ARINC

MARK 3 AVIATION SATELLITE COMMUNICATION SYSTEMS

ARINC CHARACTERISTIC 781-1

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> Thomas L. McDonald, Product Marketing Manager, Long Range Communications, Honeywell, Inc., 5353 W. Bell Road, Glendale, Arizona 85308

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ARINC CHARACTERISTIC 781-1

MARK 2 AVIATION SATELLITE COMMUNICATION SYSTEMS

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

FOREWORD

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

Aeronautical Radio, Inc. (ARINC) was incorporated in 1929 by four fledgling airlines in the United States as a privately-owned company dedicated to serving the communications needs of the air transport industry. Today, the major U.S. airlines remain the Company's principal shareholders. Other shareholders include a number of non-U.S. airlines and other aircraft operators.

ARINC sponsors aviation industry committees and participates in related industry activities that benefit aviation at large by providing technical leadership and guidance and frequency management. These activities directly support airline goals: promote safety, efficiency, regularity, and cost-effectiveness in aircraft operations.

The Airlines Electronic Engineering Committee (AEEC) is an international body of airline technical professionals that leads the development of technical standards for airborne electronic equipment-including avionics and in-flight entertainment equipment-used in commercial, military, and business aviation. The AEEC establishes consensus-based, voluntary form, fit, function, and interface standards that are published by ARINC and are known as ARINC Standards. The use of ARINC Standards results in substantial benefits to airlines by allowing avionics interchangeability and commonality and reducing avionics cost by promoting competition.

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 airline 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 the text or diagrams in this ARINC Standard.

An ARINC IA Project Initiation/Modification (APIM) form solicits any recommendations for addition of substantive material to this volume which would be the subject of a new Supplement.

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ATTACHMENTS

1. 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.

1.2. Relationship of this Document to Other ARINC Characteristics 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 AFDX-based ARINC 664 fiber and copper 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 that described by ARINC Characteristic 763.

ARINC Specification 429: *Mark 33 Digital Information Transfer System*

ARINC Specification 600: *Air Transport Avionics Equipment Interfaces*

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

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

ARINC Specification 615A: *Ethernet Based Data loading*

ARINC Specification 618: *Datalink Protocols: Air/Ground Character Orientated Protocol*

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

ARINC Specification 620: *Datalink Ground System Standard and Interface*

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

ARINC Specification 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 (AFDX) Network***

ARINC Specification 665: *Loadable Software Standards*

ARINC Characteristic 724, 724B: *ACARS Management Unit*

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

ARINC Characteristic 746: *Cabin Communications System*

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

ARINC Characteristic 758: *Communications Management Unit*

ARINC Characteristic 763: *Network Server Systems*

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: ***Cabin Equipment Interfaces (CEI) 3rd generation Cabin Management and Entertainment System – Cabin Distribution System***

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

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

RTCA DO-210D: *Minimum Operational Performance Standards for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS) Avionics (up through and including Change 2)*

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 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.

The Inmarsat network consists of: a space segment formed by the Inmarsat-2, Inmarsat-3, and Inmarsat-4 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. 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 satellites are the Inmarsat-4s, which support higher data rate services through the use of a 9 meter satellite antenna and digital beam forming. The coverage area of the satellites are formed through use of a global beam (all satellites), regional beams (Inmarsat-3 and 4) and narrow spot beams (Inmarsat-4 only). The Inmarsat Classic-Aero service is supported through all generations of Inmarsat satellites; the Swift64 service is supported through the Inmarsat-3 and Inmarsat-4 satellites, and the SwiftBroadband service is only supported through Inmarsat-4 satellites. Services offered in a given Ocean Region will operate from a single Inmarsat satellite at any one time.

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

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

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 (1525-1559 MHz for receive and 1626.5-1660.5 MHz for transmit). The system should provide a capability for aeronautical satellite communications requirements external to the aircraft.

The transmit frequency range defined above is likely to be limited by the DLNA transmit filter.

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 Communications (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 individual manufacturers based on their understanding of market needs.

The equipment is optimized to operate with the Inmarsat 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).

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 Characteristic 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 Characteristic 741 antenna subsystems, to allow a simple upgrade path to new **s**atcom services for aircraft that are already equipped with ARINC Characteristic 741 type equipment.

High Gain Antennas (HGAs), and Intermediate Gain Antennas (IGAs) are defined in this characteristic. Low Gain Antennas (LGAs) will be defined in a later supplement of this document.

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 via, e.g., 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.

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 EIRP within required limits. The HPA may be used in installations where the expected cable loss between the SDU power amplifier output and antenna input is greater than the allowable cable loss. The HPA may be located near the respective antenna to assure minimum loss of energy at the RF operating frequency and to avoid excessive thermal dissipation in the HPA.

1.6.4. Diplexer/Low Noise Amplifier (DLNA)

The Diplexer and 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 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.

ARINC 781 installations that provide SwiftBroadband services require the use of a Type D **DLNA**. See Section 2.2.4.3.

1.6.5. Low Gain Antenna (LGA)

LGAs are omnidirectional, do not require a steering command, and provide a nominal gain of 0 dBic. LGAs will be described in a future supplement.

1.6.6. Intermediate Gain Antenna (IGA)

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

1.6.7. High Gain Antenna (HGA)

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

1.7. System Performance

1.7.1. Transmitter Equipment Performance

The following table provides an indication of EIRP required per RF carrier to support various Inmarsat services.

Table 1-1 - Aircraft EIRP (dBW)

		Inmarsat 3 Satellite		Inmarsat 4 Satellite		
		Global beam	**Spot beam**	**Global beam**	**Regional beam**	**Spot beam**
1200	R, T	9.1	-	9.1	-	-
10500	R, T	20.4	17.1	20.4	15.1-13.1	-
8400	C initial	18.5	14.5	18.5	12.5-10.5	-
21000	C initial	19.5	-	19.5	-	-
Swift64		-	22.5	-	20.5-18.5	-
SwiftBroadband	LGA	-	-	-	-	[TBD]
SwiftBroadband	IGA	-	-	-	-	15.1
SwiftBroadband	HGA	-	-	-	-	20.0

Notes:

1. Inmarsat has not yet (mid 2005) finalised I4 regional beam classic EIRPs. They are anticipated to be lower than the I3 spot beam values by around 2 to 4 dB. The values above reflect saving of between 2 dB and 4 dB.

2. As an example, 2 x SwiftBroadband channels, 2 x 8400 regional beam C-Channels, and 1 x 10,500 regional beam R/T Channel operating on an Inmarsat 4 satellite require 30W RF power at the SDU output assuming 2.5 dB SDU to antenna loss, a 12 dBic antenna, and the upper values specified in the above table.

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 outputs its 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 sub-system, 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. These are minimum values with a sky temperature of 100 K. For a switched beam antenna this example corresponds to the main beam for any pointing angle.

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

The above values for G/T should be 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 aircraft antenna.
- With residual antenna pointing errors (including the effects of errors introduced by the antenna beam steering system).
- Including the noise contribution of the complete RF subsystem including antenna and low noise amplifier, at a temperature of 290 K.
- With the transmitter power amplifier **under all possible operating conditions including multicarrier operation and taking into account of any associated active and passive intermodulation effects and spurious signals caused by interaction of carriers from any Inmarsat service.**
- Including the loss and noise temperature contribution of a radome, where a radome is fitted.

Under the operational RF environment; e.g., when the receive antenna is illuminated in its operating bandwidth (34 MHz) by a total RF flux density of -100 dBW/m2 the receiver system performance is intended to provide a bit error rate (BER) of $1x10^{-5}$ 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

The ARINC Characteristic 781 Aviation Satellite Communications System comprises two major sub-systems 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 sub-systems and unit interchangeability, also defined in the above-referenced ARINC Report, is desired for the individual units. The first major sub-system comprises the SDU and the SCM. The second is the antenna sub-system, comprising two LRUs: the antenna with its integrated beam steering function, and the **DLNA**. Interchangeability is also desired for the **external flange mounted** HPA.

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 Characteristic 741 type HPA.

Additional interchangeability standards may be found in Section **2** of this Characteristic.

COMMENTARY

Even though the overall satellite system avionics suite comprises sub-systems 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 sub-system 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. 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.

2.2. Form Factors, Connectors and Index Pin Coding

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 **receptacle 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.

The SDU maximum total RF output power should be no more than 80 W (average, not peak envelope).

Note: The purpose of the output power limit is to protect the antenna.

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.

<u>Existing Classic Aero services and Swift64</u>

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°/dB and at a rate not exceeding 30°/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 – Note 1		**SwiftBroadband services – Note 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)	-30 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, 12-18 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 1-1 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.

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 1-1.

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.

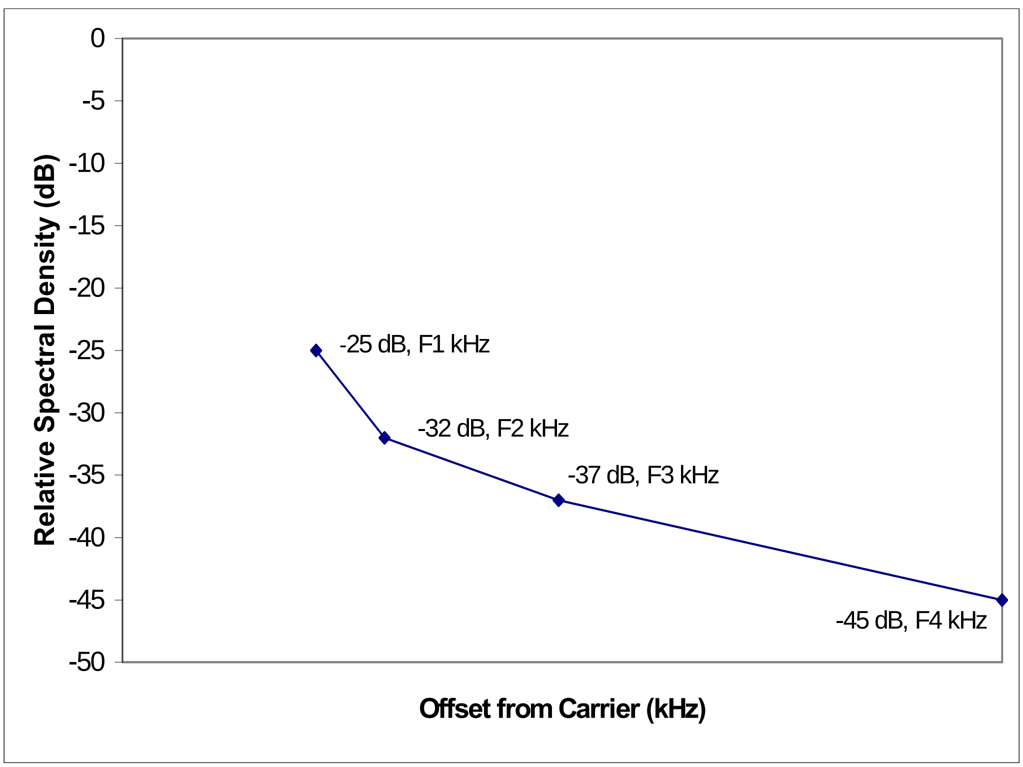


Figure 2-1 - Spectral Regrowth Envelope

Table 2-2 – Spectral Regrowth

Fx	Relative Spectral Density	Offset from Carrier for Different Channel Types			
		T0.5 Data rate 16.8 kS/s	T1.0 Data rate 33.6 kS/s	T2 Data rate 67.2 kS/s	T4.5 Data rate 151.2 kS/s
	[dB]	[kHz]	[kHz]	[kHz]	[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 type D **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 1513-1525 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 Characteristic 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: Under these conditions, the SDU should deliver not less than 80% of the rated output power (measured in watts) to the load and meet all other performance characteristics. 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 characteritics 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 1.5 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.

The nominal output power of this device should be 30W to ensure that the form factor can be met with minimal weight. The flange-mounted HPA design includes an internal plenum to allow for a flexible hose attachment for additional cooling purposes. View A-A in attachment 1-7 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 10W and informs the SDU of it being in such a mode. The figure of 10W has been identified as the required rated output of the amplifier that would facilitate minimum services of 1 x P-Channel and 1 x C-channel, or 1 x SwiftBroadband

channel (on the basis that the flange-mounted HPA is designed to be close to the antenna subsystem resulting in a less than 2.5 dB loss).

Additionally, the use of cooling fans is discouraged, but it is acknowledged that some installations may require this to aid in the cooling of this device. A 3-inch clearance at the top, bottom and heatsink sides should be provided to facilitate the passively cooled nature of this design.

Continuous operation at the nominal 30 W output power 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 only request 10W or less to retain cockpit functions in instances where the ambient temperature is at an extreme.

The form factor and connector pin out arrangement are shown in Attachment 1-7.

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 429 characteristic 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. RF characteristic for external flange mounted HPA

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 nominaly +5 dBm to +15 dBm (when the HPA is delivering full power) with a maximum value of +20 dBm. The HPA RF characteritics should be such that when driven by the SDU, the HPA meets the requirements defined in Section 2.2.1.4.

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**)

2.2.4.1. **DLNA** VSWR

The VSWR of the **DLNA**'s antenna-port and transmit-port (TX) should be 1.3:1 maximum. The **DLNA**'s 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 1.8 dB at temperatures below 25° C. The noise figure may increase with temperature to a maximum of 2.1 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. Type D **DLNA**

COMMENTARY

In August 2005, the AGCS subcommittee reached consensus on an improved **DLNA** specification to provide additional protection to GNSS and Iridium. The resulting **DLNA** is referred to as a Type D **DLNA** in this document, and has the same characteristics as a Modified Type A **DLNA** (reference ARINC Characteristic 741, Section 2.2.4.3.3) but with changes to the transmit port to antenna port rejection. **Subsequently in April 2006, the receive passband and the corresponding 120 dB rejection in the transmit port to receive port was changed from 1530-1559 MHz to 1525-1559 MHz. This change achieves alignment with the Type B DLNA. Additional requirements were also added to the transmit port to antenna port insertion loss at ambient and low temperature.**

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

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 DLNA's operating temperature range.

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

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

2.2.4.3.3. 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

2.2.4.4. 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 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.

2.2.4.6. DLNA Form Factor

See Attachment 1-8 for the form factor of the **DLNA**.

2.2.4.7. 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.

2.2.4.8. 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 form-factor, shape of mechanically steered antennas. Providers of mechanically steered antennas should comply with the performance characteristics, the A429 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 sub-system 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 centre 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-handed 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 and **DLNA** should perform such that, with a receiver having a noise figure as described in Section 2.2.1.4.6 connected at the interface at the SDU, an overall receive system figure of merit of at least -13 dB/K is achieved under all conditions (including pointing angle over the receive frequency band) with transmit power up to 60 watts (i.e., 17.8 dBW) at the HGA RF connector.

COMMENTARY

HGA noise temperature should be measured under clear sky climatic conditions on a ground plane representative of HGA mounting on the aircraft, and with the HGA protective radome in place, if part of the HGA installation.

The -13 dB/K G/T figure of merit should be met at room temperature (i.e., 290 K), for a coverage volume as specified by the antenna manufacturer. At elevated temperatures the G/T may decrease, reducing the coverage volume over which the - 13 dB/K figure is met.

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 s 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 CCIR 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 0.5dB 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, when operating with two unmodulated carriers, each with a power of 8dBW, anywhere between 1629.5 and 1660.5 MHz, the antenna should not generate seventh and higher order intermodulation products in the receive band greater than -163 dBW.

COMMENTARY

The antenna intermodulation requirements to protect the satcom receive band are based on a degradation of 6% to the system noise figure (i.e., $\Delta T/T=6\%$) and 20 dBW EIRP, 12 dBic antenna. An interference bandwidth of 192 kHz is assumed, which is equivalent to a ninth order intermodulation product formed by 5xSBB – 4xClassic bearers.

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 1629.5 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 DO229C using the curve for

"Terminal area, enroute & acquisition for all," and assuming a safety margin of 6 dB and a multiple equipement 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-handed circular. The definition of CCIR 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 and **DLNA** should perform such that, with a receiver having a noise figure as described in Section 2.2.1.4.6 connected at the interface at the SDU, an overall receive system figure of merit of at least -19 dB/K is achieved under all conditions (including pointing angle over the receive frequency band) with transmit power up to 30 watts (i.e., 14.8 dBW) at the IGA RF connector.

COMMENTARY

IGA Noise temperature should be measured under clear sky climatic conditions on a ground plane representative of IGA mounting on the aircraft, and with the IGA protective radome in place, if part of the IGA installation.

The -19 dB/K G/T figure of merit should be met at room temperature (i.e., 290K), for a coverage volume as specified by the antenna manufacturer. At elevated temperatures the G/T may decrease, reducing the coverage volume over which the -19 dB/K figure is met.

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.

2.3.3.5.8. 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 2.3.3.5.1).

2.3.3.5.9. 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.

2.3.3.5.10. 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 CCIR 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, when operating with two unmodulated carriers, each with a power of 9.1 dBW, anywhere between 1629.5 and 1660.5 MHz, the antenna should not generate seventh and higher intermodulation products in the receive band greater than -163 dBW.

COMMENTARY

The antenna intermodulation requirements to protect the satcom receive band are based on a degradation of 6% to the system noise figure (i.e.: $\Delta T/T=6\%$) and 15.1 dBW EIRP, 6 dBic antenna. An interference bandwidth of 192 kHz is assumed, which is equivalent to a ninth order intermodulation product formed by 5xSBB – 4xClassic bearers.

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 1629.5 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 DO229C using the curve for "Terminal area, enroute & acquisition for all", and assuming a safety margin of 6 dB and a multiple equipement margin of 6 dB. The satcom intermodulation assumes 15.1 dBW EIRP, 6 dBic antenna and interference bandwidth between 100kHz and 1MHz.

2.3.4. Low Gain Antenna

The LGA characteristics will be defined in a future supplement.

2.3.5. Coaxial Cable Losses

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. 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

2.3.5.3. 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 units which, when installed on an aircraft, should provide satcom services in accordance with systems specifications presently being formulated.

When designing a specific installation, specific care should be taken to ensure that the DLNA-to-antenna cable and connectors do not produce intermodulation products at levels higher than those specified for the antenna. This should influence the choice of connectors and the cable type. Care should also be taken with the metal to metal fixings between the antenna and aircraft skin.

If intermodulation products are not controlled and they fall "in channel" (which will depend on the actual RF frequencies of the Inmarsat transmit and receive carriers), then there could be significant interference to either GPS or the Inmarsat receivers.

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	Loss of Cooling Mode (refer to Section 2.8.1.)
SDU	255 VA max	[TBD] **validation still in progress**
Antenna	50 VA max	50 VA max
External HPA	**200 VA max**	**105 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 Document 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.

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**." **I**f 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 flange mounted HPA should be designed to accept, and airframe manufacturers should configure the installation to provide, forced air-cooling as defined in Section 4 of ARINC Specification 628. The airflow rate provided to the 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 flange mounted HPA should be 51 ± 5 mm of water at this rate. The flange mounted HPA should be designed to dissipate less than 170 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 flange mounted HPA may be lost. The 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 flange mounted HPA should auto-bias itself to a lower rated output (30 W nominal down to 10 W) to ensure that the heat dissipated can be passively cooled so that service is still maintained for cockpit and some basic cabin services. The heat**

dissipation target should be less than 95 W. 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.

In addition to the above requirements, the flange mounted HPA should be capable of 10 W rated output operations at 35 C° ambient, with a pressure altitude of up to 25,000 ft.

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 Specifications 429 and 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 Specification 627:** *Programmers Guide for SMART® Systems using ARINC 626 ATLAS*.

3. 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, 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.

3.0 SATCOM FUNCTIONS

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.

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 aero service.

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).

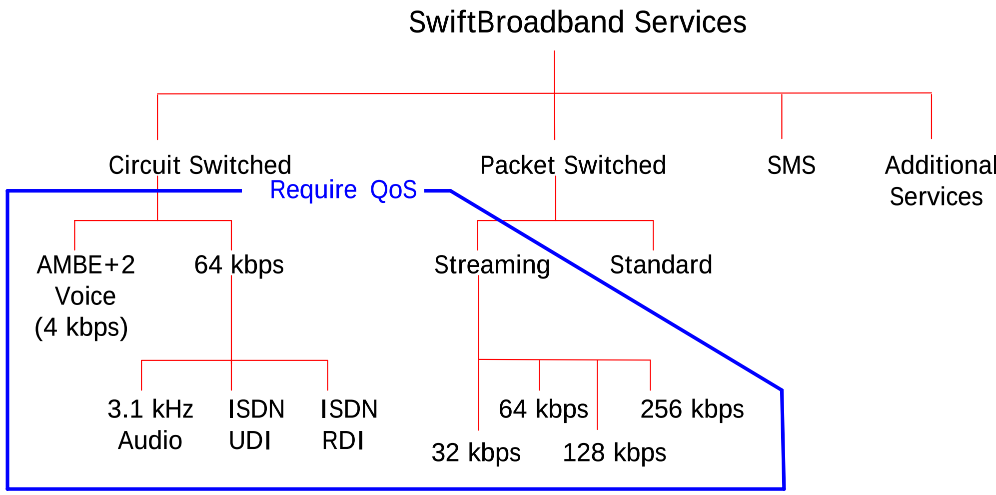
MPDS uses 33.6 kilo symbols per second (kSym/s) 16 QAM carriers for aeronautical users with a fixed coding rate in both forward and return directions. RF channels are multiplexed – that is they carry both signaling and traffic and are shared between users. MPDS uses power control of the RF carriers in 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 service capability is described in Section 1.3 and summarized in the figure below:



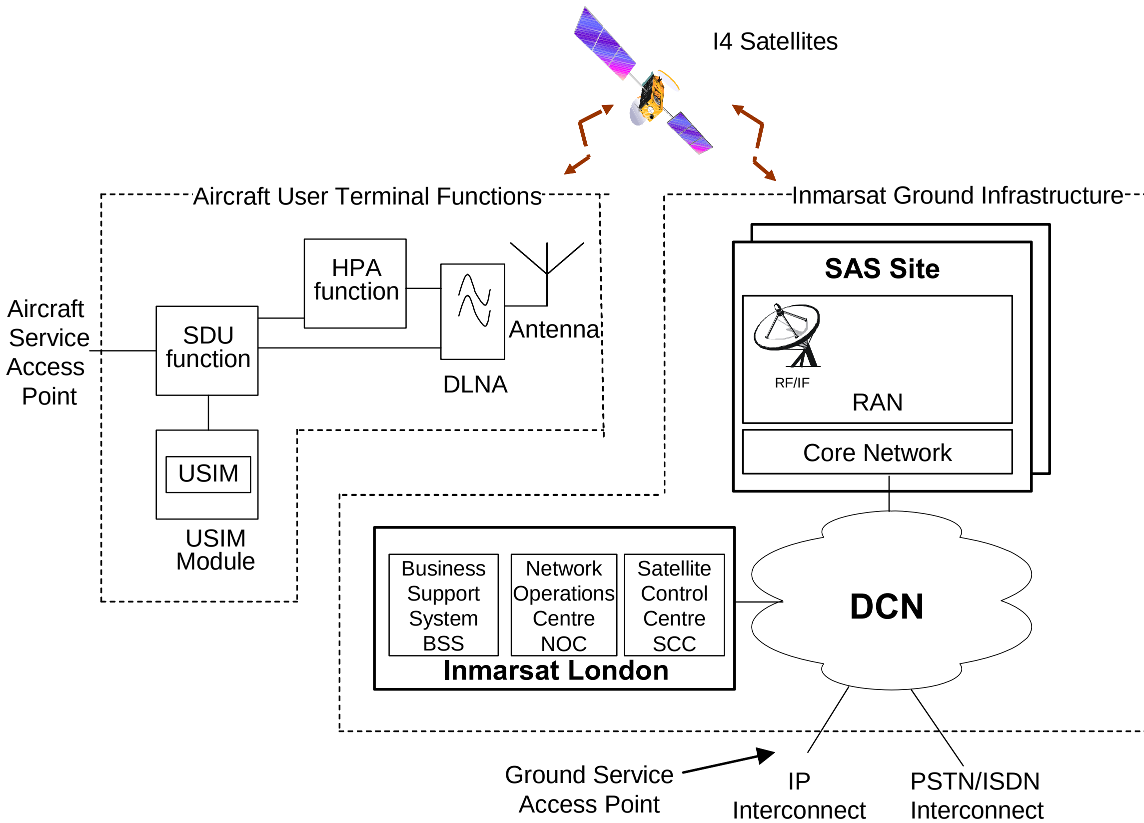
Multiple packet switched services and one circuit switched service are available at a time to a terminal. Circuit switched and streaming class services are delivered to a user via dedicated bandwidth (using Quality of Service (QoS) mechanisms in the network). The available streaming rates to a user depend on terminal class, elevation to satellite and link conditions.

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 only one difference: SwiftBroadband has a proprietary satellite radio interface ("IAI-2") instead of the terrestrial WCDMA radio interface.

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 BGAN (Broadband Global Area Network) 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 Centre (NOC), the Satellite Control Centre (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). Each satellite is typically supported by two SAS. Inmarsat sell 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.

3.0 SATCOM FUNCTIONS

The overall architecture is shown below.



Two types of Aircraft Terminal are defined being Class 6, which utilizes a High Gain Antenna and Class 7, which utilizes an Intermediate Gain Antenna. An aircraft user terminal (UT) supports one transmit and one return RF channel. An ARINC 781 AES can contain 1 or more Swiftbroadband UTs.

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 1dB 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 the figure below.

	Forward		Return			
	QPSK	QAM	QPSK		QAM	
Symbol Rate/33.6 k	80 ms		5 ms	20 ms	5 ms	20 ms
0.25	Y					
0.5				Y		
1.0	Y	Y		Y	Y	Y
2.0			Y	Y	Y	Y
4.5		Y	Y	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 does not (currently) support priority and preemption.

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:

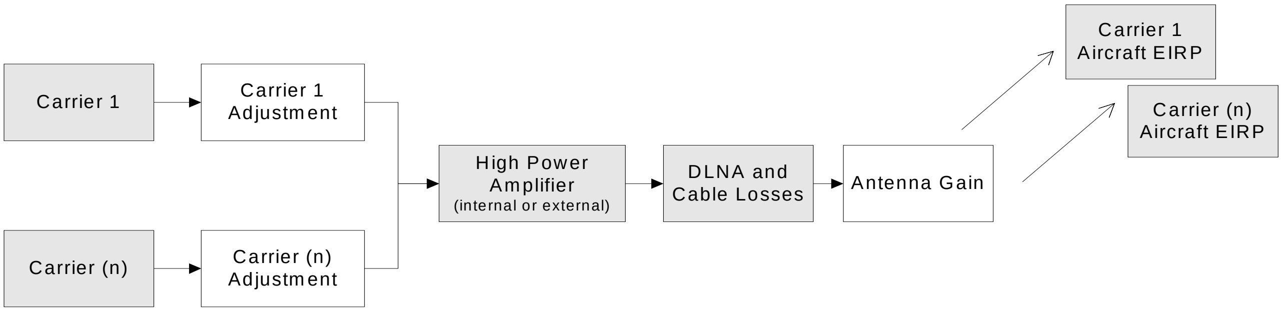
- Maintain the Aircraft EIRPs for established carriers.
- Determine the availability of RF power for additional RF carriers.
- Maintain the HPA within its operating limits (e.g., to satisfy intermodulation products requirements).
- Ensure reservation of power for on-demand transmissions, (e.g., Classic 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).



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 SBB 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 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 intermodualtion 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 are allocated such that any combination of R, T, and C channels does not produce 3rd and 5th order intermodulation products at frequencies below 1610 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 stations' database and is entered into the database during the terminal registration process:

- Category A allocations may be at any frequency in the assigned band.
- Category B allocations are 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.

COMMENTARY

At the July 2006 AGCS/RTCA SC-208 meeting, it was agreed that the SDUs frequency check should be either 1605 MHz (to protect GPS and GLONASS) or 1585 MHz (to protect GPS), depending on aircraft GNSS equipage. Consequently, it is expected that Inmarsat will propose new definitions of Category A and

Category B for Swift64 terminals together with a transition timetable.

3.1.2.4.3. Frequency Management in the AES

1. **If the AES supports SwiftBroadband, a Type D DLNA must be fitted, and no frequency checks are required in the SDU for the SwiftBroadband channel assignments.**
2. **If the AES supports R, T and C channels, frequency checks must be carried out regardless of the type of DLNA fitted. The frequency check algorithm in the SDU must ensure that any combination of R, T and C channels does not produce 3rd or 5th order intermodulation products at frequencies of f_{limit} and below.**

Note: The above requirement is not strictly technically necessary if a Type D DLNA is fitted, but it ensures compatibility between the AES and ground stations as well as alignment with RTCA DO-210D.

3. **If the AES supports Swift64 and a Type D DLNA is fitted, then no frequency checks are required for the Swift64 channel assignments. The SDU determines the type of DLNA using the SDU system configuration pins or the ORT.**
4. **If the AES supports Swift64 and a non Type D DLNA is fitted, then frequency checks must be performed. The frequency check algorithm in the SDU must ensure that any combination of Swift64, R, T and C channels does not produce 3rd or 5th order intermodulation products at frequencies of f_{limit} and below.**

If a frequency check fails, then the SDU must not transmit on the newly assigned frequency. Note that no recovery mechanism is specified.

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

If $3F_L - 2F_H \leq f_{limit}$ then the new frequency assignment must not be accepted by the SDU.

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.

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 the table below. This is a superset of interface capabilities and a specific SDU may have only a subset of these.

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[2]	F[1]					Y[2]	
ATC Cockpit Voice	4-wire Analog + discretes		F	F[1]					Y[2]	
Cabin Voice	2-wire Analog POTS/SLIC		Y	F[1]			Y		Y	
	CEPT-E1		Y	F[1]			Y		Y	
	ISDN		Y				Y		Y	
Non – ATC Cockpit Data	ARINC 429 Data-2 / Data-3									Y[3]
	Ethernet / AFDX	Y		Y	Y	Y		Y		F
ATC Cockpit Data	ARINC 429 Data-2 / Data-3									Y[3]
	Ethernet / AFDX	F		F	F					F
Cabin Data (inc. 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. Would require Voice over IP (VoIP) conversion within the SDU.
2. Expected combination for cockpit voice.
3. Expected combination for cockpit data.
4. Expected combination for (digital) cabin voice (eg GSM) and data (wired or Wi-Fi).

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, I3 spot, I4 regional spot, I4 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
- SBB 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: Inmarsat-3, Inmarsat-4, 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

There are two modes of satcom voice operations: SAT Phone (Sections 3.2.1.6 and 3.2.1.7) and SAT Radio (Section 3.2.1.8). The former describes Satellite communications by way of a telephony service to AOC and ATS. The SAT Radio feature is a new concept of operations whereby Satellite communications operates in a similar manner to a VHF radio.

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. Three 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
- SAT Radio using Inmarsat SwiftBroadBand services

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 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 & certification and pages that can be defined by the equipment manufacturers.

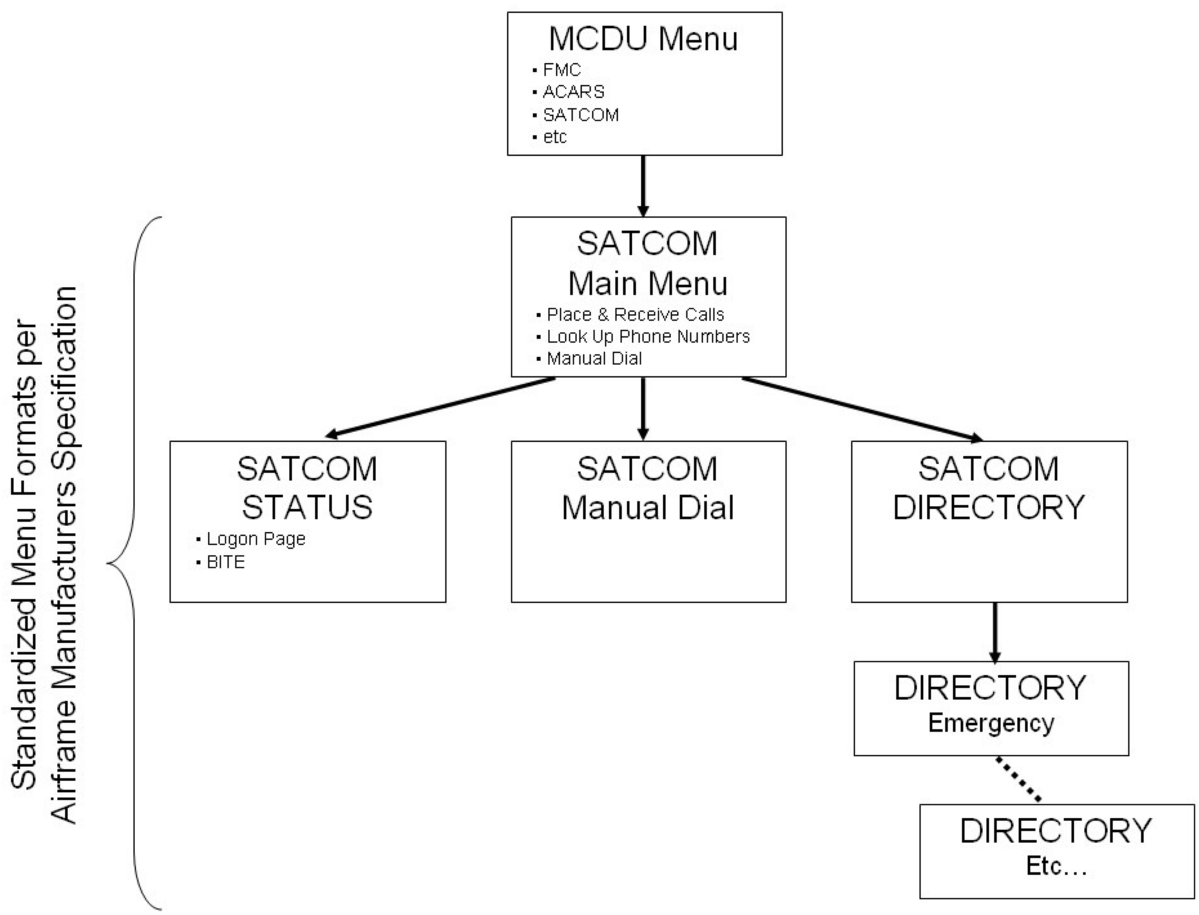


Figure 1 - Diagram depicting the menus that are expected to have airframe manufacturer specific definitions all other menus may be described by the individual avionics manufacturers

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 (eg: 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 Characteristic 739 and 739A MCDUs/SCDUs or ARINC Characteristic 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 is responsible for connecting the flight deck audio to each of the satcom voice channels. The electrical characteristic out of the SDU is analog balanced 600 ohm circuit at a nominal 10 milliwatts RMS, capable of driving an unbalanced load. The input is a “carbon microphone” interface, the same as the VHF radio (see Section 3.7.4 of ARINC Characteristic 716). Sidetone and noise insertion levels are provided by the SDU.

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

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 1-4 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 kbit/s or 4.8 kbit/s 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:

- Multistroke 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

Call Initiation State

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

Ground to Air Connected State

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

Connected State

The SDU enters the connected state and voice is connected in both ground to air and air to ground when any of the following signals are received by the SDU:

a. **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.)**

b. **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.**

c. **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

Inmarsat also offers the 4 kbit/s AMBE+2 codec for SwiftBroadband services. These circuit mode voice calls do not currently have priority and preemption in the ground segment, so caution must be applied, as the cockpit will not have the ability to have a higher priority than callers on the ground & cabin. The SDU however, can be designed to pre-empt cabin calls currently in progress on the same aircraft.

The pilot input method for placing a 4 kbit/s AMBE+2 call on SAT Phone from the MCDU should be no different to that when placing an Aero-H+/H/I voice call. The only feature lacking as stated before should be the absence of the ability to select a higher priority call than users outside of their own aircraft. Based on this, Ground to Air calls should be barred.

Since the 4 kbit/s AMBE+2 codec has not been approved by the certification authorities for use with ATC, cockpit voice use over SwiftBroadband is currently limited to non safety, business-regional & Military/Government operations and should not be used as a basis to qualify for dispatch requirements for situations requiring the use of satcom voice.

SDU manufacturers must note that if the core modules of SwiftBroadband channel cards are COTS software, then appropriate partitioning and qualification of software is required for interfacing to the cockpit system. Design level assurances must be satisfied per DO-178B. In particular, the software in charge of the call control must be qualified to a suitable hazard level and follow the procedures described in Section 3.2.1.

3.2.1.8. SAT Radio

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 trade off 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.

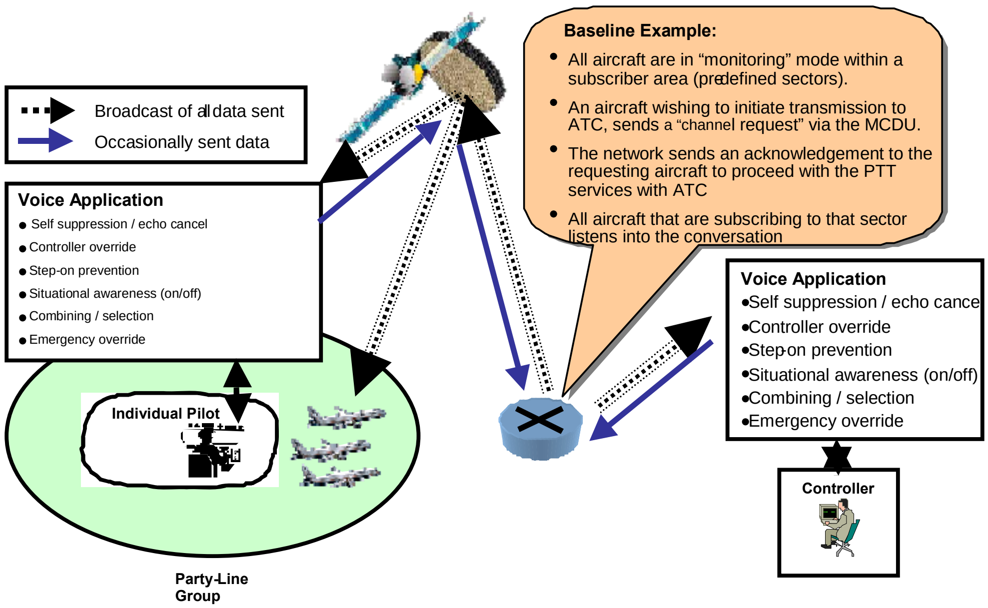


Figure 2 - Baseline Operational Concept for SAT Radio

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 Data

An ARINC 429 data bus provides communications between the satcom system and the ACARS MU/CMU system.

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 SwiftBoadband 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.

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 SwiftBroadband Circuit Switched service, SwiftBroadband Packet Switched service, Swift64 Mobile ISDN and Swift64 MPDS services as well as retrieving SDU status.

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 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,
- 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 & circuit 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. 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.
  - 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 the ground network. Secondary context traffic is supported via the PPPoE session of the parent primary and shares the parent's IP address.

  Note: SBB supports up to 11 total contexts per channel (ie 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 (& 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 SDU's 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 SBB channels) on one (or more) Ethernet interface.

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 SBB/S64 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 SBB/S64 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.

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, SBB 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 SBB/S64 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 busses (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 SBB/S64 operations. The SBB/S64 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 can not 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 can not read a valid User ORT from the SCM, then the SDU should (a) use the default User ORT, (b) declare a failure (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 (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 the table below for 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.

<u>ORT Section A: Log-on Parameter Configuration</u>

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.

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

1. Ethernet port 1 configuration
    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.

2. Ethernet port 2 configuration
    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.

3. Quadrax Ethernet port 3 configuration
    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.

4. Quadrax Ethernet port 4 configuration
    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.

5. Spare Ethernet port configuration
    a. Connected
    b. Not connected
6. Fiber Ethernet port 8 configuration
    a. Connected
    b. Not connected
7. Fiber Ethernet port 9 configuration
    a. Connected
    b. Not connected
8. Fiber Ethernet port 10 configuration
    a. Connected
    b. Not connected
9. Fiber Ethernet port 11 configuration
    a. Connected
    b. Not connected
10. Fiber Ethernet port 12 configuration
    a. Connected
    b. Not connected
11. IP Settings
    a. IP address for LAN
    b. Subnet mask for LAN
    c. Default gateway for LAN
    d. MAC addresses
    e. DHCP
        1. Enabled
        2. Disabled
    f. Host Name
12. PPPoE Settings
    a. PPPoE concentrator (AC) name
    b. Default PDP parameters
    c. Default Service Name Mapping

13. Telnet access (control function)
    a. Enabled (include user name/password)
    b. Disabled

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)

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 + Type D D/LNA
   b. ARINC 781 IGA + Type D D/LNA
   c. LGA + D/LNA + 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. Reserved

6. Position reporting

   a. Enabled
   b. Disabled

7. Reserved

8. Minimum initial EIRP for Swift64

9. Weight on wheels input polarity

   a. Ground on pin TP7D = Aircraft on ground
   b. Ground on pin TP7D = 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.

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.

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 services 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.

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. 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

Due to the dual- use nature of the satcom system, i.e., for both cockpit and cabin, there is a need to demonstrate that the functions (shared or independent) contained within the SDU can be isolated and withstand potential threats, in an open networked environment. The security risks associated with the security of the satcom system include (1) loss of satellite communications and (2)/loss of continued safe operation of the aircraft. There are three main considerations to be addressed when designing integrated security mechanisms for the SDU:

- **Identification of Threats;**
- **Plan for Mitigation Criteria;**
- **Implementation of Functional Segregation.**

For further guidance into regarding the security considerations, refer to the recommendations of **ARINC Report 811:** *Commercial Aircraft Information Security Concepts of Operation and Process Framework* and any **other** applicable regulation**s**. **Guidance from specific a**irframe **m**anufacturers should also be sought.

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 manners, from the alteration of MAC (Layer 2) & IP (Layer 3/4) addresses to assuming complete and valid source code that does more than just operate the SDU normally.

Malicious Software:

This threat could lead to unpredictable behavior of the satcom system, including the generation of misleading or erroneous information.

Denial of Service:

When realized, the cabin function portion of satcom could be commanded to be in exclusive use and prevent cockpit functions from operating correctly.

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 source of data, 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.

Malicious Software:

The SDU must be capable of at least two means of mitigation to this threat. The first means is to reasonably prevent malicious software from entering the SDU; the second is being able to detect and address errant behavior. The suggested implementation methods are described in the proceeding sections; however, the main examples to consider are the inadvertent execution of applets and macros that could launch code to perform a variety of unintended effects within the SDU or other systems to which it interfaces. If the SDU cannot process such applets or macros, 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. Consult ARINC Report 811 for guidance with regard to incident reporting.

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 a cabin user is under attack, e.g., by a constant barrage of pop-up ads. 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 and not be subject to buffer overruns. 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.

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 system and the second is cockpit-only is an example of functional segregation based purely on physical separation and the former having no interfaces to the cockpit systems. For satcom systems that do provide both cockpit and cabin services, there is also a need to show a similar type of 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 "domain" is the facility to delineate circuitry or software code and claim valid equivalence to separation within the same housing. Examples can include a channel card being dedicated solely for cabin use, but being contained within the same SDU housing. The software controlling this individual card is then partitioned into a domain. The domains 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 domain would be of the form of an interface domain that covers the physical ports of the SDU which shows separation for the required functions.

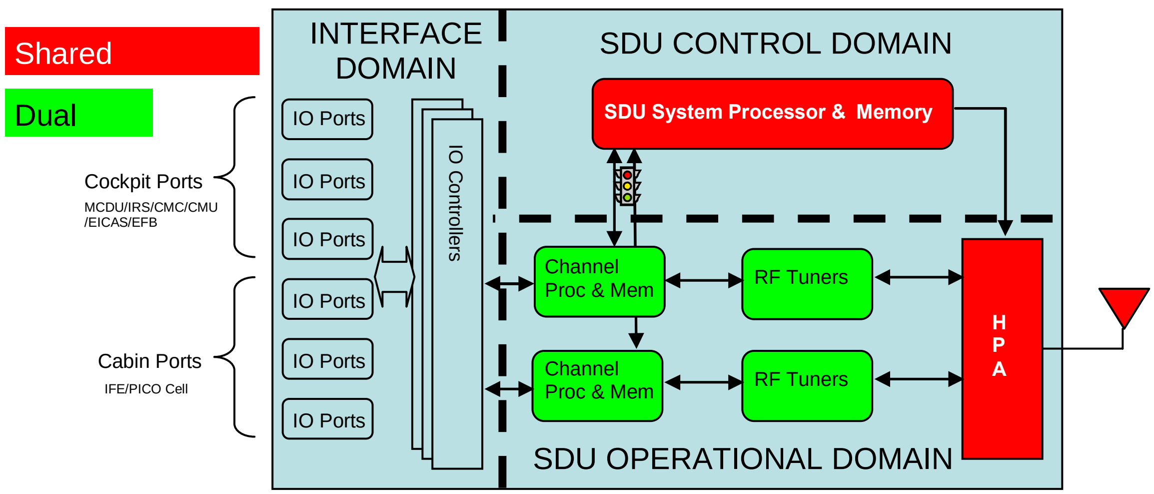


Figure 3: Identification of Domains that are internal to the SDU enclosure

Figure 3 shows conceptually a design of the SDU that is partitioned into the above three domains 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 Domain

The SDU Control Domain 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 (applets or macros) that are not native to the SDU operating system. Responsibilities 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 Domain must remain operational at all times during a threat occurrence in order to attend to the mitigation plans for each of the identified threats. This can include the reboot and reload of functions that are contained in the Operational Domain. For the instance of denial of service attacks, this domain (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 Domain

The SDU Operational Domain 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 Domain. Its access, however, is open to any of the dual -use components, which in this case represents 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 domain subject to reasonable reboot or reload to recover from the threat.

3.4.3.4.3 Interface Domain

The SDU Interface Domain 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 information on ports allocated to cockpit services. This domain should serve the equivalency of having two separate satcom systems installed on the aircraft.

3.4.3.5. Security Process

Attachment 3 of ARINC 811 describes a three-step “Information Security Process” to follow when designing security aspects into the satcom system:

Step 1: Identify information security needs and objectives.

Step 2: Select and implement security controls.

Step 3: Operate and manage security controls.

The intent of this three-step process is to iteratively propose, review and validate all that is necessary in the design consideration aspects when developing security requirements.

COMMENTARY

Only Step 1 is being described in this document at this time, to a preliminary degree. Further refinement and inclusion of Steps 2 & 3 will be addressed in a future supplement.

3.4.3.5.1 Step 1: Identify Information Security Needs and Objectives

The considerations to be made are; 1) Identify what needs to be protected, 2) Categorize them and identify physical environments and assumptions, and 3) Propose 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 comprise 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 domains within the design of the SDU. The devices within these domains can either be used as shared, dual-use or independent. In the "Interface Domain," 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 Domain," 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 Domain," the physical environment is that the system processor and memory are shared resources and must be shown not to succumb or be adequately protected from any threats.

The security objectives are to ensure that the devices in the Control domain retain full and proper function to shut down errant behavior in any device identified in the Interface and Operational domains. 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 compliance with security concerns involves exercising the security process in an iterative process of proposal and review, along with the orchestration of designing the SDU with domains to show partitioning. The ability to mitigate the impending threats by a combination of robust software techniques both internal and external to the SDU are 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. AFDX

For newer generation of aircraft, the traditional ARINC 429 based interfaces are being superseded by AFDX 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 AFDX can be simple twisted pair interfaces (for low bandwidth interfaces) or the newer Quadrax (ARINC 600) and Fiber (ARINC 801, 802, 803, 804, 805, and 806) definitions. Currently the AFDX interfaces defined in Attachments 1-3 and 1-4 specify the two quadrax and 5 fiber ports for AFDX implementation.

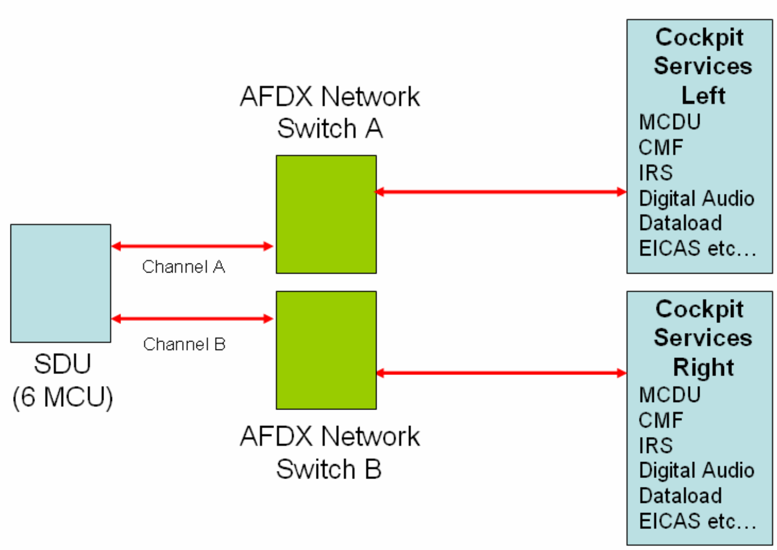


Figure 3- AFDX Interface Topology

3.6.2. Fiber Optic

Fiber Optic is the AFDX 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 AFDX also helps reduce wiring interface weight depending on how far the SDU is situated from the aircraft's avionics bay. ARINC 781 specifies 5 fiber optic ports of which only 2 ports are defined for cockpit interfaces. Channels A and B provide the redundancy for most of the above AFDX based systems and functionalities.

3.6.3. FANS/ATS over SwiftBroadband

COMMENTARY

This section is reserved for future growth, whereby datalink may be able to utilize the Internet Protocol (IP) as the transport medium. Extensive industry work must be undertaken and is indeed being discussed already at the relevant ICAO WG and AEEC Datalink meetings. At the moment, specific entities are targeting AOC messaging to explore the possibility of those messages being transmitted over IP. Once a viable proposal is found, then this section will be updated accordingly.

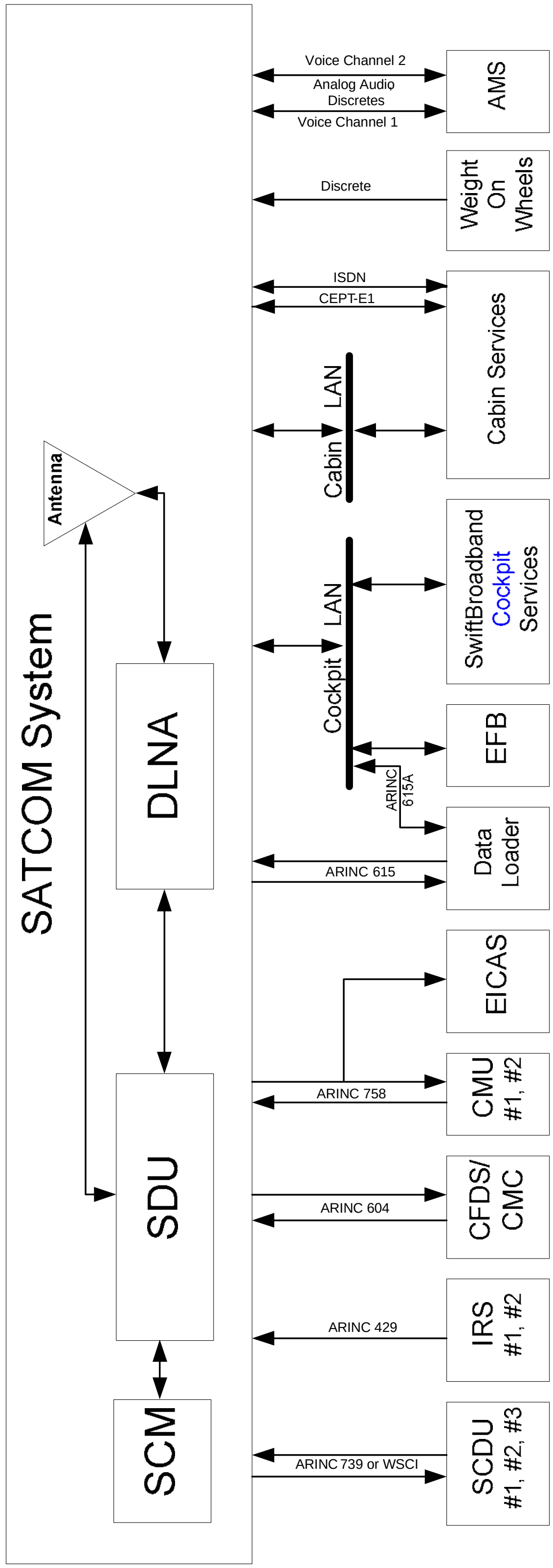
3.6.4. Multi frequency band

COMMENTARY

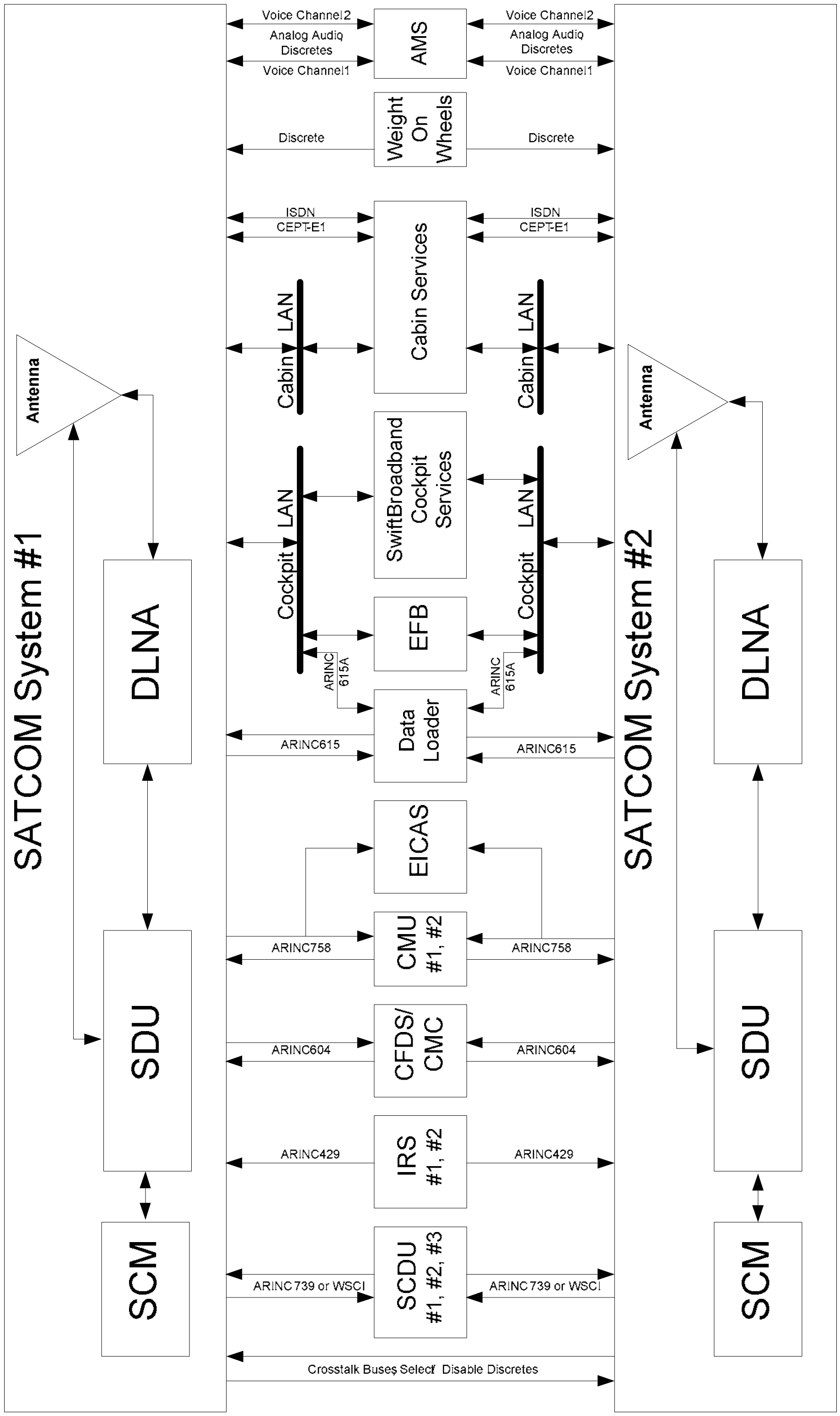
This section is reserved for future growth and refers to the in-built capability of ARINC Characteristic 781 to use the spare coax input/output port. Depending on the specific functionality of the SDU, there may be space left over for another circuit card that can handle satcom communications from a different satellite constellation using a different frequency band. This port is also left open for growth depending on what the Inmarsat-5 generation of satellites might be capable of.

It is sufficient to state that any extension of use of this coax port could lead into a wide variety of unique antenna subsystem architectures

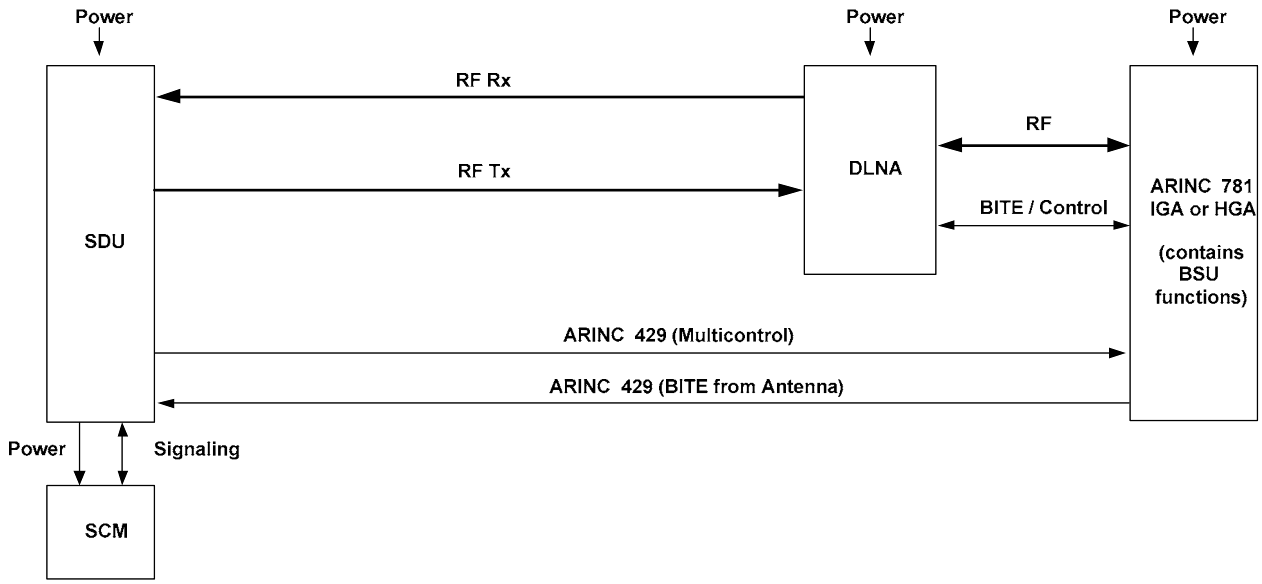
ATTACHMENT 1-1A
GENERAL CONFIGURATION OVERVIEW – SINGLE SATCOM INSTALLATION



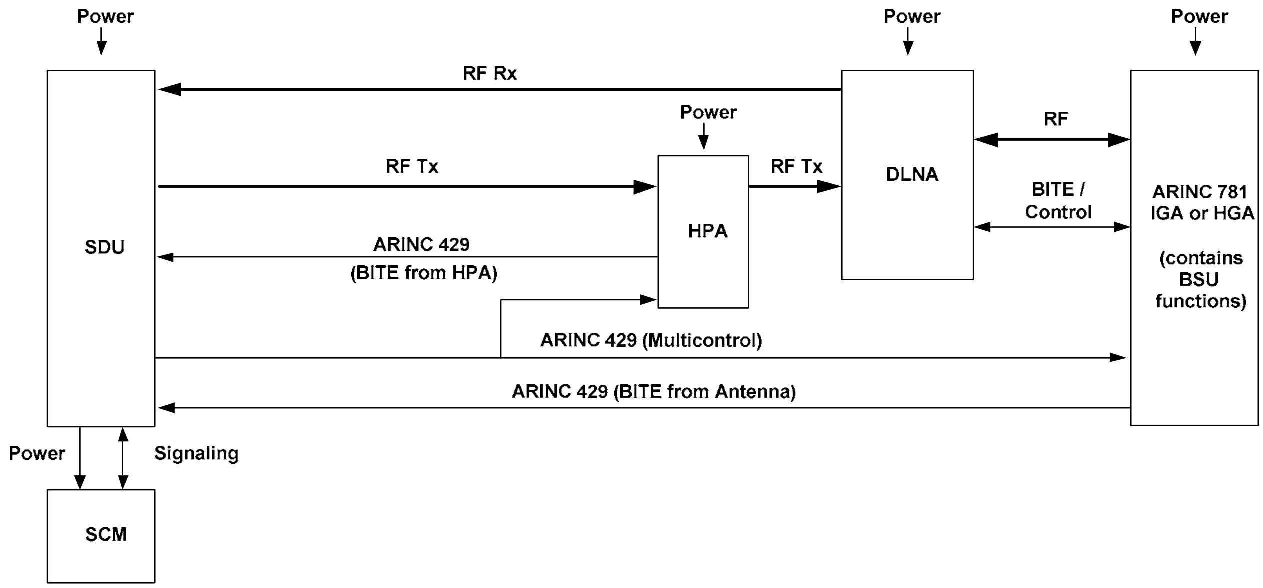
ATTACHMENT 1-1B
GENERAL CONFIGURATION OVERVIEW – DUAL SATCOM INSTALLATION



ATTACHMENT 1-2A
ANTENNA CONFIGURATION - HPA INTEGRATED IN SDU



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



Note: This configuration is expected to be used on those few aircraft where the cable 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)		TP	50 Ohm Coax	DLNA/J3 or HPA/J2	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	100BaseT		
Ethernet 1 from User to SDU	+	TP03B	100BaseT		
Ethernet Empty Cavity		TP03C	100BaseT		
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	100BaseT		
Ethernet 1 from SDU to User	-	TP04B	100BaseT		
Ethernet Empty Cavity		TP04C	100BaseT		
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	100BaseT		
Ethernet Empty Cavity		TP05B	100BaseT		
Ethernet Empty Cavity		TP05C	100BaseT		
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	100BaseT		
Ethernet 2 **from User to SDU**	+	TP06B	100BaseT		
Ethernet Empty Cavity		TP06C	100BaseT		
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	100BaseT		
Ethernet 2 **from SDU to User**	-	TP07B	100BaseT		
Ethernet Empty Cavity		TP07C	100BaseT		
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/6 HGA/6 or IGA/6**	4
Multi-Control Output	B	MP01F	A429	**HPA/8 HGA/8 or IGA/8**	4
Spare		MP01G			
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
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/3**	3
BITE Input from HPA	B	MP02F	A429	**HPA/5**	3
Spare		MP02G			
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
Spare Ethernet **from SDU to User**	**+**	MP06E	10BaseT		
Spare Ethernet **from SDU to User**	**-**	MP06F	10BaseT		
Spare ARINC 429 Input	A	MP06G	A429		29
Spare ARINC 429 Input	B	MP06H	A429		29
Spare ARINC 429 Input	A	MO06J	A429		29
Spare ARINC 429 Input	B	MP06K	A429		29
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
Spare Ethernet **from User to SDU**	**+**	MP07E	10BaseT		
Spare Ethernet **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 (Spare)		BP06			11
COAX (from DLNA)		BP07		DLNA/J2	11
Channel A		BP08	Fiber		34
Channel B		BP09	Fiber		34
Spare		BP10	Fiber		34
Spare		BP11	Fiber		34
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
+28 Vdc Hot Part 1	1			
+28 Vdc Return Part 1	2			
115 Vac Hot	18			16
115 Vac Return	19			
+28 Vdc Hot Part 2	20			
+28 Vdc Return Part 2	21			
Chassis Ground	22			
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 or not 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 inrush 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) 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 1500 ohms or less should be interpreted as the ADL is connected.

ATTACHMENT 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

15. **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 additional 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. If provided on the aircraft, GNSS data may also be obtained from the AES ID input per Note 1 in order to preserve the capability for redundant inertial data at the IRS inputs. 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	GNSS Height (HAE) or Hybrid Altitude MSL or GNSS Altitude	370, 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

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 either use the labels in the right hand column for hybrid inertial and GNSS data or the labels in both the left hand inertial data column and the data in the center GNSS data column. The additional labels are intended to support SwiftBroadband transmit signal timing requirements. There are two IRS input ports on the SDU, so it is possible for one IRS input port to receive the inertial data and for the other IRS input port to receive the GNSS data. The hybrid inertial and GNSS data solution in the right hand column is the preferred solution, as it allows for redundant navigation inputs to the SDU. Owner Requirements Table (ORT) items B4 and B5 define which IRS pins on the SDU are wired to sources of IRS data.

ATTACHMENT 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

Altitude label 370 should be used when available on the aircraft over labels 076, 261, and 361. If altitude label 370 is not available, either label 076 or 261 should be used. If labels 370, 076, and 261 are not available on the aircraft, label 361 should be used.

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.
    - One (1) 115 Vac 7.5 amp circuit breaker is provided for SDU-1, HPA-1, **DLNA**-1 and Antenna-1 for aircraft with a long distance between the SDU and antenna components.

    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 inrush 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.

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.

ATTACHMENT 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

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**. I**f 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 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. Undefined
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 inrush 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

ATTACHMENT 1-4
NOTES APPLICABLE TO STANDARD INTERWIRING

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.**

ATTACHMENT 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

1 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.

  Note: Although this pin defines 4 variables, they are not fully independent. The five most likely combinations have been defined in the table below.

ATTACHMENT 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

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, 6F, 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 (TP 3E, TP3G, TP4D, TP4E, TP4F, TP4G, TP 5D, 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, and TP6D: 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

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 + Type D DLNA	Open	Open
2	ARINC 781 IGA + Type D DLNA	Open	MP11E
3	LGA + **Type D DLNA** + LGA HPA	Open	MP11F
4	ARINC 741 TOP BSU + TOP HGA + HGA HPA **+ Type D DLNA**	Open	MP12E
5	ARINC 741 PORT BSU + PORT HGA + STARBOARD BSU + STARBOARD HGA + HGA HPA + HPR **+ Type D DLNAs**	Open	MP12F
6	**LGA + Non Type D DLNA + LGA HPA**	Open	MP13E
7	**ARINC 741 TOP BSU + TOP HGA + HGA HPA + Non Type D DLNAs**	Open	MP13F
8	Reserved for MFR	Open	MP14E
9	**ARINC 741 PORT BSU + PORT HGA + STARBOARD BSU + STARBOARD HGA + HGA HPA + HPR + Non Type D DLNA**	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

ATTACHMENT 1-4A
SYSTEM CONFIGURATION PINS DEFINITION AND INTERPRETATION

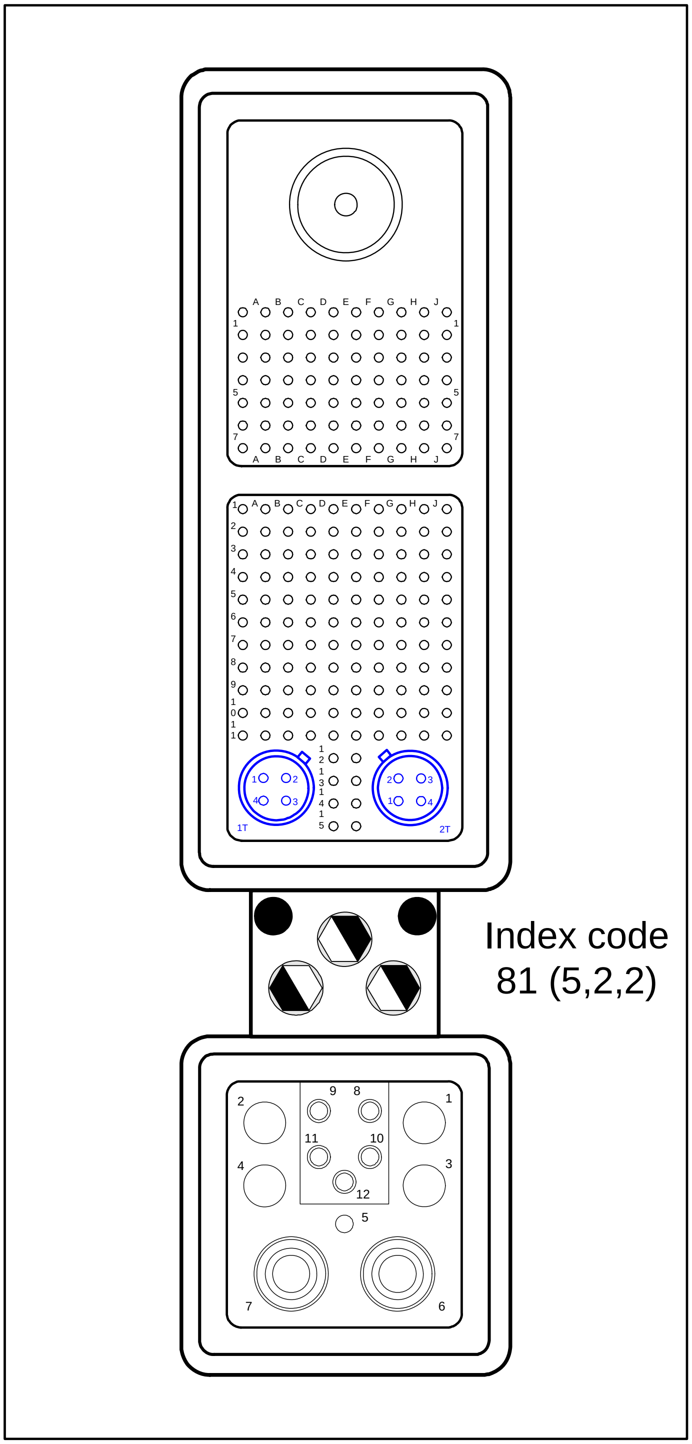
Configuration Number	Antenna Subsystem Configuration	Connect TP 4F to:	Connect TP 4G to:
40	Reserved for future	MP12F	MP14E
41	Reserved for future	MP13E	Open
42	Reserved for future	MP13E	MP11E
43	Reserved for future	MP13E	MP11F
44	Reserved for future	MP13E	MP12E
45	Reserved for future	MP13E	MP12F
46	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 TP6E, 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, **and TP6D**.

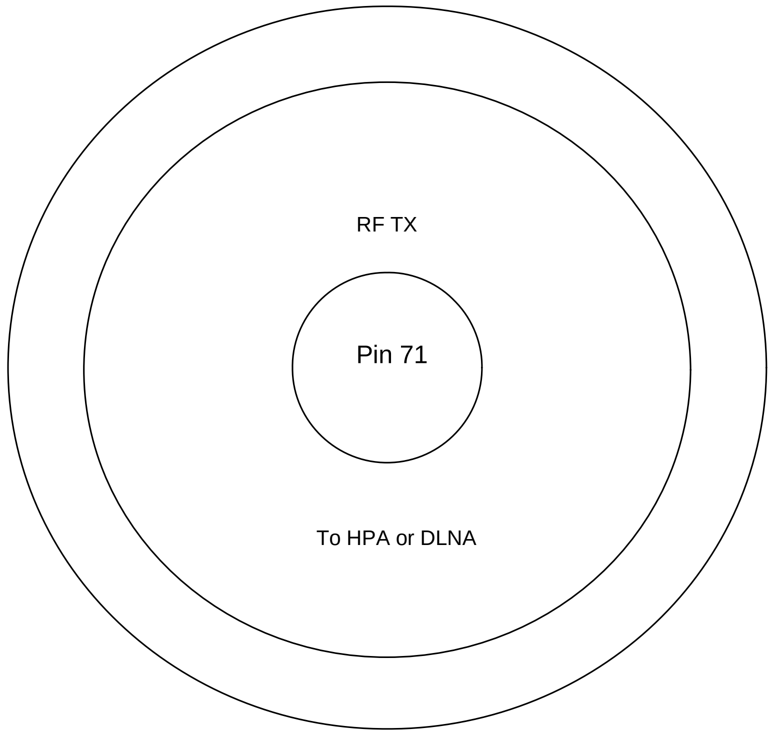
ATTACHMENT 1-5
SDU FORM FACTOR

SIZE 6 MCU
#2 Shell Connector



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

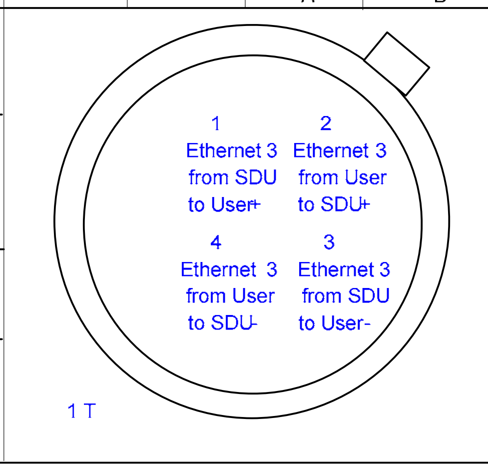
ATTACHMENT 1-5A
SDU TOP PLUG CONNECTOR LAYOUT

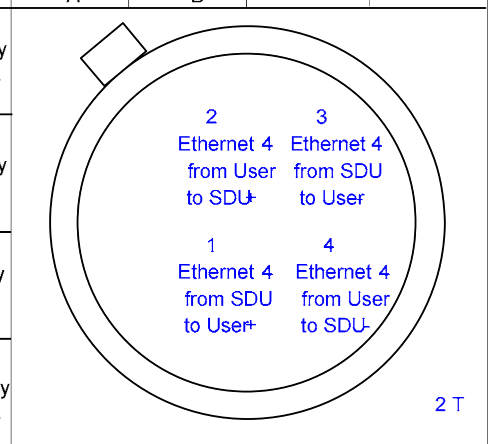


	A	B	C	D	E	F	G	H	J	
1	ATE Pin 1	ATE Pin 2	ATE Pin 3	ATE Pin 4	ATE Pin 5	ATE Pin 6	ATE Pin 7	ATE Pin 8	ATE Pin 9	ATE Pin 10
2	ATE Pin 11	ATE Pin 12	ATE Pin 13	ATE Pin 14	ATE Pin 15	ATE Pin 16	ATE Pin 17	ATE Pin 18	ATE Pin 19	ATE Pin 20
3	Ethernet 1 from SDU to User +	Ethernet 1 from User to SDU +	Empty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

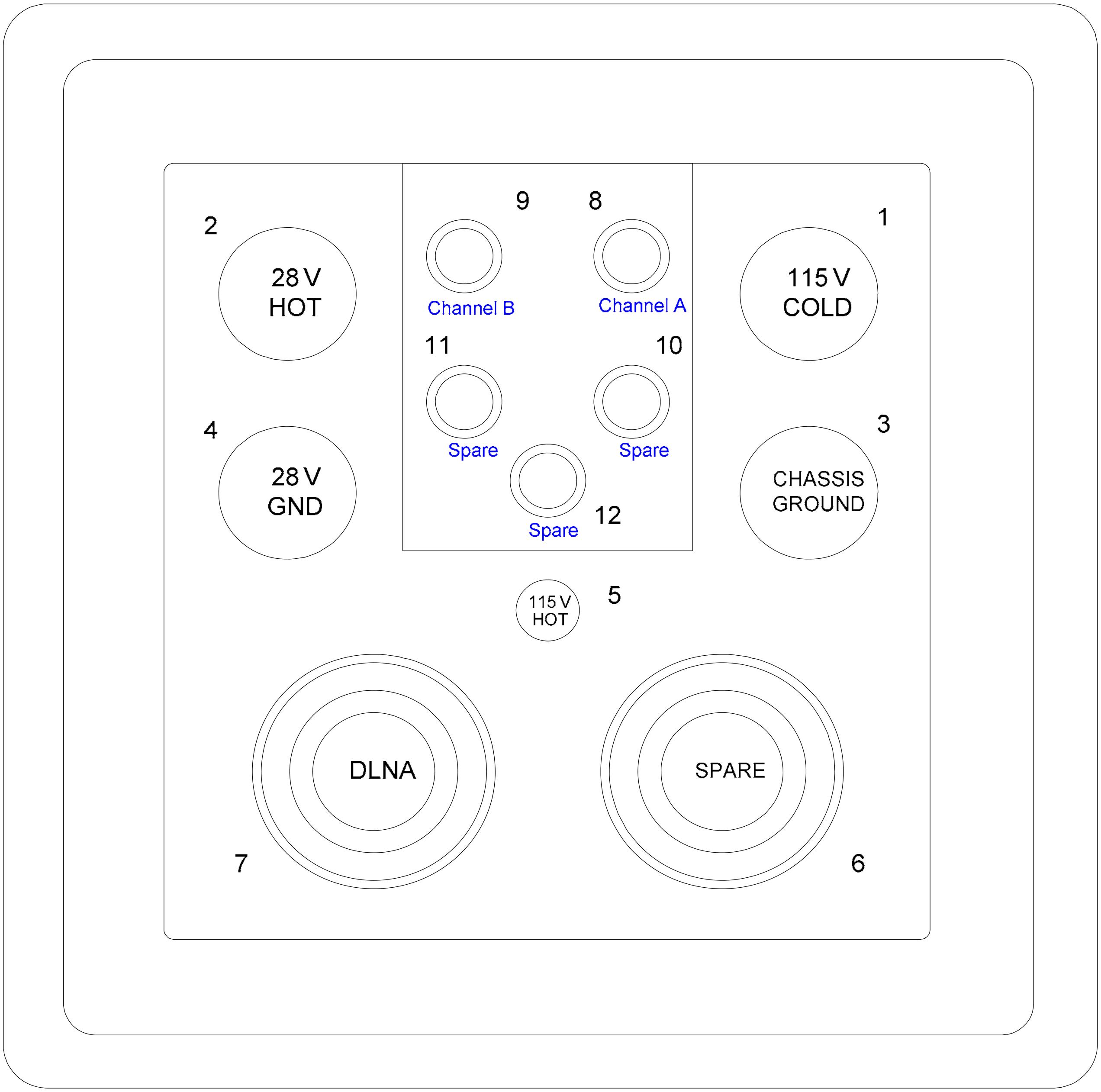
ATTACHMENT 1-5B
SDU MIDDLE PLUG CONNECTOR LAYOUT

	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 +15 V	Multi - Control Output A	Multi-Control Output B	SPARE	Call Place/End Discrete Input 2	Data from MCDU2 A	Data from MCDU2 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	SPARE	Cockpit Voice Chime Signal Contact 2	Data From Secondary IRS A	Data From Secondary IRS B
3	Data From CMU1 A	Data From CMU1 B	Cockpit Voice Call Light Output 1	SDU Data to SCM A	Spare Discrete Output	Spare Discrete Input	SPARE	Cockpit Voice Call Light Output2	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 Input1	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	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	10Base T Ethernet Spare from SDU to User +	10Base T Ethernet Spare from SDU to User -	Spare ARINC 429 Input A	Spare ARINC 429 Input B	Spare ARINC 429 Input A	Spare ARINC 429 Input B
7	AES ID Input A	AES ID Input B	Spare Discrete Input	WOW Input 1	10Base T Ethernet Spare from User to SDU +	10Base T Ethernet 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-E 1 Data Output A	Cabin CEPT -E 1 Data Output B	Service Availability Discretes 1	Service Availability Discretes 2	Cabin CEPT- E 1 Data Input A	Cabin CEPT-E 1 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				

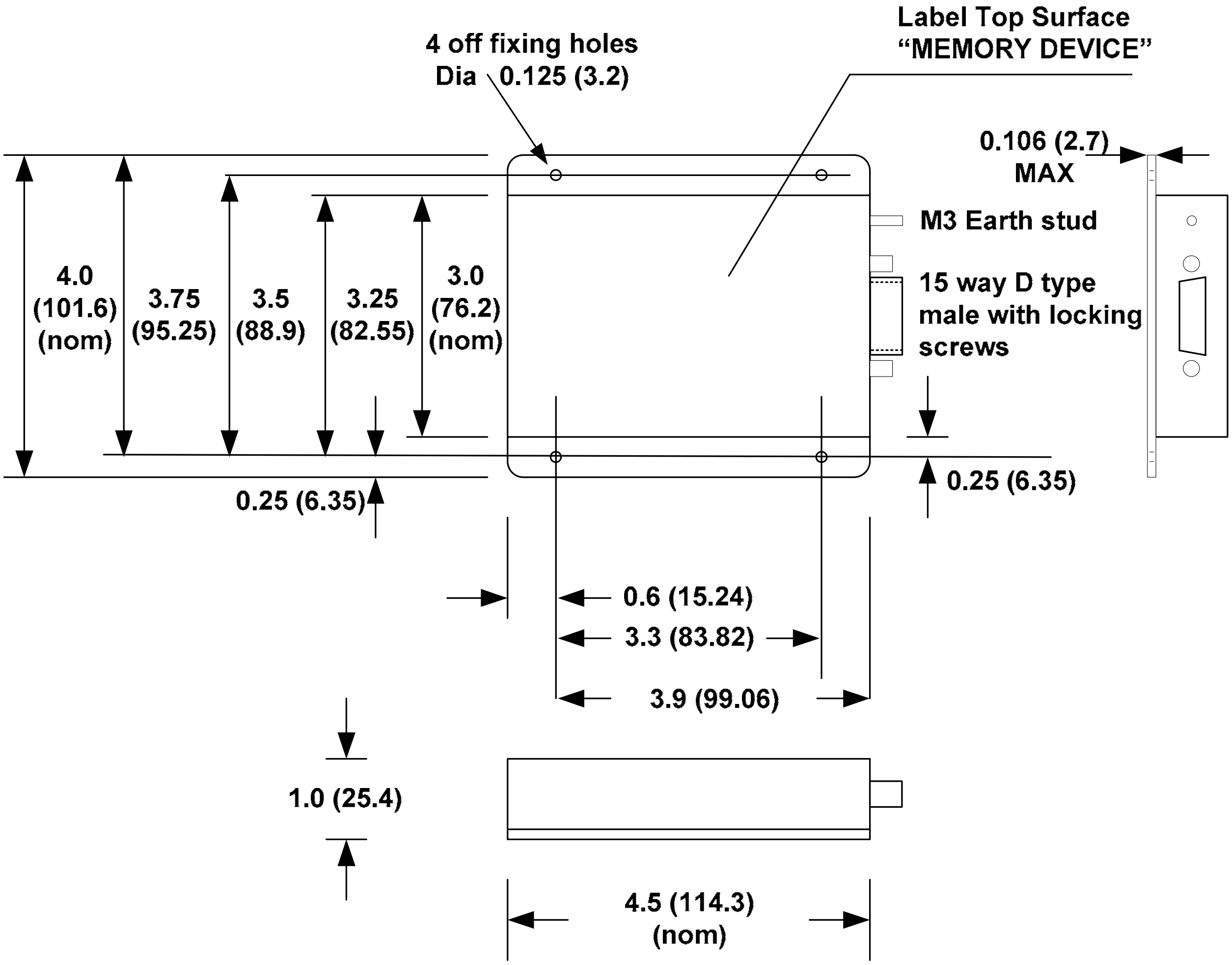




ATTACHMENT 1-5C
SDU BOTTOM PLUG CONNECTOR LAYOUT



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 1-6
SDU CONFIGURATION MODULE FORM FACTOR

SCM Connector is 15 way D type male.

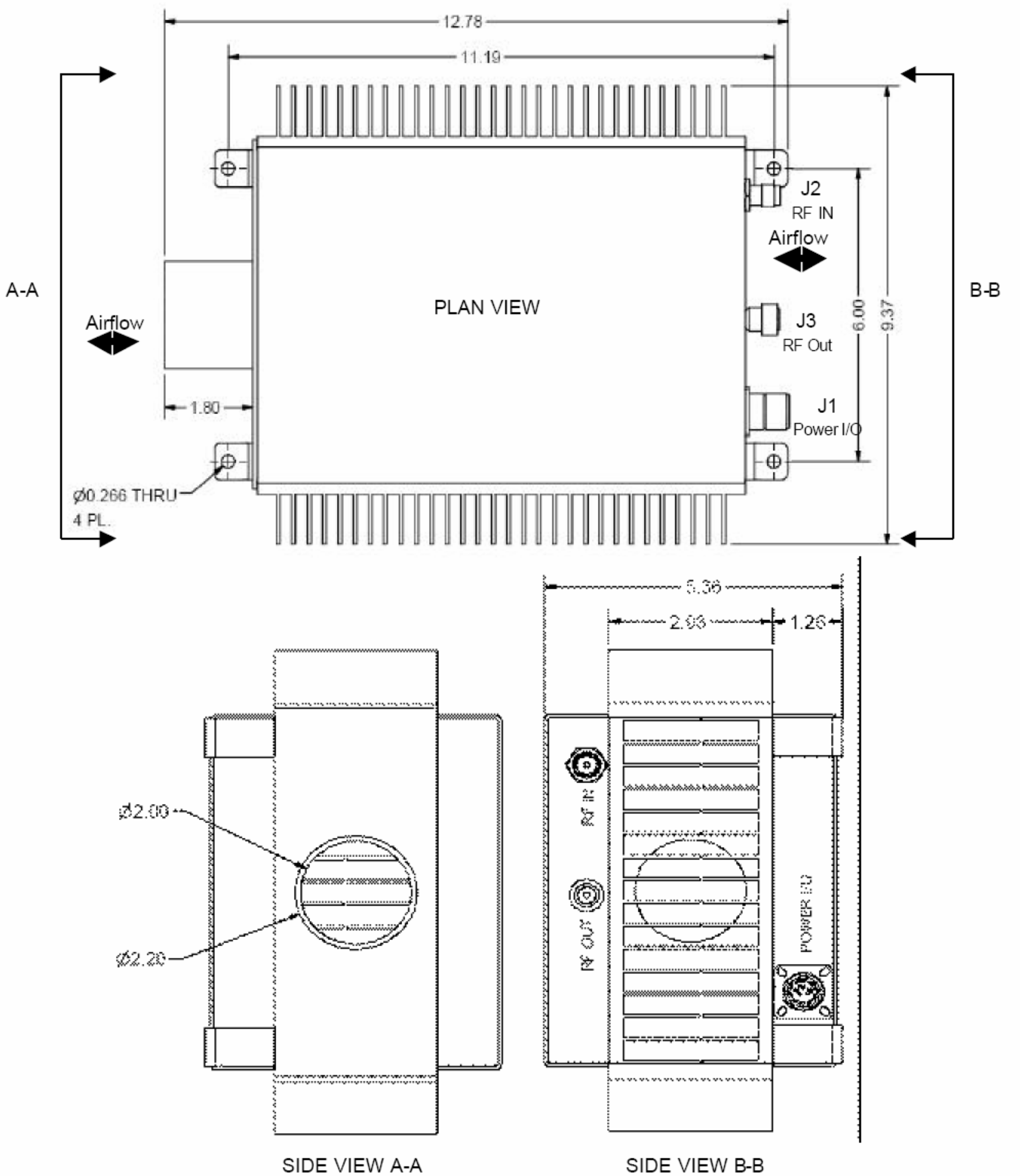
Data to SDU A **1**	**Data to SDU** B	**Data from SDU** A	**Data from SDU** B	Reserved RS232 Gnd	Spare	Chassis Ground	**Power Input** +8 to +15V **8**

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 1-7
FLANGE MOUNT HPA FORM FACTOR



- Mounting bracket locations are **included as shown.**
- A clearance of approximately 3” **on top, bottom and** sides of the HPA is recommended to facilitate cooling.

ATTACHMENT 1-7
FLANGE MOUNT HPA FORM FACTOR

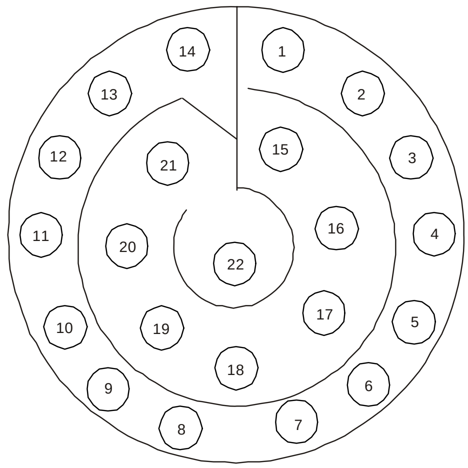
- **View B-B will require a mesh/gauze to prevent debris interference**
- The HPA will have 3 connectors, **located as shown:**

  J1 - Power/Control MIL-C-38999 Series III Insert Arrangement **13-35**

  J2 - RF Input; TNC Female

  J3 - RF Output; N Type **Female**

ATTACHMENT 1-7
FLANGE MOUNT HPA FORM FACTOR



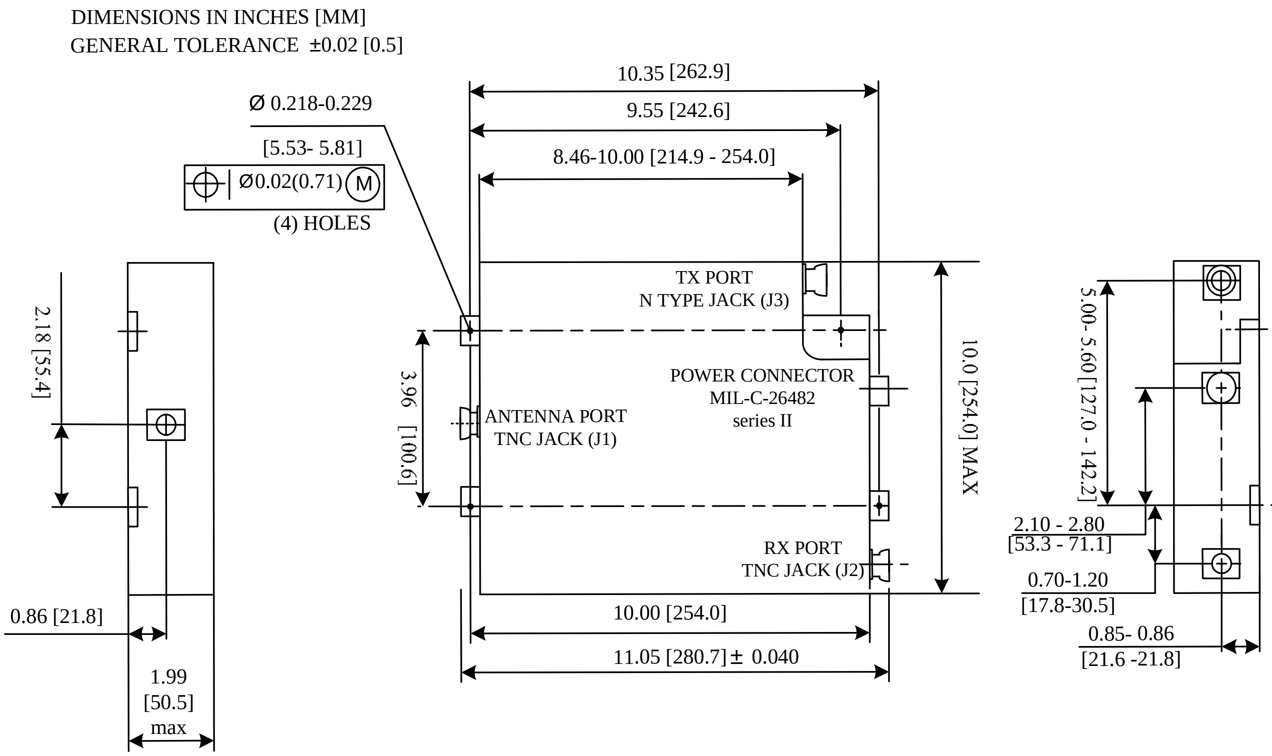
External Flange Mounted HPA Connector Pin Layout:

PIN No:		SIGNAL	DESCRIPTION
1	**	+28 Vdc Part 1	Aircraft dc Power Part 1
2	**	28 Vdc RTN Part 1	Aircraft dc Power Part 1
3	*	HPA BITE A	ARINC 429 from HPA
4	*	HPA BITE Shield	Shield for ARINC 429
5	*	HPA BITE B	ARINC 429 from HPA
6	*	HPA Control A	ARINC 429 to HPA
7	*	HPA Control Shield	Shield for ARINC 429
8	*	HPA Control B	ARINC 429 to HPA
9		Discrete BITE #1	Discrete BITE #1 from HPA
10		Discrete BITE #2	Discrete BITE #2 from HPA
11		Discrete BITE #3	Discrete BITE #3 from HPA
12		Serial Shield	Serial Shield
13		RS422 RXD A	Serial data to HPA +
14		RS422 RXD B	Serial data to HPA -
15		RS422 TXD A	Serial data from HPA +
16		RS422 TXD B	Serial data from HPA -
17		ATE Pin	Manufacturer Specific
18	**	115 Vac Hot	Aircraft ac power
19	**	115 Vac Return	Aircraft ac power
20	**	+28 Vdc Part 2	Aircraft dc Power Part 2
21	**	28 Vdc RTN Part 2	Aircraft dc Power Part 2
22	**	Chassis Ground	Chassis Ground

(*): Normally wired in an aircraft

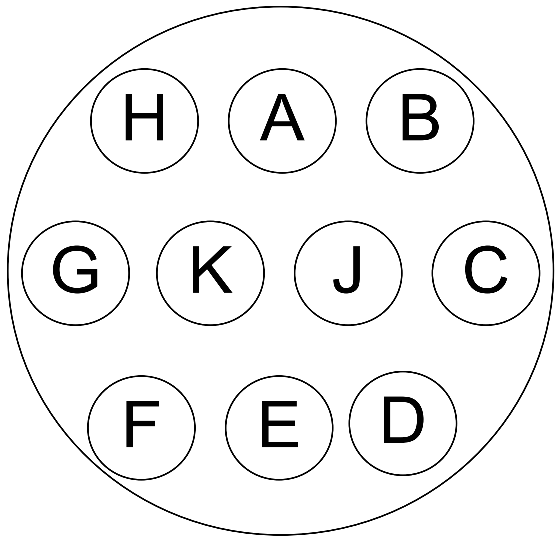
(**): Only 28V or 115V should be wired to HPA in an aircraft. Four pins are provided for 28V to share the current.

ATTACHMENT 1-8
DIPLEXER/LOW NOISE AMPLIFIER FORM FACTOR



mass 3kg max.

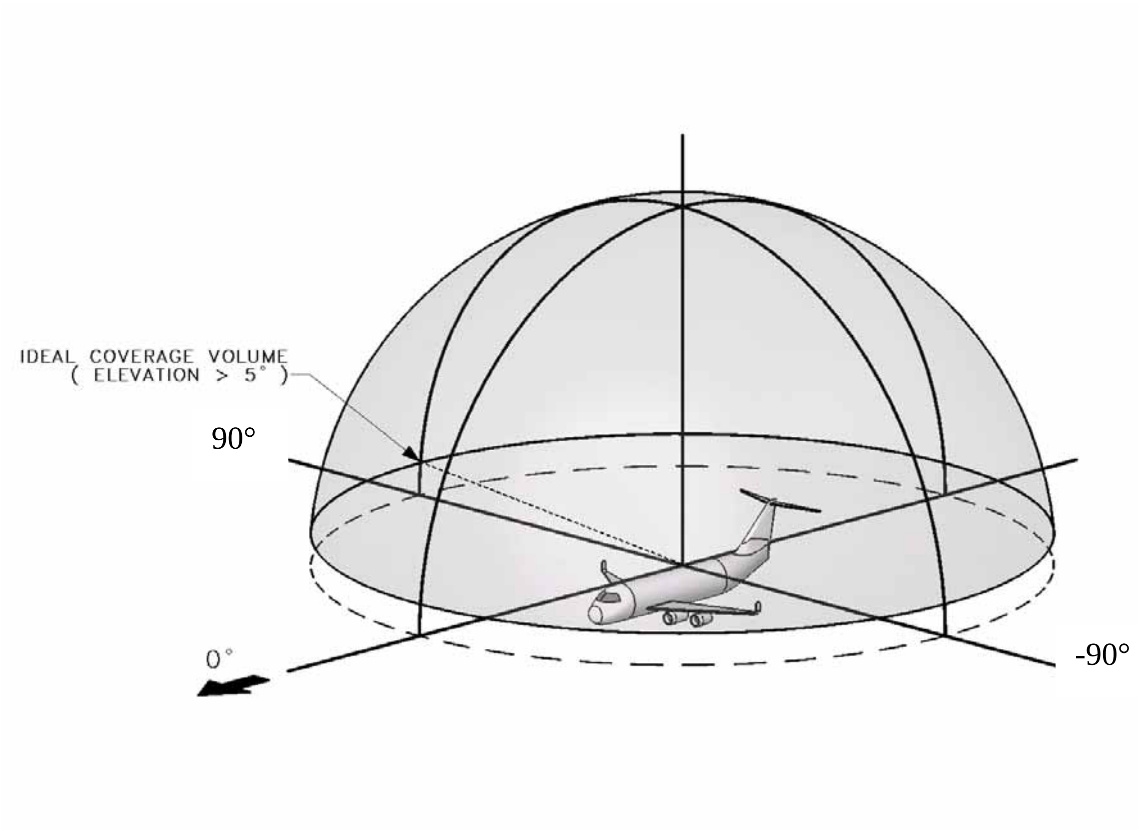
ATTACHMENT 1-8A
DLNA POWER AND CONTROL CONNECTOR LAYOUT



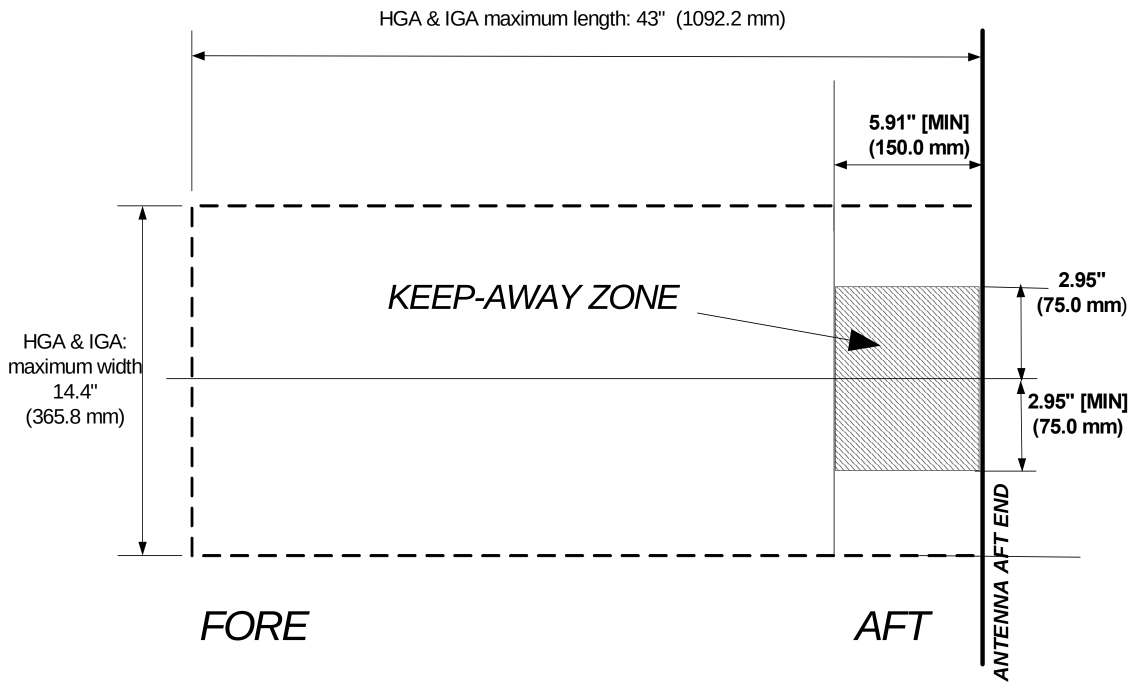
Pin	Description
Pin A	Chassis Ground
Pin B	LNA Control
Pin C	Future Spare
Pin D	Future Spare
Pin E	115 Vac Cold
Pin F	115 Vac Hot
Pin G	**+28 Vdc Hot**
Pin H	LNA BITE
Pin J	**LNA BITE** Ground
Pin K	**+28 Vdc Return**

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

ATTACHMENT 1-9
ANTENNA COVERAGE



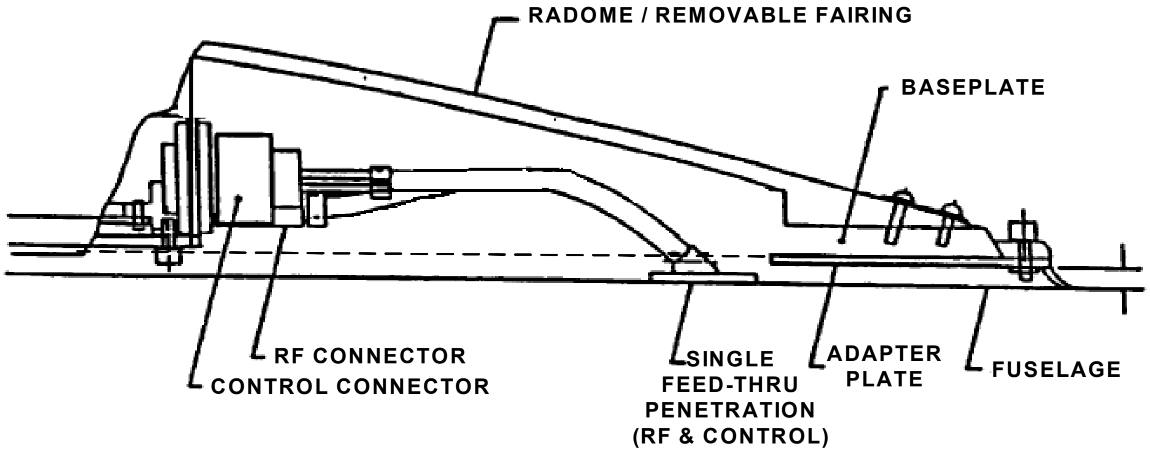
ATTACHMENT 1-10
HIGH GAIN AND INTERMEDIATE GAIN TOP MOUNT ANTENNA FOOTPRINT MAXIMUM DIMENSIONAL OUTLINE



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.

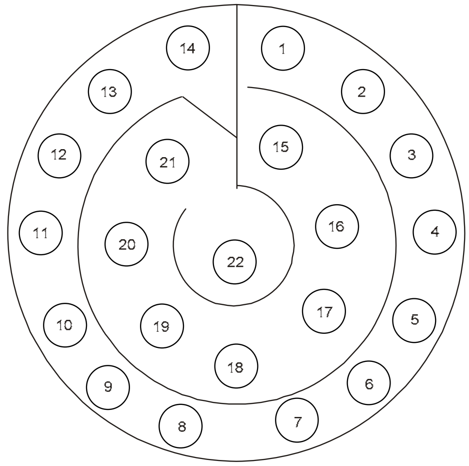
ATTACHMENT 1-10A
ANTENNA COAXIAL CABLE INTERFACE



ATTACHMENT 1-11
LOW GAIN ANTENNA FOOTPRINT

(To be included in a future supplement)

ATTACHMENT 1-12
HIGH GAIN AND INTERMEDIATE GAIN ANTENNA CONTROL CONNECTOR LAYOUT



HGA Connector PIN Layout

HGA pin assignments should conform to the table below.

HGA 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-C-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 (LSB) [25]	(MSB) Elevation (LSB) [24]	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												Octal Label							
												LSB												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)

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 (eg: -400, -800, -500).**
- **xbbb = Major Model (eg: 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 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 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 <u>or</u>	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	Globalstar	X	
21	ICO	X	
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

NOTES

These notes are numbered the same as ARINC 741.

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 sidemount)
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

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. The SDI bits should be set to reflect the Antenna's application as defined in Note 19 of Attachment 1-4. **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, 2'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**

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.

<u>Labels 220 - 221 (and 222 - 227) Inmarsat Swift64 Base Forward ID Words #1 and #2 - (Discrete)</u>

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.

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 IGA or HGA antenna, on request from the SDU, provides configuration data to the SDU for onward transmission to the central fault display system.

The configuration data is:

- Name of the LRU
- Part number of the LRU
- Serial Number of LRU
- Name of software application
- Software part number

2 PROTOCOL

The configuration data may be requested by the SDU at any time once the antenna resets and initializes.

Configuration data is requested by the SDU via the 227 word, using the "configuration" function select (see Section 3.2). Upon receipt of the "configuration" function select in the 227 word, the antenna sets the "In Progress" bit (29) in the Antenna Maintenance Word (Label 350). When the SDU notes the set "In Progress" bit from the antenna, it sends the 227 words with the "null" function selected.

After the "In Progress" bit in the antenna Maintenance Word (Label 350) has been set by the antenna, the antenna transmits a response using label 356 (see Section 3).

The response data transmitted is formatted so that it can be displayed with 24 characters per row and up to 10 rows per page. All data is transferred using a subset of the ISO 8859-5 alphabet. Typically only one page is sent.

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 is 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 the following information is for column 1 of the next row.
6. The first three characters starting with information for the next row column 1 is 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 the following information 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).

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

3 DEFINITION OF ARINC 429 WORDS

3.1 ACU/BSU Maintenance Word – ACU/BSU to SDU (Label 350)

BIT 29 in Label 350 indicates that the antenna is in process of sending configuration data to the SDU.

BIT	DESCRIPTION	BIT = 0	BIT = 1
29	IN PROGRESS	NOT IN PROGRESS	IN PROGRESS

3.2 ARINC 781 Command Summary Word (SDU →Antenna)

The antenna receives the following word and responds according to the information contained in the Function Select field.

COMMAND SUMMARY WORD LABEL 227 Rate = 0.5 – 10/sec					
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**

<u>**Function Select**</u>

000 0000 = Null
000 0010 = Configuration

<u>**Equipment ID**</u>

0001 1000 0001 (181_H = **satcom**)

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

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 configuration data.

An ARINC 781 compliant antenna responds to Command Words with the **satcom** equipment I.D. of 181 when the appropriate SDI code is set. If the SDI ALL CALL or ‘Top’ code is encoded in the SDI field the antenna responds to the command word. If the SDI code is not equal to ALL CALL or ‘Top’ the antenna does not respond.

3.3 STX Word (Start of Text)

CONFIGURATION DATA LABEL 356 Rate = 0.5 – 10/sec					
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 Character for “STX”

3.4 SYN Word (Synchronization Word)

CONFIGURATION DATA LABEL 356 Rate = 0.5 – 10/sec						
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

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

BITS	DEFINITIONS
1 – 8	Octal Label 356
9 – 15	Present Data Page Number (normally 1)
16	Unused
17 - 23	Total Number of Data Pages Available (normally 1)
24	Unused
25 - 31	ISO 8859-5 Character for "SYN"

3.5 Intermediate Word

CONFIGURATION DATA LABEL 356 Rate = 0.5 – 10/sec						
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 + 1Character of the Configuration Data

3.6 ETX Word (End of Text)

CONFIGURATION DATA LABEL 356 Rate = 0.5 – 10/sec						
32	31 → 25	24	23 → 17	16	15 → 09	08 → 01
P	ETX	PAD	CHAR or NULL	PAD	CHAR or NULL	LABEL
PAR	0000011	0	XXXXXXX	0	XXXXXXX	01110111

The character ETX is used to indicate that the next character shall be displayed in column 1 of the next row (Similar to CR/LF). All data shall be transferred using a subset of the ISO 8859 #5 alphabet specified in Section 4. **The ETX character 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 a NULL character (0000000).**

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

3.7 EOT Word (End of Transmission)

CONFIGURATION DATA			LABEL 356		Rate = 0.5 – 10/sec	
32	31 → 25	24	23 → 17	16	15 → 09	08 → 01
P	EOT	PAD	CHAR or NULL	PAD	CHAR or NULL	LABEL
PAR	0000100	0	XXXXXXX	0	XXXXXXX	01110111

The EOT character 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 a NULL character (0000000).

BITS	DEFINITIONS
1 – 8	Octal Label 356
9 – 15	Configuration Data character or NULL
16	Unused
17 – 23	Configuration Data character or NULL
24	Unused
25 - 31	ISO 8859-5 Character for "EOT"

4 CONFIGURATION DATA

All data is transferred using a subset of the ISO 8859-5 alphabet **plus addition of STX, ETX, EOT, and SYN** as specified in ARINC Specification 429, Part 1, Attachment 5.

Table ISO 8859-5 - Alphabet Subset

HEX MSB → HEX LSB ↓	0	1	2	3	4	5
0	NULL		SPACE	0		P
1				1	A	Q
2	STX			2	B	R
3	ETX		#	3	C	S
4	EOT			4	D	T
5			%	5	E	U
6		SYN	&	6	F	V
7			Apostrophe	7	G	W
8			<	8	H	X
9			>	9	I	Y
A			Asterisk		J	Z
B			+		K	
C		Deg Symbol	Comma		L	
D		Square Symbol	Minus		M	
E		↓	Period		N	
F		→	/		O	

ATTACHMENT 2A
ANTENNA CONFIGURATION DATA REPORTING

The configuration data 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 and above	Manufacturer specific	24 max

All rows are left justified **and should be equal to or less 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.

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	Bit Status 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.

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	Bit Status 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.

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #6 for satcom

Bit No.	Function	Bit Status 1	Bit Status 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.

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #7 for satcom

Bit No.	Function	Bit Status 1	Bit Status 0
1 2	Label 357 (Octal)		
3 4 5			
6 7 8			
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	Reserved	Inactive	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.

BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #8 for satcom

Bit No.	Function	Bit Status 1	Bit Status 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.

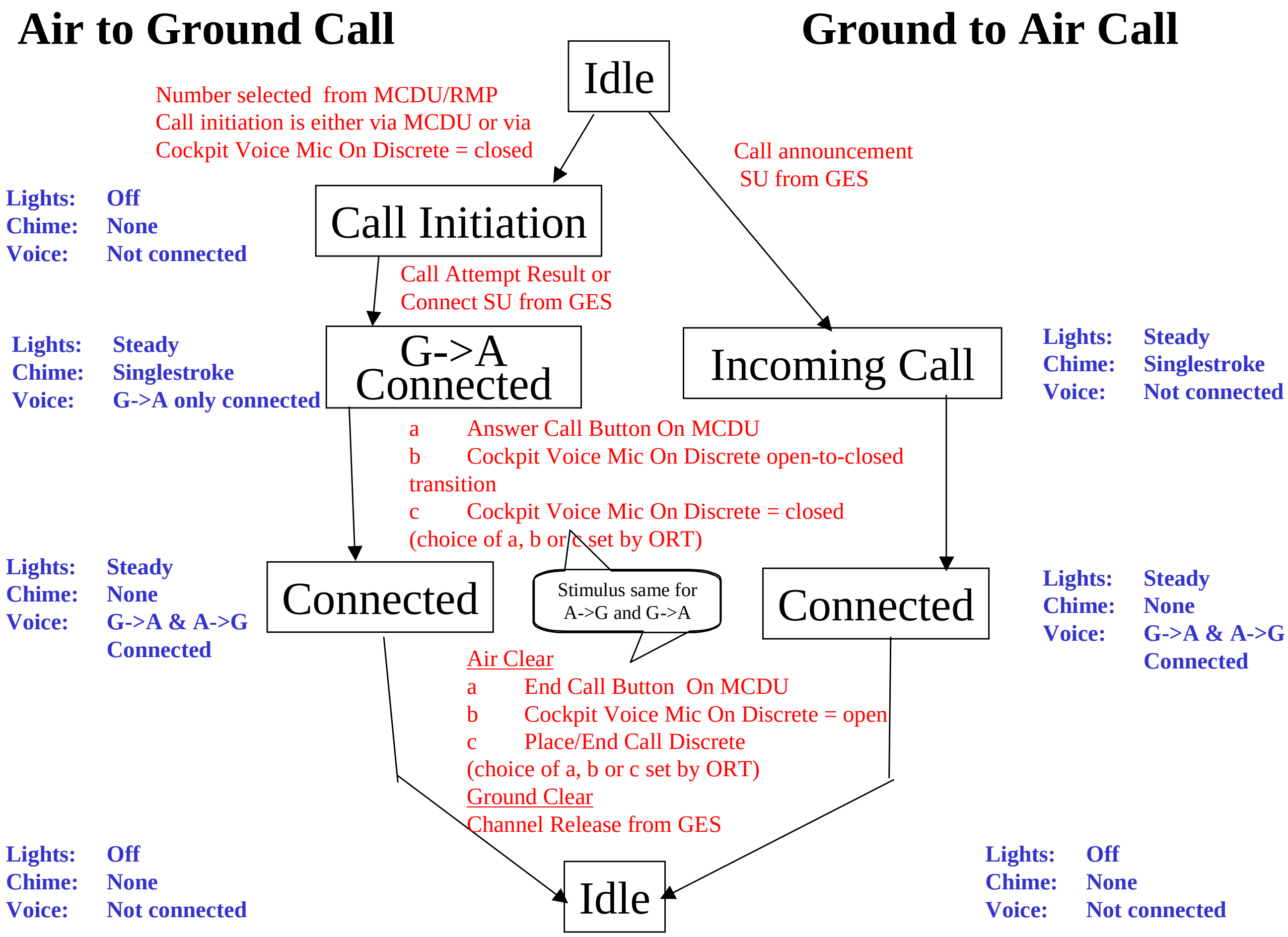
BIT-ORIENTED FAULT REPORTING PROTOCOL
Fault Summary Word #9 for satcom

Bit No.	Function	Bit Status	
		1	0
1 2 3 4 5 6 7 8	Label 361 (Octal)		
9 10	SDI		
11	SDU Fiber Ethernet Port #1	Inactive	OK
12	SDU Fiber Ethernet Port #2	Inactive	OK
13	SDU Fiber Ethernet Port #3	Inactive	OK
14	SDU Fiber Ethernet Port #4	Inactive	OK
15	SDU Fiber Ethernet Port #5	Inactive	OK
16	SDU Size 22 Pins Ethernet Port #1	Inactive	OK
17	SDU Size 22 Pins Ethernet Port #2	Inactive	OK
18	SDU Size 22 Pins Ethernet Port Spare	Inactive	OK
19	SDU Quadrax Ethernet Port #3	Inactive	OK
20	SDU Quadrax Ethernet Port #4	Inactive	OK
21		Failed	OK
22		Failed	OK
23		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		Failed	OK
29		Failed	OK
30 31	SSM		
32	Parity (Odd)		

Note:

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/AFDX	Ethernet/AFDX	Ethernet/AFDX
	ATC Cockpit Data	Data-2/3, Ethernet/AFDX	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	Independent,	Warm	None

ATTACHMENT 4-A
ARINC 781 SDU FUNCTIONS MATRIX

Section	Feature/Function	Options	Cockpit & Cabin SATCOM (Example)	Cabin Only SATCOM (Example)
	Operations	Cold Standby, Warm Standby, Hot Standby, Cooperative	Standby, Cooperative	
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
3.5	Future Growth			
3.5.1	AFDX		Yes – Future	No
3.5.3	FANS/ATS over SBB		Yes – Future	No
3.5.4	Multi-Frequency Band		Yes – Future	Yes - Future

(1) SDU manufacturers should clearly state what combination of different channel are 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
AFDX Copper (Cockpit voice & data)		No	No
AFDX Fibre (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

ATTACHMENT 5
ETHERNET INTERFACE

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ATTACHMENT 5
ETHERNET INTERFACE

1. 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 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.

1.2. End to end Architecture Overview

The architecture below closely resembles that which would occur in an aircraft with a SwiftBoadband SDU. This represents a single channel. The interface to be implemented must support such an architecture.

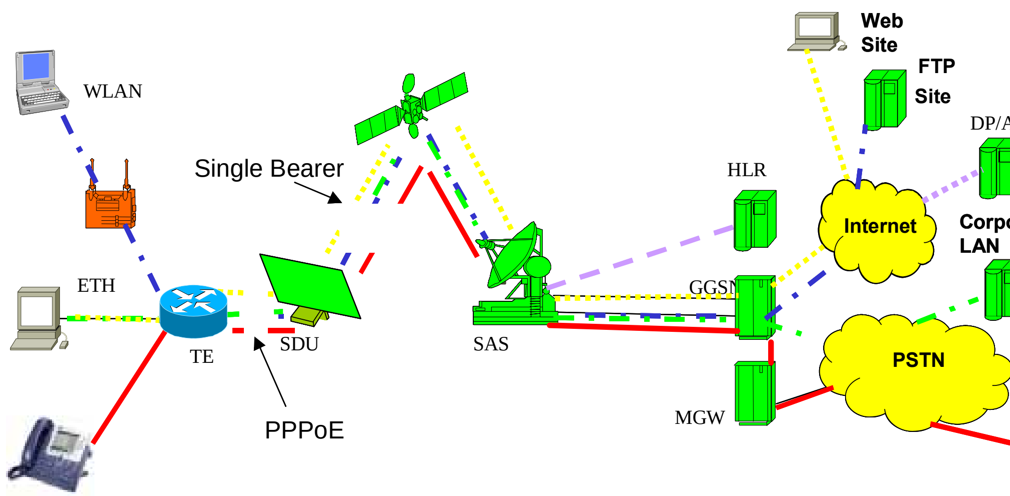

Figure 1: Future Network Architecture

Note that in this model:

- PPP over Ethernet is carrying the PPP session between the TE/Router and the SDU.
- Multiple devices are attached to a network to access the SDU via a TE/Router device
- Wireless devices may be deployed
- Multiple sessions are in operation to different devices
- Different services (for instance voice) may be offered (additional terrestrial infrastructure required and shown)

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. 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 & termination of primary contexts, and modification and termination of secondary contexts.

2.2. Aircraft Architecture

This Interface concept supports a wide variety of aircraft architectures including those:

- With or without servers
- With single or multi-channel SDUs
- With single or multiple SDUs
- With single or multiple servers

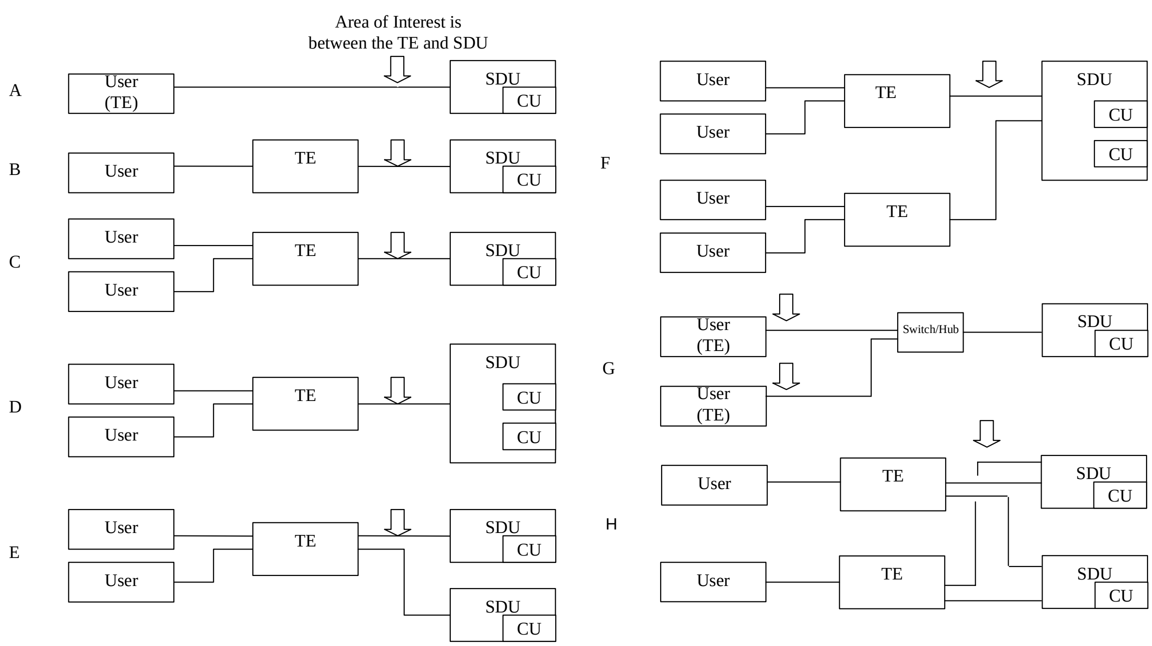

Figure 2: The following scenarios should be supported by the interface.

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 Context with in 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 (TFT) 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 SDU's 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 it not required.

2.3.4. Streaming Class

This Class provides dedicated data in rates of 32, 64, 128 and 256kbps per Channel Unit. 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 uniformed latency (jitter) for applications such as videoconferencing, steaming video and voice over IP applications.

Note: Each Channel Unit supports up to a total of 11 contexts (ie sum of the primary + secondary contexts.)

2.4. Interface Fundamentals

2.4.1. Ethernet

Ethernet 802.3 is the physical interface.

2.4.2. TCP/IP

SDU shall implement a TCP/IP V4 network stack.

2.4.3. PPPoE

PPPoE is the protocol used to establish a PDP Context. The SDU shall implement a RFC 2516 compliant PPPoE Access Concentrator.

2.4.4. PPP Server

PPP is terminated in the SDU. The SDU shall implement a RFC 1661 compliant PPP Server.

2.4.5. PPPoE Context Relationship

Each primary context is supported in a separate PPPoE session, and is allocated a unique public routable IP address by the Core Network. 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 host a Telnet service (RFC 854) for establishing, modifying and creating secondary contexts.

Each control line equates to a single telnet session. There is no mandated pairing between PPPoE sessions/PDP contexts and control lines. The control line addresses a particular PDP context using a special AT command within a Telnet session.

2.4.7. Traffic Flow Templates

Traffic Flow Templates (TFT) (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, Control Line via Telnet and via ORT.

3. 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.

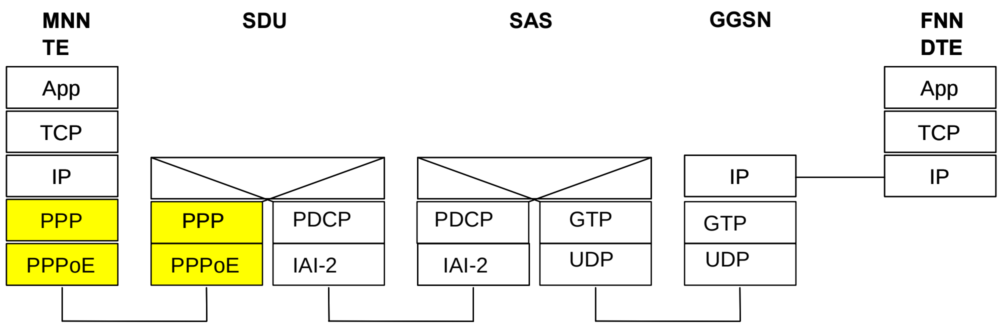

Figure 3: Protocol Stack for User Plane for Routed Multiple TE Devices

In multiple user operation, a bridge, hub or switch is placed between the MNN TE devices (each of which runs a PPPoE stack) and the SDU. The SDU is aware of all devices on the network.

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

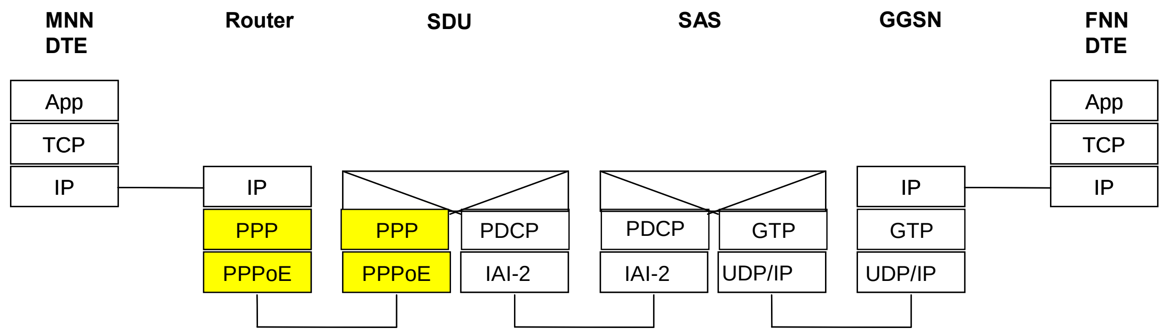

Figure 4: Protocol Stack for User Plane for Routed Multiple TE Device

In this case there is only a single device (the Router) that is requesting service – the SDU does not need to know that there are multiple MNN TEs. The advantage of this approach is that it does not require PPPoE in the TE.

3.3. Protocol Operation for BGAN Context Setup

The following describes the PPPoE set up message sequencing including specific messaging that should be expected when implementing a PPPoE interface to a SBB SDU.

3.3.1. PPPoE Sequence

The sequence diagram below shows in broad terms the stages needed to establish an IP call from a PPPoE client (TE).

ATTACHMENT 5
ETHERNET INTERFACE

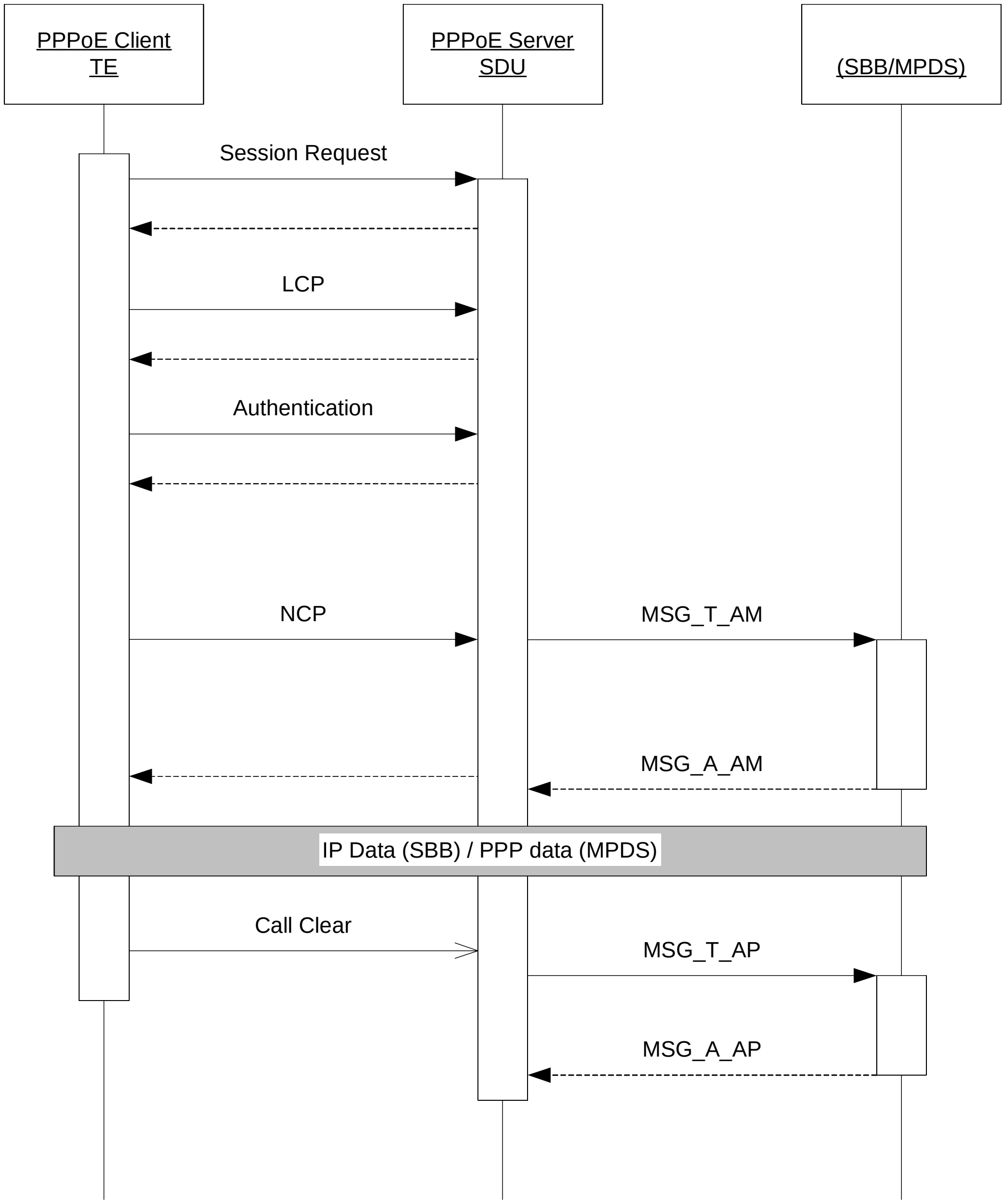

Figure 5: PPPoE IP Call

3.3.2. PPPoE Session

A PPPoE session needs to be established between the TE (PPPoE client) and the SDU (PPPoE server). This would involve the discovery protocol, Link Control Protocol (LCP), authentication and Network-layer Control Protocol (NCP) stages.

3.3.3. Discovery Stage

The discovery stage is initiated by the PPPoE client (TE) to find out if there are any PPPoE servers attached.

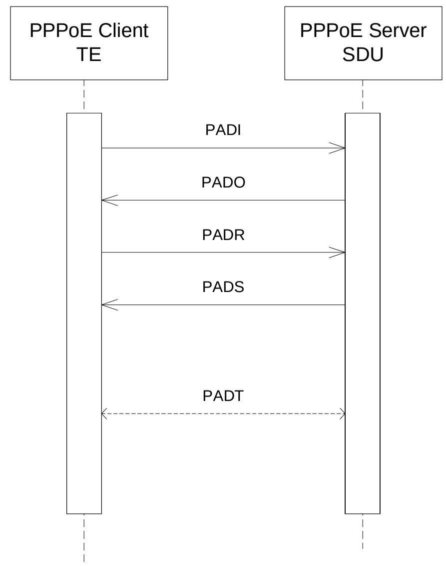

Figure 6: PPPoE Discovery

Stage	Comment
1	The PPPoE client (TE) broadcasts a PPPoE Active Discovery Initiation (PADI) packet. As it is a broadcast packet all attached devices on the network, including the SDU, will receive it.
2	The PPPoE server (SDU) receives the PADI and responds to the PPPoE client with a PPPoE Active Discovery Offer (PADO) packet. The PADO must uniquely identify the SDU. To achieve this MAC address of the SDU will be used as part of the PPPoE servers identifying name. Additionally the PADO may contain a number of Service-Name TAGs. These will be used to map to different SBB bearer types. The SDU shall only send the Service name that it believes are available.
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).

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 exchanges a user name and password between the TE's PPPoE client and the SDU's PPP Server.

The SDU shall successfully authenticate the TE regardless of what it has been presented with. (Spoof Authentication)

The SDU shall store the username and password 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 Section 7.**

The SDU shall support the following authentication protocols: CHAP and 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 recived a Activate PDP Context Accept message from the network. The Activate PDP Context contains the PPP IP parameters.

Failure of this phase will result in the PPPoE session being terminated

3.3.6.1. PPP Parameters interfacing to UMTS during NCP

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. IP forwarding will be used to forward all IP packets received by the SDU though the PPPoE session from the PPPoE client (TE).

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 shall contain a reason code that is mapped from the message derived from the Inmarsat cause code. These are documented in xxx

3.3.9. Access Concentrator Name

The SDU shall support the configuration of an Access Concentrator name via the ORT. A PPPoE client (TE) optionally can use this AC name in its PADI to target the session request directly to a SDU. This is needed where there are multiple SDU on a network.

ATTACHMENT 5
ETHERNET INTERFACE

3.3.10. PPPoE to Core SBB Network

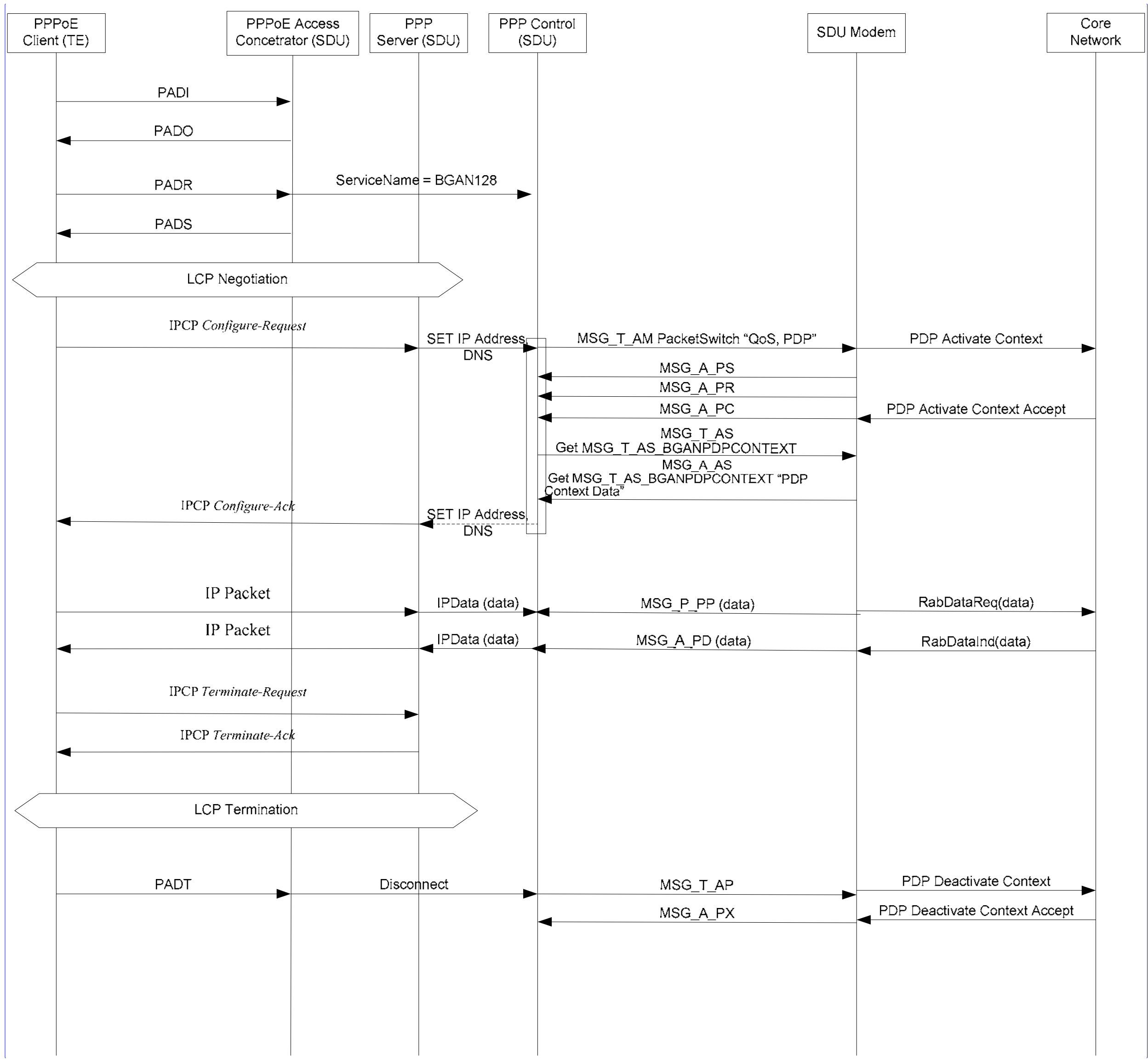

Figure 7: Message Sequencing Chart

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 parameters (separated by a colon). Some services require parameters.

Example: BGAN:STREAM64K

3.3.11.2. 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

3.3.11.3. 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

3.3.11.4. Parameters

Parameters are dependant on the service being requested.

3.3.11.4.1. 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 some ORT).

SBB Option Name	Description
BACKGROUND	Places a Primary Background PDP Context
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
STREAM256K	Places a Primary Streaming class PDP Context at the data rate of 256k
AT String	This allows the TE PPPoE client to enter a full AT Context activation string. The letters “AT” must be present. Example of full PPPoE service name string: BGAN: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

3.3.11.4.2. 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.

3.3.11.4.3. Parameter field for ISDN

This documents the Option field for the MPDS 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#

3.3.11.5. 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:STREAM256K{?}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 though SBB was available but it failed due to network congestion).

3.3.12. Offered Service-Name

PPPoE must, in response to a PADI, 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.

Note that as per RFC2516, the SDU will not send a PADO if the requested service is not 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.

4. 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. Without a control line, only a single Primary context connection per PPPoE session is supported, up to the maximum of 11 PDP contexts.

The PDP context can be set up and initiated either by the use of ORT profiles stored at the SDU, or by placing a full context definition AT string in the PADR PPPoE message.

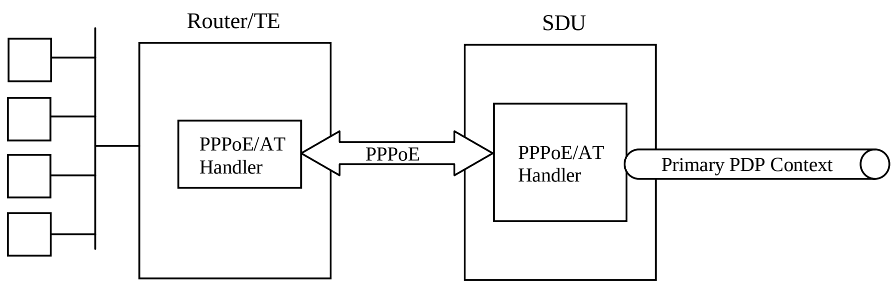

Figure 8: Stage 1, No Control Line, Single User

4.1.2. Interface Stage 1 implementation (no control line) multi user

The following shows the relationship between a single TE and a SDU, but with multiple Primary PDP contexts open. Again, each context is initiated then supported in a separate PPPoE Session and no Secondary contexts or context modification is possible.

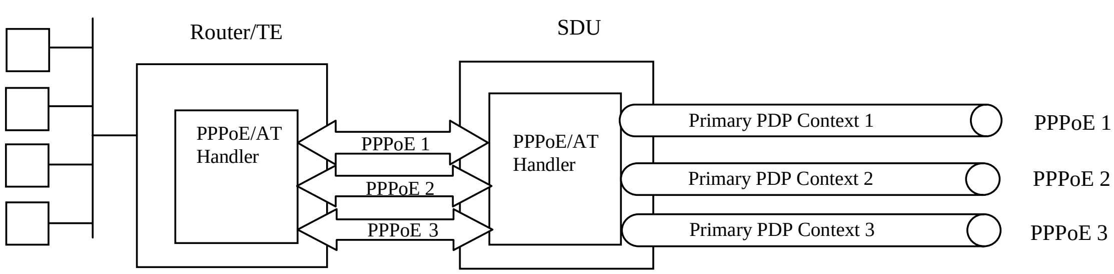

Figure 9: Stage 1, No Control Line, Multiple Pppoe Sessions

4.2. Out of Band Control Line

4.2.1. Control Line Concept and Stack diagram

The ability to readily modify and initiate additional secondary PDP contexts is a required feature of a scaleable SwiftBroadband based system. The following introduces and explains the concept of an 'out of band control line' between TE and SDU.

Using PPPoE as an interface mechanism between a TE and a SDU does have limitations. The PDP context definition, QoS and activation AT command strings have to be presented together via the PADR tag during the initial PPPoE Active Discovery Phase. Once this phase is complete, then no further transport mechanism is available. This does pose a problem. Should the need arise for further TE to SDU transaction such as establishing a Secondary Context and Traffic Flow template, then PPPoE itself is not sufficient. This limitation highlights the need for a dedicated out of band TE to SDU control line.

To address this limitation, a Telnet session shall be used at the application layer to handle the AT commands for the purpose of implementing a control line. This requires the SDU to implement a Telnet server to pass AT commands to the SDU, and a TE with a Telnet based application to interact with it.

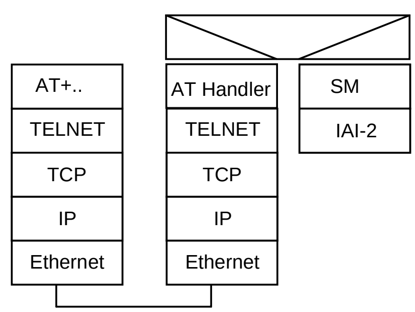

Figure 10: Protocol Stack for a TE to SDU Control Line

4.2.2. Interface Stage 2 implementation (with control line)

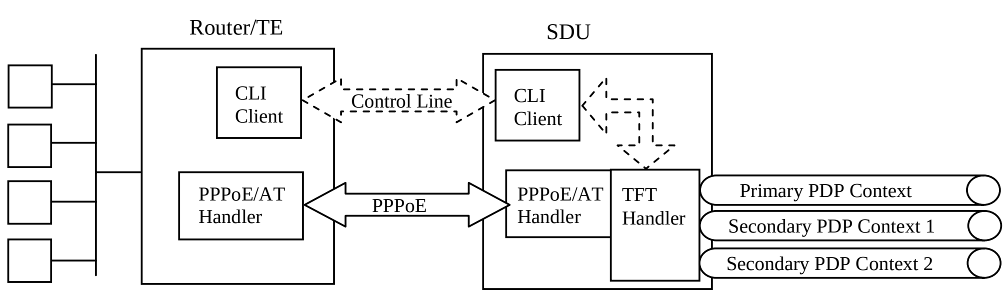

Figure 11: Stage 2, Control Line Added, Single Pppoe Session

In addition to the standard PPPoE handler, a CLI (command line interface) 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 TBD Annex 1.??

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.

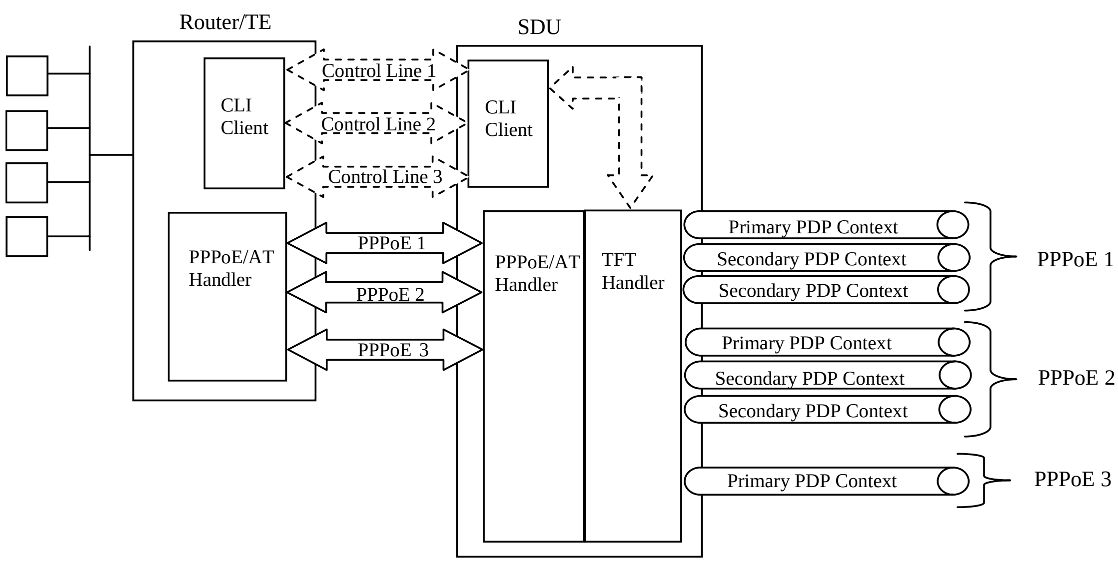

Figure 12: Stage 2, Control Line Added, Multiple Contexts/Pppoe Sessions Sharing

In the previous diagram, the SDU has seven active contexts. Following the convention described, three PPPoE sessions are required. This scheme should also be used with a stage 1 implementation as well,, where each separate primary context would therefore have its own PPPoE session.

The number of control lines shown in the diagram is not mandatory

4.2.3. Stage 3 implementation

As a further development, using the same interface as in the previous section, it may be desirable for a single/multiple SDUs to support multiple router/TEs. The diagram below shows such a configuration.

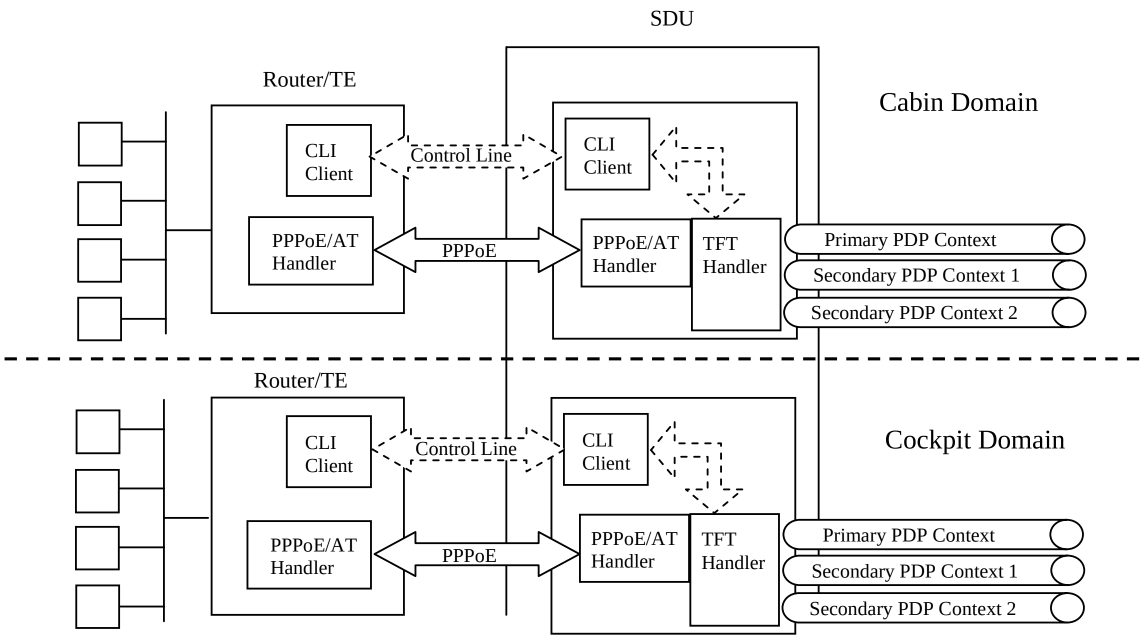

Figure 13: Stage 3, Multiple Router/Tes With A Single SDU

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 for multiple TCP client session.

4.2.4.1. AT Handler

The telnet session shall be implemented to accept UMTS TS 27.007 commands and defined extensions for the purpose of command and control of Secondary PDP Context and Traffic Flow Templates.

4.2.5. 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.

4.2.7. AT Command Extension for Binding a Telnet Session to PDP Primary Context

The AT command for binding between a Telnet 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 Telnet session; it shall not available via PPPoE.

Command		Possible response(s)
Set Command	_IPDPS=<PDP_addr>	OK ERROR
Read Command	_IPDPS?	_IPDPS: <PDP_addr>
Test Command	_IPDPS=?	ERROR
Unsolicited result code		_IPDPS: <PDP_addr>

4.2.7.1. Set Command

The set command specifies one <PDP_addr> to be selected with the Telnet Session that sends the set command. Each <PDP_addr> has a corresponding PPPoE Session. All subsequent PDP Context related AT commands from the Telnet 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 <PDP_addr> does not exist.

4.2.7.2. Read Command

The read command returns the currently selected `<PDP_addr>` by the Telnet Session that sends the read command. If no PPPoE Session selected, `<NULL_PDP_addr>` is returned.

4.2.7.3. Test Command

Not supported.

4.2.7.4. Unsolicited Result Code

For each unsolicited AT result code, it shall be preceded with a unsolicited result code of _IPDPS:. For those unsolicited AT result codes that are not related to PDP Context, _IPDPS: <NULL_PDP_addr> shall be used.

For example:

A Telnet Session is associated with two PPPoE Sessions. One Secondary PDP Context has been deactivated by the Network.

`_IPDPS: <PDP_addr_1>` // the following result code relates to `<PDP_addr_1>`

`NO CARRIER` // indicating one of the PDP Contexts has been

// terminated when +CGEREP is disabled

`AT_IPDPS=<PDP_addr_1>` // to find out which PDP Contexts has been terminated

`AT+CGACT?` // by querying the remaining activated PDP Contexts of

// `<PDP_addr_1>`

{note: for certain generic unsolicited AT result *codes, the SDU may send them to all relevant Telnet Sessions.}*

4.2.7.5. Defined Values

`<PDP_addr>`: a string parameter that identifies the PPPoE by the address of the Primary PDP Context. At present only IPv4 addresses **are** supported in the form of `aaa.bbb.ccc.ddd`.

`<NULL_PDP_addr>`: a string parameter that identifies the null Primary PDP Context, i.e. for AT commands that are not related to an established Primary PDP Context. At present only IPv4 addresses **are** supported in the form of `0.0.0.0`.

4.3. Scaling PDP Contexts Concepts

Presented below are four examples of how one might wish to scale the BGAN service mid connection.

In the following simplified examples an initial Primary PDP context of streaming class 32 kb/s is negotiated and activated via the initial PPPoE connection. The need arises for a higher bandwidth streaming class connection.

4.3.1. Scaling a PDP Context without a Control Line

4.3.1.1. Additional Secondary/Primary Context (stage 1)

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 secondary or new primary context.

Here, the current PDP context is terminated and a new higher bandwidth context is defined and activated. Though this is a valid method of scaling up the bandwidth available, it does require that the controlling server handling IP traffic have the ability to buffer the IP traffic in order to suspend the session whilst the new context is initiated. Ideally the same IP address would be allocated to the new context by means of a static IP request in the PDP context definition. Though the actual time to carry out this exchange is minimal, this is unacceptable to certain traffic types, transcoded GSM voice calls and other application types may be intolerant of the momentary interruption in end-to-end IP connectivity.

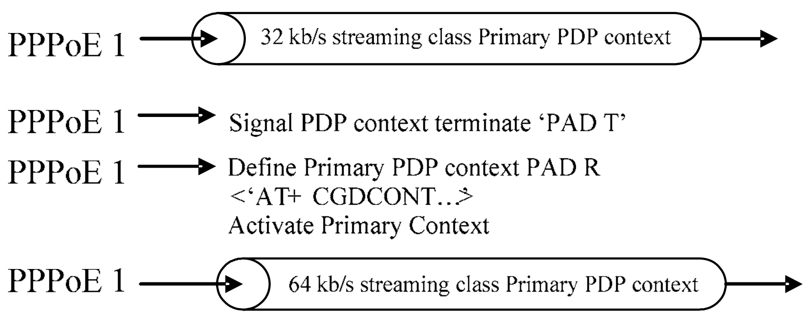

Figure 14: Scaling with New Primary Context

4.3.1.2. Additional Primary Context (stage 1, 2 and 3)

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.

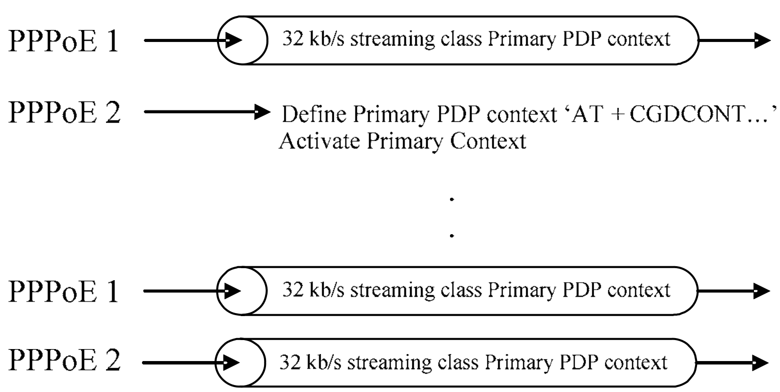

Figure 15: Scaling with Additional Primary Context

4.3.2. Scaling a PDP Context with a control line

4.3.2.1. Additional Secondary Context (stage 2 and 3)

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, then enforced traffic separation, by port address for example, is not desirable.

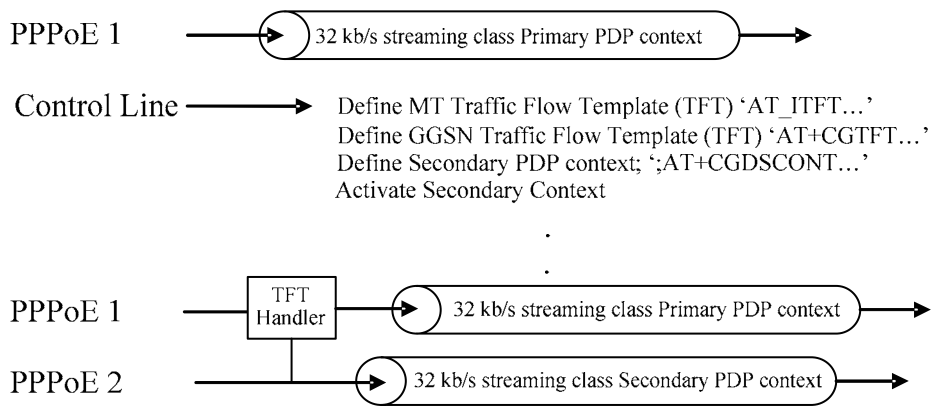

Figure 16: Scaling with Additional Secondary Context

4.3.2.2. PDP Context Modify (stage 2 and 3)

With a control line available, it is possible to signal to ‘Modify’ the current PDP context 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.

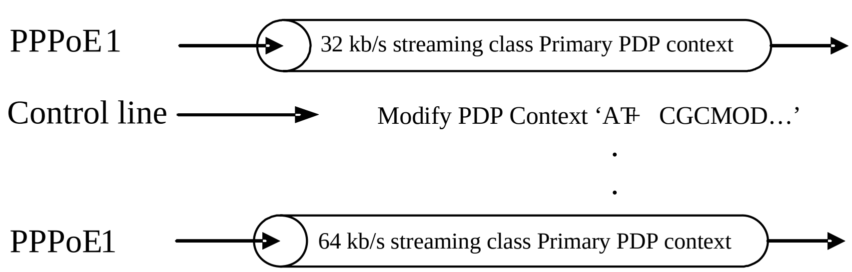

Figure 17: Scaling By Modifying the Primary Context

```
            PrimaryContextDescriptor plusCGDCONT;
            SecondaryContextDescriptor plusCGDSCONT;
        }
        PDPQualityOfService plusCGEREQ OPTIONAL;
        PDPTrafficFlowTemplates SEQUENCE (0..8) OF plusCGTFT;
}
```

4.4. Recommended Pairing AT Command

The recommended AT command for binding between a Telnet Session and one ore 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 Telnet session; it shall not available via PPPoE.

Command		**Possible response(s)**
Set Command	`_IPDPS=<PDP_addr>`	`OK` `ERROR`
Read Command	`_IPDPS?`	`_IPDPS: <PDP_addr>`
Test Command	`_IPDPS=?`	`ERROR`
Unsolicited result code		`_IPDPS: <PDP_addr>`

4.4.1. Set Command

The set command specifies one `<PDP_addr>` to be selected with the Telnet Session that sends the set command. Each `<PDP_addr>` has a corresponding PPPoE Session. All subsequent PDP Context related AT commands from the Telnet 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 `<PDP_addr>` does not exist.

4.4.2. Read Command

The read command returns the currently selected `<PDP_addr>` by the Telnet Session that sends the read command. If no PPPoE Session selected, `<NULL_PDP_addr>` is returned.

4.4.3. Test Command

Not supported.

4.4.4. Unsolicited Result Code

For each unsolicited AT result code, it shall be preceded with a unsolicited result code of _IPDPS:. For those unsolicited AT result codes that are not related to PDP Context, _IPDPS: <NULL_PDP_addr> shall be used.

For example:

A Telnet Session is associated with two PPPoE Sessions. One Secondary PDP Context has been deactivated by the Network.

_IPDPS: <PDP_addr_1>	// the following result code relates to <PDP_addr_1>
NO CARRIER	// indicating one of the PDP Contexts has been
	// terminated when +CGEREP is disabled
AT_IPDPS=<PDP_addr_1>	// to find out which PDP Contexts has been
terminated	
AT+CGACT?	// by querying the remaining activated PDP Contexts
of	
	// <PDP_addr_1>

{note: for certain generic unsolicited AT result *code, the SDU may send them to all relevant Telnet Sessions.}*

4.4.5. Defined Values

<PDP_addr>: a string parameter that identifies the PPPoE by the address of the Primary PDP Context. At present only IPv4 addresses **are**~~is~~ supported in the form of aaa.bbb.ccc.ddd.

<NULL_PDP_addr>: a string parameter that identifies the null Primary PDP Context, i.e. for AT commands that are not related to an established Primary PDP Context. At present only IPv4 addresses **are** supported in the form of 0.0.0.0.

4.5. 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 terminated by a CRLF pair. The entire ServiceName TAG_value string is not null terminated.

The following rules apply:

- The ServiceName TAG_value may include exactly one or both **of** +CGDCONT or +CGDSCONT.
- The ServiceName TAG_value may then include **a value of** either 0 or 1 of +CGEQREQ.
- The ServiceName TAG_value may then include **values** between 0 and 8 of +CGTFT.

This is described in ASN.1 terminology below:

```
ServiceNameTAG_value ::= {
    PDPContextType CHOICE {
```

4.6. AT Commands

4.6.1. Relevant TS 27.007 Commands

4.6.1.1. Define PDP Context +CGDCONT

Command	Possible response(s)
+CGDCONT=[<cid> [,<PDP_type> [,<APN> [,<PDP_addr> [,<d_comp> [,<h_comp> [,<pd1> [,…[,pdN]]]]]]]]]	OK ERROR
+CGDCONT?	+CGDCONT: <cid>, <PDP_type>, <APN>,<PDP_addr>, <d_comp>, <h_comp>[,<pd1>[,…[,pdN]]] [<CR><LF>+CGDCONT: <cid>, <PDP_type>, <APN>,<PDP_addr>, <d_comp>, <h_comp>[,<pd1>[,…[,pdN]]] [...]]
+CGDCONT=?	+CGDCONT: (range of supported <cid>s), <PDP_type>,,,(list of supported <d_comp>s), (list of supported <h_comp>s)[,(list of supported <pd1>s)[,…[,(list of supported <pdN>s)]]] [<CR><LF>+CGDCONT: (range of supported <cid>s), <PDP_type>,,,(list of supported <d_comp>s), (list of supported <h_comp>s)[,(list of supported <pd1>s)[,…[,(list of supported <pdN>s)]]] [...]]

Description

The set command specifies PDP context parameter values for a PDP context identified by the (local) context identification parameter, `<cid>`. The number of PDP contexts that may be in a defined state at the same time is given by the range returned by the test command.

A special form of the set command, +CGDCONT= <cid> causes the values for context number <cid> to become undefined.

The read command returns the current settings for each defined context.

The test command returns values supported as a compound value. If the SDU supports several PDP types, <PDP_type>, the parameter value ranges for each <PDP_type> are returned on a separate line.

Defined values

`<cid>`: (PDP Context Identifier) a numeric parameter which specifies a particular PDP context definition. The parameter is local to the TE-MT interface and is used in other PDP context-related commands. The range of permitted values (minimum value = 1) is returned by the test form of the command.

`<PDP_type>`: (Packet Data Protocol type) a string parameter which specifies the type of packet data protocol

X.25	ITU-T/CCITT X.25 layer 3 (Obsolete)
IP	Internet Protocol (IETF STD 5)
IPV6	Internet Protocol, version 6 (IETF RFC 2460)
OSPIH	Internet Hosted Octect Stream Protocol (Obsolete)
PPP	Point to Point Protocol (IETF STD 51)

`<APN>`: (Access Point Name) a string parameter which is a logical name that is used to select the GGSN or the external packet data network.

If the value is null or omitted, then the subscription value will be requested.

`<address>`: a string parameter that identifies the MT in the address space applicable to the PDP.

If the value is null or omitted, then a value may be provided by the TE during the PDP startup procedure or, failing that, a dynamic address will be requested.

The read form of the command will continue to return the null string even if an address has been allocated during the PDP startup procedure. The allocated address may be read using the +CGPADDR command.

`<d_comp>`: a numeric parameter that controls PDP data compression (applicable for SNDCP only) (refer 3GPP TS 44.065 [61])

0 - off (default if value is omitted)
1 - on (manufacturer preferred compression)
2 - V.42bis
3 - V.44

Other values are reserved.

`<h_comp>`: a numeric parameter that controls PDP header compression (refer 3GPP TS 44.065 [61] and 3GPP TS 25.323 [62])

0 - off (default if value is omitted)
1 - on (manufacturer preferred compression)
2 - RFC1144 (applicable for SNDCP only)
3 - RFC2507
4 - RFC3095 (applicable for PDCP only)

Other values are reserved.

`<pd1>`, … `<pdN>`: zero to N string parameters whose meanings are specific to the `<PDP_type>`

4.6.1.2. Define Secondary PDP Context +CGDSCONT

Command	Possible response(s)
+CGDSCONT=[<cid> ,<p_cid> [,<d_comp> [,<h_comp>]]]	OK ERROR
+CGDSCONT?	+CGDSCONT: <cid>, <p_cid>, <d_comp>, <h_comp> [<CR><LF>+CGDSCONT: <cid>, <p_cid>, <d_comp>, <h_comp> [...]]
+CGDSCONT=?	+CGDSCONT: (range of supported <cid>s), (list of <cid>s for active primary contexts), (list of supported <d_comp>s), (list of supported <h_comp>s)

Description

The set command specifies PDP context parameter values for a Secondary PDP context identified by the (local) context identification parameter, `<cid>`. The number of PDP contexts that may be in a defined state at the same time is given by the range returned by the test command.

A special form of the set command, +CGDSCONT= `<cid>` causes the values for context number `<cid>` to become undefined.

The read command returns the current settings for each defined context.

Defined values

`<cid>`: (PDP Context Identifier) a numeric parameter which specifies a particular PDP context definition. The parameter is local to the TE-MT interface and is used in other PDP context-related commands. The range of permitted values (minimum value = 1) is returned by the test form of the command.

`<p_cid>`: (Primary PDP Context Identifier) a numeric parameter which specifies a particular PDP context definition which has been specified by use of the +CGDCONT command. The parameter is local to the TE-MT interface. The list of permitted values is returned by the test form of the command.

`<d_comp>`: a numeric parameter that controls PDP data compression (applicable for SNDCPonly) (refer 3GPP TS 44.065 [61])

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0 - off (default if value is omitted)
1 - on (manufacturer preferred compression)
2 - V.42bis
3 - V.44

Other values are reserved.

<h_comp>: a numeric parameter that controls PDP header compression (refer 3GPP TS 44.065 [61] and 3GPP TS 25.323 [62])

0 - off (default if value is omitted)
1 - on (manufacturer preferred compression)
2 - RFC1144 (applicable for SNDCP only)
3 - RFC2507
4 - RFC3095 (applicable for PDCP only)

Other values are reserved.

4.6.2. UT Traffic Flow Template _ITFT

3GPP Specification	Section
Implementation	Mandatory
Notes	Implementation generally to TS 27.007 Clause 10.2.3 except this command shall implement the TFT in the UT (rather than in the GGSN) – note the reversal of source address for destination address and some minor restrictions.

Command	Possible Response(s)
_ITFT=[<cid>, [<packet filter identifier>, <evaluation precedence index> [,<destination address and subnet mask> [,<protocol number (ipv4)> [,<destination port range> [,<source port range> [,<ipsec security parameter index (spi)> [,<type of service (tos) (ipv4) and mask>]]]]]]]]	OK ERROR
_ITFT?	_ITFT: <cid>, <packet filter identifier>, <evaluation precedence index>, <destination address and subnet mask>, <protocol number (ipv4)>, <destination port range>, <source port range>, <ipsec security parameter index (spi)>, <type of service (tos) (ipv4) and mask > [<CR><LF>_ITFT: … […]]
_ITFT=?	_ITFT: <PDP_type>, (list of supported <packet filter identifier>s), (list of supported <evaluation precedence index>s), (list of supported <destination address and subnet mask>s), (list of supported <protocol number (ipv4)>s), (list of supported <destination port range>s), (list of supported <source port range>s), (list of supported <ipsec security parameter index (spi)>s), (list of supported <type of service (tos) (ipv4) and mask >s)

In the following description **underlined** values are changes from TS 27.007 _CGTFT

Description

This command allows the TE to specify a Packet Filter - PF for a Traffic Flow Template - TFT that is used in the Terminal for routing of up-link packets onto different QoS flows towards the Core Network. The concept is further described in the 3GPP TS 23.060

A TFT consists of from one and up to four Packet Filters, each identified by a unique <packet filter identifier>. A Packet Filter also has an <evaluation precedence index> that is unique within all TFTs associated with all PDP contexts that are associated with the same PDP address.

The set command specifies a Packet Filter~~s~~ that is to be added to the TFT stored in the MT and used for the context identified by the (local) context identification parameter, <cid>. Since this is the same parameter that is used in the +CGDCONT and +CGDSCONT commands, the _ITFT command is effectively an extension to these commands. The Packet Filters consist of a number of parameters, each of which may be set to a separate value.

A special form of the set command, _ITFT= <cid> causes all of the Packet Filters in the TFT for context number <cid> to become undefined. At any time there may exist only one PDP context with no associated TFT amongst all PDP contexts associated to one PDP address. At an attempt to delete a TFT, which would violate this rule, an ERROR or +CME ERROR response is returned. Extended error responses are enabled by the +CMEE command.

The read command returns the current settings for all Packet Filters for each defined context.

The test command returns values supported as a compound value. TFTs shall be used for PDP-type IP and PPP only. For PDP-type PPP a TFT is applicable only when IP traffic is carried over PPP. If PPP carries header-compressed IP packets, then a TFT cannot be used.

Defined values

`<cid>`: a numeric parameter which specifies a particular PDP context definition (see the +CGDCONT and +CGDSCONT commands).

The following parameters are defined in 3GPP TS 23.060[47] -

`<packet filter identifier>`: Numeric parameter, value range from 1 to 4.

`<destination address and subnet mask>`: Consists of dot-separated numeric (0-255) parameters on the form 'a1.a2.a3.a4.m1.m2.m3.m4', for IPv4. (Only one address **is** supported, although SubNet Mask may extend this to a range of addresses)

`<protocol number (ipv4)>`: Numeric parameter, value range from 0 to 255.

<destination port range>: Consists of dot-separated numeric (0-65535) parameters on the form 'f.t'. (Only one port range to be supported)

<source port range>:Consists of dot-separated numeric (0-65535) parameters on the form 'f.t'. (Only one port range to be supported)

<ipsec security parameter index (spi)>: Hexadecimal parameter, value range from 00000000 to FFFFFFFF. Support for this parameter to be optional.

<type of service (tos) (ipv4) and mask>:
Dot-separated numeric (0-255) parameters on the form 't.m'.

<evaluation precedence index>: Numeric parameter, value range from 0 to 255.

4.6.3. Traffic Flow Template +CGTFT

Command	Possible Response(s)
+CGTFT=[<cid>, [<packet filter identifier>, <evaluation precedence index> [,<source address and subnet mask> [,<protocol number (ipv4) / next header (ipv6)> [,<destination port range> [,<source port range> [,<ipsec security parameter index (spi)> [,<type of service (tos) (ipv4) and mask / traffic class (ipv6) and mask> [,<flow label (ipv6)>]]]]]]]]]	OK ERROR
+CGTFT?	+CGTFT: <cid>, <packet filter identifier>, <evaluation precedence index>, <source address and subnet mask>, <protocol number (ipv4) / next header (ipv6)>, <destination port range>, <source port range>, <ipsec security parameter index (spi)>, <type of service (tos) (ipv4) and mask / traffic class (ipv6) and mask>, <flow label (ipv6)> [<CR><LF>+CGTFT: <cid>, <packet filter identifier>, <evaluation precedence index>, <source address and subnet mask>, <protocol number (ipv4) / next header (ipv6)>, <destination port range>, <source port range>, <ipsec security parameter index (spi)>, <type of service (tos) (ipv4) and mask / traffic class (ipv6) and mask>, <flow label (ipv6)> […]]
+CGTFT=?	+CGTFT: <PDP_type>, (list of supported <packet filter identifier>s), (list of supported <evaluation precedence index>s), (list of supported <source

Command	Possible Response(s)
	address and subnet mask>s), (list of supported <protocol number (ipv4) / next header (ipv6)>s), (list of supported <destination port range>s), (list of supported <source port range>s), (list of supported <ipsec security parameter index (spi)>s), (list of supported <type of service (tos) (ipv4) and mask / traffic class (ipv6) and mask>s), (list of supported <flow label (ipv6)>s) [<CR><LF>+CGTFT: <PDP_type>, (list of supported <packet filter identifier>s), (list of supported <evaluation precedence index>s), (list of supported <source address and subnet mask>s), (list of supported <protocol number (ipv4) / next header (ipv6)>s), (list of supported <destination port range>s), (list of supported <source port range>s), (list of supported <ipsec security parameter index (spi)>s), (list of supported <type of service (tos) (ipv4) and mask / traffic class (ipv6) and mask>s), (list of supported <flow label (ipv6)>s) […]]

Description

This command allows the TE to specify a Packet Filter - PF for a Traffic Flow Template - TFT that is used in the GGSN for routing of down-link packets onto different QoS flows towards the TE. The concept is further described in the 3GPP TS 23.060[47]. A TFT consists of from one to eight Packet Filters, each identified by a unique `<packet filter identifier>`. A Packet Filter also has an `<evaluation precedence index>` that is unique within all TFTs associated with all PDP contexts that are associated with the same PDP address.

The set command specifies a Packet Filters that is to be added to the TFT stored in the MT and used for the context identified by the (local) context identification parameter, `<cid>`. The specified TFT will be stored in the GGSN only at activation or MS-initiated modification of the related context. Since this is the same parameter that is used in the +CGDCONT and +CGDSCONT commands, the +CGTFT command is effectively an extension to these commands. The Packet Filters consist of a number of parameters, each of which may be set to a separate value.

A special form of the set command, +CGTFT= `<cid>` causes all of the Packet Filters in the TFT for context number `<cid>` to become undefined. At any time there may exist only one PDP context with no associated TFT amongst all PDP contexts associated to one PDP address. At an attempt to delete a TFT, which would violate this rule, an ERROR or +CME ERROR response is returned. Extended error responses are enabled by the +CMEE command.

The read command returns the current settings for all Packet Filters for each defined context.

The test command returns values supported as a compound value. If the MT supports several PDP types, the parameter value ranges for each PDP type are returned on a separate line. TFTs shall be used for PDP-type IP and PPP only. For PDP-type PPP, a TFT is applicable only when IP traffic is carried over PPP. If PPP carries header-compressed IP packets, then a TFT cannot be used.

Defined values

`<cid>`: a numeric parameter which specifies a particular PDP context definition (see the +CGDCONT and +CGDSCONT commands).

The following parameters are defined in 3GPP TS 23.060[47] -

`<packet filter identifier>`: Numeric parameter, value range from 1 to 8.

`<source address and subnet mask>`: Consists of dot-separated numeric (0-255) parameters on the form 'a1.a2.a3.a4.m1.m2.m3.m4', for IPv4 and
'a1.a2.a3.a4.a5.a6.a7.a8.a9.a10.a11.a12.a13.a14.a15.a16.
m1.m2.m3.m4.m5.m6.m7.m8.m9.m10.m11.m12.m13.m14.m15.m16', for IPv6.

`<protocol number (ipv4) / next header (ipv6)>`: Numeric parameter, value range from 0 to 255.

`<destination port range>`: Consists of dot-separated numeric (0-65535) parameters on the form 'f.t'.

`<source port range>`:Consists of dot-separated numeric (0-65535) parameters on the form 'f.t'.

`<ipsec security parameter index (spi)>`: Hexadecimal parameter,
value range from 00000000 to FFFFFFFF.

`<type of service (tos) (ipv4) and mask / traffic class (ipv6) and mask>`:
Dot-separated numeric (0-255) parameters on the form 't.m'.

`<flow label (ipv6)>`: Hexadecimal parameter, value range from 00000 to FFFFF. Valid for IPv6 only.

`<evaluation precedence index>`: Numeric parameter, value range from 0 to 255.

Some of the above listed attributes may coexist in a Packet Filter while others mutually exclude each other. The possible combinations are shown in 3GPP TS 23.060[47].

4.6.3.1. Quality of Service Profile (Requested) +CGQREQ

Command	Possible Response(s)
`+CGQREQ=[<cid> [,<precedence > [,<delay> [,<reliability.> [,<peak> [,<mean>]]]]]]`	OK ERROR
`+CGQREQ?`	`+CGQREQ: <cid>, <precedence >, <delay>, <reliability>, <peak>, <mean> [<CR><LF>+CGQREQ: <cid>, <precedence >, <delay>, <reliability.>, <peak>, <mean> […]]`
`+CGQREQ=?`	`+CGQREQ: <PDP_type>, (list of supported <precedence>s), (list of supported <delay>s), (list of supported <reliability>s) , (list of supported <peak>s), (list of supported <mean>s) [<CR><LF>+CGQREQ: <PDP_type>, (list of supported <precedence>s), (list of supported <delay>s), (list of supported <reliability>s) , (list of supported <peak>s), (list of supported <mean>s) […]]`

Description

This command allows the TE to specify a Quality of Service Profile that is used when the MT sends an Activate PDP Context Request message to the network.

The set command specifies a profile for the context identified by the (local) context identification parameter, `<cid>`. Since this is the same parameter that is used in the `+CGDCONT` and `+CGDSCONT` commands, the `+CGQREQ` command is effectively an extension to these commands. The QoS profile consists of a number of parameters, each of which may be set to a separate value.

A special form of the set command, `+CGQREQ= <cid>` causes the requested profile for context number `<cid>` to become undefined.

The read command returns the current settings for each defined context.

The test command returns values supported as a compound value. If the MT supports several PDP types, the parameter value ranges for each PDP type are returned on a separate line.

Defined values

`<cid>`: a numeric parameter which specifies a particular PDP context definition (see the +CGDCONT and +CGDSCONT commands).

The following parameters are defined in 3GPP TS 23.107 [46]:

`<precedence>`: a numeric parameter which specifies the precedence class

<delay>: a numeric parameter which specifies the delay class

<reliability>: a numeric parameter which specifies the reliability class

<peak>: a numeric parameter which specifies the peak throughput class

<mean>: a numeric parameter which specifies the mean throughput class

If a value is omitted for a particular class, then the value is considered to be unspecified.

4.6.3.2. 3G Quality of Service Profile (Requested) +CGEQREQ

Command	Possible Response(s)
+CGEQREQ=[<cid> [,<Traffic class> [,<Maximum bitrate UL> [,<Maximum bitrate DL> [,<Guaranteed bitrate UL> [,<Guaranteed bitrate DL> [,<Delivery order> [,<Maximum SDU size> [,<SDU error ratio> [,<Residual bit error ratio> [,<Delivery of erroneous SDUs> [,<Transfer delay> [,<Traffic handling priority>]]]]]]]]]]]]]	OK ERROR
+CGEQREQ?	+CGEQREQ: <cid>, <Traffic class> ,<Maximum bitrate UL> ,<Maximum bitrate DL> ,<Guaranteed bitrate UL> ,<Guaranteed bitrate DL> ,<Delivery order> ,<Maximum SDU size> ,<SDU error ratio> ,<Residual bit error ratio> ,<Delivery of erroneous SDUs> ,<Transfer delay> ,<Traffic handling priority> [<CR><LF>+CGEQREQ: <cid>, <Traffic class> ,<Maximum bitrate UL> ,<Maximum bitrate DL> ,<Guaranteed bitrate UL> ,<Guaranteed bitrate DL> ,<Delivery order> ,<Maximum SDU size> ,<SDU error ratio> ,<Residual bit error ratio> ,<Delivery of erroneous SDUs> ,<Transfer delay> ,<Traffic handling priority> […]]
+CGEQREQ=?	+CGEQREQ: <PDP_type>, (list of supported <Traffic class>s) ,(list of supported <Maximum bitrate UL>s), (list of supported <Maximum bitrate DL>s), (list of supported <Guaranteed bitrate UL>s), (list of supported <Guaranteed bitrate DL>s),(list of supported <Delivery order>s) ,(list of supported <Maximum SDU size>s) ,(list of supported <SDU error ratio>s) ,(list of supported <Residual bit error ratio>s) ,(list of supported <Delivery of

Command	Possible Response(s)
	erroneous SDUs>s) ,(list of supported <Transfer delay>s) ,(list of supported <Traffic handling priority>s) [<CR><LF>+CGEQREQ: <PDP_type>, (list of supported <Traffic class>s) ,(list of supported <Maximum bitrate UL>s), (list of supported <Maximum bitrate DL>s), (list of supported <Guaranteed bitrate UL>s), (list of supported <Guaranteed bitrate DL>s),(list of supported <Delivery order>s) ,(list of supported <Maximum SDU size>s) ,(list of supported <SDU error ratio>s) ,(list of supported <Residual bit error ratio>s) ,(list of supported <Delivery of erroneous SDUs>s) ,(list of supported <Transfer delay>s) ,(list of supported <Traffic handling priority>s) […]]

Description

This command allows the TE to specify a UMTS Quality of Service Profile that is used when the MT sends an Activate PDP Context Request message to the network.

The set command specifies a profile for the context identified by the (local) context identification parameter, `<cid>`. The specified profile will be stored in the MT and sent to the network only at activation or MS-initiated modification of the related context. Since this is the same parameter that is used in the +CGDCONT and +CGDSCONT commands, the +CGEQREQ command is effectively an extension to these commands. The QoS profile consists of a number of parameters, each of which may be set to a separate value.

A special form of the set command, +CGEQREQ= `<cid>` causes the requested profile for context number `<cid>` to become undefined.

The read command returns the current settings for each defined context.

The test command returns values supported as a compound value. If the MT supports several PDP types, the parameter value ranges for each PDP type are returned on a separate line.

Defined values

`<cid>`: a numeric parameter which specifies a particular PDP context definition (see +CGDCONT and +CGDSCONT commands).

The following parameters are defined in 3GPP TS 23.107 [46] -

`<Traffic class>:` a numeric parameter that indicates the type of application for which the UMTS bearer service is optimised.

0 - conversational
1 - streaming
2 - interactive
3 - background
4 - subscribed value

If the Traffic class is specified as conversational or streaming, then the Guaranteed and Maximum bitrate parameters should also be provided. Other values are reserved.

`<Maximum bitrate UL>`: a numeric parameter that indicates the maximum number of kbits/s delivered to UMTS (up-link traffic) at a SAP. As an example a bitrate of 32kbit/s would be specified as '32' (e.g. AT+CGEQREQ=…,32, …). This parameter should be provided if the Traffic class is specified as conversational or streaming (refer TS 24.008 [8] subclause 10.5.6.5).

`<Maximum bitrate DL>`: a numeric parameter that indicates the maximum number of kbits/s delivered by UMTS (down-link traffic) at a SAP. As an example a bitrate of 32kbit/s would be specified as '32' (e.g. AT+CGEQREQ=…,32, …). If the parameter is set to '0' the subscribed value will be requested. This parameter should be provided if the Traffic class is specified as conversational or streaming (refer TS 24.008 [8] subclause 10.5.6.5).

`<Guaranteed bitrate UL>:` a numeric parameter that indicates the guaranteed number of kbits/s delivered to UMTS (up-link traffic) at a SAP (provided that there is data to deliver). As an example a bitrate of 32kbit/s would be specified as '32' (e.g. AT+CGEQREQ=…,32, …). If the parameter is set to '0' the subscribed value will be requested. This parameter should be provided if the Traffic class is specified as conversational or streaming (refer TS 24.008 [8] subclause 10.5.6.5).

`<Guaranteed bitrate DL>:` a numeric parameter that indicates the guaranteed number of kbits/s delivered by UMTS (down-link traffic) at a SAP (provided that there is data to deliver). As an example a bitrate of 32kbit/s would be specified as '32' (e.g. AT+CGEQREQ=…,32, …). If the parameter is set to '0' the subscribed value will be requested. This parameter should be provided if the Traffic class is specified as conversational or streaming (refer TS 24.008 [8] subclause 10.5.6.5).

`<Delivery order>:` a numeric parameter that indicates whether the UMTS bearer shall provide in-sequence SDU delivery or not.

0 - no
1 - yes
2 - subscribed value.

Other values are reserved.

`<Maximum SDU size>:` a numeric parameter (1,2,3,…) that indicates the maximum allowed SDU size in octets. If the parameter is set to '0' the subscribed value will be requested (refer TS 24.008 [8] subclause 10.5.6.5).

`<SDU error ratio>:` a string parameter that indicates the target value for the fraction of SDUs lost or detected as erroneous. SDU error ratio is defined only for conforming traffic. The value is specified as 'mEe'. As an example a target SDU error ratio of $5 \cdot 10^{-3}$ would be specified as '5E3' (e.g. `AT+CGEQREQ=…,"5E3",…`). '0E0' means subscribed value (refer TS 24.008 [8] subclause 10.5.6.5).

`<Residual bit error ratio>:` a string parameter that indicates the target value for the undetected bit error ratio in the delivered SDUs. If no error detection is requested, Residual bit error ratio indicates the bit error ratio in the delivered SDUs. The value is specified as 'mEe'. As an example a target residual bit error ratio of $5 \cdot 10^{-3}$ would be specified as '5E3' (e.g. `AT+CGEQREQ=…,"5E3",…`). '0E0' means subscribed value (refer TS 24.008 [8] subclause 10.5.6.5).

`<Delivery of erroneous SDUs>:` a numeric parameter that indicates whether SDUs detected as erroneous shall be delivered or not.

0 - no
1 - yes
2 - no detect
3 - subscribed value

Other values are reserved.

`<Transfer delay>:` a numeric parameter (0,1,2,…) that indicates the targeted time between request to transfer an SDU at one SAP to its delivery at the other SAP, in milliseconds. If the parameter is set to '0', the subscribed value will be requested (refer TS 24.008 [8] subclause 10.5.6.5).

`<Traffic handling priority>:` a numeric parameter (1,2,3,…) that specifies the relative importance for handling of all SDUs belonging to the UMTS bearer compared to the SDUs of other bearers. If the parameter is set to '0', the subscribed value will be requested (refer TS 24.008 [8] subclause 10.5.6.5).

`<PDP_type>:` (see +CGDCONT and +CGDSCONT commands).

If a value is omitted for a particular class then the value is considered to be unspecified.

4.6.3.3. 3G Quality of Service Profile (Minimum Acceptable) +CGEQMIN

Command	Possible Response(s)
+CGEQMIN=[<cid> [,<Traffic class> [,<Maximum bitrate UL> [,<Maximum bitrate DL> [,<Guaranteed bitrate UL> [,<Guaranteed bitrate DL> [,<Delivery order> [,<Maximum SDU size> [,<SDU error ratio> [,<Residual bit error ratio> [,<Delivery of erroneous SDUs> [,<Transfer delay> [,<Traffic handling priority>]]]]]]]]]]]]]	OK ERROR
+CGEQMIN?	+CGEQMIN: <cid>, <Traffic class> ,<Maximum bitrate UL>, <Maximum bitrate DL> ,<Guaranteed bitrate UL> ,<Guaranteed bitrate DL>, <Delivery order> ,<Maximum SDU size> ,<SDU error ratio> ,<Residual bit error ratio> ,<Delivery of erroneous SDUs> ,<Transfer delay> ,<Traffic handling priority> [<CR><LF>+CGEQMIN: <cid>, <Traffic class> ,<Maximum bitrate UL> ,<Maximum bitrate DL> ,<Guaranteed bitrate UL> ,<Guaranteed bitrate DL>, <Delivery order> ,<Maximum SDU size> ,<SDU error ratio> ,<Residual bit error ratio> ,<Delivery of erroneous SDUs> ,<Transfer delay> ,<Traffic handling priority> […]]
+CGEQMIN=?	+CGEQMIN: <PDP_type>, (list of supported <Traffic class>s) ,(list of supported <Maximum bitrate UL>s) ,(list of supported <Maximum bitrate DL>s), (list of supported <Guaranteed bitrate UL>s), (list of supported <Guaranteed bitrate DL>s) ,(list of supported <Delivery order>s) ,(list of supported <Maximum SDU size>s) ,(list of supported <SDU error ratio>s) ,(list of supported <Residual bit error ratio>s) ,(list of supported <Delivery of erroneous SDUs>s) ,(list of supported <Transfer delay>s) ,(list of supported <Traffic handling priority>s) [<CR><LF>+CGEQMIN: <PDP_type>, (list of supported <Traffic class>s) ,(list of supported <Maximum bitrate UL>s), (list of supported <Maximum bitrate DL>s) ,(list of supported <Guaranteed bitrate UL >s), (list of supported <Guaranteed bitrate DL >s) ,(list of supported <Delivery order>s) ,(list of supported

Command	Possible Response(s)
	<Maximum SDU size>s) ,(list of supported <SDU error ratio>s) ,(list of supported <Residual bit error ratio>s) ,(list of supported <Delivery of erroneous SDUs>s) ,(list of supported <Transfer delay>s) ,(list of supported <Traffic handling priority>s) […]]

Description

This command allows the TE to specify a minimum acceptable profile, which is checked by the MT against the negotiated profile returned in the Activate/Modify PDP Context Accept message.

The set command specifies a profile for the context identified by the (local) context identification parameter, <cid>. The specified profile will be stored in the MT and checked against the negotiated profile only at activation or MS-initiated modification of the related context. Since this is the same parameter that is used in the +CGDCONT and +CGDSCONT commands, the +CGEQMIN command is effectively an extension to these commands. The QoS profile consists of a number of parameters, each of which may be set to a separate value.

A special form of the set command, +CGEQMIN= <cid> causes the minimum acceptable profile for context number <cid> to become undefined. In this case, no check is made against the negotiated profile.

The read command returns the current settings for each defined context.

The test command returns values supported as a compound value. If the MT supports several PDP types, the parameter value ranges for each PDP type are returned on a separate line.

Defined values

<cid>: a numeric parameter which specifies a particular PDP context definition (see +CGDCONT and +CGDSCONT commands).

The following parameters are defined in 3GPP TS 23.107 [46] -

<Traffic class>: a numeric parameter that indicates the type of application for which the UMTS bearer service is optimized.

0 - conversational
1 - streaming
2 - interactive
3 - background

Other values are reserved.

<Maximum bitrate UL>: a numeric parameter that indicates the maximum number of kbits/s delivered to UMTS (up-link traffic) at a SAP. As an example, a bitrate of 32kbit/s would be specified as '32' (e.g. AT+CGEQMIN=…,32, …) (refer TS 24.008 [8] subclause 10.5.6.5).

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<Maximum bitrate DL>: a numeric parameter that indicates the maximum number of kbits/s delivered by UMTS (down-link traffic) at a SAP. As an example, a bitrate of 32 kbit/s would be specified as '32' (e.g. AT+CGEQMIN=…,32, …) (refer TS 24.008 [8] subclause 10.5.6.5).

<Guaranteed bitrate UL>: a numeric parameter that indicates the guaranteed number of kbits/s delivered to UMTS (up-link traffic) at a SAP (provided that there is data to deliver). As an example, a bitrate of 32 kbit/s would be specified as '32' (e.g. AT+CGEQMIN=…,32, …) (refer TS 24.008 [8] subclause 10.5.6.5).

<Guaranteed bitrate DL>: a numeric parameter that indicates the guaranteed number of kbits/s delivered by UMTS (down-link traffic) at a SAP (provided that there is data to deliver). As an example, a bitrate of 32 kbit/s would be specified as '32' (e.g. AT+CGEQMIN=…,32, …) (refer TS 24.008 [8] subclause 10.5.6.5).

<Delivery order>: a numeric parameter that indicates whether the UMTS bearer shall provide in-sequence SDU delivery or not.

0 - no
1 – yes

Other values are reserved.

<Maximum SDU size>: a numeric parameter (1,2,3,…) that indicates the maximum allowed SDU size in octets (refer TS 24.008 [8] subclause 10.5.6.5).

<SDU error ratio>: a string parameter that indicates the target value for the fraction of SDUs lost or detected as erroneous. SDU error ratio is defined only for conforming traffic. The value is specified as 'mEe'. As an example, a target SDU error ratio of $5 \cdot 10^{-3}$ would be specified as '5E3' (e.g. AT+CGEQMIN=…,"5E3",…) (refer TS 24.008 [8] subclause 10.5.6.5).

<Residual bit error ratio>: a string parameter that indicates the target value for the undetected bit error ratio in the delivered SDUs. If no error detection is requested, Residual bit error ratio indicates the bit error ratio in the delivered SDUs. The value is specified as 'mEe'. As an example, a target residual bit error ratio of $5 \cdot 10^{-3}$ would be specified as '5E3' (e.g. AT+CGEQMIN=…,"5E3",…) (refer TS 24.008 [8] subclause 10.5.6.5).

<Delivery of erroneous SDUs>: a numeric parameter that indicates whether SDUs detected as erroneous shall be delivered or not.

0 - no
1 - yes
2 - no detect

Other values are reserved.

<Transfer delay>: a numeric parameter (0,1,2,…) that indicates the targeted time between request to transfer an SDU at one SAP to its delivery at the other SAP, in milliseconds (refer TS 24.008 [8] subclause 10.5.6.5).

<Traffic handling priority>: a numeric parameter (1,2,3,…) that specifies the relative importance for handling of all SDUs belonging to the UMTS bearer compared to the SDUs of other bearers (refer TS 24.008 [8] subclause 10.5.6.5).

<PDP_type>: (see +CGDCONT and +CGDSCONT commands).

If a value is omitted for a particular class then the value is considered to be unspecified.

4.6.3.4. 3G Quality of Service (Negotiated) +CGEQNEG

Command	Possible Response(s)
+CGEQNEG =[<cid>[,<cid>[,…]]]	+CGEQNEG: <cid>, <Traffic class> ,<Maximum bitrate UL>, <Maximum bitrate DL> ,<Guaranteed bitrate UL>, <Guaranteed bitrate DL> ,<Delivery order> ,<Maximum SDU size> ,<SDU error ratio> ,<Residual bit error ratio> ,<Delivery of erroneous SDUs> ,<Transfer delay> ,<Traffic handling priority> [<CR><LF>+CGEQNEG: <cid>, <Traffic class> ,<Maximum bitrate UL>, <Maximum bitrate DL> ,<Guaranteed bitrate UL>, <Guaranteed bitrate DL> ,<Delivery order> ,<Maximum SDU size> ,<SDU error ratio> ,<Residual bit error ratio> ,<Delivery of erroneous SDUs> ,<Transfer delay> ,<Traffic handling priority> […]]
+CGEQNEG=?	+CGEQNEG: (list of <cid>s associated with active contexts)

Description

This command allows the TE to retrieve the negotiated QoS profiles returned in the Activate PDP Context Accept message.

The execution command returns the negotiated QoS profile for the specified context identifiers, <cid>s. The QoS profile consists of a number of parameters, each of which may have a separate value.

The test command returns a list of <cid>s associated with active contexts.

Defined values

<cid>: a numeric parameter which specifies a particular PDP context definition (see +CGDCONT and +CGDSCONT commands).

The following parameters are defined in 3GPP TS 23.107 [46] -

<Traffic class>: a numeric parameter that indicates the type of application for which the UMTS bearer service is optimized.

0 - conversational
1 - streaming
2 - interactive
3 – background

Other values are reserved.

<Maximum bitrate UL>: a numeric parameter that indicates the maximum number of kbits/s delivered to UMTS (up-link traffic) at a SAP. As an example a bitrate of 32 kbit/s would be specified as '32' (e.g. +CGEQNEG:…,32, …) (refer TS 24.008 [8] subclause 10.5.6.5).

<Maximum bitrate DL>: a numeric parameter that indicates the maximum number of kbits/s delivered by UMTS (down-link traffic) at a SAP As an example, a bitrate of 32 kbit/s would be specified as '32' (e.g. +CGEQNEG:…,32, …) (refer TS 24.008 [8] subclause 10.5.6.5).

<Guaranteed bitrate UL>: a numeric parameter that indicates the guaranteed number of kbits/s delivered to UMTS (up-link traffic) at a SAP (provided that there is data to deliver). As an example, a bitrate of 32 kbit/s would be specified as '32' (e.g. +CGEQNEG:…,32, …) (refer TS 24.008 [8] subclause 10.5.6.5).

<Guaranteed bitrate DL>: a numeric parameter that indicates the guaranteed number of kbits/s delivered by UMTS (down-link traffic) at a SAP (provided that there is data to deliver). As an example, a bitrate of 32 kbit/s would be specified as '32' (e.g. +CGEQNEG:…,32, …) (refer TS 24.008 [8] subclause 10.5.6.5).

<Delivery order>: a numeric parameter that indicates whether the UMTS bearer shall provide in-sequence SDU delivery or not.

0 - no
1 – yes

Other values are reserved.

<Maximum SDU size>: a numeric parameter that (1,2,3,…) indicates the maximum allowed SDU size in octets (refer TS 24.008 [8] subclause 10.5.6.5).

<SDU error ratio>: a string parameter that indicates the target value for the fraction of SDUs lost or detected as erroneous. SDU error ratio is

defined only for conforming traffic. The value is specified as 'mEe'. As an example, a target SDU error ratio of $5 \cdot 10^{-3}$ would be specified as '5E3' (e.g., +CGEQNEG:…,”5E3”,…) (refer TS 24.008 [8] subclause 10.5.6.5).

`<Residual bit error ratio>:` a string parameter that indicates the target value for the undetected bit error ratio in the delivered SDUs. If no error detection is requested, **the** Residual bit error ratio indicates the bit error ratio in the delivered SDUs. The value is specified as 'mEe'. As an example a target residual bit error ratio of $5 \cdot 10^{-3}$ would be specified as '5E3' (e.g. +CGEQNEG:…,”5E3”,…) (refer TS 24.008 [8] subclause 10.5.6.5).

`<Delivery of erroneous SDUs>:` a numeric parameter that indicates whether SDUs detected as erroneous shall be delivered or not.

0 - no
1 - yes
2 - no detect

Other values are reserved.

`<Transfer delay>:` a numeric parameter (0,1,2,…) that indicates the targeted time between request to transfer an SDU at one SAP to its delivery at the other SAP, in milliseconds (refer TS 24.008 [8] subclause 10.5.6.5).

`<Traffic handling priority>:` a numeric parameter (1,2,3,…) that specifies the relative importance for handling of all SDUs belonging to the UMTS bearer compared to the SDUs of other bearers (refer TS 24.008 [8] subclause 10.5.6.5).

If a value is omitted for a particular class then the value is considered to be unspecified.

4.6.3.5. PS Attach or Detach +CGATT

Command	Possible Response(s)
+CGATT= [<state>]	OK ERROR
+CGATT?	+CGATT: <state>
+CGATT=?	+CGATT: (list of supported <state>s)

Description

The execution command is used to attach the MT to, or detach the MT from, the Packet Domain service. After the command has completed, the MT remains in V.250 command state. If the MT is already in the requested state, the command is ignored and the OK response is returned. If the requested state cannot be achieved, an ERROR or +CME ERROR response is returned. Extended error responses are enabled by the +CMEE command.

Any active PDP contexts will be automatically deactivated when the attachment state changes to detached.

The read command returns the current Packet Domain service state.

The test command is used for requesting information on the supported Packet Domain service states.

Note: This command has the characteristics of both the V.250 action and parameter commands. Hence it has the read form in addition to the execution/set and test forms.

Defined Values

`<state>`: indicates the state of PS attachment

0 - detached
1 - attached

Other values are reserved and will result in an ERROR response to the execution command.

4.6.3.6. PDP Context Activate or Deactivate +CGACT

Command	Possible Response(s)
`+CGACT=[<state> [,<cid>[,<cid>[,…]]]]`	`OK` `ERROR`

`+CGACT?`	`+CGACT: <cid>, <state>`
	`[<CR><LF>+CGACT: <cid>, <state>`
	`[...]]`

`+CGACT=?`	`+CGACT: (list of supported <state>s)`

Description

The execution command is used to activate or deactivate the specified PDP context(s). After the command has completed, the MT remains in V.250 command state. If any PDP context is already in the requested state, the state for that context remains unchanged. If the requested state for any specified context cannot be achieved, an ERROR or +CME ERROR response is returned. Extended error responses are enabled by the +CMEE command. If the MT is not PS attached when the activation form of the command is executed, the MT first performs a PS attach and then attempts to activate the specified contexts. If the attach fails then the MT responds with ERROR or, if extended error responses are enabled, with the appropriate failure-to-attach error message.

If no <cid>s are specified, the activation form of the command activates all defined contexts.

If no <cid>s are specified, the deactivation form of the command deactivates all active contexts.

The read command returns the current activation states for all the defined PDP contexts.

The test command is used for requesting information on the supported PDP context activation states.

Note: This command has the characteristics of both the V.250 action and parameter commands. Hence it has the read form in addition to the execution/set and test forms.

Defined Values

`<state>`: indicates the state of PDP context activation

0 - deactivated
1 - activated

Other values are reserved and will result in an ERROR response to the execution command.

`<cid>`: a numeric parameter which specifies a particular PDP context definition (see the +CGDCONT and +CGDSCONT commands).

4.6.3.7. Show PDP address +CGPADDR

Command	Possible response(s)
+CGPADDR=[<cid> [,<cid> [,…]]]	+CGPADDR: <cid>,<PDP_addr> [<CR><LF>+CGPADDR: <cid>,<PDP_addr> [...]]
+CGPADDR=?	+CGPADDR: (list of defined <cid>s)

Description

The execution command returns a list of PDP addresses for the specified context identifiers.

The test command returns a list of defined <cid>s.

Defined values

<cid>: a numeric parameter which specifies a particular PDP context definition (see the +CGDCONT and +CGDSCONT commands). If no <cid> is specified, the addresses for all defined contexts are returned.

<PDP_address>: a string that identifies the MT in the address space applicable to the PDP. The address may be static or dynamic. For a static address, it will be the one set by the +CGDCONT and +CGDSCONT commands when the context was defined. For a dynamic address it will be the one assigned during the last PDP context activation that used the context definition referred to by <cid>. <PDP_address> is omitted if none is available.

4.6.3.8. Packet Domain event reporting +CGEREP

Command	Possible response(s)
+CGEREP=[<mode>[,<bfr>]]	OK ERROR
+CGEREP?	+CGEREP: <mode>,<bfr>
+CGEREP=?	+CGEREP: (list of supported <mode>s),(list of supported <bfr>s)

Description

Set command enables or disables **the** sending of unsolicited result codes, `+CGEV: XXX` from MT to TE in the case of certain events occurring in the Packet Domain MT or the network. `<mode>` controls the processing of unsolicited result codes specified within this command. `<bfr>` controls the effect on buffered codes when `<mode>` 1 or 2 is entered. If a setting is not supported by the MT, `ERROR` or `+CME ERROR:` is returned.

Read command returns the current mode and buffer settings

Test command returns the modes and buffer settings supported by the MT as compound values.

Defined values

`<mode>`:

0 buffer unsolicited result codes in the MT; if MT result code buffer is full, the oldest ones can be discarded. No codes are forwarded to the TE.

1 discard unsolicited result codes when MT-TE link is reserved (e.g. in on-line data mode); otherwise forward them directly to the TE

2 buffer unsolicited result codes in the MT when MT-TE link is reserved (e.g. in on-line data mode) and flush them to the TE when MT-TE link becomes available; otherwise forward them directly to the TE

`<bfr>`:

0 MT buffer of unsolicited result codes defined within this command is cleared when <mode> 1 or 2 is entered

1 MT buffer of unsolicited result codes defined within this command is flushed to the TE when <mode> 1 or 2 is entered (OK response shall be given before flushing the codes)

Defined events

The following unsolicited result codes and the corresponding events are defined -

+CGEV: REJECT <PDP_type>, <PDP_addr>

A network request for PDP context activation occurred when the MT was unable to report it to the TE with a +CRING unsolicited result code and was automatically rejected.

`+CGEV: NW REACT  <PDP_type>, <PDP_addr>, [<cid>]`

The network has requested a context reactivation. The `<cid>` that was used to reactivate the context is provided if known to the MT.

`+CGEV: NW DEACT  <PDP_type>, <PDP_addr>, [<cid>]`

The network has forced a context deactivation. The `<cid>` that was used to activate the context is provided if known to the MT.

+CGEV: ME DEACT <PDP_type>, <PDP_addr>, [<cid>]

The mobile termination has forced a context deactivation. The <cid> that was used to activate the context is provided if known to the MT.

+CGEV: NW DETACH

The network has forced a PS detach. This implies that all active contexts have been deactivated. These are not reported separately.

+CGEV: ME DETACH

The mobile termination has forced a PS detach. This implies that all active contexts have been deactivated. These are not reported separately.

+CGEV: NW CLASS <class>

The network has forced a change of MT class. The highest available class is reported (see +CGCLASS).

+CGEV: ME CLASS <class>

The mobile termination has forced a change of MT class. The highest available class is reported (see +CGCLASS).

4.6.3.9. GPRS network registration status +CGREG

Command	Possible response(s)
+CGREG=[<n>]	
+CGREG?	+CGREG: <n>,<stat>[,<lac>,<ci>] *+CME ERROR: <err>*
+CGREG=?	+CGREG: (list of supported <n>s)

Description

The set command controls the presentation of an unsolicited result code +CGREG: <stat> when <n>=1 and there is a change in the MT's GPRS network registration status, or code +CGREG: <stat>[,<lac>,<ci>] when <n>=2 and there is a change of the network cell.

Note: If the GPRS MT also supports circuit mode services, the +CREG command and +CREG: result code applies to the registration status and location information for those services.

The read command returns the status of result code presentation and an integer <stat> which shows whether the network has currently indicated the registration of the MT. Location information elements <lac> and <ci> are returned only when <n>=2 and MT is registered in the network.

Defined values

<n>:

<u>0</u> disable network registration unsolicited result code

1 enable network registration unsolicited result code +CGREG: <stat>

2 enable network registration and location information unsolicited result code +CGREG: <stat>[,<lac>,<ci>]

<stat>:

0 not registered, MT is not currently searching an operator to register to
The UE is in GMM state GMM-NULL or GMM-DEREGISTERED-INITIATED.
The GPRS service is disabled, the UE is allowed to attach for GPRS if requested by the user.

1 registered, home network
The UE is in GMM state GMM-REGISTERED or GMM-ROUTING-AREA-UPDATING-INITIATED INITIATED on the home PLMN.

2 not registered, but MT is currently trying to attach or searching an operator to register to
The UE is in GMM state GMM-DEREGISTERED or GMM-REGISTERED-INITIATED. The GPRS service is enabled, but an allowable PLMN is currently not available. The UE will start a GPRS attach as soon as an allowable PLMN is available.

3 registration denied
The UE is in GMM state GMM-NULL. The GPRS service is disabled, the UE is not allowed to attach for GPRS if requested by the user.

4 unknown

5 registered, roaming
The UE is in GMM state GMM-REGISTERED or GMM-ROUTING-AREA-UPDATING-INITIATED on a visited PLMN.

<lac>: string type; two byte location area code in hexadecimal format (e.g. "00C3" equals 195 in decimal)

<ci>: string type; two byte cell ID in hexadecimal format

5. Service Status

SNMP optionally can be used to retrieve SDU operational status of the AES and communication links. Further work needed to document this feature.

6. ORT Values required for Ethernet interface

The ORT shall define the following settings per Ethernet interface of the SDU

6.1.IP Settings

6.1.1.DHCP

Defines **whether or not** the interface receives **an** IP address setting from DHCP server.

Values are Enable or Disable.

6.1.2. IPv4 address

Defines the IP address -of the interface on the SDU. **This c**an be a null value if the interface is configured for DHCP.

6.1.3. Default gateway

Defines the default gateway IP address for the interface.

6.1.4. Host Name

Defines the Host name of the interface.

6.2. PPPoE Settings

6.2.1. AC Name

Defines the PPPoE Access Concentrator name for the interface.

The SDU shall implement this feature but it is optional for the PPPoE client to use it.

6.2.2. Default Service Name Mapping

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 Section **3.3.11.** PPPoE Service Names.

6.2.3.Telnet Server

6.2.3.1.User name

The username for telnet control line session.

6.2.3.2.Password

The password for telnet control line session.

7. Error Codes for PADT PPPoE Messages

This section shall define the messages appended to a PADT. TBD Request Honeywell provides.

ATTACHMENT 6
ATTACHMENT REFERENCE GUIDE

Attachment Number	Description
1-1A	General Configuration Overview – Single **s**atcom
1-1B	General Configuration Overview – Dual **s**atcom
1-2A	Satcom System Configuration - HPA Integrated in SDU
1-2B	Satcom System Configuration - Optional Flange Mounted HPA
1-3	Standard Interwiring
1-4	Notes Applicable to Standard Interwiring
1-4A	System Configuration Pins Definition and Interpretation Introduction
1-5	SDU Form Factor
1-5A	SDU Top Plug Connector Layout
1-5B	SDU Middle Plug Connector Layout
1-5C	SDU Bottom Plug Connector Layout
1-6	SCM Form Factor
1-6A	SCM Connector Layout
1-7	Flange Mount HPA Form Factor
1-7A	Flange Mount HPA Connector Layout
1-8	Diplexer/LNA Form Factor
1-8A	Diplexer/LNA Connector Layout
1-9	Antenna Coverage
1-10	High Gain and Intermediate Gain Antenna Footprint
1-10A	Closeup View of the Coaxial Interface for Top Mounted HGA and IGA
1-11	Low Gain Antenna Footprint
1-12	High Gain and Intermediate Gain Antenna Control Connector Layout
2	ARINC 429 Labels And Word Formats Used In The Aviation Satellite Communications System
2A	Antenna Configuration Data Reporting
2B	Bit-Oriented Fault Reporting Protocol
3	**Cockpit Voice – SAT Phone State Machine for Normal Operation**
4-A	**ARINC 781 SDU Functions Matrix**
4-B	**ARINC 781 SDU Interfaces Matrix**
5	**Ethernet Interface Control Document**
6	Attachment Reference Guide

APPENDIX 1
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
AFDX	**Avionics Full Duplex Switched Ethernet**
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
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
ATE	Automatic Test Equipment
ATLAS	Abbreviated Test Language for All Systems
ATS	Air Traffic Services
BABT	**British Approvals Board for Telecomunications**
BER	**Bit Error Rate**
BIT	**Binary Digit**
BITE	Built In Test Equipment
BGAN	**Broadband Global Area Network**
BNR	**2's complement binary notation**
BP	Bottom Plug
bps	**bits per second**
BRI	**Basic Rate Interface**
BSS	**Business Support System**

APPENDIX 1
ACRONYMS

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**
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**
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**
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

APPENDIX 1
ACRONYMS

EIRP	Effective Isotropic Radiated Power
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
FPLMTS	Future Public Land Mobile Telecommunications System
FT	Functional Test
FW	Failure Warning
G/T	Gain to Noise Temperature Ratio
GES	Ground Earth Station
GHz	Gigahertz (10^9 Hz)
GLONASS	Global Navigation Satellite System
GND	**Ground**
GNSS	**Global Navigation Satellite System**
GPS	Global Positioning System
GSDB	GES-Specific Data Broadcast
GSM	**Global System for Mobiles**
HAE	**Height Above Ellipsoid**
HF	**High Frequency**
HGA	High Gain Antenna
HLD	High Power Amplifier/Low Noise Amplifier/Diplexer
HMI	**Human Machine Interface**
HPA	High Power Amplifier
HPR	**High Power Relay**
HSDU	**High Speed Data Unit**
Hz	Hertz
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**

APPENDIX 1
ACRONYMS

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)
kS/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
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**

APPENDIX 1
ACRONYMS

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**
PCS	**Payload Control System**
PDP	**Packet Data Protocol**
PER	**Packet Error Rate**
PLMN	Public Land Mobile Network
POTS	**Plain Old Telephone Service**
PPP	**Point-to-Point Protocol**
PPPoE	**Point-to-Point Protocol Over Ethernet**
PS	**Packet Switched**
PSDN	Packet Switched Data Network
Psid	**P-Channel used for satellite identification**
PSTN	Public Switched Telephone Network
PTT	Push-to-Talk
QAM	**Quadrature Amplitude Modulation**
QoS	**Quality of Service**
QPSK	**Quadrature Phase Shift Keying**
RAM	**Random Access Memory**
RAN	**Radio Access Network**
REN	**Ringer Equivalent Number**
RDI	**Restricted Data Interface**
RF	Radio Frequency
RMP	Radio Management Panel
RMS	**Root Mean Square**
ROM	**Read Only Memory**
RTCA	**RTCA Inc.**
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

APPENDIX 1
ACRONYMS

SDI	Source/Destination Identifier
SDM	**Inmarsat System Definition Module**
SDU	Satellite Data Unit
SELCAL	**Selective Calling**
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**
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**
USIMs	**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**
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**

AERONAUTICAL RADIO, INC.
2551 Riva Road
Annapolis, Maryland 24101-7435

SUPPLEMENT 1
TO
ARINC CHARACTERISTIC 781

MARK 3 AVIATION SAATELLITE COMMUNICATION SYSTEMS

Published: November 22, 2006

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering 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 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.

ARINC Standard – Errata Report

1. Document Title

ARINC Characteristic 781-1: *Mark 3 Aviation Satellite Communication System*
Published:

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 IA Project Initiation/Modification (APIM)

1.0 Name of Proposed Project **APIM #: _____**

(Insert name of proposed project.)

2.0 Subcommittee Assignment and Project Support

2.1 Identify AEEC Group

(Identify an existing or new AEEC group.)

2.2 Support for the activity

Airlines: *(Identify each company by name.)*

Airframe Manufacturers:

Suppliers:

Others:

2.3 Commitment for resources *(Identify each company by name.)*

Airlines:

Airframe Manufacturers:

Suppliers:

Others:

2.4 Chairman: (Recommended name of Chairman.)

2.5 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. Use the following symbol to check yes or no below. ☒)

3.2 Planned usage of the envisioned specification

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 ❑

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 softwareware 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 benefit unique to the equipment supplier's point of view.)

5.0 Documents to be Produced and Date of Expected Result

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

** Indicate unsupported meetings and meeting days, i.e., technical working group or other ad hoc meetings that do not requiring IA staff support.*

6.0 Comments

(Insert any other information deemed useful to the committee for managing this work.)

For IA Staff use

Date Received: _____________ IA Staff Assigned: ___________

Estimated Cost: _____________

Potential impact: ______

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

Forward to committee(s) (AEEC, AMC, FSEMC): _____________ Date Forwarded:_____________

Committee resolution: _______

*(**0** Withdrawn **1** Authorized **2** Deferred **3** More detail needed **4** Rejected)*

Assigned Priority:______ Date of Resolution:_________________

*(**A** High - execute first **B** Normal - may be deferred.)*

Assigned to SC/WG:_________________