (SB200)

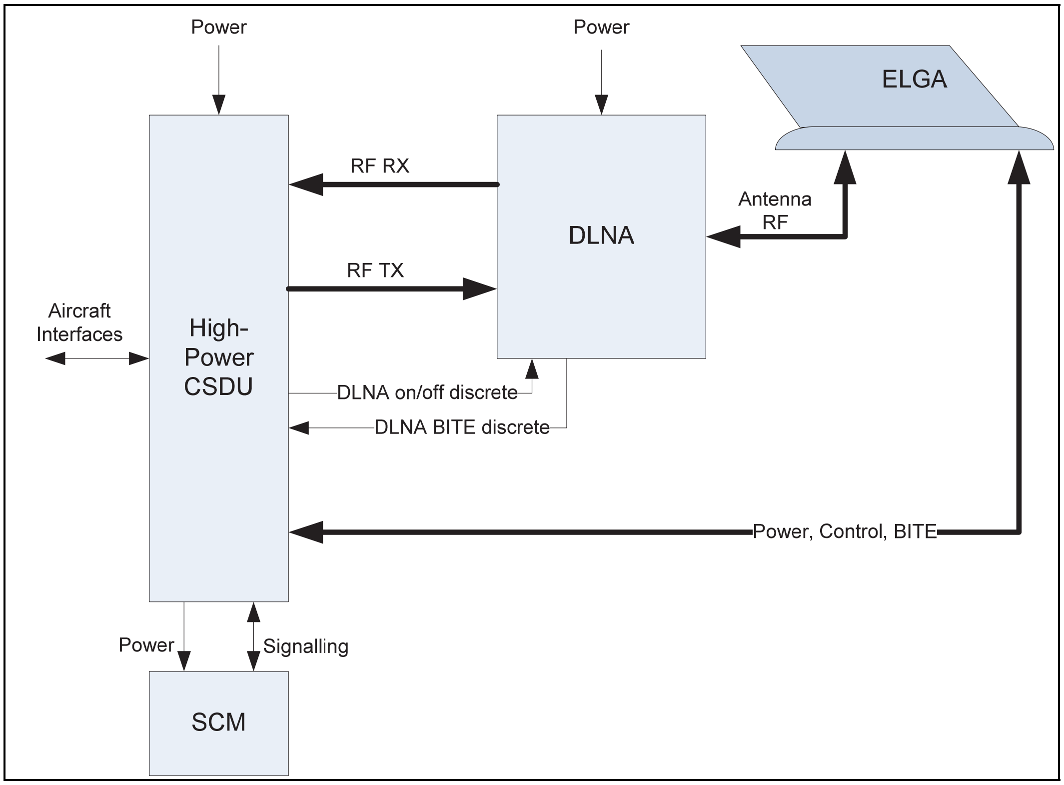

Figure 10 – Compact Satcom System – Configuration 2 – Alternate wiring

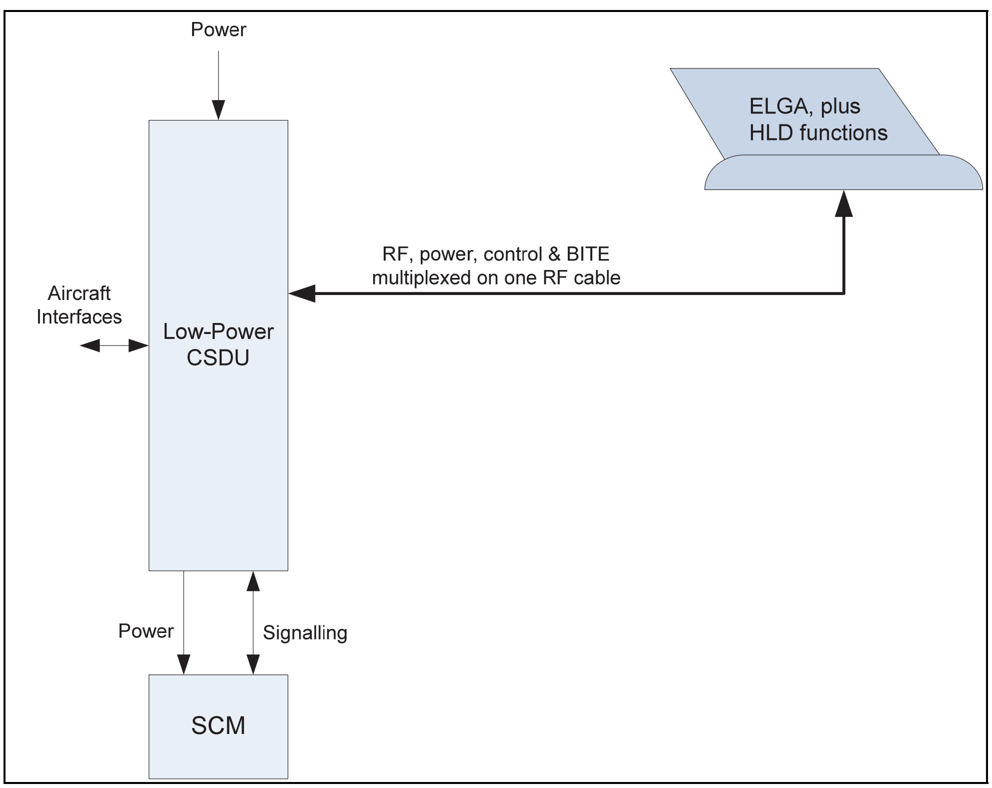

Figure 11 – Compact Satcom System – Configuration 3

ATTACHMENT 8
ATTACHMENT REFERENCE GUIDE

APPENDIX A
ACRONYMS

3D	Three Dimensions
3GPP	Third Generation Partnership Project
A/C	Aircraft
AAC	Aeronautical Administrative Communications
ac	Alternating current
AC	Access Concentrator
ACARS	Aircraft Communications Addressing and Reporting System
ACP	Audio Control Panel
ADIRS	Air Data Inertial Reference System
ADL	Airborne Data Loader
ADSU	Automatic Dependent Surveillance Unit
AEEC	Airlines Electronic Engineering Committee
AES	Aircraft Earth Station
AGGW	**ACARS Ground Gateway**
AGC	Automatic Gain Control
AGCS	Air/Ground Communication Systems Subcommittee
AM/PM	Amplitude Modulation/Phase Modulation
AMBE	Advanced Multi-Band Excitation (speech encoding algorithm)
AMCP	Aeronautical Mobile Communications Panel
AMM	**Aircraft Maintenance Manual**
AMS	Audio Management System
AMSS	Aeronautical Mobile Satellite Services
ANT	Antenna
AOC	Aeronautical Operational Control
APC	Aeronautical Passenger Communications
APM	Airplane Personality Module
ARINC	Aeronautical Radio Inc.
AT	Attention
ATC	Air Traffic Control
ATG	**Air to Ground**
ATE	Automatic Test Equipment
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 binary notation
BP	Bottom Plug

APPENDIX A
ACRONYMS

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
CCIR	International Consultative Committee for Radio
CCS	Cabin Communications System
CDM	Configuration Data Module
CDU	Control Display Unit
CEPT	European Postal and Telecommunications Committee
CFDS	Centralized Fault Display System
CFR	Code of Federal Regulations
CLI	Command Line Interface
CMC	Central Maintenance Computer
CMU	Communications Management Unit
CN	Core Network
COAX	Coaxial Cable
CODEC	Coder/Decoder
CPD	Cabin Packet Data
CPDF	Cabin Packet-mode Data Function
CR/LF	Carriage Return/Line Feed
CRC	Cyclic Redundancy Check
CS	Circuit Switched
CSDU	**Compact SDU**
CTU	Cabin Telecommunications Unit
DLNA	Diplexer/Low Noise Amplifier
dB	Decibel
dB/K	Decibel per Kelvin
dBi	Decibel relative to isotropic
dBic	Decibel relative to isotropic, circular polarization
dBm	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

APPENDIX A
ACRONYMS

DP	Distribution Partner
DTMF	Dual Tone Multi-Frequency
ECAM	Electronic Centralized Aircraft Monitoring
EDU	Electronic Display Unit
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 Text
EQID	Equipment Identifier
ETX	End of Text
EUROCAE	European Organization for Civil Aviation Equipment
EVM	Error Vector Magnitude
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FID	Forward Identification Number (for Swift 64 services)
FMC	Flight Management Computer
FNN	Fixed Network Node
FPLMTS	Future Public Land Mobile Telecommunications System
FT	Functional Test
FW	Failure Warning
G/T	Gain to Noise Temperature Ratio
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
GSM	Global System for Mobiles
GTA	**Ground to Air**
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

APPENDIX A
ACRONYMS

HPR	High Power Relay
HSDU	High Speed Data Unit
HSN	Harmonics, Spurious, and Noise
Hz	Hertz
I-2	Inmarsat-2
I-3	Inmarsat 3
I-4	Inmarsat 4
I/Q	In-Phase and Quadrature (Modulation)
IAI-2	Inmarsat Air Interface-2
ICAO	International Civil Aviation Organization
ID	Identification
IF	Intermediate Frequency
IGA	Intermediate Gain Antenna
IMEI	International Mobile Equipment Identifier
IMEISV	International Mobile Equipment Identifier Software Version
IMSI	International Mobile Subscriber Identity
IMT-2000	International Mobile Telecommunications 2000
INS	Inertial Navigation System
IP	Internet Protocol
IRS	Inertial Reference System
ISDN	Integrated Services Digital Network
ISO	International Standards Organization or (International Organization for Standardization)
ITU	International Telecommunication Union
kg/hr	kilo gram per hour
kHz	kilo hertz (10^3 Hz)
kSym/s	kilo Symbols per second
LAN	Local Area Network
L-band	Portion of the microwave band of the electromagnetic spectrum ranging roughly 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
LRU	Line Replaceable Unit
LSB	Least Significant Bit
mA	milli ampere
MAC	Media Access Control (address)
MASPS	Minimum Aviation System Performance Standards
MBS	Multiple Bearer System

APPENDIX A
ACRONYMS

MCDU	Multi-Purpose Control and Display Unit
MCU	Modular Concept Unit
MEO	Medium Earth Orbit
MFR	Manufacturer
MHz	Megahertz (10^6 Hz)
MIL	Military
M-ISDN	Modular Integrated Services Digital Network
MOPS	Minimum Operational Performance Standards
MP	Middle Plug
MPDS	Mobile Packet Data Service
ms	milli second
MSB	Most Significant Bit
MTSAT	Multifunction Transport Satellite
NCD	No Computed Data
NCS	Network Coordination Station
NOC	Network Operations Center
NS	Non-Safety
NVM	Non Volatile Memory
OEM	Original Equipment Manufacturer
ORT	Owner Requirements Table
PADT	PPPoE Active Discovery Termination
PBX	Private Branch Exchange
PC	Public Call
PCM	Pulse Code Modulation
PCS	Payload Control System
PDP	Packet Data Protocol
PER	Packet Error Rate
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

APPENDIX A
ACRONYMS

RAM	Random Access Memory
RAN	Radio Access Network
REN	Ringer Equivalent Number
RDI	Restricted Data Interface
RF	Radio Frequency
RMP	Radio Management Panel
RMS	Root Mean Square
ROM	Read Only Memory
RTCA	RTCA Inc.
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 Module
SDU	Satellite Data Unit
SELCAL	Selective Calling
SIP	**Session Initiation Protocol**
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

APPENDIX A
ACRONYMS

TNC	Threaded Neill Concelman (RF connector)
TP	Top Plug
TT&C	Telemetry Tracking & Control
Tx	Transmit
UDI	Unrestricted Data Interface
UMS	User Modifiable Software
UMTS	Universal Mobile Telephone System
USIM	UMTS Subscriber Identity Modules
UT	User Terminal
V	Volts
VA	Volt Ampere (measure of electrical power)
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
WOW	Weight on wheels
WSC	Williamsburg SDU Controller
WSCI	Williamsburg SDU Controller Interface
XL	**Extended L-band**

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”.

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.

B-3 Analysis Methodology

ARINC Report 811: *Commercial Aircraft Information Security Concepts of Operation and Process Framework*, produced by the SEC subcommittee and adopted at the AEEC General Session in October 2005, defines a three step risk-based information security process framework which can be employed to

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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 vendors. The intended audience includes all organizations (e.g., airlines, aircraft and avionics suppliers, AEEC subcommittees, service providers, etc.) that specify, acquire, develop, implement, test, operate, and maintain secure aircraft information systems.

Important: This document uses security terminology that may be unfamiliar to the reader, who is therefore strongly encouraged to become familiar with the content of the ARINC Report 811.

This framework was first used in January 2006 by the AEEC Datalink Security working group 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).

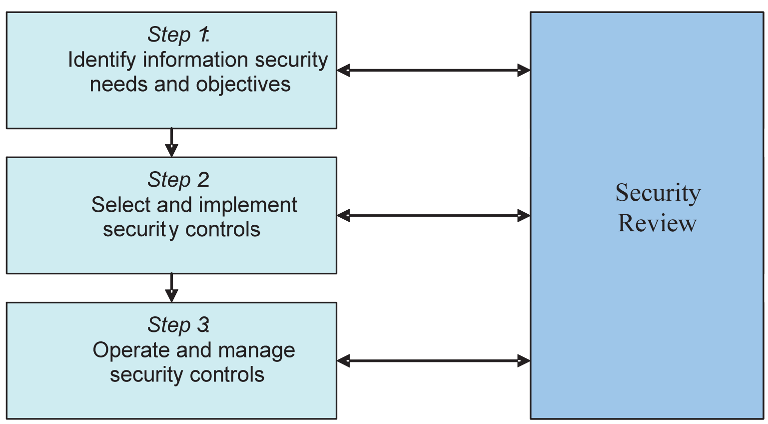

Figure 1

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?
- 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 shall 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.

Please consult ARINC Report 811 for further decomposition and explanation of these steps.

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 (Table 3.3 of ARINC 781), 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[1], 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 below 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 beginning on page 56.

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[1] In May 2008, Inmarsat shared its roadmap for support of safety services on SwiftBroadband. Service introduction is not expected to happen before 2012.

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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 [2]
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.

2 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

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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 & config	High	High	Medium
SDU operational status	Low	Medium	Medium
Safety services	Medium	High	High

Notes:

1. Due to sensitivities to tracking of individual pilots' 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.

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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.

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
		Swift Broadband	Swift64	"Classic" Aero	
Non - ATC Cockpit Voice	4-wire Analog + discretes	X		X	ACD
ATC Cockpit Voice	4-wire Analog + discretes	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 & Packet Data)	CEPT-E1	X	X	X	AISD/PIESD
	ISDN	X	X		
	Ethernet	X	X		
	2-wire Analog POTS/SLIC	X	X	X	

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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).

The threats shall be identified considering each SDU interface in turn. 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 watched closely.

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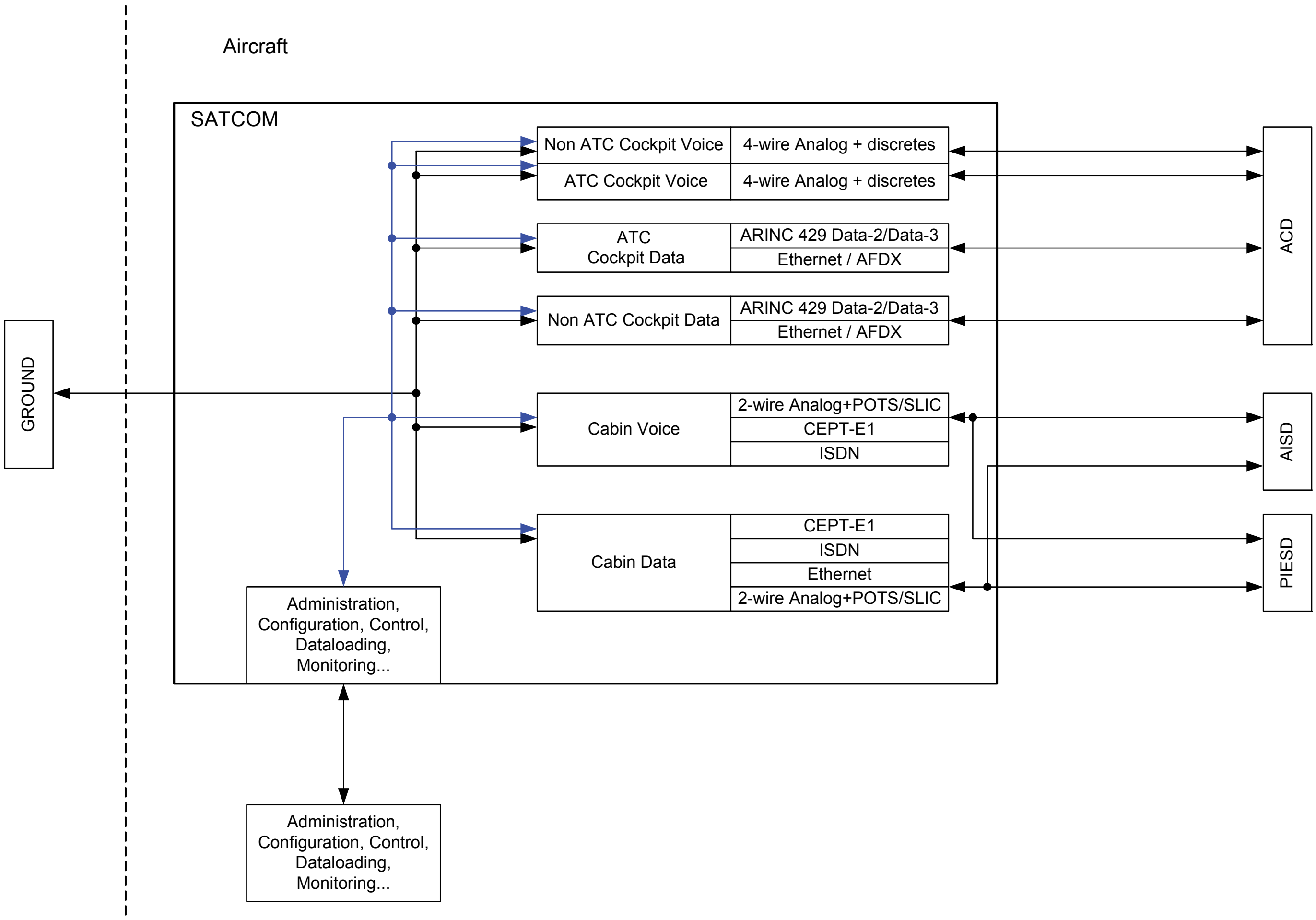

Figure 2

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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

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Threat Identifier	Threat Description	Likelihood	Severity
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
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

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Threat Identifier	Threat Description	Likelihood	Severity
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
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 2. 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.

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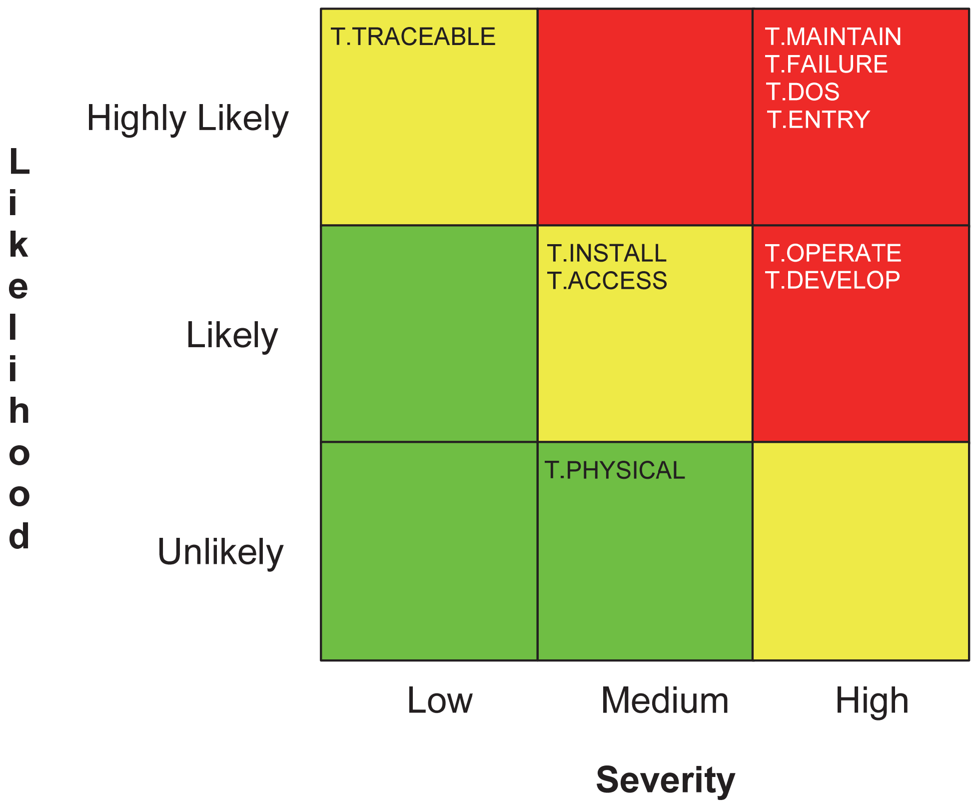

Figure 3

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 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 811.

Table 4 details some of the relevant policies.

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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. *Note*: 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
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.

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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
- 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.
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.

The main objective is to respond to O.SECURE with respect to other objectives as constraints.

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.

Following in Table 7 below are the recommended security controls for ARINC 781 systems that address the major threats identified in Table 3 above.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

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 PIESD. 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
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 shall 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.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

Control	Control Description and Suggested Implementation
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 a 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 a end point of such a communication). T.ENTRY.5
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 support authenticated and encrypted communications to go through satcom with ACD or AISD. As the AGCS Subcommittee is only concerned with the satcom airborne implementation, such communications may not be compatible with the ground installation. Moreover, satcom may not be the only standard IP communication means (as shown in Figure 6), and such authenticated and encrypted communication shall be common to all those means. This is the reason for controls added 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 the Table 3-3 of the main document in the future, cockpit data may be able to use SBB services instead of “Classic” Aero, it shall demonstrate that the 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

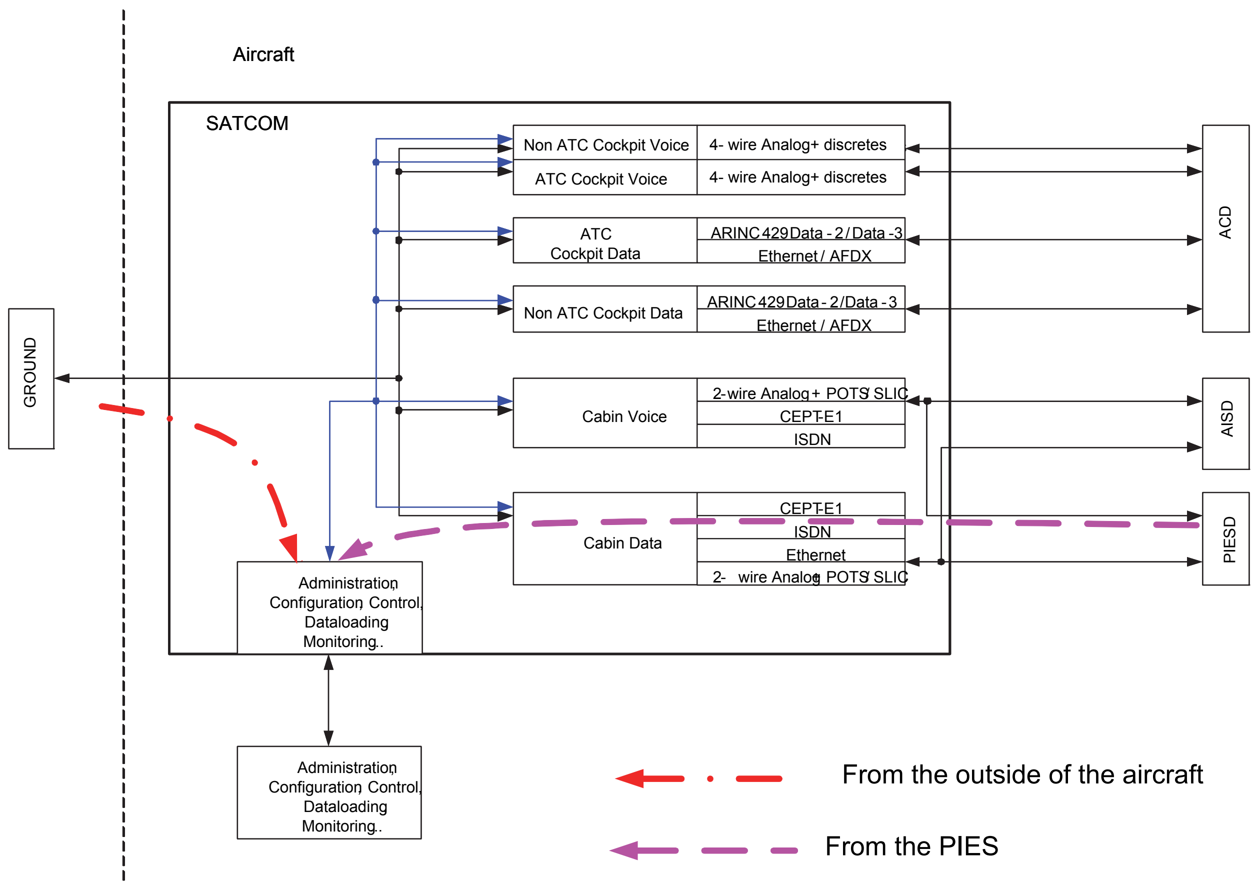

Figure 4 - Integrity

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

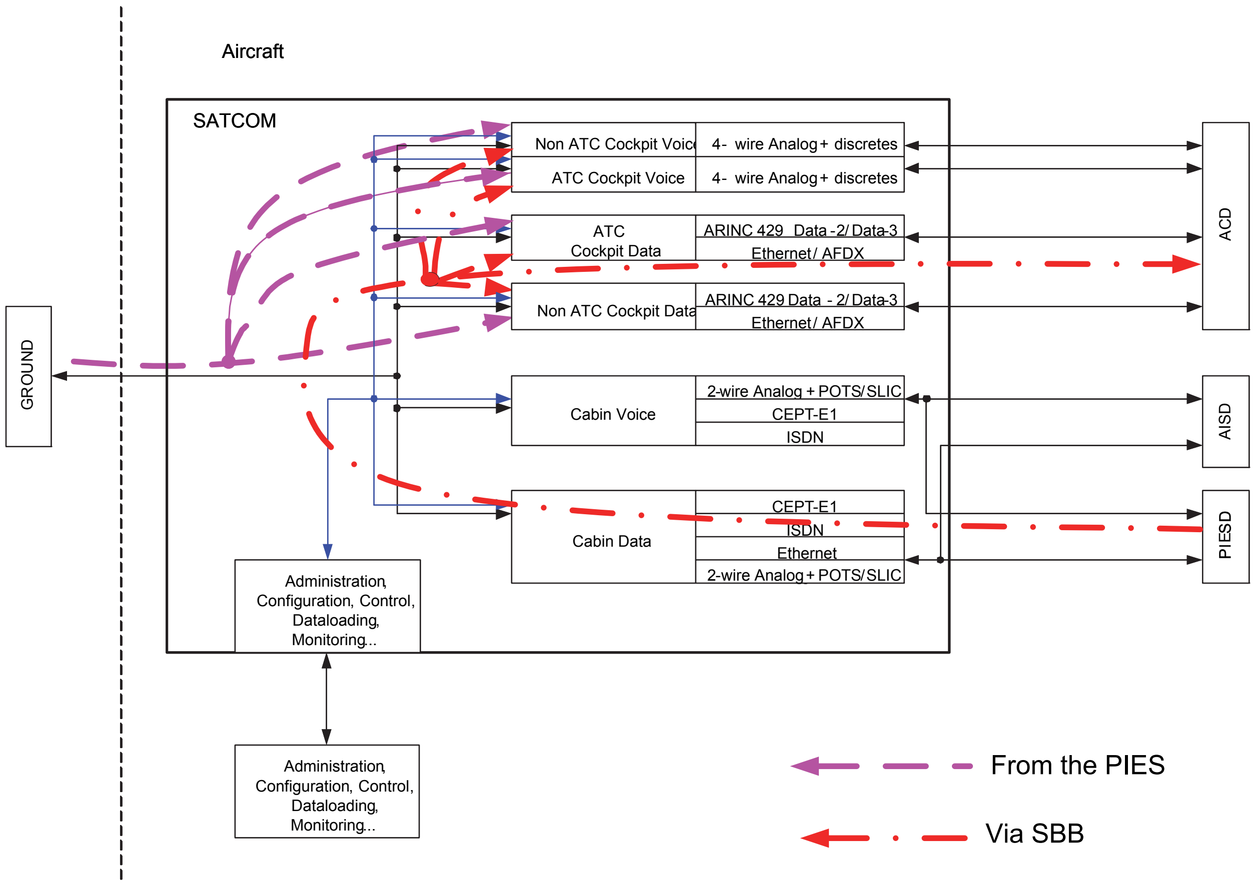

Figure 5 – Protection of the ACD (whatever is the Inmarsat services used)

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

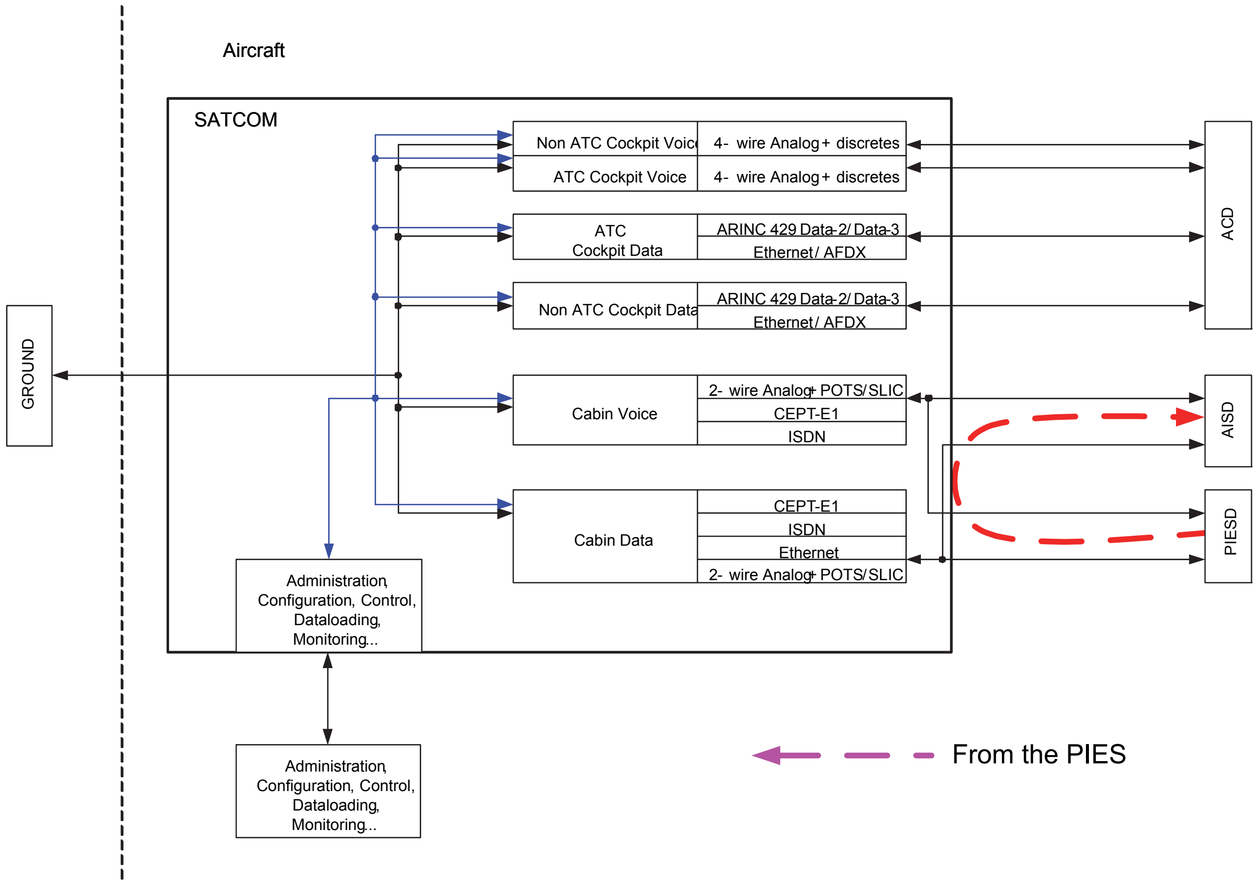

Figure 6 – Protection of the AISD

The next section, “Specific ARINC Report 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 sub-group 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.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

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 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.

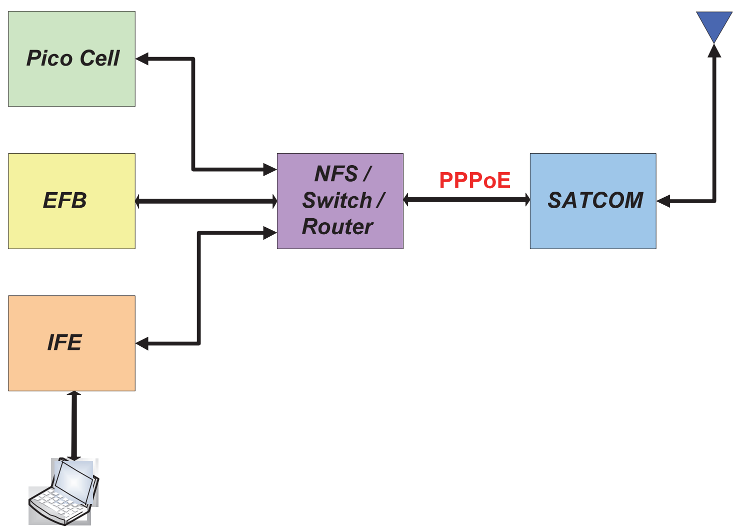

Figure 7

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

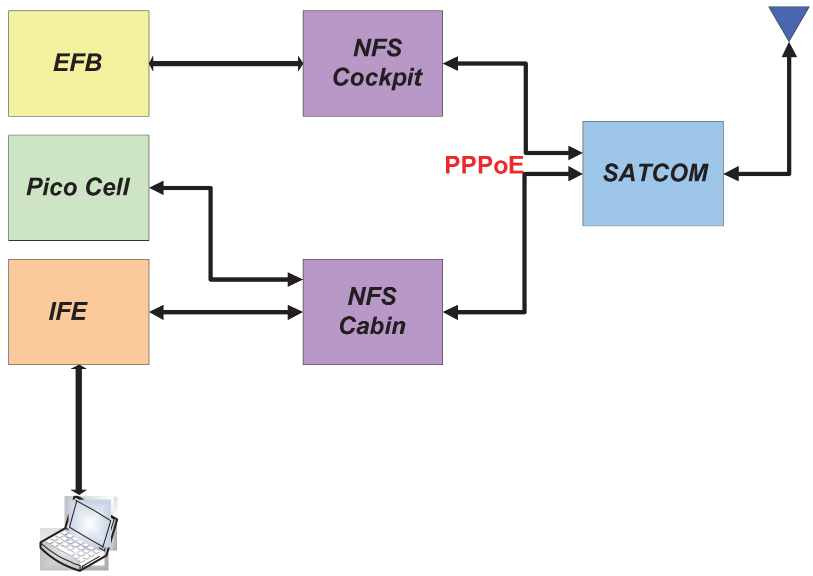

Figure 8

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.

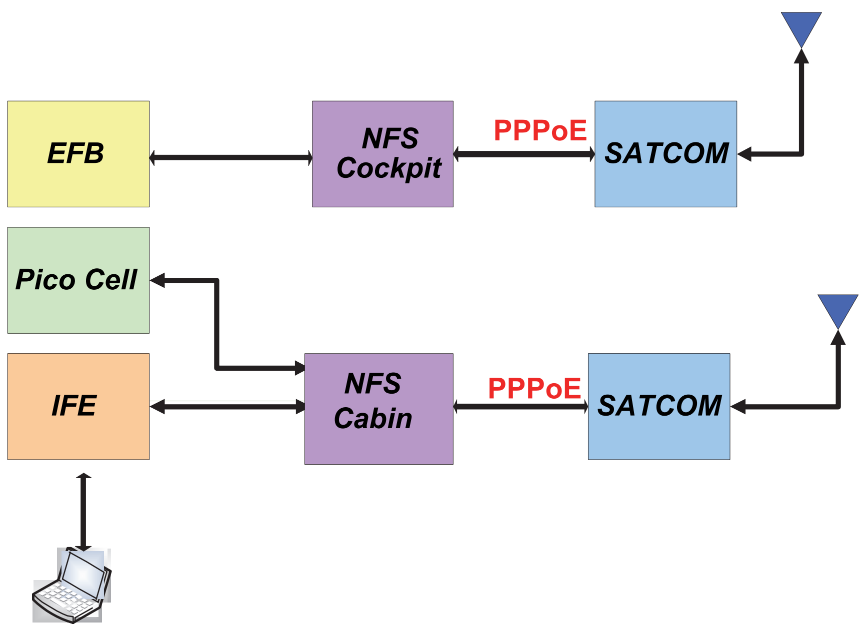

Figure 9

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).

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

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 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 is an area that will be studied further by the AEEC NIS Subcommittee, and will focus on specification of a communications manager function that would be instantiated separately from the NFS/switch/router, and be responsible for securely managing and controlling all offboard links.

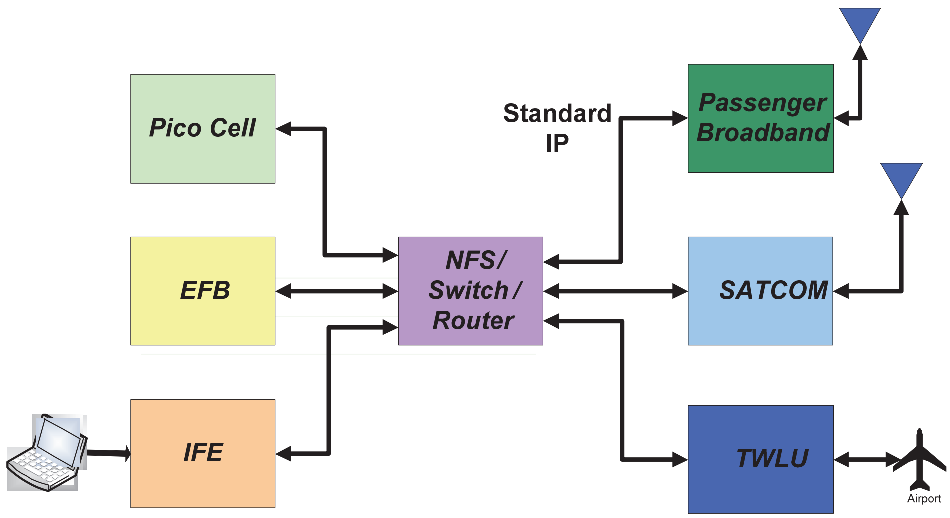

Figure 10

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.

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

B-7 Explanation of terminology used for security categorization

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 “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 discernable 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 some passengers in airline services

APPENDIX B
SECURITY ANALYSIS OF THE SATCOM ETHERNET INTERFACE

“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.
- 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 specified in ARINC429 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 1660.5MHz.
- 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

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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 1.8dB to 1.2dB and 2.1dB to 1.6dB 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 22-35W, and 30-60W 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 51mm 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.

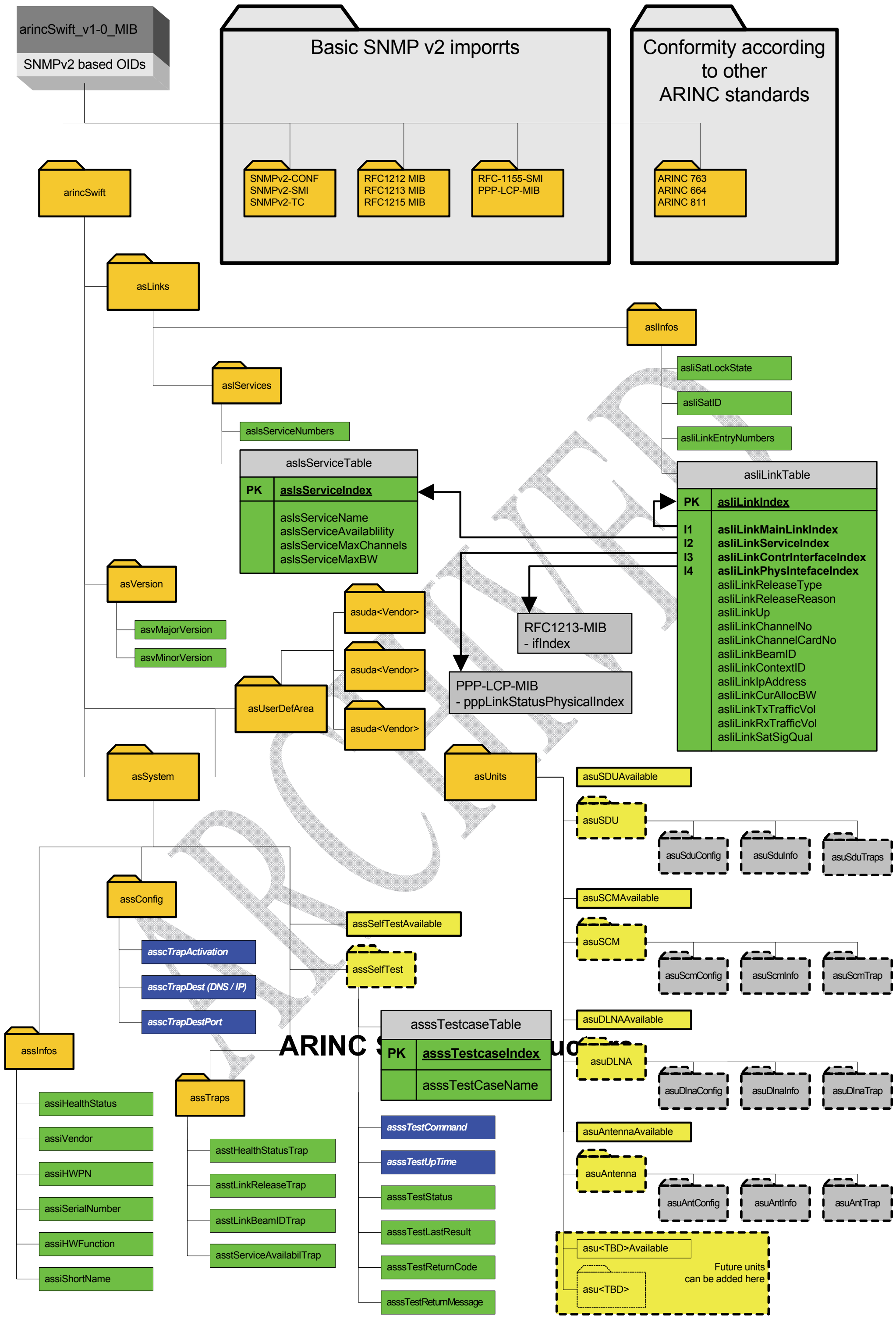
The following material is archived for future consideration and revision.

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.


arincSwift_v1-0_MIB
SNMPv2 based OIDs
Basic SNMP v2 imporrts
Conformity according to other ARINC standards
arincSwift
SNMPv2-CONF SNMPv2-SMI SNMPv2-TC
RFC1212 MIB RFC1213 MIB RFC1215 MIB
RFC-1155-SMI PPP-LCP-MIB
ARINC 763 ARINC 664 ARINC 811
asLinks
asliInfos
asliSatLockState
asliSatID
asliLinkEntryNumbers
aslServices
aslsServiceNumbers
aslsServiceTable
PK aslsServiceIndex
aslsServiceName
aslsServiceAvailablility
aslsServiceMaxChannels
aslsServiceMaxBW
asliLinkTable
PK asliLinkIndex
I1 asliLinkMainLinkIndex
I2 asliLinkServiceIndex
I3 asliLinkContrInterfaceIndex
I4 asliLinkPhysIntefaceIndex
asliLinkReleaseType
asliLinkReleaseReason
asliLinkUp
asliLinkChannelNo
asliLinkChannelCardNo
asliLinkBeamID
asliLinkContextID
asliLinkIpAddress
asliLinkCurAllocBW
asliLinkTxTrafficVol
asliLinkRxTrafficVol
asliLinkSatSigQual
asVersion
asvMajorVersion
asvMinorVersion
asuda<Vendor>
asuda<Vendor>
asuda<Vendor>
asUserDefArea
RFC1213-MIB - ifIndex
PPP-LCP-MIB - pppLinkStatusPhysicalIndex
asSystem
asUnits
asuSDUAvailable
asuSDU
asuSduConfig
asuSduInfo
asuSduTraps
asuSCMAvailable
asuSCM
asuScmConfig
asuScmInfo
asuScmTrap
asuDLNAAvailable
asuDLNA
asuDlnaConfig
asuDlnaInfo
asuDlnaTrap
asuAntennaAvailable
asuAntenna
asuAntConfig
asuAntInfo
asuAntTrap
asu<TBD>Available
asu<TBD>
Future units can be added here
assConfig
asscTrapActivation
asscTrapDest (DNS / IP)
asscTrapDestPort
assSelfTestAvailable
assSelfTest
asssTestcaseTable
PK asssTestcaseIndex
asssTestCaseName
asssTestCommand
asssTestUpTime
asssTestStatus
asssTestLastResult
asssTestReturnCode
asssTestReturnMessage
assInfos
assiHealthStatus
assiVendor
assiHWPN
assiSerialNumber
assiHWFunction
assiShortName
assTraps
asstHealthStatusTrap
asstLinkReleaseTrap
asstLinkBeamIDTrap
asstServiceAvailabilTrap

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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.

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 fax +1 410-266-2047 or standards@arinc.com

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
Document a	*# of mtgs*	*# of mtg days*	*mm/yyyy*	*mm/yyyy*
Document b	*# of mtgs*	*# of mtg days*	*mm/yyyy*	*mm/yyyy*

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

For IA staff use only

Date Received: : Click here to enter a date. IA staff : ____________

Potential impact: ______

*(**A**. Safety **B**. Regulatory **C**. New aircraft/system **D**. Other)*

Resolution: _______

Authorized, Deferred, Withdrawn, More Detail Needed, Rejected)

Assigned to SC/WG:________________

Completed forms should be submitted to the AEEC Executive Secretary.