HF DATA LINK SYSTEM

ARINC CHARACTERISTIC 753-3

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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

Activities of AERONAUTICAL RADIO, INC. (ARINC)

and the

Purpose of ARINC Characteristics

Aeronautical Radio, Inc. is a corporation in which the United States scheduled airlines are the principal stockholders. Other stockholders include a variety of other air transport companies, aircraft manufacturers and non-U.S. airlines.

Activities of ARINC include the operation of an extensive system of domestic and overseas aeronautical land radio stations, the fulfillment of systems requirements to accomplish ground and airborne compatibility, the allocation and assignment of frequencies to meet those needs, the coordination incident to standard airborne communications and electronics systems and the exchange of technical information. ARINC sponsors the Airlines Electronic Engineering Committee (AEEC), composed of airline technical personnel. The AEEC formulates standards for electronic equipment and systems for the airlines. The establishment of Equipment Characteristics is a principal function of this Committee.

An ARINC Equipment Characteristic is finalized after investigation and coordination with the airlines who have a requirement or anticipate a requirement, with other aircraft operators, with the Military services having similar requirements, and with the equipment manufacturers. It is released as an ARINC Equipment Characteristic only when the interested airline companies are in general agreement. Such a release does not commit any airline or ARINC to purchase equipment so described nor does it establish or indicate recognition of 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 Characteristic. An ARINC Characteristic has a twofold purpose, which is:

(1) To indicate to the prospective manufacturers of airline electronic equipment the considered opinion of the airline technical people, coordinated on an industry basis, concerning requisites of new equipment, and

(2) To channel new equipment designs in a direction which can result in the maximum possible standardization of those physical and electrical characteristics which influence interchangeability of equipment without seriously hampering engineering initiative.

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1.0 INTRODUCTION

1.1 Purpose of This Document

This document contains the physical form and fit dimensions, the electrical interface definition and a description of the functional operation of the airborne components of the High Frequency Data Link (HFDL) communications system. An overview of the associated ground system is also provided. The protocols used in the HFDL system are defined in ARINC Specification 635 “HF Data Link Protocols”.

The intent of this document is to provide general and specific design guidance for the development and installation of the airborne equipment. As such, this guidance covers the desired operational capability of the HFDL system and the standards necessary to achieve interchangeability of the airborne hardware. The HF Data Link system has various modes of operation which are described more fully in Chapters 3, 4 and 5.

COMMENTARY

> Equipment manufacturers should note that this document aims to encourage them to produce maintenance-free, high performance equipment. They are at liberty to accomplish this by the use of design techniques they consider to be the most appropriate. Their airline customers are more interested in the end result than in the means to achieve it.

1.2 Relationship to Other Documents

This Characteristic introduces functionality into the components of the HFDL by way of reference. Many of these references are to other Airline Electronic Engineering Committee (AEEC) documents. The designer should use the most current version of the referenced document unless a specific version is given. A list of referenced documents is provided in Appendix D for the readers convenience.

1.3 System Overview

The HFDL System consists of the Airborne HFDL System Configuration described in Section 1.3.1 and the Ground System Configuration described in Section 1.3.2.

1.3.1 Airborne HFDL System Configuration

The HFDL avionics system hardware consists of an HF Data Unit (HFDU) or an integrated voice/data HF Data Radio (HFDR). The HFDR provides either voice or data communications services in a simplex mode on demand. The HFDU interfaces with a conventional analog Single Side Band (SSB) HF transceiver already installed in the aircraft to provide voice or data communications services in a simplex mode on demand also. This document assumes that the airborne components implementing HF Data Link are arranged as shown in Attachments 2 through 4 and that they function within the system operating rules specified in ARINC Specification 635, ARINC Specification 637, and ARINC Specification 638.

The HFDL system should have two main modes:

a. The Data mode for digital data transmission as described throughout this document and ARINC Specification 635,

b. The Voice mode, which is identical in function and control as the existing HF Voice Radios, according to ARINC Characteristic 719.

As an HF Packet Communications (HFPAC) bridge, the High Frequency Data Link (HFDL) system is an integral part of the HFPAC/Aeronautical Telecommunication Network (ATN) communications protocol suite. Detailed background of HFPAC/ATN can be found in ARINC Specifications 635, 637 and 638.

COMMENTARY

> The use of the HFDL system (Attachments 2 through 4), for sole means of ATN operation depends on the integrity and availability requirements set forth by world wide agencies. Aeronautical operators planning to implement ATN capability may need to install additional equipment.

Depending on the selected mode, the HFDL avionics system operates with a Communications Management Unit (CMU) Mark 2 (see ARINC Characteristic 758), a Management Unit (MU) (see ARINC Characteristics 597, 724 and 724B, and ARINC Specification 618), a Centralized Fault Display Interface Unit (CFDIU) (see ARINC Report 604) or Onboard Maintenance System (OMS) (see ARINC Report 624). c-1

The Aircraft Communications Addressing and Reporting System (ACARS) Management Unit (MU) or Communications Management Unit (CMU) is the onboard router for the Aeronautical Telecommunications Network (ATN). As such, all application messages intended for transmission to the ground are sent onboard to the MU or CMU, which in-turn has the responsibility to determine the most efficient subnetwork over which to transmit the packet, and to route the packet accordingly. The MU or CMU also implements any management protocols required to ensure the continued and correct operation of the various bridges located onboard the aircraft.

1.3.2 Ground System Configuration

The aeronautical HF subnetwork provides air/ground data and voice communications capability. Ground service is provided by a network of HF ground stations strategically located to cover major oceanic air routes as well as continental areas.

The HFDL air/ground subnetwork provides primarily Airline Operational Control (AOC) and Air Traffic Control (ATC) data and voice communications services. Optional services, FAX and voice patch, may also be available at some ground stations.

1.4 Terms

Antenna: Built-In Antenna; not considered as part of the HFDR

CFDS: Central Fault Display System

Coupler: Antenna tuning device to match the antenna impedance to the 50 ohm coaxial transmission line

1.0 INTRODUCTION

1.4 Terms (cont'd)

HFDL: High Frequency Data Link; HF Data/Voice Communication Subnetwork Air/Ground

HFDR: High Frequency Data Radio; used for the airborne HF Transceiver

HFDU: High Frequency Data Unit; The HFDU contains the Modem for the system when the Modem is a separate LRU

OMS: On-Board Maintenance System

1.5 Interchangeability

System interchangeability, as defined in Section 2.0 of ARINC Report 607, "Guidance for Designers of Airborne Electronic Equipment", is desired for the HFDR and HFDU. The standards necessary to ensure this level of interchangeability are set forth in Chapter 2 of this document.

1.6 Regulatory Approvals

The equipment must meet all applicable regulatory requirements. Manufacturers are urged to obtain all necessary information for such regulatory approval. This information is not contained in this characteristic, nor is it available from ARINC.

2.0 INTERCHANGEABILITY STANDARDS

2.1 Introduction

This chapter sets forth the specific form factor, mounting provisions, interwiring, input and output interfaces and power supply characteristics desired for the HF Data Radio and HF Data Unit. These standards permit the parallel, but independent design of compatible equipment and airframe installations.

Unit interchangeability is required for the HF Data Radio, HF Data Unit, and Antenna Coupler, regardless of manufacturing source.

COMMENTARY

> In order to achieve the full benefit of the economics offered by these changes, the industry desires that any provisions for backwards compatibility with earlier generations of HF Communications equipment described by ARINC Characteristic 719 be provided as basic provisions.

The ARINC 753 transceiver (HFDR) is pin- and function-compatible with the ARINC 719 transceiver. When an HF Data Radio is installed in an ARINC 719 slot, (replacing an ARINC 719 transceiver) it should operate with ARINC 719 radio functionality. An HF Data Unit attached to this array would be required to obtain HF Data Link functionality.

2.2 Form Factor, Connector, and Index Pin Coding

The HFDR and HFDU should comply with the dimensional standards in ARINC Specification 600, "Air Transport Avionics Equipment Interfaces (NIC Phase 1)", for the 6 MCU and 4 MCU form factors respectively. The HFDR and HFDU should also comply with ARINC Specification 600 standards with respect to weight, racking attachments, front and rear projections and cooling.

COMMENTARY

> The only form factor defined in this Characteristic is the Modular Concept Unit (MCU) defined in ARINC Specification 600. Packaging of the HFDR in accordance with ARINC Specification 404A was not considered desirable. However, some retrofit installations into aircraft racking for ARINC 404A equipment are expected.

The HFDR and HFDU should each be provided with a low insertion force, Size 2 Shell ARINC Specification 600 service connector. This connector, which should accommodate service interconnections in its middle plug (MP) and top plug (TP) inserts and power interconnections in its bottom plug (BP) insert, should be located on the center grid of the HFDR and HFDU rear panel. Index pin code 10 should be used for the HFDR. Index pin code 20 should be used for the HFDU. The pin coding for the HFDR and HFDU are depicted in Attachments 2-3D and 3-3D respectively.

If bench testing of the HFDR and HFDU with Automatic Test Equipment (ATE) necessitates interconnect capabilities that are not covered by the pin assignments on the service connector set forth in Attachments 2-3A through 2-3C and 3-3A through 3-3C (including pins TP4A through TP4D which are designated for unspecified ATE function use) an auxiliary connector should be provided whose type and location are selected by the equipment manufacturer. As this auxiliary connector is not used while the HFDR or HFDU is installed in the aircraft, it should be provided with a cover to ensure protection from damage, contamination, etc., during that time. The manufacturer should observe the standards of ARINC Specification 600 when choosing the location for the connector. Also, other than accommodating the needs for equipment identification by the ATE described in Section 8 of this document, the manufacturer is free to make whatever use of both the service connector ATE pins and the auxiliary connector pins he wishes.

COMMENTARY

> The auxiliary connector is specified to permit completion of the interface without recourse to the use of individual "test leads" from the ATE, each of which has to be clipped, or otherwise secured, to a test point on the equipment.

2.3 Standard Interwiring

The standard interwiring to be installed for the HFDR and HFDU are set forth in Attachments 2-2 and 3-2 respectively. This interwiring is designed to provide the degree of interchangeability specified in Section 1.5 of this Characteristic.

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 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 the final "polish" on equipment in development.

COMMENTARY

> The reader is cautioned to give due consideration to the specific notes in Attachment 5 as they apply to the standard interwiring. Manufacturers are cautioned not to rely on special wires, cabling or shielding for use with particular units because they do not exist in a standard installation. Furthermore, manufacturers are encouraged to utilize, for ATE purposes, only those pins designated for ATE, and not make use of pins not currently defined or left for customer definition.

2.4 Power Circuitry

2.4.1 Primary Power Input

The HFDR should be designed to accept 115 Vac, 400 Hz, three phase power. The HFDR should be protected by a 5 ampere circuit breaker in each phase.

2.0 INTERCHANGEABILITY STANDARDS

The HFDU, if installed, should be designed to accept 115 Vac, 400 Hz, single phase power. The HFDU should be protected by a single 2 ampere circuit breaker. See ARINC Characteristic 413A, "Guidance for Aircraft Electrical Power Utilization and Transient Protection".

2.4.2 Power Control Circuitry

The primary power to the HF transceiver should not normally be controlled by a master on/off switch. It should be noted that no on/off switches will be needed in most installations. A master on/off power switching capability should be provided as an option. When this option is selected, power input to the transceiver should be accomplished using the pins reserved for switched power.

2.4.3 Common Ground

The wires designated as "Common Ground" (or as chassis ground) are used for the dc ground return to the aircraft structure and may be grounded to the chassis of the equipment if the manufacturer so desires. In any event, they will be grounded to the aircraft structure. They should not be used as common returns for any circuits carrying ac currents.

2.4.4 Internal Circuit Protection

The basic master power protection means for the HFDR will be external to the unit and utilize a standard circuit breaker rating. Within the equipment, no master power protection means is to be provided, although subdistribution circuit protection is acceptable where the set manufacturer feels this would improve the overall reliability of the equipment.

If internal protection by fuses is employed, these fuses should not be accessible when the set is installed in the aircraft radio rack, but should be replaceable only when the equipment goes through the service shop.

If such subdistribution circuit protection is by means of circuit breakers, the majority of airlines prefer that these be accessible on the front panel of the equipment so that they can be reset in service.

2.4.5 Abnormal Power

The HFDL equipment should accept power variations without adverse effects upon equipment performance. Refer to ARINC Report 413A, "Guidance for Aircraft Electrical Power Utilization and Transient Protection" or ARINC Report 609, "Design Guidance for Aircraft Electrical Power Systems". The equipment should be of such design that it will not be damaged by power supply frequencies and/or voltages below the minimum or exceeding the maximum specified operating voltage and frequency, and if operation is interrupted under these conditions, the equipment should automatically resume normal operation when the frequency and/or voltage returns within limits. Set manufacturers should provide their own protection, wholly within the equipment against the possibility of one of the three ac line circuits being interrupted by an aircraft electrical system power phase failure in the aircraft. The equipment should not be damaged in any way if one phase lead is opened and it is desirable the equipment:

a. Continue to operate at reduced power, or,

b. Cease operating entirely, or,
c. Malfunction in such a manner as to make it evident to the crew that such a failure has occurred, in order to guard against attempted continued operation which is not providing satisfactory communications.

2.5 System Functions and Signal Characteristics

A list of the system functions and signal characteristics used to provide the desired level of interchangeability for the HFDR and HFDU are set forth in Chapters 4, 5 and 6 of this document and ARINC Specification 635.

2.6 Environmental Conditions

The HFDL Line Replaceable Units (LRUs) should be specified environmentally in terms of the requirements of RTCA Document DO-160C, "Environmental Conditions and Test Procedures for Airborne Electronic and Electrical Equipment and Instruments". Attachment 6 to this document tabulates the relevant environmental categories.

2.7 Cooling

The HFDR and HFDU should be designed to accept, and airframe manufacturers should configure the installation to provide forced air cooling as defined in ARINC Specification 600. The standard HFDR installation should provide an air flow rate of 57.2 kg/hr of 40º C (max.) air and the unit should not dissipate more than an average of 260 watts of power. The standard HFDU installation should provide an air flow rate of 22 kg/hr of 40º C (max.) air and the unit should not dissipate more than an average of 100 watts of power. The coolant air pressure drop through the HFDR should be 25 ± 5 mm of water and 5 ± 5 mm of water through the HFDU at standard conditions. The HFDR and HFDU should be designed to expend this pressure drop to maximize the cooling effect. Adherence to the pressure drop standard is needed to allow interchangeability of the equipment. Continuous transmitter operation without ARINC cooling is permissible as long as the internal blower operates continuously and the ambient air temperature does not exceed 55º C.

COMMENTARY

> Although the HFDR and HFDU are packaged in accordance with ARINC Specification 600, some retrofit installations are made into aircraft racking designed in accordance with ARINC Specification 404A. The cooling provisions of these racking standards were intentionally established such that ARINC 600 equipment would be compatible with ARINC 404A racking. Thus, the HFDR and HFDU cooling provisions are compatible with ARINC 404A aircraft racking.

2.0 INTERCHANGEABILITY STANDARDS

The HFDR and/or HFDU designer should consider that the HFDR and HFDU are expected to operate without substantially lower reliability in an aircraft installation in which cooling is not available. A loss of cooling should not cause total loss of functionality, although a partial reduction in output power is acceptable.

COMMENTARY

The specified cooling air flow rate is based on an estimated average power dissipation. However, it should be noted that the power dissipation of the HFDR during transmission is higher than the estimated average. Thus, the specified air flow rate is less than the rate recommended in ARINC Specification 600 (NIC) for the maximum dissipation.

Equipment failures in aircraft due to inadequate thermal management have plagued the airlines for many years. In Section 3.5 of ARINC Specification 600 they have written down everything they believe airframe and equipment suppliers need to know to prevent such problems in the future. They regard this material as "required reading" for all potential suppliers of HFDR/HFDU and aircraft installation.

2.8 Grounding and Bonding

The attention of equipment and airframe manufacturers is drawn to the guidance material in ARINC Specification 600, Section 3.2.4 as well as ARINC Specification 404A, Section 6 and Appendix 2 on the subject of equipment and radio rack grounding and bonding.

2.9 Standardized Signaling

The standard electrical inputs and outputs from the systems should be in the form of a digital format or switch contact. Standards should be established exactly to assure the desired interchangeability of equipment.

Certain basic standards established herein are applicable to all signals. Unless otherwise specified the signals should conform with the standards set forth in the subsections below.

2.9.1 ARINC 429 DITS Data Bus

ARINC Specification 429 "Mark 33 Digital Information Transfer System (DITS)" is the controlling document for data word formats, refresh rates, resolutions, etc. Material in this document on these topics is included for reference purposes only. In the event of conflict between this document and ARINC Specification 429, the latter should be assumed to be correct.

2.9.2 Standard "Open"

The standard "open" signal is characterized by a resistance of 100,000 ohms or more with respect to signal common.

COMMENTARY

In many installations, a single switch is used to supply a logic input to several LRUs. One or more of these LRUs may utilize a pull-up resistor in its input circuitry. The result is that an "open" may be accompanied by the presence of +27.5 Vdc nominal. The signal could range from 12 to 36 Vdc.

2.9.3 Standard "Ground"

A standard "ground" signal may be generated by either a solid state or mechanical type switch. For mechanical switch-type circuitry a resistance of 10 ohms or less to signal common would represent the "ground" condition. Semiconductor circuitry should exhibit a voltage of 3.5 Vdc or less with respect to signal common in the "ground" condition.

2.9.4 Standard "Applied Voltage" Output

The standard "applied voltage" is defined as having a nominal value of +27.5 Vdc. This voltage should be considered to be "applied" when the actual voltage under the specified load conditions exceeds 18.5 volts (+36 Vdc maximum) and should be considered to be "not applied" when the equivalent impedance to the voltage source exceeds 100,000 ohms.

2.9.5 Standard Discrete Input

A standard Discrete Input should recognize incoming signals having two possible states, "open" and "ground". The characteristics of these two states are defined in Sections 2.9.2 and 2.9.3 of this Characteristic. The maximum current flow in the "ground" state should not exceed 20 milliamperes.

The "true" condition may be represented by either of the two states (ground or open) depending on the aircraft configuration.

COMMENTARY

In the past installations there have been a number of voltage levels and resistances for Discrete states. In addition the assignments of "Valid" and "Invalid" states for the various voltage levels and resistances were sometimes interchanged, which caused additional complications. In this Characteristic a single definition of Discrete levels is being used in an attempt to "standardize" conditions for Discrete signals.

The voltage levels and resistances used are, in general, acceptable to hardware manufacturers and airlines. This definition of Discretes is also being used in the other ARINC 700-Series Characteristics, however, there are a few exceptions for special conditions. The logic sources for the Discrete Inputs to the HFDL system are expected to take the form of switches mounted on the airframe component (flap, including gear, etc.) from which the input is desired. These switches will either connect the Discrete Input pins on the connector to airframe dc ground or leave them open circuit as necessary to reflect the physical condition of the related components. The HFDR and/or HFDU will, in each case, be expected to provide the dc signal to be switched. Typically, this is done through a pull-up resistor. The HFDL system input should sense the voltage on each input to determine the state (open or closed) of each associated switch.

2.0 INTERCHANGEABILITY STANDARDS

The selection of the values of voltages (and resistances) which define the state of an input is based on the assumption that the Discrete Input utilizes a ground-seeking circuit. When the circuit senses a low resistance or a voltage of less than 3.5 Vdc, the current flow from the input signifies a "ground" state. When a voltage level between 18.5 and 36 Vdc is present or a resistance of 100,000 ohms or greater is presented at

2.9.5 Standard Discrete Input (cont'd)

the input, little or no current should flow. The input may utilize an internal pull-up to provide for better noise immunity when a true "open" is present at the input. This type of input circuit seems to be the "favorite" among both manufacturers and users.

Because the probability is quite high that the sensors (switches) will be providing similar information to a number of users, the probability is also high that unwanted signals may be impressed on the inputs to the HFDL system from other equipment, especially when the switches are in the open condition. For this reason, equipment manufacturers are advised to base their logic sensing on the "ground" state of each input. Also, both equipment and airframe suppliers are cautioned concerning the need for isolation to prevent sneak circuits from "fouling up" the logic. Typically diode isolation is used to prevent this from happening.

2.9.6 Standard Discrete Output

A standard Discrete output should exhibit two states, "open" and "ground" as defined in Sections 2.9.2 and 2.9.3. In the "open" state, provision should be made to present an output resistance of a least 100,000 ohms. In the "ground" state provision should be made to sink at least 20 milliamperes of current. Non-Standard current sinking capability may be defined.

COMMENTARY

Not all Discrete output needs can be met by the Standard Discrete output defined above. Some Discrete outputs may need to sink more current than the standard value specified above.

A Discrete output may need to source current. Discrete outputs which are to source current should utilize the standard "Applied Voltage" output defined in Section 2.9.4. These special cases are noted in the text describing each applicable Discrete output function and in the notes to interwiring.

COMMENTARY

Although defined here, Discrete outputs which provide a current output rather than a current sink are not "Standard Discrete outputs".

2.9.7 Standard Program Pin Input

Program pins may be assigned on the HFDR and/or HFDU service connectors for the purpose of identifying a specific aircraft configuration or to select (enable) optional performance. The optional operational function may be in effect at all times or only under certain conditions, such as when the aircraft is on the ground (identified by the enabling of the Air/Ground Discrete input).

COMMENTARY

Program pins may be used for a variety of purposes. Program pins enable a piece of equipment to be used over a greater number of airframe types. One way this is done is by identifying the unique characteristics of the airframe in which the unit is installed. Another is to identify the location (left, right, center) of the unit. Often program pins are used to enable (turn on) options for alternate or extended performance characteristics.

The encoding logic of the Program pin relies upon two possible states of the designated input pin. One state is an "open" as defined in Section 2.9.2 of this Characteristic. The other state is a connection (short circuit i.e., 10 ohms or less) to the pin designated as the "Program Common" pin.

COMMENTARY

Normally, the "primary" location or "usual", "common" or "standard" function is defined by the "open" logic and the optional response is programmed (encoded) by connection to Program Common.

3.0 SYSTEM DESIGN

3.1 Introduction

This section provides background information for the design of the HFDL airborne equipment. The HFDL airborne equipment consists of the HF Data Radio or an HF Data Unit combined with an HF Transceiver. Detailed specifications for the HFDR and HFDU are given in Sections 4 and 5 respectively.

3.2 System Design

c-1 HF Data Link provides the capability to send Airline Operational Control (AOC) and Air Traffic Control (ATC) data to and from aircraft equipped with either an ACARS Management Unit (MU) or a Communications Management Unit (CMU also referred to as ATN Router). HF Data Link capability on the aircraft side should be provided by means of the standard configurations A shown in Attachment 2-1A, 2-1C, and 2-1D and configurations B shown in Attachments 3-1A, 3-1B and Attachment 3-1C respectively.

In configuration A, all HFDL functions are implemented in an HF Data Radio (HFDR) which interfaces directly to a MU or CMU via a pair of ARINC 429 buses.

In configuration B, all HFDL functions except for transmission/reception via HF radio are implemented in an HF Data Unit (HFDU) which interfaces to a MU or CMU via a pair of ARINC 429 buses and to a HF transceiver. The HF transceiver may be a transceiver which complies with ARINC 719 or an older generation HF transceiver which complies with ARINC 559A.

Standard configurations A and B specify that the MU or CMU have two ARINC 429 ports dedicated to transmission and reception of HFDL downlink and uplink data. In addition, all decision making regarding the use of HF versus VHF or Satellite Communications (SATCOM) resides in the MU or CMU.

3.2.1 AOC and ATS

AOC services and Air Traffic Services (ATS) are provided using frequencies that are dedicated to these services. HFDL ground stations which provide overlapping or adjacent AOC/ATS service coverage in a given area operate on different frequencies in order to avoid mutual interference.

COMMENTARY

> AOC/ATS frequencies may be re-used in sufficiently separated coverage areas. AOC/ATS services are provided to ground and air users equipped with ACARS and ATN data communications equipments on the same AOC/ATS frequencies. Thus, in some aircraft the HFDU or HFDR interfaces with an ACARS Management Unit while in others they interface with a Communications Management Unit.

The air/ground protocols used to provide AOC/ATS packet data communication services are defined in ARINC Specification 635.

3.2.2 Other Services

Other services may be available at some ground stations.

COMMENTARY

> The HF Data Link Subcommittee recognized that the primary use of HF Data Link should be for ATC and AOC purposes. At some future date if excess capacity is available then other services such as AAC and APC may be added.

3.3 HFDL Avionics Components

Along with the Satellite Data Unit (SDU), the Mode S Airborne Data Link Processor (ADLP), and the VHF Data Radio (VDR), the HF Data Link avionics is a bridge to the ground. The HFDL components implement layers one and two as well as functions of layer three of the ACARS/Aeronautical Telecommunications Network (reference ARINC Specification 635), and as such is responsible for all functionality associated with those layers. See Attachment 1.

COMMENTARY

> HF Data Link can support ATN air-ground data transmissions. The integrity and availability of the various transmission media may not be similar. Full ATN capability may have to be realized by integrating multiple systems.

3.3.1 HF Data Radio

The HF Data Radio (HFDR) provides the means to process, transmit and receive data as well as analog voice. The HFDR Transceiver should operate on frequencies spaced 100 Hz apart in the 2-30 MHz band. Simultaneous analog voice and data transmission is not required. Voice transmission should be compatible with current Single Side Band (SSB) HF transceivers. Data transmission should also be compatible with ground HF transmitting and receiving systems which may use conventional SSB HF transceivers.

The HFDR system performs the following functions:

a. Single Side Band simplex transmission and reception of analog voice or digital data (selectable, but not simultaneous) in a standard channel in the aeronautical HF bands as defined in Section 4 and subsections

b. Encoding and modulation of digital data, and demodulation and decoding of digital data as defined in ARINC Specification 635

c. HF frequency search and link acquisition per the protocols defined in ARINC Specification 635

d. Error-free air/ground data exchange in an environment where multiple aircraft share the same communications channel using the protocols defined in ARINC Specification 635

3.0 SYSTEM DESIGN

3.3.1 HF Data Radio (cont'd)

e. Exchange of downlink and uplink data with the MU or CMU per the protocols defined in ARINC Specification 635

f. SELCAL output lines to a selective calling decoder elsewhere in the aircraft for the purpose of alerting the pilot of an incoming voice call

g. Analog Data Input and Output for compatibility with ARINC 719 retrofit installations; These connections are used with external modem equipment where an HFDR transceiver is being used as a spare with an external HFDU or where some other type of modem waveform is desired (non-HFDL type)

COMMENTARY

Simplex operation (antennas)(radio transmitters). A method of operation in which communication between two stations takes place in one direction at a time. Note: This includes ordinary transmit-receive operation, press-to-talk operation, voice operated carrier and other forms of manual or automatic switching from transmit to receive.

3.3.2 HF Data Unit

The HFDU provides the means to process, transmit and receive data via a standard ARINC 719 or ARINC 559A conventional SSB HF transceiver tunable over the HF band (2-30 MHz).

The HFDU interfaces with the MU or CMU as shown in Attachment 3-1A, 3-1B and 3-1C.

The HFDU system performs the following functions:

a. HF transceiver tuning and control as defined in Section 5.5 and subsections

b. Encoding and modulation of digital data and demodulation and decoding of digital data as defined in ARINC Specification 635

c. HF frequency search and link acquisition per the protocols defined in ARINC Specification 635

d. Error-free air/ground data exchange in an environment where multiple aircraft share the same communications channel using the protocols defined in ARINC Specification 635

e. Exchange of downlink and uplink data with the MU or CMU per the protocols defined in Section 5.8 of this document and ARINC Specification 635

3.3.3 HF Data Link Control Functions

The switching of the HFDR or the HFDU/HF transceiver combination between voice and data modes is accomplished by means of an HF Data Control Function (HFDCF) defined in Section 6. This function may be integrated into a Radio Control Panel (RCP), a centralized radio management system or it may be provided in a separate HF Data Control Panel (HFDCP) at the discretion of the airline and/or the airframe manufacturer.

When the HFDR or the HFDU/HF transceiver combination are in the Voice mode, frequency tuning is controlled by the crew from the centralized radio management system or Radio Control Panel. When the HFDR or the HFDU/HF transceiver combination are in the Data mode, frequency tuning is controlled by the HFDL functions implemented in the HFDR or the HFDU respectively. During analog data operation, the HFDR frequency tuning is controlled by an external modem. c-1

3.4 Optional Additional Components

The provisions explained in the following sections should not be included in the basic provision for the airborne HFDL system, but can be provided additionally by suppliers.

3.4.1 Central Maintenance System

The HFDR communicates with the Central Maintenance System (CMS)/Centralized Fault Display Interface Unit (CFDIU), according to ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment (BITE)", which is the repository for maintenance information; otherwise the CMU should maintain this database. Reference Section 9.2 of this document.

3.4.2 Analog Data Operation

The HFDR contains an analog data system interface as defined in ARINC Characteristic 719; pinouts have been reserved for this option. Reference Attachment 2-2.

If the optional analog data system component interface is provided, the HFDR may be used as an ARINC 719 HF communication radio for both voice and data. The Data mode would be provided by an external modem which would provide either ARINC Specification 635 type data functionality or some other user desired protocol. This is provided so that HFDR transceivers can be used as universal spares in that they can be used in either an ARINC 719 or ARINC 753 slot.

3.5 Interlocks on Dual HFDR Systems

Each system should contain interlocking circuitry tailored to ensure satisfactory automatic tune-up when two systems are installed on the same aircraft.

The interlocking should be effective for all combinations and manipulations of the pilot's controls regardless of whether a common antenna or dual antennas are employed. When dual installations are used with automatic antenna tuning units, interlocking circuitry should be provided to prevent one system from being tuned or operated while the other system is in the self-tuning process. When one system is kept from tuning after channeling because the other unit is re-tuning, the system should be designed so that the one unit automatically re-tunes after the other has completed its re-tuning.

3.0 SYSTEM DESIGN

When one unit is removed or its power is shut off, the interlock system should not prevent the other system from operating or tuning. However, the design of interlocks should be such as to assure no simultaneous operations of two transmitters.

3.6 HFDR and HFDU Modes of Operation

The HFDR and HFDU/HF Transceiver combination operate in Voice or Data modes. The switching between these modes is controlled by the crew from an HF Data Control Function (HFDCF) in the cockpit. When the HFDR or HFDU/HF Transceiver combination is in the Voice mode, the Multifunction Control Display Unit (MCDU) should display HF Data Link-In-Voice to alert the crew. The information needed to display this warning is sent by the HFDR/HFDU to the MU/CMU via an ARINC 429 interface.

3.6.1 HFDR Mode Select

An HFDL mode signal (either TP7G or bits 18 and 19 in Label 207) from the HFDCF to the HFDR is used to enable or disable the data link operation. The details are defined in Section 4.6.1.

c-1 When data link operation is disabled, the HFDR operates as an ARINC 719 HF transceiver. The cockpit audio input modulates the SSB carrier when the PTT is keyed. Similarly, the analog data signal from an external modem modulates the SSB carrier when the signal is present or when the Data keyline is keyed. Frequency selection is accomplished by a cockpit control panel (or external modem equipment) connected to the serial ARINC 429 or to the parallel tuning ports on the HFDR.

When data link operation is enabled, the HFDR performs all HF Data Link functions as defined in ARINC Specification 635. Downlink/uplink data is exchanged with the MU/CMU via a pair of ARINC 429 ports. The functions associated with the ARINC 719 transceiver are disabled during data link operation.

The HFDR periodically sends an ARINC 429 status word containing the state of the HFDL mode to the MU/CMU.

3.6.2 HFDU/HF Transceiver Combination Mode Select

A Voice/Data mode Discrete input, MP12D, from the HFDCF to the HFDU is used to place the HFDU in the Voice or Data mode. The details are defined in Section 5.2.

When in the Data mode, the HFDU controls the tuning of the HF transceiver and performs the HF Data Link functions defined in ARINC Specification 635. Downlink/uplink data is exchanged with the HF transceiver via transmit and receive audio lines, and with the MU/CMU via a pair of ARINC 429 ports. In the Voice mode, the HFDU stops data transmission and reception functions.

The HFDU sends a status word to the MU/CMU periodically to inform it whether the HFDU/HF transceiver combination is in the Voice or Data mode. Switching of the HF transceiver between Voice and Data modes depends on the type of HF transceiver. Three different cases need to be considered.

3.6.2.1 ARINC 719 HF Transceiver Controlled By Discretes

In these installations (Frequency Source Select, pin MP2K, open), the ARINC 719 transceiver has separate audio ports for voice and data communications, and separate voice PTT and data keylines. A Voice/Data Mode Select Discrete input, MP2D, from the HFDCF to the HF transceiver is used to select between the voice and data audio and keyline ports.

In addition, the tuning of the transceiver to voice frequencies is controlled from a dedicated HF Radio Control Panel in the cockpit connected to one of the transceiver serial ARINC 429 frequency tuning ports, generally Port B, MP3G and MP3H. ARINC 429 words with Label 037 are used to tune the HF transceiver to the appropriate voice frequency. The second serial ARINC 429 frequency tuning port, generally Port A, MP3E and MP3F, is connected to the HFDU (See Attachment 3-1A). The HFDU should also use ARINC 429 words with Label 037 to tune the HF transceiver to the appropriate data frequency. A Frequency Port Select Discrete input, MP3J, from the HFDCF to the HF transceiver is used to select between Frequency Tuning Ports A and B. The state of the Frequency Port Select Discrete should be tied to the state of the Voice/Data Mode Select Discrete, MP2D.

3.6.2.2 ARINC 719 HF Transceiver Controlled By ARINC 429 Words

In these installations, (Frequency Source Select, pin MP2K, grounded), the ARINC 719 transceiver also has separate audio ports for voice and data communications, and separate voice PTT and data keylines. However the Voice/Data Mode Select Discrete input, MP2D, to the HF transceiver is ignored by the radio. Instead, an ARINC 429 word with Label 207 should be used to place the HF transceiver in the Voice or Data mode. In addition, the tuning of the transceiver to voice frequencies is controlled from the Radio Management System in the cockpit which is normally connected to both serial ARINC 429 frequency tuning Ports A and B. ARINC 429 words with Label 205 are used to tune the HF transceiver to the appropriate voice frequency.

In order to provide HDFL capability in these installations with the addition of an HFDU and an HFDCF, the Radio Management System should be disconnected from the ARINC 429 Frequency Tuning Port A and connected only to the ARINC 429 Frequency Tuning Port B MP3G/H as shown in Attachment 3-1B. The capability to tune the HF transceiver to a voice frequency from either of the two Radio Management Panels which comprise the Radio Management System should still be retained.

The Voice/Data Mode Select discrete input, MP2D, to the HF transceiver from the HFDCF need not be connected. The data frequency tuning ARINC 429 serial output from the HFDU should be connected to the serial ARINC 429 Frequency Tuning Port A, MP3E/F, of the HF transceiver as shown in Attachment 3-1B. The HFDU should also use ARINC 429 words with Label 207/205 to place the

3.6.2.2 ARINC 719 HF Transceiver Controlled By ARINC 429 Words (cont'd)

transceiver in Data mode and to tune the HF transceiver to the appropriate data frequency. A Frequency Port Select discrete input, MP3J, from the HFDCF to the HF should be used to select between Frequency Tuning Ports A and B.

3.6.2.3 ARINC 559A HF Transceiver

In these installations, the ARINC 559A HF transceiver audio ports and keyline (PTT) should be shared between the cockpit audio and HFDU data audio and Data Keyline. In addition, the ARINC 559A HF transceiver has a single parallel discrete tuning input which should also be shared between the Radio Control Panel and the HFDU to tune the radio to the voice or data frequency, respectively.

A function which switches between cockpit and HFDL audio, keying, and tuning signals based on the state of the Voice/Data Mode Discrete input, MP12D, from the HFDCF should be implemented either in the Radio Control Panel, or the HFDU, as shown in Attachment 3-1C, at the discretion of the aircraft operator.

4.0 HF DATA RADIO DESIGN c-1

4.1 Introduction

This section sets forth the specifications for the HF Data Radio transmitter and receiver parameters. The HF Data Radio (HFDR) provides the primary functions of voice and data link. For compatibility with existing ARINC 719 installations the HFDR also provides Amplitude Modulated Equivalent (AME), Continuous Wave (CW), Selective Calling (SELCAL) and Analog Data functions. In addition to providing traditional HF radio functionality the HFDR contains an internal data modem and controller. The data communications protocols to be implemented in the HFDR are defined in ARINC Specification 635.

4.2 Transceiver

4.2.1 Tuning

The HFDR transceiver can be tuned by either parallel Re-Entrant type tuning or by ARINC 429 Serial type tuning. The HFDR unit should be able to automatically determine which type of tuning is being provided to it. When operating in the HFDL Data mode the HFDR transceiver should disregard external frequency tuning controls as the frequency will be internally controlled by the data link processor.

4.2.1.1 Frequency Switching Time

The transmitter channel/frequency change time (power amplifier tuning) should not exceed 1 second (excluding coupler tune time) when changing from one transmit channel/frequency to another transmit channel/frequency.
c-1 Antenna Coupler tuning should be initiated by the operation of the Push-to-Talk (PTT) or keyline.

COMMENTARY

> Designers of the HFDL system should realize that the existing ARINC 719 equipment can take as long as 400 ms to change bands. As the protocol evolves, this timing should be kept in mind in order that the HFDL system should retrofit into existing ARINC 719 installations. The following sections detail new timing characteristics that should be met by newer ARINC 753 Equipment.

COMMENTARY

> The HFDL controller should scan frequencies from highest to lowest as this minimizes the number of rotations of the bandswitch assembly in existing ARINC 719 transceivers. This should result in faster switching of frequencies.

Voice Mode

The HFDR transmitter should be tunable to any frequency in the HF range within 250 ms, excluding power amplifier and coupler tune time.

The HFDR receiver should be tunable to any frequency in the HF range within 250 ms.

Data Mode

When controlled by the link processor in the HFDR Transceiver, the transmitter should be tuned to the appropriate frequency. The HF transmitter should be tunable to any frequency in the HF range within 250 ms, excluding power amplifier and coupler tune time.

When listening for a squitter, the receiver scans over the systems HF frequency pool and listens to each of the frequencies for approximately 35 seconds. The receiver should be tunable to any frequency in the HF range within 250 ms.

4.2.2 Transmitter - Receiver Interaction

The HFDR should operate in a simplex mode with transmit/receive switching times no worse than with those of ARINC 719 and ARINC 559A HF transceivers.

4.2.2.1 Transmit to Receive Turnaround Time

Voice Mode

With the receiver squelch set to operate at 3 µV, the receiver should recover after transmission to provide 90% of its output at an input level of 10 µV modulated 30% at 1 kHz in less than 100 ms.

Analog Data Mode c-1

The receiver should recover after transmission to provide 90% of its output at an input level of 10 µV modulated 30% at 1 kHz in less than 100 msec.

4.2.2.2 Receive to Transmit Turnaround Time

Voice Mode

The Transmitter power output should reach 90% of its rated output power within 250 ms from the time the Microphone Key (MP1C) line is grounded.

Analog Data Mode c-1

The Transmitter power output should reach 90% of its rated output power within 250 ms from the time the Analog Data Key (MP1K) line is grounded.

COMMENTARY

> When the HFDR transceiver is operated with the ARINC 719 type coupler attached, the coupler inserts a delay of 200 ms between the time the keyline is c-1
> activated and the time the coupler returns "Key Interlock" back to the transceiver. This creates a delay in the transmitter coming on the air. For the data function this delay, in addition to other delays, necessitates the prekey as described in the ARINC Specification 635.

HFDR transceivers should exceed the above specifications. However, the HFDL system is capable of withstanding the specified delay to allow compatibility with older ARINC 719 transceivers.

COMMENTARY

> HFDR Transceivers do not have an HFDL data keyline external to the unit so these delays should be accounted for internal to the unit hardware and software.

4.0 HF DATA RADIO DESIGN

4.3 Transmitter

c-3 The HF Data Link class of emission is 2K80J2DEN and the HF Voice class of emission is 2K80J3E.

4.3.1 Power Output

Power output should be measured in terms of peak envelope power (PEP) and measured directly in accordance with permissible distortion and spectrum limits with two tones applied to the transmitter (rather than utilizing the method recommended by the International Radio Consultative Committee (CCIR)). Power output should be measured at nominal line voltage working into a 50 ohm resistive load. A proportional reduction of power output at the same distortion is permitted with reduced line voltage below the nominal down to the minus 10% line voltage limits.

COMMENTARY

> R.F. Power amplifiers typically have average power limiters that are set to 125 W average power. When running the tests specified below that require 400 W PEP output using a two tone test, the average power ALC circuit may be defeated. Normal duty cycle and cooling requirements should be observed during testing to avoid overheating.

4.3.1.1 SSB Suppressed Carrier

The transmitter output should be 400 watts PEP, +1 dB, -1.5 dB when measured per Section 4.3.1.

4.3.1.2 SSB Full Carrier (AME)

The transmitter output should be 125 watts average, +1 dB, -1.5 dB into a 50 ohm load. The output should be measured with the sideband amplitude equal to the carrier amplitude.

4.3.1.3 Tune Power

In the tune mode, the HF transmitter should output a power level of 70 to 100 watts into a 50 ohm load.

4.3.1.4 VSWR Tolerance

The HF transmitter should be able to operate with a load VSWR of 2.0:1. The transmitter should not be damaged when the load is either an open or a short circuit at the transceiver antenna connector.

4.3.1.5 Transmit Duty Cycle

The transmitter should be rated for continuous Amplitude Modulated Equivalent (AME) transmit when supplied with continuous 360 lbs/hr cooling air and the ambient temperature does not exceed 55º C. The transmitter should be duty cycle rated for 1-minute AME transmit, 4-minute receive, when supplied with 125 lbs cooling air at 55º C ambient temperature.

The transmitter should be rated for continuous operation at 55º C ambient temperature as long as the internal blower operates continuously by ungrounding pin MP3K of the aircraft rear connector.

4.3.2 Frequency Stability

The maximum frequency error of 20 Hz between actual and selected frequency should be held under all environmental conditions for which the equipment is designed.

Adjustments of the frequency to correct for slow random or non-random drifts should be required no more often than every year (approximately 4000 hours operating time).

The frequency reference means should be designed so as to facilitate shop adjustments of the frequency when required, and the set manufacturers should provide whatever facilities or special test equipment or procedural instructions are required to facilitate this checking as a routine shop operation.

There is no requirement, nor is it acceptable to include any pilot-operated or front panel adjustments of the frequency standard, or of any corrector circuits, to allow either pilot adjustment or line service adjustment of the basic frequencies using either WWV transmissions or other test facilities. All frequency adjustments are to be accomplished exclusively in the overhaul shop, and the design of the equipment should be such as to assure reliable and accurate frequency control in the equipment for the period between shop overhauls. It is acceptable, however for a means to be provided whereby qualified personnel may check the frequency accuracy of the equipment in the aircraft or in flight using WWV transmissions, if the manufacturer so desires. However, no means are to be provided for correcting this error in flight or during line maintenance.

4.3.3 Phase Stability

The phase jitter caused by the transmitting path between the (analog) input from the modem and the power output should not exceed 3 degrees rms measured in a 500 microsecond sampled interval.

4.3.4 Audio Input

Microphone Input

The HFDR should work with microphones designed as per ARINC Characteristic 538A and ARINC Characteristic 559A. Equipment manufacturers are encouraged to design microphone input circuits in future equipment according to the following standards:

a. Excitation voltage: 16 Vdc

b. Filter-network resistance: 200 ohm

c. Load resistance: 150 ohm

Analog Data Ports

A separate pair of transmitter audio input leads, labelled “Analog Data In Hi” and “Analog Data In Lo” should be provided, isolated from ground and from other internal circuitry for dc and having an input impedance of 600 ohms. A service adjustment should be provided independently of the audio input to the transmitter to control the input level.

4.0 HF DATA RADIO DESIGN

4.3.4.1 Input Level

Microphone Input

Nominal audio input level should be 0.25 Vrms and should provide for adjustment of input levels from 0.1 Vrms to 5.5 Vrms.

Analog Data Ports

The data audio input level should be 0.5 Vrms nominal with provision for adjustment for levels of 0.1 to 5.5 Vrms into 600 ohms.

4.3.4.2 Audio Processing and Modulation Limiting

Microphone Input

It is desirable that some form of speech processing be included with sufficient extra gain, still meeting the microphone input level specifications of Section 4.3.4.1. Service adjustment provisions are to be included to allow setting the speech processing to the desired amount.

Whether or not speech processing is included, automatic modulation limiting should be provided such that when adjusted for proper input level as in Section 4.3.4, and with full rated PEP output as in Section 4.3.1, an increase of 10 dB in the steady-state input signal level should not result in spectrum output extending beyond the limits.

COMMENTARY

The foregoing specifications are for design purpose and have no relation to the adjustment procedures that are employed in an actual operating environment.

Analog Data Ports

No waveform processing should be provided on this input circuit, however modulation limiting (similar to that for voice operation, but with no clipping) should be provided so that with the service adjustment properly set initially, the input signal can be increased to a level of at least 10 dB and preferably 20 dB above the preset value without the transmitter exceeding the spectrum limits and without distortion of the data signals.

4.3.4.3 Frequency Response

Microphone Input

The overall frequency response measured from the microphone audio input should not vary more than from +2 to -6 dB with respect to the 1 kHz reference level through the range of 350 Hz to 2500 Hz.

Analog Data Ports

The overall frequency response should not vary by more than ± 4 dB from a 1 kHz reference level over the frequency range of 350 to 2500 Hz.

4.3.4.4 Transmit Audio Distortion

With transmitter power output on single-sideband of 400 W PEP and with sinusoidal modulating inputs the distortion as indicated on an external monitor detector should not exceed 10%.

With the sideband peak level equal to carrier level while employing sine wave input on SSB-full carrier transmission, the distortion as read on a linear monitor detector on the RF signal should not exceed 25% at the 400 W PEP output level.

It is recognized that the spectrum performance characteristics of the transmitter set forth in Sections 4.3.6 and 4.3.6.1 are far more stringent on the design of the transmitter and its linearity than is this specification for distortion of the audio signal.

COMMENTARY

In the event that a manufacturer chooses to exceed the specified power output specified under Section 4.3.1 or wishes to design a SSB System complying with ARINC Characteristic 719 in all respects except with a lesser rated power output than specified in Section 4.3.1, it should be understood that the transmitter distortion be within the limits as specified above and with spectrum limitations as set forth in Section 4.3.4.3 and with the automatic modulation limiting of Section 4.3.4.2, but with each of these test specifications modified watt figure specified under Section 4.3.1 of this Characteristic. In other words, it is not considered acceptable for a set manufacturer to rate his SSB equipment at a power rating based on a dummy load test of the equipment and then meet the specifications of spectrum and distortion at an entirely different power rating level. For purposes of this ARINC Characteristic, the power output rating of the equipment is considered to be that output at which the distortion and spectrum limitations specified herein can be met or exceeded.

4.3.5 Transmitter Keying

Operation of the PTT or data keyline should cause the transmitter to operate in the transmit mode. When operating in the Data mode the HF Data Link Modem should control the keyline functions. When powered “off”, the HFDR should not cause a “key event” to occur.

4.3.6 Occupied Spectrum

Suitable transmitter circuit filtering should be employed, and the linearity of the transmitter should be such, as to assure the following spectrum limits, when checked with a two-tone test on SSB-suppressed carrier transmission or with a single-tone test with SSB-full carrier transmission:

a. All spectrum components at a frequency lower in frequency than 100 Hz below the carrier frequency and higher in frequency than 2.9 kHz above the carrier frequency should be attenuated at least 30 dB below PEP.

b. All emissions lower in frequency than 3.1 kHz below the carrier frequency and higher in frequency than 5.9 kHz above the carrier frequency should be attenuated at least 38 dB below PEP.

c. With the exception of emissions on a harmonic of the desired frequency, all other spectrum components

4.0 HF DATA RADIO DESIGN

4.3.6 Occupied Spectrum (cont'd)

lower in frequency than 6.1 kHz below the carrier frequency and higher in frequency than 8.9 kHz above the carrier frequency should be attenuated at least 54 dB and preferably 60 dB or more below PEP.

d. Any emissions on a harmonic of the desired frequency should be down at least 43 dB below PEP as measured in a 50 ohm load. All intermodulation distortion and spurious radiation should be at least 43 dB below PEP.

The above specifications should be met with the introduction of any modulation tone or tones either inside or outside the transmitter frequency response bandwidth.

4.3.6.1 Intermodulation Distortion

Whether or not speech processing is included, automatic modulation limiting should be provided such that when adjusted for proper input level, with full rated PEP output, an increase of 10 dB in the steady-state input signal level should not result in spectrum output extending beyond the limits. Intermodulation distortion products of the 3rd and 5th order should be at least 24 dB below either tone of a two tone test signal at full rated output power. The 7th order products should be at least 34 dB below either tone.

4.3.6.2 Harmonics

All harmonically related spurious emissions should be not less than 43 dB below full rated output when measured into a 50 ohm resistive load at full rated output power.

4.3.6.3 Non-Harmonics

All non-harmonically related spurious emissions should be less than 25 microwatts when measured into a 50 ohm resistive load at full rated output power and more than 20 kHz frequency offset.

4.3.7 Tone Tuning Signal

A tuning tone signal should be generated within the HFDR Transceiver and should be mixed into the sidetone output channel at the appropriate level specified. A service adjustment of this level is desirable within the HFDR Transceiver. Within the HFDR Transceiver the tone signal should be generated whenever tuning is in progress.

COMMENTARY

c-2 ARINC 719 style couplers applied tune tone the entire time that they were actually "tuning". These were typically between 1 and 15 seconds depending on frequency. New generation "digital" or "ARINC 753" couplers have the advantage of being able to tune very quickly resulting in short tune tones being heard in the sidetone. The end users of the HFDR equipment should therefore make appropriate changes to pilot flight manuals to help the flightdeck crews to understand the new operation.

4.4 Receiver

4.4.1 Sensitivity

With a 1 µV (hard) signal, the signal plus-noise-to-noise ratio should be $\geq$ 10 dB for SSB operation. With a 4 µV (hard) signal, amplitude modulated 30% at 1 kHz, the signal plus-noise-to-noise ratio should be 10 dB for AM operation. c-1

4.4.2 Selectivity

COMMENTARY

The users of this document should be aware that the receiver selectivity characteristics, in this document, have been improved over those in ARINC Characteristic 719 to improve the performance in the data mode.

4.4.2.1 SSB Suppressed Carrier

The receiver passband should not attenuate the desired input signal more than 4 dB below the peak of the desired signal over the frequency range. The carrier frequency is f_c. The attenuation of the signal should be at least 35 dB from f_c to f_c –300 Hz, and from f_c + 2900 Hz to f_c + 3300 Hz. c-3 The attenuation should be at least 60 dB for frequencies less than fc –300 Hz or greater than f_c + 3000 Hz. The Attachment 8 for a graphical depiction.

4.4.2.2 Amplitude Modulated Equivalent (AME)

The bandwidth at the 6 dB points should be at least 5.5 kHz and the skirt bandwidth at 60 dB down should not exceed 12 kHz.

4.4.2.3 Group Delay

The group delay of the HFDR should not vary by more than 0.5 ms over the passband of 350 Hz to 2500 Hz between the antenna port and the Analog Data Output, MP1F and MP1G.

COMMENTARY

The users of this document should be aware that the receiver group delay characteristics were not included in ARINC Characteristic 719. Group delay has been included in this document to improve the performance in the Data mode.

4.4.3 Frequency Stability

The receiver frequency stability should conform to Section 4.3.2 of this document.

4.4.4 Spurious Responses

All spurious responses, including images, should be down at least 60 dB. All spurious responses within the HF frequency band should be down at least 60 dB and preferably 80 dB.

4.0 HF DATA RADIO DESIGN

4.4.5 Audio Output

Audio/Sidetone Output

An audio output should be provided which is isolated from ground. A service control should be provided within the transceiver for adjustment of the output level. The adjustment should vary the output from 5 mW to 50 mW into a 600 ± 20% ohm resistive load. The nominal setting should be 10 mW at 1 kHz. The output circuit should be able to endure a short circuit (zero ohms) and open circuit, and should operate normally after removal of the short or open.

Analog Data Output

An audio output should be provided which is isolated from ground. A service control should be provided within the transceiver for adjustment of the output level. The adjustment should vary the output from -10 dBm to +10 dBm into a 600 ± 20% ohm resistive load. The nominal setting should be 0 dBm at 1 kHz. The output should be able to endure a short circuit (zero ohms) and open circuit, and should operate normally after removal of the short or open. The output level should be independent of the effects of the squelch and noise limiter circuits.

4.4.5.1 Source Impedance

Audio/Sidetone Output

The audio output circuit should present less than 20 ohms impedance to the load circuit under all power-on conditions (signal and no-signal) when measured using the Figure 1 and Figure 2 methods of Attachment 9. The audio output circuit should present less than 1000 ohms impedance to the load circuit (measured using the Figure 2 method of Attachment 9) when no power is applied to the unit. The source impedance limits should apply over the frequency range of 100 Hz to 6 kHz.

Analog Data Output

The data output should have a source impedance of 100 ohms or less.

4.4.5.2 Gain

The receiver gain should be such that a 2 µV signal modulated 30% at 1 kHz produces at least 10 mW of output into a 600 ohm ± 20 % resistive level.

4.4.5.3 Frequency Response

Audio/Sidetone Output

The audio power output level should not vary more than 4 dB over the frequency range 300 Hz to 2500 Hz with respect to a reference level of up to 10 mW established at 1 kHz with a constant input carrier level modulated 30%. A sharp cut-off in response below 300 Hz and above 2500 Hz is desirable. Frequencies above 3750 Hz should be attenuated at least 20 dB and preferably 40 dB.

Analog Data Output

The audio power output level should not vary more than 4 dB over the frequency range 300 Hz to 2500 Hz with respect to a reference level of 1 mW established at 1 kHz with a constant input carrier level modulated 30%. A sharp cut-off in response below 300 Hz and above 2500 Hz is desirable. Frequencies above 3750 kHz should be attenuated at least 20 dB and preferably 40 dB.

4.4.5.4 Distortion

Audio/Sidetone Output

With an input signal of 1 mV modulated with 1 kHz and the receiver gain adjusted to produce 10 mW into a 600 ohm resistive load, the total harmonic distortion should not exceed 5% with 30% modulation or 10% with 90% modulation (with the gain control reset to maintain the output at 10 mW), including any effects of the noise limiter.

Analog Data Output

With an input signal of 1 millivolt modulated with 1 kHz and the receiver gain adjusted to provide 0 dBm into a 600 ohm resistive load, the total distortion should not exceed 5 percent in SSB.

4.4.5.5 Hum Level

Hum and noise in the receiver output should be at least 40 dB below 10 mW output with a reference input of 1 mV modulated with 1 kHz and 30% AM.

4.4.5.6 Phase Shift

Audio/Sidetone Output

With 1 mV modulated with 1 kHz and the output level adjusted for 10 mW into a 600 ohm resistive load, the audio output phase should not depart from that of the positive going modulation envelope at the receiver input by more than -30 degrees or +120 degrees.

COMMENTARY

> The phase shift limits of the audio output are different from those of Selective Calling (SELCAL) output due to the number of stages used for the processing of each signal.

Analog Data Output

With 1 mV modulated with 1 kHz and the output level adjusted for 10 mW into a 600 ohm resistive load, the analog data audio output phase should not depart from that of the positive going modulation envelope at the receiver input by more than -30 degrees or +120 degrees.

4.4.5.7 Phase Stability

Analog Data Output

The phase jitter caused by the receiving path between the antenna input and the (analog) output to the modem should not exceed 3 degrees rms measured in a 500 microsecond sampled interval.

4.0 HF DATA RADIO DESIGN

4.4.6 Automatic Gain Control

Variation of percentage modulation should have negligible effect on the automatic gain control.

The receiver output should not vary more than 6 dB with input signals between 5 µV and 100 mV. The output should not increase by more than 2 dB from 100 mV to 1 V input level. The receiver should not overload with 1 V (hard) RF energy applied to the antenna terminals. The receiver should not be damaged with 20 volts of RF energy (hard) applied to the antenna terminals. Recovery time of the protection circuit should be less than 0.5 seconds.

COMMENTARY

The test procedure for measuring AGC time constant is described in RTCA DO-163 Appendix B, Test Procedure T-1. A method similar to step C can be used to test the protection circuit recovery. Input 20 V and switch to a 1 V signal. Measure the recovery time.

4.4.6.1 Voice Mode

Voice Mode Time Constants

The attack time for a 60 dB increase in RF signal (step function) should be less than 50 ms.

The decay time for a 60 dB decrease in RF signal (step function) should be between 1 and 2 seconds.

c-1

4.4.6.2 Analog Data and Data Link Mode

Data Mode Time Constants

The attack time for a 60 dB increase in RF signal (step function) should be less than 10 ms.

The decay time for a 60 dB decrease in RF signal (step function) should be typically 25 ms, including a hold time.

4.4.6.3 Settling Time

The automatic gain control of the receiver should be capable of controlling slow level variations of the input signal of ± 5 dB with a loop settling time of typically 20 dB/sec.

4.4.7 RF Sensitivity Control and/or Squelch Control

Inasmuch as some customers may desire to use an RF Sensitivity Control while other customers may desire to use a squelch control instead of an RF sensitivity control, the receiver should be designed to operate with either one or the other as the external control. Both functions should be controlled by the Receive/Transmit (R/T) Control Data Bus provided as shown in the standard interwiring. Note that although the standard R/T Control Data Bus might provide for both a squelch control and an RF sensitivity control to be employed at the panel, the set design need not provide for operation of the receiver with both controls as it is not expected that both controls would be used in a particular aircraft installation. The user should determine which he wishes to employ in a particular aircraft, depending upon the mode of operation employed with the SSB equipment, and therefore, should decide whether a control panel containing a squelch control, or a control panel containing an RF sensitivity control should be utilized. The control panel should be so designed that a given R/T Unit is capable of operation in one group of aircraft in an airline equipped with RF sensitivity controls and in another group of aircraft in that same airline equipped with squelch controls.

COMMENTARY

When HF operation is employed under conditions where SELCAL is utilized it is generally deemed advisable to operate the HF equipment with the RF sensitivity at maximum so that SELCAL transmissions should always be received. Under these conditions, it is usually impractical for an aural monitor to be maintained on the circuit by the crew members because of the heavy noise level on the HF receiver. Thus, if this mode of operation is employed, it is extremely important that a highly satisfactory squelch system be incorporated in the HF equipment with provisions for manual control of the squelch threshold. In this case, the squelch threshold adjustment would apply only to the headphone output circuits, so that SELCAL reception should be at full sensitivity at all times, irrespective of the threshold sensitivity of the squelch circuit employed for the aural monitoring. Manufacturers should recognize the operational desire for a satisfactory squelch system and endeavor to meet customer's requirements.

The range of the RF sensitivity control, when utilized should be approximately 50 dB and should be essentially linear in dB per unit of angular rotation of the linear control. The range of the squelch control should be the minimum required to effect complete quieting of the receiver under the worst conditions of noise. The range of control provided for both RF sensitivity and squelch should be divided into a minimum of 16 increments by the R/T Control Data Bus Circuitry.

The RF sensitivity and squelch can also be controlled via the Label 207 word on the ARINC 429 control bus input. Bit 22 of the Label 207 word defines if the next 7 bits represent the magnitude of the squelch control or the RF sensitivity control. A binary one represents RF sensitivity and a binary zero represents squelch. Bits 23 through 29 are defined for the magnitude of the resistance. Bit 29 is the most significant bit and bit 23 is the least significant bit. A binary 0000000 represents 0 ohms and a binary 1111111 represents a resistance of 5000 ohms. The HFDR transceiver should automatically determine if analog or digital squelch/RF sensitivity is being used. In the event both analog and digital is provided, the analog should prevail. When the HFDR transceiver is operated in the Data mode, squelch should be set to squelched and the sensitivity should be set to max.

COMMENTARY

Existing ARINC 719 radios do not support ARINC 429 type control of RF sensitivity and squelch. These bits were allocated by the ARINC 429 Specification, but not very well defined. This Characteristic is now defining them for implementation in new ARINC 753 type HFDRs.

4.0 HF DATA RADIO DESIGN

4.4.8 SSB Mode Linearity

With the HFDR in the SSB mode with any two-tone test signal corresponding to any signal level from threshold sensitivity to 20 mV, the intermodulation product (difference frequency of the two test tones) should be at least 40 dB and preferably 50 dB below the output of the two desired tones. Furthermore, at signal levels up to 100 mV, the intermodulation product should be at least 30 dB below the output of the two desired tones.

Interfering Signal Linearity

With a 1200 Hz single tone SSB signal applied, having any level from threshold sensitivity level to 100 mV, and with an interfering carrier applied 3 kHz higher in frequency than the desired signal carrier frequency, it should be possible to increase the level of this interfering carrier to a level corresponding to at least 10 mV and preferably 100 mV before the 1800 Hz intermodulation product equals the level of the 1200 Hz desired signal output.

4.5 SELCAL Output

An output isolated from ground having a source impedance of 300 ohm or less and independent of the voice output and its associated squelch, noise limiters, audio compressors, etc. should be provided. A service adjustment independent of the voice or sidetone outputs should be provided within the transceiver for output level adjustment.

4.5.1 Frequency Response

The total receiver frequency response should be such that no more than a 3 dB difference in levels occurs for any two SELCAL tones between 300 Hz and 1500 Hz.

4.5.2 Distortion

With an input signal of 1 mV modulated 30% at 1 kHz and the level adjusted to provide 0.5 V output into 600 ohms, the total distortion should not exceed 5.0%.

4.5.3 Phase Shift

With 1 mV modulated with 1 kHz and the output level adjusted to 0.5 V into 600 ohm resistive load, the audio output phase should not depart from that of the positive going modulation envelope at the receiver input by more
c-2 than + 22.5° or less than + 135°.

COMMENTARY

The phase shift limits of the SELCAL output are different from those of the audio output due to the number of stages required for the processing of each signal type.

4.5.4 Differential Phase Delay

The differential delay through the receiver to audio frequencies (f) from 300 Hz to 1500 Hz should be less than 1/(10f) sec.

4.6 HFDR - System Interface

4.6.1 Voice/Analog Data/Data Link Mode Selection

The HFDR determines its Voice/Analog Data/Data Link operating mode from information provided by the HF Data Control Function (HFDCF). Refer to the table in Attachment 14.

4.6.1.1 Data Link

Depending on the airplane configuration, the HFDR Data Link mode selection is commanded by the discrete input TP7G, or by bits 18 and 19 in the Label 207 word on the HF Frequency Select ARINC 429 bus. The HFDR also monitors the Data Link mode selection for the opposite side HFDR via discrete input TP3K or bits 18 or 19 of the Label 207 word.

When connected as installation number 1 (see Section 4.6.13), the HFDR is in Data Link mode when TP7G = ground, or when Label 207 bit 18 = 1. The HFDR determines the opposite side HFDR to be in Data Link mode if either TP3K = ground, or if Label 207 bit 19 = 1. Otherwise, the opposite side HFDR is not considered to be in Data Link mode. c-1

When connected as installation number 2, the HFDR is in Data Link mode when TP7G = ground, or when Label 207 bit 19 = 1. The HFDR determines the opposite side HFDR to be in Data Link mode if either TP3K = ground, or if Label 207 bit 18 = 1. Otherwise, the opposite side HFDR is not considered to be in Data Link mode.

COMMENTARY

Each HFDR reports the Data Link mode selection status of itself and of the opposite side HFDR in the Label 270 word sent to the MU/CMU as specified in Section 10.3.1. This ensures that the Data Link mode information for both HFDRs is available to the MU/CMU even after one HFDR has malfunctioned.

In the Data Link mode, the HFDR performs the air/ground data transfer protocols defined in ARINC Specification 635, including the specific functions defined in the following sections. When in Data Link mode, the HFDR ignores the voice keyline, MP1C, the microphone input MP1A & MP1B, the analog data transmit keyline, MP1K, and the analog data input, MP4A & MP4B.

4.6.1.1.1 Master/Slave Mode Selection

While an HFDR is selected to Data Link mode, it operates either as a Master or Slave HFDR. The HFDR Data Link Master/Slave mode selection is commanded by bits 26, 27 of the Label 276 word from the CMU, the Label 272 word from the offside radio, the Voice/Data mode of the radio and the offside radio, and the current fault status of the HFDR.

When Label 276 words are supplied to the HFDR, bits 26 and 27 are used to determine the master/slave status of the HFDR. When no Label 276 words are supplied, the master/slave determination is made based on the Label 272 word from the offside radio, the Voice/Data mode of the radio and the offside radio, and the current fault status of c-2

4.6.1.1.1 Master/Slave Mode Selection (cont'd)

c-2 the HFDR. For details describing the logic for Master/Slave determination see Attachment 15.

4.6.1.2 Voice or Analog Data

The HFDR operates in either Voice or Analog Data mode when not commanded into Data Link mode. Voice/Analog Data mode selection is commanded by the discrete input MP2D, or by bit 11 in the Label 207 word of the HF Frequency Select ARINC 429 bus.

c-1 If the HFDR conventional (i.e. not Data Link) tuning is accomplished by ARINC 429 Label 037 or by re-entrant code over the 21 parallel discrete lines, the HFDR is in Analog Data mode when MP2D = ground, otherwise it is in Voice mode.

If the HFDR tuning is accomplished by ARINC 429 Labels 205 and 207, the HFDR is in Analog Data mode when Label 207 bit 11 = 1, otherwise it is in Voice mode. The HFDR ignores MP2D in this case.

In the Voice or Analog Data mode, the HFDR inhibits all Data Link transmission and reception functions and periodically sends notification of its status to the MU/CMU using an ARINC 429 Label 270 status word. (See Section 10.3.1)

In Voice mode, the HFDR ignores the analog data transmit keyline, MP1K, and the analog data input, MP4A & MP4B. In Analog Data mode, the HFDR ignores the voice keyline, MP1C, and the microphone input MP1A & MP1B.

4.6.2 HFDR Voice Transceiver Tuning

The HFDR transceiver can be frequency tuned by Serial ARINC 429 or Re-entrant methods. The HFDR should automatically determine which tuning method is being provided.

COMMENTARY

> A "Frequency Program" pin on MP2J was originally provided for this purpose, but was not connected in aircraft installations. The line can be used to definitively determine that ARINC 429 serial control is in use by grounding this pin. The HFDR software can monitor this line for direct quick determination of tuning method.

In existing aircraft, the HFDR software should determine the tuning method by monitoring the inputs and determining which tuning method is present on its inputs.

COMMENTARY

> Older aircraft use re-entrant tuning and newer aircraft use ARINC 429 serial control. The HFDR transceiver should be designed to be retrofitable into all types of aircraft in order to minimize airline spare inventory.

4.6.2.1 ARINC 719 Style HF Transceiver Tuning

Tuning of the HFDR transceiver should be accomplished by sending a tuning command via a low-speed ARINC 429 bus connected to Port A or B of the HFDR transceiver. The tuning command consists of one 32-bit word or optionally two 32-bit words encoded as specified in ARINC Specification 429, Section 3.1.

The "Frequency Source Select" discrete input line on MP2K should determine if the HFDR should respond to a Label 037 word or Label 205/207 words. When MP2K is grounded the HFDR should respond to Label 205/207 words. The HFDR should consider the input control invalid if both the Label "205" and "207" words are not provided. The Label "205" word can optionally contain 2 words with the second containing the 100 Hz frequency information. Reference Appendix C for the ARINC 429 word formats for the HFDR.

The Port A/B Select Discrete on MP3J determines if the HFDR responds to Port A or Port B. Port A is selected when the Port A/B Select discrete is grounded.

COMMENTARY

> The SDI inputs are used in aircraft that have Radio Management Panels (RMP's) which control several HF and VHF radios.

The transceiver should be designed to utilize the serial digital frequency/function selection system described in ARINC Specification 720. Two serial digital data input ports should be provided, one labeled "Frequency Select Port A", MP3E & MP3F, and the other "Frequency Select Port B", MP3G & MP3H. The transceiver should determine which of these ports should be open to admit data by reference to the binary state of the Port Select Discrete, MP3J.

4.6.2.2 ARINC 559A Style HF Transceiver Tuning

Tuning of ARINC 559A HF transceivers should be accomplished by the grounding/opening of 21 parallel discrete lines using a re-entrant code defined in ARINC Characteristic 559A, Attachment 5. The mode of the c-1 HFDR is also controlled by MP3A and MP3B which select the SSB/AM or LSB/USB modes respectively.

4.6.3 HF Transceiver Keying

4.6.3.1 Voice Mode

The HFDR should be capable of being placed into the grounded. The PTT Hi-line is used in the Voice mode to "key" the transmitter for voice operation the same as in all ARINC 719 transceivers.

4.6.3.2 Analog Data Mode

The "DATA KEY" input is retained for compatibility with other ARINC 719 transceivers and is used in conjunction with the "Analog Data Inputs". When the HFDR is placed in the Analog Data Mode (see Section 4.6.1) the HFDR "keys" if either the Data Key (MP1K) or an analog signal is detected on the "Analog Data Inputs" (MP1H, c-1 MP1J). When the Analog Data mode is enabled and the HFDR is operating in the "ARINC 719 Coupler" mode, the HFDR should ground the PTT Hi-line (MP1C), so as to place the Antenna Coupler in the transmit mode whenever the HFDR transmits analog data. If the HFDR is operating in the "ARINC 753 coupler" mode it should send the appropriate serial commands to the Antenna Coupler to "key" the Antenna Coupler. See Section 7.4.1.1 for Coupler Mode definition.

4.6.3.3 Data Link Mode

c-1 When operating in the HF Data Link Mode the HFDR controls all "keying" by an internal Data Link control function. However, the HFDR must signal the Antenna Coupler when to go into the transmit mode. When the HF Data Link mode is enabled and the HFDR is operating in the "ARINC 719 Coupler" mode, the HFDR should ground the PTT Hi-line (MP1C), so as to place the Antenna Coupler in the transmit mode whenever the HFDR transmits data. If the HFDR is operating in the "ARINC 753 coupler" mode, it should send the appropriate serial commands to the Antenna Coupler to "key" the Antenna Coupler. See Section 7.4.1.1 for Coupler Mode definition.

4.6.4 HF Antenna Coupler Tuning Initiation

The HFDR should initiate and complete the tuning of the HF antenna coupler prior to the first transmission after a frequency change.

Antenna tuning should be initiated by grounding the keyline briefly. The HFDR should monitor the Tune Power Ground line from the coupler to determine when antenna tuning is completed. The HFDR should also monitor the c-1 Coupler Fault #1 (MP4E) line from the coupler to determine whether tuning has failed or was successfully completed.

4.6.5 ACARS MU/CMU Interface Functions

The interface between the HFDR and the ACARS MUs or the CMUs should be via a transmit/receive pair of ARINC 429 ports. This pair of ports should be used to interface to ACARS MU's or CMU's which have HF Data Link provisions. The ACARS MU/CMU - HFDL interface protocols are defined in Section 10 of this document. The System Address Label (SAL) for HF #1 is 340. The SAL for HF #2 is 344. The SAL for the MU/CMU is 304. c-1

4.6.6 Voice/Data Mode Switching Function

c-1 See Section 4.6.1.

4.6.7 Other Interfaces

The HFDR should also interface to other equipments on the aircraft to obtain position information, Universal Coordinated Time information, ICAO 24-bit aircraft address, to upload/download maintenance data, and to a Data Loader.

4.6.7.1 Aircraft Position Data

Current latitude, longitude and altitude data may be used by the HFDR to optimize its search of HF ground stations and frequencies. The HFDR should obtain latitude, longitude and altitude data by interfacing to the appropriate sources on the aircraft. Different airplane configurations may provide the position data on only one or several of the following input ports, and the HFDR should choose the port used for position data in the following priority order if more than one position data c-1 source is present: the input port for position (TP7E and TP7F), the CMC input port, (MP4A and MP4B), the MU/CMU input ports (TP9A, TP9B, TP9E, and TP9F).

In aircraft installations where the latitude and longitude is available on an ARINC 429 bus, this data may be encoded in Binary Coded Decimal (BCD) or Binary (BNR) form. The 32-bit BCD and BNR word formats for latitude and longitude are defined in ARINC Specification 429. c-1

In aircraft installations where altitude is available on ARINC 429 buses, this data should be encoded in BNR form. The 32-bit BNR word format is defined in ARINC Specification 429.

4.6.7.2 Universal Coordinated Time (UTC) Data

Current UTC data may also be used by the HFDR, along with the aircraft position, to optimize its search for a working frequency. The HFDR should obtain UTC data by interfacing to an appropriate source on the aircraft. Different airplane configurations may provide the time data on only one or several of the following input ports, and the HFDR should choose the port used for UTC in the following priority order if more than one UTC data source is present: the input port for time (TP7A and TP7B), the input port for position (TP7E and TP7F), the CMC input port, (MP4A and MP4B), the MU/CMU input ports (TP9A, TP9B, TP9E, and TP9F). c-1

In aircraft installations where the UTC is available on ARINC 429 buses, this data may be encoded in BCD or BNR form. The label determines the format used. The 32-bit word formats are defined in ARINC Specification 429, Attachment 6.

4.6.7.3 ICAO 24-Bit Aircraft Address Data

When in the air the HFDR should use the ICAO 24-bit aircraft address held in NVM if available. When on the ground the HFDR should apply the following paragraphs a) through e). If the HFDR is unable to determine the ICAO 24-bit aircraft address it should declare an external input fault, zero the NVM ICAO 24-bit aircraft address value, and indicate in Label 350 bit 27 that the ICAO 24-bit aircraft address can not be obtained by any means. c-2

The HFDR should select in order of precedence one of the following means of receiving ICAO 24-bit aircraft address information:

a. From CMU #1, via the CMU ARINC 429 Low or High speed bus interface on pins TP9A/TP9B using Labels 214 & 216

b. From CMU #2, via the CMU ARINC 429 Low or High speed bus interface on pins TP9E/TP9F using Labels 214 & 216 c-1

c. From a source such as Mode S Transponder, APM, etc. of ICAO 24-bit aircraft address via the dedicated ARINC 429 Low or High speed input port provided on pins TP3B/TP3C using Labels 275 & 276, or 214 & 216

d. From a source such as Mode S Transponder, etc. of ICAO 24-bit aircraft address via the dedicated ARINC 429 Low or High speed input port provided on pins TP7C/TP7D using Labels 275 & 276, or 214 & 216 c-2

4.0 HF DATA RADIO DESIGN

4.6.7.3 ICAO 24-Bit Aircraft Address Data (cont'd)

c-2 c-1

e. From 25 discrete pins made up of 24 pins for the ICAO 24-bit aircraft address and one pin for address even parity. Pins assigned to take on the binary "one" state in a given code should be jumpered to pin TP15K (Address Common) on the airframe side of the connector. Pins assigned to take on the binary "Zero" state in the code should be left open circuit). An ICAO 24-bit aircraft address of all zeros should be considered invalid

c-2 c-1

The ICAO 24-bit aircraft address should be acquired when the HFDR is first powered up from the first valid ICAO 24-bit aircraft address received. For an ICAO 24-bit aircraft address to be deemed valid the following must hold: the bus on which the ICAO 24-bit aircraft address is to be received must be active (as determined by receiving three consecutive activity labels); the data must not be zero; and both labels needed for an ICAO 24-bit aircraft address must be present. See Attachment 13 which identifies the activity label for each HFDR ARINC 429 port. The acquired address should be stored in non-volatile memory, should not be rewritten until both the aircraft is on ground (Section 4.6.10) and power is cycled through an on/off power cycle.

c-2

COMMENTARY

The Mode S transponder initially, at power up, provides ICAO 24-bit aircraft address values of zero for a short amount of time. Until the transponder is removed from 'standby mode' it does not provide an ICAO 24-bit aircraft address with a valid "normal" SSM. After power is first applied to the aircraft avionics the ICAO 24-bit aircraft address from the transponder shows "NCD". Once the bus is deemed to be active, and the ICAO 24-bit aircraft address data it provides has a value other than zero, it is acceptable to use the ICAO 24-bit aircraft address provided from the transponder during these times as long as the SSM is not "FW" (Failure Warning) condition.

4.6.7.4 Maintenance Data

The HFDR should provide a pair of ARINC 429 low-speed transmit/receive ports to interface to the Onboard Maintenance System on aircraft installations so equipped. See Section 9 of this document.

4.6.7.4.1 Maintenance System Identification

The HFDR should determine the presence and type of maintenance system on board the aircraft from the state of three programming pins CFDS Mode A, TP3D, CFDS Mode B, TP3E, and CFDS Mode C, TP3F, according to the definitions in Attachment 7, Table 7.5. However, if the three discrete pins are open then another means to determine if a CMC is present must be used.

4.6.7.5 Data Loader

The HFDR should provide a low speed transmit and a high speed receive pair of ARINC 429 ports to interface to a Portable and/or Airborne Data Loader. The Data Loader is described in ARINC Report 615. The HFDR should be capable of distinguishing its own unique address (System Address Label) as several LRU's may share a single high speed ARINC 429 bus. As an additional precaution, the HFDR should not data load unless the "Load Discrete" line (TP11E) is grounded. HFDR#1 and HFDR#2 should use the SAL 340, regardless of the installed position of the HF Data Radios.

c-1

COMMENTARY

The HFDR uses the single SAL of HFDR#1 for all HFDR radios regardless of installed position in order to avoid the need for separate data load diskettes for each radio in a dual system. Implementors are advised to use caution when using data loaders. This can be avoided by aircraft wiring that ensures a ground (Low) is not applied simultaneously to pin TP11E of both HF Data Radios.

4.6.7.6 Cross-Talk Bus Data

The HFDR should provide a low speed transmit and receive pair of ARINC 429 ports to exchange HFDL Master/Slave and HFDL Signal Quality information with the opposite-side HFDR using the Label 272 word defined in Table 4-1 below. The Label 272 word should be broadcast by each HFDR to the opposite side radio at 1 second intervals whether it is operating as master or slave. The SSM bits of the Label 272 word should be set to valid only when the HFDL System Table Dbase version contained in squitters received from the HFDL ground station matches the HFDR's System Table Dbase version. Otherwise the SSM bits should be set to invalid. c-2

Bits	Function	Slave HFDL Word Value
1-8	Label	272
9-10	SDI	10 = HFDL #1, 01 = HFDL #2
11	Master/Slave ID	0 = Master HFDL, 1 = Slave HFDL
12	GS ID bit 1	LSB
13-18	GS ID bits 2-7	
19	GS ID bit 8	MSB
20-24	Frequency/ Channel ID	Frequency identifier (index into frequency table as depicted in Attachment 2-10C, range is 1 to 20) with MSB = bit 24.
25	HF Data Mode Status	0 = HF Data disabled 1 = HF Data enabled
26-27	Max bps	00 = 300 10 = 600 01 = 1200 11 = 1800
28	Vendor Defined	
29	Max bps confidence	
30-31	SSM	00 = Normal operation 10 = Invalid data 01 = Functional test 11 = Fault warning
32	Parity	Odd Parity

c-3 c-2

Table 4-1
Link Management In Slave Mode Bit Formats

4.6.8 Status Indication

4.0 HF DATA RADIO DESIGN

c-1 The HFDR should provide an HF Data Link Data Link Lost output indication, on the ARINC 429 output bus to the MU/CMU, an HFDL Fault output indication, TP7H, and an HFDL Transmit Inhibit Status indication, TP9J, to the HFDCF via separate discrete outputs and on the ARINC 429 output bus to the MU/CMU.

c-1 4.6.8.1 HF DATA LINK LOST Bit

c-3 The HFDR status should be indicated in the ARINC 429 Label 270 word bit 11, as defined in Section 10.3.1 of this document. If the HFDL system is in the Voice mode, the DATA LINK LOST condition should be indicated.

4.6.8.2 HFDR FAULT Indication Discrete and Bit

c-1 A discrete "high" should indicate HFDL Fault, while a discrete "low" should indicate that the HFDL function of the HFDR is operating normally. The HFDR status should also be included in an ARINC 429 Label 270 word, bit 16, sent to the MU/CMU as defined in Section 10 of this document.

4.6.8.3 HFDL Transmit Inhibit Status Indication Discrete and Bit

A discrete "high" should indicate HFDL data transmissions are inhibited, while a discrete "low" should indicate that data transmissions are not inhibited. The HFDL Transmit Inhibit Status is indicated by Discrete TP9J and should also be included in the ARINC 429 Label 270 word, bit 22, sent to the MU/CMU as defined in Section 10 of this document.

4.6.9 Built-In Tests

The HFDR should perform Built-In Test Equipment (BITE) diagnostics in accordance with Section 9.0 of this document.

4.6.10 Air/Ground Discrete Input

The HFDR makes use of Air/Ground Discrete Input, MP4G, to determine the flight status of the aircraft. Pin TP5B is the Air/Ground Logic discrete that is used to reverse the sense of the Air/Ground Discrete Input. With TP5B "open" or "1", MP4G "short" or "0", indicates airborne, and "open" or "1", indicates the aircraft is on the ground. A "short" or "0", on TP5B reverses the sense of MP4G.

4.6.11 Transmit Inhibit Discrete Input

c-1 While the Air/Ground Discrete Input, MP4G, indicates "Aircraft on ground", the HFDR uses the Transmit Inhibit Discrete Input, TP3G, to determine if the data radio should be allowed to make data transmission. While MP4G indicates "Aircraft in air", TP3G is ignored. This is to prevent automatic data transmissions from occurring while the aircraft is in certain ground operations. The source of this discrete can be from various sources such as parking brake, oil pressure, doors, etc. The source selection would be according to air carrier choice. An additional strap, TP3H, is provided to change the polarity of the Transmit Discrete Input. With TP3H "open" or "1", TP3G "short" or "0" indicates the transmitter is inhibited, and "open" or "1" indicates the transmitter is enabled. A "short" or "0" on TP3H reverses the sense of TP3G.

4.6.12 Key Event Output

The HFDR transceiver provides a "Key Event" output, MP2E, which provides a "short" or "0" logic output when the transceiver is "keyed" in the Voice mode. This output is not active in the CW, Analog Data, or HFDL modes. This output is intended to be connected to the flight data recorder. c-1

4.6.13 SDI Input Pin Definition

When the HFDR is used in aircraft that have Radio Management Panels the HFDR is tuned using ARINC 429 Label "205", "206", or "207" words, reference Appendix C. These words contain bits for SDI. The SDI input pins MP4J, SDI 0, and MP4H, SDI 1, are used to identify the installation position number. Connect SDI 0 and SDI 1 to ground (SDI common MP4K) per the following table to configure the installation number of the HFDR. Note that inverted logic is used, in that grounds are logical "1".

Installation Number	SDI 1	SDI 0
Not Used	Open	Open
1	Open	Ground
2	Ground	Open
3	Ground	Ground

Table 4-2
SDI Input Pin Definition

The HFDR should be wired for either position 1 or 2 in order to operate in Data Link mode. Installation numbers zero and three are not used for HF Data Link. Regardless of the type of HF control panel used, the HFDR SDI Straps as defined above are used by Data Link OMS when generating or responding to the various ARINC 429 Labels as defined in subsequent sections of this Characteristic. c-2

4.6.14 HFDL Transmit Inhibit Override Discrete Definition

The HFDR includes a pin to allow service personnel or the pilots to override the data transmit inhibit function while on the ground. Data transmit inhibit override is active when this discrete input (TP7J) is at a "ground" state. To disable the override mode, this discrete input is set "high" or "open". Label 270 bit 23 on the ARINC 429 output bus should reflect the state of this discrete input.

COMMENTARY

> To avoid leaving an HFDR in data transmit inhibit override the means should be to provided to warn the service personnel and pilots that override mode is active.

4.6.15 Chopper Control

The HFDR should provide a Chopper Control output on pin MP5A. This pin provides a "short" or "0" whenever the transmitter in the HFDR is transmitting regardless of modulation mode.

4.6.15 Chopper Control (cont'd)

COMMENTARY

4.0 HF DATA RADIO DESIGN

The chopper control output is provided for retrofit compatibility. This output was used in older aircraft that were outfitted with couplers using chopper stabilized control systems, such as models 180L2, 180L3, 180L3A, and possibly others.

4.6.16 Strap Even Parity

The HFDR should use the Strap Even Parity input discrete, TP3A, to detect single failures in the wiring of the following discrete inputs:

Discrete Input Name	Pin #
SDI 0	MP4J
SDI 1	MP4H
CFDS Mode A	TP3D
CFDS Mode B	TP3E
CFDS Mode C	TP3F
TX Inhibit Program Input	TP3H
Air/Ground Program Discrete	TP5B
Frequency Source Select	MP2K
Narrow/Wide Range	MP5J
CMU #1/#2 Speed Select	TP5A

Table 4-3
Discrete Inputs

TP3A should be wired “open” when the number of discretes wired “open” in the table above is odd. Otherwise TP3A should be wired “short”. In the event the Strap Even Parity discrete does not match the parity calculated from the discrete inputs, the HFDR should set bit 24 in the Label 350 CFDS word.

4.6.17 ICAO Strap Even Parity

The HFDR should use the ICAO Strap Even Parity input discrete, TP15K, to detect single failures in the wiring of the 24 discrete ICAO 24-bit aircraft address pins TP11F to TP11K, TP13A to TP13K, and TP15A to TP15J.

TP15K should be wired “open” when the number of discretes wired “open” in the ICAO 24-bit aircraft address is odd. Otherwise TP15K should be wired “short”

In the event the ICAO Strap Even Parity discrete does not match the parity calculated from the discrete ICAO 24-bit aircraft address pins, the HFDR should declare a “DATA LINK LOST” fault.

4.6.18 CMU #1/#2 Speed Select

The CMU Speed Select Discrete Input, TP5A, is used to determine the bus data rate, as defined in ARINC Specification 429, for the output bus to the MU/CMU and the input bus from the MU/CMU. A “high” indicates low speed and a “low” indicates high speed.

COMMENTARY c-3

ARINC Specification 429 Part 3, “Mark 33 Digital Information Transfer System (DITS), Section 2.5, also indicates in Attachment 10, Tables 10-4 and 10-5, variables of Low and High Speed Bit Oriented Protocol. TP5A should only be used to select the physical data rate and should not be used to select which Table 10.4 or 10.5 to use. c-3

c-3

4.6.19 HFDR Installed Discrete Output

The HFDR transceiver provides an “HFDR Installed” output on TP4J, which provides a “ground” or “0” to indicate to other equipment on the aircraft that an HF Data Radio is installed. Note that this output is internally connected to ground.

4.6.20 Ruthless Preemption

The HF Data Radio provides the flight crew with absolute control over the mode of operation. The flight crew should have the ability to immediately change the operating mode from HF Data Link to HF Voice regardless of data link message status. A selection of Voice mode should always interrupt any Data mode operations without delay. For the purposes of this Section, “without delay” means ≤ 500 ms. The immediate mode change to voice operation may happen during the reception of a data message from the ground, or during the transmission of a message to the ground. It is recognized that in either case, the potential for a lost/delayed message exists.

There are two basic methods to preempt HF data transmission. These are crew initiated Voice/Data mode selection and the transmission of voice communications by a second HF transceiver. The Voice/Data mode selection is under the positive control of the flight crew. The flight crew may select the Voice mode at anytime using the cockpit HF Data Control Function that may be in the Radio Control Panel, or a separately mounted control panel. When the Voice mode is selected, the transition to voice operation should be accomplished without delay. See Sections 3.6.1, 3.6.2.1, 3.6.2.2, 4.6.1, and Attachment 14 of this document, and ARINC Specification 635, Section 5.2.5.1.5.

A second preemption mode occurs when an aircraft is equipped with a dual HF installation. It is very common for such installations to employ only a single antenna system. In this case, the equipment operating in the Data mode should monitor the mode of the other system using the logic defined in Section 4.6.1.1. The data system should monitor the opposite side voice system PTT connected to TP7K.

If the data system, while not otherwise transmit inhibited (see Section 4.6.11 Transmit Inhibit Discrete Input) detects the other side is in Voice mode and is being keyed for a voice transmission, the data system should, without delay, stop transmitting. After the opposite side voice system returns to the receive mode, the data system should inhibit any data transmissions for a period of time long enough for the crew to hear any acknowledgments or messages. See Sections 6.2 (b) and 6.2.2 for some additional information. The Data Link system should delay not less than 30 c-3

seconds, or more than 90 seconds before resuming data transmissions, unless transmission is otherwise inhibited.

4.0 HF DATA RADIO DESIGN

COMMENTARY

Specification of a minimum delay time before resuming data transmissions is to avoid unacceptable interruptions in voice communication. Specification of a maximum delay time is to avoid unacceptable degradation in datalink performance. Certification regulatory requirements may change the minimum and maximum delay times. These regulatory requirements may change over time as HF Data Link and its use continues to evolve. Consequently, consideration should be given to making these parameters easy to change in the implementation.

5.0 HF DATA UNIT DESIGN

5.1 Introduction

The HFDU should provide the means to transmit and receive data via a standard ARINC 719 or ARINC 559A SSB HF transceiver tunable over the HF band (2-30 MHz).

The HFDU functions are as follows:

a. HF voice/data mode enable switching

b. Air/ground data transmit functions

c. Air/ground data receive functions

d. HF transceiver tuning

e. HF transceiver keying

f. Antenna coupler tuning

g. ACARS MU/CMU interface functions, and

h. Built-in-test functions

The following sections define the HFDU functions.

5.2 HF Voice/Data Mode Enable Switching

The HFDU should monitor Voice/Data mode discrete input, MP12D, from an HF Data Link Control Function (HFDCF) in the cockpit to determine when to enable Voice or Data mode. See Section 6 for a definition of the HFDCF. If the discrete input is "high", the HFDU should disable the Data mode.

When the Data mode is disabled, the HFDU should inhibit all data transmission functions and periodically send notifications of its status to the MU/CMU.

In the Data mode, the HFDU should perform the air/ground data transfer protocols defined in ARINC Specification 635 including the specific functions defined in the following sections.

5.3 Air/Ground Data Transmission Functions

5.3.1 HF Transceiver Audio Interface

The HFDU data transmit output should be an audio signal with -6 dB spectrum points between 440 Hz and 2440 Hz and -20 dB points between 300 Hz and 2580 Hz. The audio output level delivered to a 600 ohm load should be adjustable between 0.1 mW and 1 mW. The audio output impedance should be 600 ohms balanced.

COMMENTARY

> In installations where the HFDU interfaces to ARINC 719 HF transceivers, the HFDU transmit audio output should be connected to the dedicated data audio input on the transceiver. Hence, no special precautions need to be taken. However, in installations where the HFDU interfaces to ARINC 559A HF transceivers, the HFDU transmit audio output should be connected to a transceiver audio input which is to be shared with voice audio from the Audio Control Panel. Hence, a means to switch between the two audio inputs to the transceiver should be provided. The switching should be done according to whether the HF transceiver is to be used for voice or data.

5.3.2 Transmit Audio Waveform

The output audio waveform should consist of a nominal 249 ms prekey, followed by a 295 ms preamble, and data. The prekey, preamble and data segments should be encoded as specified in Section 4 of ARINC Specification 635.

5.3.3 HF Transceiver Keying

The HFDU should be capable of keying ARINC 719 HF transceivers and ARINC 559A HF transceivers by grounding a discrete line output.

COMMENTARY

> In installations where the HFDU interfaces to ARINC 719 HF transceivers, the HFDU keyline should be connected to the dedicated Data Keyline input on the transceiver. Hence, no special precautions need to be taken. However, in installations where the HFDU interfaces to ARINC 559A HF transceivers, the HFDU keyline should be connected to a transceiver keyline input which is to be shared with the push-to-talk line from the Audio Control Panel (ACP). Hence, a means to switch between the two keylines to the HF transceiver should be provided. The switching should be done according to whether the HF transceiver is being used for voice or data.

5.4 Air/Ground Data Receive Functions

5.4.1 HF Transceiver Audio Interface

The HFDU should function properly with audio from an ARINC 719 transceiver with a frequency response of ± 6 dB from 350 Hz and 2500 Hz. The input level should be from a source impedance of less than 100 ohms at less than 0.5 Vrms. The HFDU should operate normally with an input signal variation of ± 10 dB. The HFDU should have an input impedance of 600 ohms balanced.

5.4.2 Receive Audio Waveform

The received audio waveform should consist of the waveform defined in ARINC Specification 635, Section 4 subject to the distortions defined in ARINC Specification 635, Section 4.

5.5 HF Transceiver Tuning

The HFDU should use the Serial/Parallel input discrete, MP11C, to determine the frequency tuning interface to the HF transceiver. When MP11C is "open", the HF transceiver is an ARINC 719 transceiver. When MP11C is "short", the HF transceiver is an ARINC 559A transceiver. In addition, if the HF transceiver tuning is per ARINC 719, the HFDU should use the Serial Tune Label Select discrete input, MP15A, to determine the type ARINC 429 words to use to tune the HF transceiver. With MP15A "open", the HFDU should use Label 037 words, and with MP15A "short", it should use Label 205/207 words as defined below.

5.0 HF DATA UNIT DESIGN

5.5.1 ARINC 719 HF Transceiver Tuning

Tuning of ARINC 719 HF transceivers should be accomplished by sending a tuning command via a low-speed ARINC 429 bus connected to Port A of the HF transceiver.

When the ARINC 719 HF Transceiver is configured for voice/data switching via a discrete input (MP2K discrete on the HF transceiver set "high"), the tuning command should consist of one Label 037 32-bit word encoded as specified in ARINC Specification 429, Section 3.

When the ARINC 719 HF transceiver is configured for voice/data switching via a Label 207 ARINC 429 word command (MP2K discrete on the HF transceiver set "low"), the tuning command should consist of one Label 205 32-bit word encoded as specified in ARINC Specification 429, Section 3.0.

The average channel tuning time is less than 1 second from the time the command is received by the HF transceiver.

5.5.2 ARINC 559A HF Transceiver Tuning

Tuning of ARINC 559A HF transceivers should be accomplished by the grounding/opening of 21 parallel discrete lines using a re-entrant code defined in ARINC Characteristic 559A, Attachment 5.

COMMENTARY

> ARINC 559A HF transceivers provide for only one set of 21 parallel discrete inputs for tuning. Hence these inputs should be shared between the Radio Control Panel and the HFDU. A means to control the switching between the two sets of parallel lines should be provided. The switching should be done according to whether the HF transceiver is being used for voice or data.

The average tuning time is less than 8 seconds from the time the command is received by the HF transceiver.

5.6 HF Antenna Coupler Tuning Initiation

The HFDU should initiate the tuning of the HF antenna coupler prior to the first transmission after a frequency change. Antenna tuning should be initiated by momentarily grounding the Data Keyline. The HFDU should monitor the Tune Power Ground line from the coupler to determine when antenna tuning is completed. The HFDU should also monitor the Tune Fail line from the coupler to determine whether tuning has failed or was successfully completed.

5.7 Air/Ground Data Transfer Protocol

The HFDU should control the transmission and reception of air/ground data packets using the protocols defined in ARINC Specification 635.

5.8 ACARS MU/CMU Interface Functions

The HFDU should interface to one ACARS MU or one or two CMUs which have HF Data Link provisions via one transmit and two receive ARINC 429 ports. The speed of the ARINC 429 ports should be set as defined in Section 5.9.7. An optional pair of transmit and receive MSK audio ports may also be provided to interface to ACARS MUs which do not have HF Data Link provisions. Refer to Section 4.6.5 for the System Address Labels (SALs).

When the ARINC 429/MSK Interface Select discrete input, MP13C, is "open", the HFDU should use the ARINC 429 ports to communicate with the MU/CMU. With MP13C "short", the HFDU should use the MSK audio ports to communicate with the ACARS MU. The ACARS MU/CMU - HFDL interface protocols are defined in Section 6 of ARINC Specification 635.

5.9 Other Interfaces

The HFDU should provide for the interfaces defined in Section 4.6.7 of this document.

5.9.1 Aircraft Position Data

The HFDU may use the position data available on pins TP12C and TP12D as defined in Section 4.6.7.1 of this document.

5.9.2 Universal Coordinated Time (UTC) Data

The HFDU may use UTC data available on pins TP10C and TP10D as defined in Section 4.6.7.2 of this document.

5.9.3 ICAO 24 bit Aircraft Address Data

The HFDU should acquire the ICAO 24 bit aircraft address according to Section 4.6.7.3 of this document.

5.9.4 Maintenance Data

The HFDU should provide maintenance data according to Section 4.6.7.4 of this document.

5.9.4.1 Maintenance System Identification

The HFDU should determine the presence and type of maintenance system on board the aircraft from the state of three programming pins CFDS Mode A, MP5H; CFDS Mode B, MP5J; and CFDS Mode C, MP5K; according to the definitions in Table 7.5 of Attachment 7. However, if the three discrete pins are open then another means to determine if a CMC is present should be used.

5.9.5 Data Loader

The HFDU should provide a low speed transmit and a high speed receive pair of ARINC 429 ports on pins TP4A and TP4B to interface to a Portable and/or Airborne Data Loader. The Data Loader Discrete, MP14C should be used to determine the presence of a data loader

5.9.6 Air/Ground Discrete Input

The HFDU should monitor the Air/Ground Input discrete, MP11D, to determine the flight status of the aircraft and the Air/Ground Polarity Select discrete, MP13A, to determine the sense of the Air/Ground Input discrete. With MP13A "open", MP11D "short" indicates airborne, and MP11D "open" indicates the aircraft is on the ground. With MP13A "short" the logic of MP11D is reversed.

5.0 HF DATA UNIT DESIGN

5.9.7 MU/CMU Interface Speed Select

The HFDU should monitor the CMU/MU Speed Select discrete input, MP14A, to select the ARINC 429 bus speed "High" or "Low" to the MU/CMU. A discrete open implies low speed and a short implies high speed.

5.9.8 Transmit Inhibit Discrete Input

The HFDU should make use of Transmit Inhibit discrete input, MP15B, to determine whether the HFDL transmit function should be enabled or not. An additional programming pin Transmit Inhibit Polarity, MP14B, should be used to determine the sense of MP15B. With MP14B "open", MP15B "short" indicates the HFDL transmit function should be inhibited, and "open" should indicate the HFDL transmit function is enabled. With MP14B "short", the sense of MP15B is reversed.

5.9.9 SDI Inputs

The HFDU should make use of the SDI 0 and SDI 1 input discretes, MP11B and MP13D respectively, in the encoding of the Label 205/207 ARINC 429 words used to tune the HF transceiver in aircraft installations where the Serial Tune Label Select discrete input, MP15A, is "short". The SDI 0 and SDI 1 input discretes should therefore be wired the same way as the SDI discrete inputs to the HF transceiver to which the HFDU interfaces. The HFDU should also use the SDI 0 and SDI 1 input discretes in the encoding of the Label 270 words sent to the MU/CMU, Label 350 words sent to the CMC, and in the decoding of Label 227 words received from the CMC. The logic of the SDI 0 and SDI 1 inputs is as defined in Section 4.6.13. In the event the Strap Even Parity discrete does not match the parity calculated from the discrete inputs, the HFDU should set bit 24 in the Label 350 CFDS word.

5.9.10 Strap Even Parity

The HFDU should use the Strap Even Parity input discrete, MP13B, to detect single failures in the wiring of the following discrete inputs:

Discrete Input Name	Pin #
SDI 0	MP11B
SDI 1	MP13D
CFDS Mode A	MP5H
CFDS Mode B	MP5B
CFDS Mode C	MP5K
Air/Ground Polarity Select	MP13A
Serial/Parallel Tune Select	MP11C
Serial Tune Label Select	MP15A
CMU/MU Bus Select	MP14A
ARINC 429/MSK Interface Select	MP13C
TX Inhibit Polarity	MP14B

Table 5-1 Discrete Inputs

MP13B should be wired "open" when the number of discretes wired "open" in the table above is odd. Otherwise, MP13B should be wired "short". In the event the Strap Even Parity discrete does not match the parity calculated from the discrete inputs, the HFDR should set bit 24 in the Label 350 CFDS word.

5.10 Status Indications

The HFDU should provide an HF DATA LINK LOST indication discrete, MP10D, and an HFDU FAULT indication, MP10C, to the HFDCF.

5.10.1 HF DATA LINK LOST Indication Discrete

The HFDU should provide a DATA LINK LOST indication in accordance with Section 4.6.8.1 of this document.

5.10.2 HFDU FAULT Indication Discrete

The HFDU should provide a FAULT indication in accordance with Section 4.6.8.2 of this document.

5.11 Built-In Tests

The HFDU should perform Built-In Test Equipment (BITE) diagnostics in accordance with Section 9.0 of this document.

6.0 DATA LINK CONTROL FUNCTIONS

6.1 Introduction

An HF Data Control Function (HFDCF) should provide the crew in the cockpit with the means to control the shared use of the HF transceiver or HFDR for HF Data Link and voice communications. The HFDCF also should display HF Data Link status information. The HFDCF can monitor the HFDR status via low speed ARINC 429 by decoding the HFDL status word, Label 270, as defined in Table 10-1 and Label 350 as defined in Attachment 7. c-1

The HFDCF may be integrated into a Radio Control Panel, or a centralized radio management system, or in retrofit installations, the HFDCF may be incorporated in a separate HF Data Control Panel (HFDCP) at the discretion of the airline operator of the aircraft and/or the airframe manufacturer.

6.2 HFDCF Functions

The HFDCF functions for aircraft equipped with an HFDR or an HFDU should consist of:

a. HF voice/data mode selection

b. Programmable automatic voice-to-data return and programmable default to voice or data

c. HF Data Link enabling

d. Monitoring of HFDL equipment for DATA LINK LOST, fault conditions, HFDR Installed Status, HFDL Transmit Inhibit status, and c-1

e. HF Data Link status display

The HFDCF should provide the following additional functions in aircraft equipped with an HFDU:

f. HFDU mode selection

g. ARINC 719 frequency tuning port selection, and

h. RF sensitivity or squelch control

6.2.1 HF Voice/Data Select

Both the HFDR and ARINC 719 HF transceivers have a Voice/Data discrete input that is used to select the mode of operation. ARINC 719 HF transceivers also have separate audio ports for data and voice as well as separate data and voice (PTT) keylines. The Voice/Data select discrete input controls the selection of the appropriate audio and keyline ports.

The HFDCF should provide an HF Data Link (HFDL) Mode Enable discrete output (Pin 15) to the HFDR or ARINC 719 HF transceiver Voice/Data select port. The discrete output level should be controlled by the crew by means of an HF Voice/Data toggle switch or equivalent.

When the HF Voice/Data "switch" is in the voice position, the HFDL Mode enable, discrete output should be "high", and the crew should have complete control of the tuning of the HF transceiver.

When the HF Voice/Data switch is in the data position, the HFDL Mode Enable discrete output should be "low" and the HFDR/HFDU should control the tuning of the HFDR/HF radio.

6.2.2 Programmable Functions

The HFDCF should provide the capability to be programmed via a configuration discrete input (Pin 14) to default to Data mode (discrete input "low") or Voice mode (discrete input "high") on power on and in the event of an HFDU, HFDR, HFDCF fault.

The HFDCF should also provide the capability to be programmed to automatically return to Data mode from Voice mode via a second configuration discrete (Pin 13).

When programmed for automatic voice-to-data return (discrete input "high"), the HFDCF (via Pin 10) should monitor the push-to-talk input to the HF transceiver or HFDR to return them automatically to the Data mode from the Voice mode if no voice activity has been detected for a user specified time, ranging from 0 to 6 minutes.

COMMENTARY

> Depending on the aircraft configuration, certification regulatory requirements may not allow (or may require) activation of automatic reversion to data. c-1

6.2.3 HF Data Link ON/OFF Switch

An ON/OFF switch on the HFDCF should provide the crew with the means to enable or disable HF Data Link operation.

When the switch is in the OFF position, the HFDCF should disable HF Data Link operation by setting the HFDL mode Enable (Pin 15), HF frequency port select (Pin 16), and RF sensitivity (Pin 17) discretes to "high". The HF transceiver/HFDU combination or the HFDR should be in the Voice mode and the HFDCF Status display should indicate Voice. The crew in the cockpit should then have complete control of the tuning of the HF transceiver or HFDR.

When the switch is in the ON position, HF Data Link operation should be enabled and the HF Voice/Data switch described in Section 6.2.1 should be used by the crew to control the HF transceiver/HFDU combination or the HFDR mode of operation.

6.2.4 HF DATA LINK LOST Indication

If HF DATA LINK LOST is to be annunciated, the HFDCF should monitor a discrete input (Pin 12) from the HFDU or the corresponding Label 270 bit 11 from the HFDU/HFDR which indicates when an HF DATA LINK LOST condition occurs. See Section 5.10.1 for a definition of the discrete states. c-1

6.2.5 HFDL FAULT Indication

The HFDCF should monitor a discrete input (Pin 4) or the corresponding Label 270 bit 16 from the HFDU/HFDR which indicates when an HFDL Fault condition occurs. See Section 4.6.8.2 for a definition of the discrete states. c-1

6.0 DATA LINK CONTROL FUNCTIONS

6.2.6 HF Data Link Status Display

The HFDCF functions should consist of:

a. Displaying whether the HFDL function has been enabled

b. Displaying whether the HF transceiver-HFDU or HFDR is in voice or data mode

c. Displaying HF Data Link DATA LINK LOST condition, and

d. Displaying HFDR/HFDU and HFDCF FAULT condition

COMMENTARY

If a single lamp is used in the HFDCF to display a fault in the HFDR/HFDU or the HFDCF, a separate discrete output (Pin 3) can be used to indicate an HFDCF fault. This discrete output should be “high” when there are no faults in the HFDCF, and it should be “low” when an internal HFDCF fault has been detected.

6.2.7 HFDU Mode Select

The HFDCF should provide a separate discrete output (Pin 18) to place the HFDU in Voice or Data mode. The discrete output should be “high” when in the Voice mode, and it should be “low” when in the Data mode.

6.2.8 HF Frequency Port Select

ARINC 719 and ARINC 753 HF transceivers have two ARINC 429 bus input Ports, A and B, that may be used to control the transceiver operating frequency. In most aircraft installations, the Radio Control Panel in the cockpit is connected to Port B while Port A is not used. The HFDU should be connected to Port A. A Frequency Port Select discrete input controls the selection of Port A or B.

In HF Data Link installations consisting of an ARINC 719 or 753 HF transceiver/HFDU combination, the HFDCF should provide a discrete output (Pin 16) to the HF transceiver Frequency Port Select input. The discrete output should be “high” when in the Voice mode, and it should be “low” when the in the Data mode.

6.2.9 RF Sensitivity or Squelch Control

An analog signal from the Radio Control Panel to the HF transceiver is used to control the RF sensitivity of the HF transceiver with maximum sensitivity achieved when the analog input is grounded.

In order to override any RF sensitivity setting in the Radio Control Panel, other than maximum sensitivity during data operation in HF Data Link installations consisting of an HF transceiver/HFDU combination, the HFDCF should provide a discrete output (Pin 17) to the RF sensitivity or squelch control input to the HF transceiver. This discrete should be grounded (“low”) in the HF Data mode, and open (“high”) in the HF Voice mode.

COMMENTARY

If the HFDCF is integrated into the Radio Control Panel, then the RF sensitivity analog signal should be grounded in Data mode operation and set to any level desired by the crew in Voice mode operation.

6.2.10 HFDR Installed Function

If the HFDCF is integrated into a Radio Management Panel, then the RMP should monitor two discrete inputs (HFDR1 Installed and HFDR2 Installed) to determine if an HF Data Radio is installed. See Section 4.6.19 for a definition of the discrete states. c-1

6.2.11 HFDL Transmit Inhibit Status Indication

The HFDCF should monitor a discrete input or the corresponding Label 270 bit 22 from the HFDU/HFDR which indicates when data transmissions are inhibited. See Section 4.6.8.3 for a definition of the discrete states.

7.0 ANTENNA SYSTEMS

7.1 Introduction

The standard HFDR interwiring in Attachment 2-2 shows connections to the "symbolic" antenna coupler leads that are designated by the letters (A) through (P). However, these do not represent any particular antenna coupler, but merely the generic functions of essentially all couplers. ARINC Characteristic 719, Attachment 5, tabulates these symbolic function connections in terms of specific pin connections and connector types for various antenna couplers. For optimized overall efficiency, shunt/notch antennas are recommended. Additional guidance for antenna installations is provided in ARINC Characteristic 719, Appendix 0.

7.2 Antenna

Various kinds of antennas are installed in the various types of airframes; for details refer to Characteristic ARINC 719, Appendix 0.

COMMENTARY

The user should realize that one of the factors limiting the potential throughput of the HF communication system is the signal loss associated with the cabling between the HFDR and the antenna.

There are no specific form factors set forth herein for the antennas to be employed with this particular equipment as there are numerous designs presently on the market for this purpose.

Designers of new antennas are encouraged to survey the present antenna mounting provisions and maintain compatibility insofar as is practicable with the present standard mountings, depending on the particular aircraft type for which the antenna is intended and the need to minimize weight.

Dual HF installations sharing a common antenna do not allow simultaneous transmissions.

7.3 HF Antenna Coupler

The Antenna Coupler should be form, fit, and function compatible with ARINC Characteristic 719 installations. The HF Antenna Coupler may be connected to the HFDR
c-1 Transceiver via a single 50 ohm coaxial RF cable.

COMMENTARY

The HFDL Antenna Coupler should be backward compatible with existing installations. The existing transceiver interface and interwiring should be retained to allow for ease of retrofit. Many of the parameters in ARINC Characteristic 719 pertaining to the antenna coupler are applicable to newer generation antenna couplers.

7.3.1 Matching

The antenna couplers should provide, in order to be compatible with the SSB equipment covered by this Characteristic, a match from the antenna system to the 50 ohm transmission line corresponding to a standing wave ratio of 1.3:1 or less.

COMMENTARY

As the SSB equipment can only provide full power output capability when the antenna coupler VSWR is kept low, it is naturally important from the user's standpoint to obtain the best possible VSWR in the antenna coupler.

7.3.2 Frequency Coverage

The coupler should be designed to cover the "wide frequency range" of 2.0 to 29.9999 MHz. Inasmuch as the Antenna Coupler should usually be designed to operate specifically with a general class of antenna types covering a specific frequency range, this Characteristic does not set forth any specific antenna impedance characteristics for new Antenna Couplers.

7.3.3 Power Handling Capability

The Antenna Coupler should be designed to safely
operate at a maximum power level of 504 watts PEP and at c-1
an average power level of 160 watts.

COMMENTARY

Although previous industry discussion many years ago led to the conclusion that Antenna Couplers should be designed with adequate power handling capacity to accommodate at least a 1 kW PEP, it has subsequently been determined that such a power handling capacity on civil aircraft is not necessary.
The figure of 504 watts PEP is deemed to be more
realistic for the guidance of antenna coupler c-1
manufacturers.

7.3.4 Tune Mode

After the first tuning to a specified frequency, the tuning values may be stored and be available for future use.

7.3.5 Interwiring

The new generation of HF Antenna Couplers should be capable of communicating serial data over existing aircraft wiring. In addition, the ability to operate with older ARINC 719 interface units should be supported. The new generation transceiver and coupler should be capable of detecting whether they are connected to new or old generation equipment and automatically select the appropriate control interface. To allow usage of old generation couplers, the wiring according to ARINC Characteristic 719 should be maintained.

7.4 Multiwire Serial Interface (MSI)

Current HF transceivers and antenna couplers communicate over parallel wires carrying discrete signals. The additional functionality and flexibility of the new HFDR system indicates a need for greater communications flexibility, implying the need for a serial data bus. In addition, it is considered important that each unit should have the ability to operate with their older ARINC 719 interface counterparts.

Because of the cost and inconvenience of rewiring aircraft already in service, it is considered imperative that the new HFDR transceiver and antenna coupler should be capable of communicating using the existing aircraft wiring.

7.0 ANTENNA SYSTEMS

7.4 Multiwire Serial Interface (MSI) (cont'd)

The following paragraphs describe an interface which uses the existing aircraft wiring to communicate using both discrete signals and a serial bus, depending on the capabilities of the transceiver and coupler in the system. This interface approach allows complete backwards compatibility with older HF radio systems, allows older aircraft to be easily upgraded, and allows ARINC 719 equipment to serve as spares for new radios.

7.4.1 Physical Layer

The Physical Layer comprises the physical medium and the circuitry used to send information between the transceiver and the antenna coupler.

7.4.1.1 Physical Medium

ARINC 719 Signal Description	ARINC 753 Signal Usage
Rechannel pulse (Ground Pulse)	Transceiver RTS/CTS signal
Tune Power	Coupler RTS/CTS signal
+27.5 Vdc (Interlock Excitation)	Balanced serial data high, non-inverting
Keyline Interlock	Balanced serial data low, inverting
Keyline	not used
115 Vac	115 Vac
Transceiver Fault (optional)	not used
Coupler Fault (optional)	not used

Table 7-1 Signal Description and Useage

7.4.1.1.1 Serial vs. Parallel Interface Selection

In order to support intermixing of old generation units with new generation units, a means should be provided such that an ARINC 753 capable unit can accurately detect whether it is connected to a new or old generation unit. This enables new ARINC 753 interface units to automatically switch interface characteristics depending on whether they are connected to new ARINC 753 serial or old ARINC 719 parallel interface units.

7.4.1.1.1.1 Detection Scheme

The basis of the detection scheme is that the transceiver first attempts to communicate with the antenna coupler over the ARINC 753 interface, reference Section 7.4.1.1.1.3. If the coupler responds to this request the MSI interface can be selected. If the coupler does not respond, the transceiver switches to the ARINC 719 interface, reference Section 7.4.1.1.1.2. To prevent misinterpretation by couplers, which are not switched on due to different power supply connections, this procedure is repeated each time a new frequency is selected. A rechannel pulse should be sent to the antenna coupler when the transceiver is in the ARINC 719 mode.

Once communication is established over the ARINC 753 interface, further detection tests can be omitted. If the communication link malfunctions, the transceiver should fall back to the detection procedure.

The detection procedure is as follows:

a. After power up, the transceiver attempts to send an Initialize Coupler command (10_h) to the coupler by switching its RTS/CTS (Rechannel Pulse) line to medium level (RTS function).

b. If an ARINC 753 coupler is connected, the coupler responds with its RTS/CTS (Tune Power) line to low level (CTS function). The transceiver perceives the capability of the coupler to respond to ARINC 753 control and responds by sending the serial data associated with the Initialize Coupler command (10_h). Upon receipt of Initialize Coupler command data, the coupler responds with a command Acknowledge. The system now operates using the ARINC 753 interface.

c. If an ARINC 719 coupler is connected, the coupler does not recognize the medium level RTS/CTS (Rechannel Pulse) line of the transceiver and does not respond. The transceiver switches to the ARINC 719 interface if the coupler fails to respond to the Initialize Coupler command (10_h) after three attempts.

d. In order to achieve proper interface determination in the event that transceiver and coupler are powered up at different times, the transceiver precedes each ARINC 719 rechannel operation by switching its RTS/CTS (Rechannel pulse) line to medium level (RTS function). If the coupler does not respond with a CTS function, the transceiver assumes the coupler is not capable of data communications and proceeds with a normal ARINC 719 rechannel operation.

e. Upon power up, the antenna coupler monitors the transceiver RTS/CTS (Rechannel pulse) line to determine which interface is used. If the coupler detects a medium level RTS/CTS line it responds according to ARINC 753 protocol, reference Section 7.4.2. If it detects a low level RTS/CTS line without a preceding RTS function (medium level) it responds as an ARINC 719 coupler and recognizes the Rechannel Function.

7.4.1.1.1.2 Parallel Interface (ARINC 719) Definition

The parallel interface signals and their use are as described in ARINC Characteristic 719. This section provides some additional characterization of the indicated ARINC 719 signals in order to ensure interchangablility with the currently installed HF radio equipment.

Rechannel Pulse (Ground Pulse)

Rechannel pulse is a logic signal used by the transceiver to cause the antenna coupler to enter an untuned state with the tuning network bypassed. The rechannel pulse is used in order to tune to another frequency. This signal should also cause the antenna coupler to clear its fault status.

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The transceiver should present a high impedance if rechannel is not asserted.

The transceiver should present a low impedance to ground (0.5 Vdc max at 100 mA minimum sink current) for at least 90 ms in order to assert Rechannel.

Tune Power

Tune Power is a logic signal used by the antenna coupler to cause the transmitter to output tuning power with CW at F0 when the transmitter is keyed.

The coupler should present a high impedance if Tune Power is not asserted.

The coupler should present a low impedance to ground (1.5 Vdc max at 150 mA minimum sink current) to assert Tune Power.

+27.5 Vdc (Interlock Excitation)

Interlock Excitation of +27.5 Vdc is supplied by the transceiver for use in the coupler for the Keyline Interlock circuitry. The transceiver should be capable of supplying 0.5 A continuous and 8 A peak for 20 ms (per ARINC Characteristic 719).

Keyline Interlock

The Keyline Interlock signal is provided by the antenna coupler as an interlock on RF transmission to the transceiver.

The coupler should present +27.5 Vdc nominal with a minimum 50 mA source in order to allow RF transmission for tuning or system operation.

The coupler should present a high impedance (0 Vdc from the coupler) in order to inhibit all RF transmission from the transceiver.

7.4.1.1.1.3 Multiwire Serial Interface (ARINC 753 or MSI) Definition

When the MSI is selected then the indicated interconnect signals take on the following characteristics:

Transceiver RTS/CTS

Transceiver RTS/CTS is a tri-level logic signal used by the transceiver to indicate to the coupler either a Request-To-Send (RTS), Clear-To-Send (CTS), or neither RTS nor CTS.

The transceiver should present a high impedance if neither RTS nor CTS are being asserted.

The transceiver should present 7.5 Vdc ± 1 Vdc at 10 mA minimum sink current in order to assert RTS.

The transceiver should present a low impedance to ground (0.5 Vdc max at 50 mA minimum sink current) in order to assert CTS.

Coupler RTS/CTS

Coupler RTS/CTS is a tri-level logic signal used by the antenna coupler to indicate to the transceiver either a Request-To-Send (RTS), Clear-To-Send (CTS), or neither RTS nor CTS.

The coupler should present a high impedance if neither RTS nor CTS are being asserted.

The coupler should present 7.5 Vdc ± 1 Vdc at 10 mA minimum sink current in order to assert RTS.

The coupler should present a low impedance to ground (0.5 Vdc max at 50 mA minimum sink current) in order to assert CTS.

Balanced Serial Data High and Balanced Serial Data Low

This pair of signals is a differential pair used for bi-directional serial data transfers between the transceiver and the antenna coupler. The RTS/CTS signal described in the Link Layer Protocol Section 7.4.2 determines when the transceiver or coupler may transmit data on the bus.

Bus Transmitter Characteristics (Defined at LRU Connector)

The differential output voltage across the balanced pair at the bus transmitter should be as follows when the bus transmitter is open circuit:

	Logic "1"	Logic "0"
Serial Data High referenced to Serial Data Low	-6.0V to -1.5V	+1.5V to +6V

The bus transmitter should have an output impedance of 100 ± 50 ohms divided evenly between each line of the pair.

Bus Receiver Characteristics (Defined at LRU Connector)

The differential input voltages across the balanced pair at the bus receiver should be associated with the following logic levels:

	Logic "1"	Logic "0"
Serial Data High referenced to Serial Data Low	< -0.2V	> +0.2V

The bus receiver should exhibit input characteristics as follows:

a. Differential Input Resistance 100 ohms minimum

b. Differential Input Capacitance 100 nF maximum

c. Resistance to Ground 1000 ohms minimum

d. Capacitance to Ground 100 nF maximum

The format of the serial data should be:

7.4.1.1.1.3 Multiwire Serial Interface (ARINC 753 or MSI) Definition (cont'd)

Symbols: Start bits are represented by "logic 0", stop bits and the marking state of the bus are indicated by "logic 1".

Word Format: Serial words should be 8 bits of data (LSB transmitted first), preceded by one start bit, and followed by one parity bit and then 1 stop bit.

Parity: Parity should be even.

Data Rate: Data transmission should be at 9600 bits per second, asynchronous.

COMMENTARY

Note that these specifications are essentially the same as EIA RS-485 with the addition of some transmitter wave shaping capacitance to reduce EMI effects.

7.4.2 Link Layer Protocol

The link layer protocol is the protocol used, on the physical interface, when a device (hereafter called the source device) desires to transmit data to another device (hereafter called the sink device). The actual meaning of the specific data is not relevant at this layer.

7.4.2.1 Link Protocol Sequencing

The general sequence of events for the link layer protocol is given as follows:

a. A source device should first verify that the sink device is indicating neither CTS or RTS.

b. The source should assert RTS.

c. The sink, upon receiving an RTS from the source should prepare to receive a message and then assert CTS. Note that if both the Transceiver and the coupler assert RTS, then the coupler should de-assert its RTS and then become the sink device (and assert CTS when it is ready to receive).

d. The source should then transmit its message, comprised of a length byte followed by the data and concluding with a check byte.

e. The source should relinquish the bus and prepare to receive an acknowledge word. When the source is prepared to receive this word the source should assert CTS.

f. The sink, upon receiving a CTS from the source, should assume message transmission is complete. The sink should check the validity of the message. The sink should then transmit to the source an Acknowledge word, if the transfer is deemed valid, or a Not Acknowledge word, if the transfer is invalid.

g. The source should then de-assert CTS.

h. The sink should then de-assert CTS.

i. If the source received a Not Acknowledged word, then it should try to re-send the message by repeating the above process.

7.4.2.2 Link Protocol Message Description

The Link protocol message is a variable length packet of 8 bit data words (bytes).

a. The first word of a message is the length of the message in bytes. This length includes the length byte itself and all other protocol words. The length byte can represent values from 3 to 255.

b. Following the length byte is one or more data word(s) with up to 253 bytes in number.

c. The last word of a message is the checksum byte. It is used as a check on the integrity of the message transfer. The checksum is a modulo 256 sum of all preceding message bytes, including the length byte, but not the checksum byte itself.

Message integrity is checked by several means:

a. First, each of the serial data words should be individually valid, i.e. the framing and parity should both be correct. If any individual word is invalid then the entire message should be deemed invalid.

b. Second, the received message should be of the exact length given by the length byte or the entire message should be deemed invalid.

c. In addition, the modulo 256 sum of all bytes (except the checksum byte) should equal the checksum byte of the message or the entire message should be deemed invalid.

The Acknowledge (ACK) and Not Acknowledge (NACK) words are dependent upon the direction of the message transfer.

The transceiver indicates ACK by sending the byte: 17_h

The transceiver indicates NACK by sending the byte: $2B_h$

The coupler indicates ACK by sending the byte: $4D_h$

The coupler indicates NACK by sending the byte: $8E_h$

The source device should attempt to repeat the message if it receives a Not Acknowledged word. It should attempt to send the message at least 3 times before declaring a communication fault.

There is no provision at the link layer for multiple packet messages. If this feature is desired, then it should be implemented in a higher protocol layer.

7.4.2.3 Link Protocol Timings

The diagram in Attachment 10 shows a typical transfer using the Link Protocol. Shown is the scenario where both the transceiver and the coupler attempt to send a message at the same time. The coupler yields the bus to the transceiver and the transceiver then transfers a message to the coupler. The coupler is shown acknowledging the transfer, which is then completed.

The times in Table 7-2 below are considered absolute maximum (minimum) for correct operation. If a timing is violated then the message transfer should be deemed invalid.

Times	Description of Timing Function	Value
t1	RTS asserted to CTS asserted	50 ms max
t2	CTS asserted to Data Bus driven.	0 ms min
t3	CTS asserted to 1st data word completed	10 ms max
t4	Data word completed to subsequent data word completed	10 ms max
t5	Last data word completed to CTS asserted.	1-10 ms max
t6	CTS asserted to Acknowledge word completed.	90 ms max
t7	Acknowledge word completed to CTS not asserted.	10 ms max
t8	CTS not asserted to CTS not asserted.	10 ms max

Table 7-2 Link Protocol Timing

Note that times are the same regardless of the direction of communication.

7.4.3 Control Protocol

The control protocol provides the commands and responses used to control the interface between the transceiver and the antenna coupler. The commands and responses described in this section are transported between the transceiver and the antenna coupler using the Multiwire Serial Interface (see Section 7.4.1 for the Physical Layer and Section 7.4.2 for the Link Layer Protocol).

The control protocol uses, as its basis, a Command - Complete sequence. When a command (or request) is issued by one unit the other unit should indicate when the command is completed as well as providing any related information or status. The commands, responses, and their codes are listed in Section 7.4.3.4, along with a description of the purpose, effects, and limitations of each.

COMMENTARY

> The "Command/Complete" protocol was chosen because operations between transceivers and antenna couplers tend to be essentially sequential control, dependent on one operation completing before another begins.

7.4.3.1 Sequencing

No command should be considered completed until the complete message has been received. The state of the sink device cannot be assumed before the sink has indicated command completion. As an example, the transceiver should not assume the coupler is ready for transmit until the antenna coupler has indicated that the Key command has been completed.

Queuing of commands is not permitted. Both the antenna coupler and the transceiver are allowed to have only one command pending completion. If another command is received before the previous is completed, the previous command should be aborted and the new command begun.

COMMENTARY

> The limit on pending commands, which significantly simplifies the protocol, is permitted by the nature of antenna coupler operations, i.e. the sequential nature of tuning. As a benefit, this also allows an easy method of aborting pending commands in the case of operator input or fault conditions.

7.4.3.2 Aborting Commands

If the sink device receives a command that it is unable to complete, either because of fault conditions or because the command is inappropriate, then the sink should abort the command and send that information to the command source. The command source should "close" the command in question and, if necessary, take appropriate action. The aborting device should indicate the reason for its action in the abort message according to the following table:

Reason for Aborting Command	Code
Fault Status Prevents Completion	00_h
Mode/Configuration Prevents Completion	01_h
Antenna Interlocked	02_h
Capability Not Implemented	03_h
Duplicate Command	04_h
Subsequent Command Overrode	05_h
Unrecognized Command	06_h
Unrecognized Parameter(s)	07_h
Invalid Parameter(s)	08_h
Spare	09_h
. . .	. . .
Spare	FE_h
Other/Indeterminate	FF_h

Table 7-3 Aborting Commands

7.4.3.2 Aborting Commands (cont'd)

If a device receives a command which duplicates the command it is presently operating upon, it should abort the initial command by issuing a Duplicate Command Abort code (04_h) and begin operation on the new instance of that command. The Duplicate Command Abort code (04_h) enables the commanding device to determine that the abort is for the first instance of the command and that a command is still pending.

Note that if a device aborts a command with the reasons Unrecognized Command, Unrecognized Parameters, Invalid Parameters and/or the command being aborted is not a command the commanding device considers pending, then it is possible that the message transfer was somehow corrupted. Any currently pending command should be considered aborted, and the commanding device may reissue the command. The commanding device should ensure that the receiving device is compatible with the protocol version being used for commands (see Request Coupler Version and Request Transceiver Version messages).

7.4.3.3 RF Operations

The transceiver should only transmit RF in response to a request by the antenna coupler or after it receives a Key Command/Complete sequence. Once RF is OFF, either by command of the antenna coupler, fault conditions, or the Unkey sequence, the transceiver once again requests permission in order to transmit.

7.4.3.4 Control Protocol Command and Request Messages

The result of the MSI Link Layer transfer is one or more 8 bit words which are used to form a transceiver-coupler control protocol message. The general format of this control protocol message is one byte coded to indicate the particular command or request, with zero or more subsequent words indicating any data or parameters associated with the command or request. Command completed and command aborted messages follow the same general format.

Table 7-4 describes the messages comprising the control protocol. The *Dir*. field indicates the direction of the transfer. The *Code* or *Data* field contains a command code (in hexadecimal format) along with identifiers for the data parameters and a number to indicate the data field width, in bits. Words of 16, 32, or 64 bits are broken into bytes (octets) with the least significant byte sent first. Single bit and 4 bit fields (nibbles or semi-octets) should be packed into bytes with the first field listed being in the lowest order bits. If the 1 bit and 4 bit fields do not evenly pack into a byte, then the byte should be filled with 0's in the upper order bits.

COMMENTARY

As an example, if there was data comprising a field of 8 bits (a), followed by a field of 4 bits (b), a field of 1 bit (c), another field of 1 bit (d), and followed by a field of 16 bits (low order = e, high order = g) they would be transmitted as follows:

1st byte transmitted:	MSB	aaaaaaaa	LSB
2nd byte transmitted:		00dcbbbb	
3rd byte transmitted:		eeeeeeee	
4th byte transmitted:		gggggggg	

Note: In the following table, all hexadecimal values end in "h" and all binary values end in "b".

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Table 7-4 Control Protocol Definitions

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Initialize Coupler - This command causes the antenna coupler to return to its initial state. The initial state is: Receive (Unkeyed), Untuned, Not tuning, Antenna interlock released, History Storage enabled, Quick Tunes enabled, and in Dual System Receive mode (unless external discretes indicate otherwise). During this initialization all antenna coupler faults should be cleared. The coupler should also adapt it's operation according to the following configuration words: Ignore Freq OOR: Ignore Frequency Out Of Range. If this bit is 1_b then the coupler should not declare a fault for frequencies which are beyond its ability to tune. A 0_b indicates a fault should be declared. Silent Quick Tune: If this bit is a 1_b, then when a Quick Tune is used for a tune operation, there is no VSWR check before the tune operation is completed. If either FaultThr or RetunrThr is exceeded during operation, then the Quick Tune used should be marked invalid. A 0_b indicates that the Quick Tune should be checked before the tune operation is completed. ContThr: Contingency Tune VSWR Threshold. This value, when divided by 100, gives a VSWR (i.e., the value 235 means a VSWR of 2.35:1). The coupler should attempt to tune to a VSWR of 1.3:1 as normal. If a tune is not possible, however, the best tune point yet encountered during the tune operation should be utilized if it results in a VSWR of the threshold or better. When the coupler cannot tune to within 1.3:1 and the VSWR is greater than the threshold, then the coupler should indicate a failure to tune. The default value should be 200 which corresponds to a VSWR of 2.0:1. c-1 FaultThr: Fault VSWR Threshold. If the value is non-zero, the coupler should monitor the VSWR during operation (i.e. while tuned and in transmit) and declare a VSWR fault if the observed VSWR is greater than the Fault threshold divided by 100. If the value is zero, the coupler should not indicate a fault based upon VSWR during operation. The default value should be 0 which means the function is disabled. RetuneThr: Retune VSWR Threshold. If the value is non-zero, the coupler should monitor the VSWR during operation (i.e. while tuned and in transmit) and issue a Retune Request message if the observed VSWR is greater than the Retune threshold divided by 100. If the value is zero, the coupler should not request a retune based upon VSWR during operation. The default value should be 0 which means the function is disabled. KeyStkTO: Key Stuck Time-Out. This value represents the maximum time, in seconds, for which the coupler may remain continuously keyed. When the value is non-zero, the coupler should declare a Key Stuck fault if the coupler is continuously keyed for longer than the Key Stuck threshold. When the value is zero, the coupler should not declare a fault based upon the duration of key. The default value should be 0 which means the function is disabled.	XCVR → CPLR	10_h Ignore Freq OOR (1) Silent Quick Tunes (1) ContThr (16) FaultThr (16) RetuneThr (16) KeyStkTO (16)	M

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Table 7-4 Control Protocol Definitions (cont'd)

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
COMMENTARY The use of configuration words allows for desirable operational characteristics to be selected while also allowing for backwards compatibility with current ARINC 719 parallel controlled couplers (all values default to 0). Care should be taken to not indicate inappropriate configuration combinations (i.e., FaultThr less than either RetuneThr or ContThr, etc.) or confusing operation may result.			
Initialize Coupler Completed - This message informs the transceiver that the initialize coupler command has been completed. The antenna coupler should now be in its initialization state. The status information shown should be the same format as the coupler status message.	XCVR ← CPLR	11_h Frequency (32) Op Mode Code (4) Tune Status (4) Power Requested (4) Dual Sys Status (4) Key Status (1) Quick Tune Status (1) History Status (1) Ignore Freq OOR (1) Silent Quick Tunes (1) ContThr Status (16) FaultThr Status (16) RetuneThr Status (16) KeyStkTO Status (16) Fault Status (8) (Vendor Codes)	M
Initialize Coupler Aborted - This message informs the transceiver that the initialize coupler command has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	12_h Abort Code (8)	M

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Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Coupler Key - This command instructs the antenna coupler to enter the transmit state. In particular, this causes the antenna interlock (to the other antenna coupler) to be asserted, the coupler switched into the RF path, and a tune sequence to begin if the frequency has changed since the last key. This is the only method by which the transceiver is able to request permission to transmit RF.	XCVR → CPLR	20_h	M
Coupler Key Completed - This message informs the transceiver that the coupler key command has been completed and the antenna coupler is now in the transmit state. This message constitutes permission for the transceiver to transmit RF.	XCVR ← CPLR	21_h	M
Coupler Key Aborted - This message informs the transceiver that the coupler key command has been aborted and the antenna coupler is *not* in the transmit state. If the antenna coupler aborts the key command because it cannot comply with the key command (if the antenna is interlocked, for example), then an advisory message should be sent to the transceiver prior to the key abort. This message inhibits RF transmission from the transceiver. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	22_h Abort Code (8)	M
Coupler Unkey - This command instructs the antenna coupler to enter the receive state. The particular actions caused by this command depend upon the current operating mode as determined by the Operating Mode Select command.	XCVR → CPLR	24_h	M
Coupler Unkey Completed - This message informs the transceiver that the coupler unkey command has been completed and the antenna coupler is now in the receive state.	XCVR ← CPLR	25_h	M
Coupler Unkey Aborted - This message is to inform the transceiver that the coupler unkey command has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	26_h Abort Code (8)	M
New Frequency - This command instructs the antenna coupler to operate on a new frequency. Frequency is a 32 bit integer indicating frequency in Hz. The action taken upon receipt of a New Frequency command depends upon the current state of the Key. If the coupler is Unkeyed, then the antenna coupler should clear its faults (if any). If the coupler is Keyed, then RF is disabled, faults cleared, and the antenna coupler untuned. A tune is initiated on a subsequent coupler Key command.	XCVR → CPLR	30_h Frequency (32)	M

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Table 7-4 Control Protocol Definitions (cont'd)

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
New Frequency Completed - This message informs the transceiver that the New Frequency command has been completed. The antenna coupler is now ready to tune the new frequency. Note that at this time the antenna coupler is effectively unkeyed (even if it was keyed prior to the New Frequency command) and it becomes necessary for the transceiver to re-key the coupler in order to tune the coupler and receive permission to transmit.	XCVR ← CPLR	31_h	M
New Frequency Aborted - This message informs the transceiver that the new frequency command has been aborted. The antenna coupler should now be bypassed. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	32_h Abort Code (8)	M
RF OFF - This command instructs the transceiver to turn off the RF. This message constitutes denial of permission for the transceiver to transmit RF.	CPLR → XCVR	50_h	M
c-1 **RF OFF Completed** - This message informs the antenna coupler that the RF OFF command has been completed and RF has been turned off. COMMENTARY The antenna coupler should verify the RF OFF condition before it takes action that might damage the coupler.	CPLR ← XCVR	51_h	M
RF OFF Aborted - This message informs the antenna coupler that the RF OFF command has been aborted. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	52_h Abort Code (8)	M
Request Tune RF - This command instructs the transceiver to supply RF at the operating frequency. This RF should be at the tune power level and have a CW signal present.	CPLR → XCVR	54_h	M
Request Tune RF Completed - This message informs the antenna coupler that the Tune RF request has been completed and RF at the operating frequency is available. COMMENTARY The antenna coupler should verify the presence of RF before RF related measurements are taken.	CPLR ← XCVR	55_h	M
Request Tune RF Aborted - This message informs the antenna coupler that the Tune RF request has been aborted. The transceiver should turn RF OFF if this should occur. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	56_h Abort Code (8)	M

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Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Request Test RF - This command instructs the transceiver to supply RF at the frequency specified by Test Frequency. The RF should be at the tune power level and have the characteristics described in the Request Tune RF command above. COMMENTARY It is anticipated that the test frequency identified here is the one sent to the antenna coupler in the Perform Coupler Transmit BIT command. The transceiver should not rely on the Perform Coupler Transmit command, however, and be able to respond to any frequency in its capability.	CPLR → XCVR	58_h Test Freq (32)	M
Request Test RF Completed - This message informs the antenna coupler that the RF request has been completed and RF at the specified frequency is available. COMMENTARY The antenna coupler should verify the presence of RF before RF related measurements are taken.	CPLR ← XCVR	59_h	M
Request Test RF Aborted - This message informs the antenna coupler that the Test RF request has been aborted. The transceiver should turn RF OFF if this should occur. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	$5A_h$ Abort Code (8)	M
Operate at Reduced Power - This command instructs the transceiver to operate at a reduced power level. Implementation of this command is optional. COMMENTARY This command is usually performed in order to cause a graceful degradation in the case of the antenna coupler overheating.	CPLR → XCVR	60_h	O
Operate at Reduced Power Completed - This message informs the antenna coupler that the Operate at Reduced Power command has been completed. The transceiver has accepted the command and should operate at significantly lower power.	CPLR ← XCVR	61_h	O
Operate at Reduced Power Aborted - This message informs the antenna coupler that the Operate at Reduced Power command has been aborted (essentially, the request has been denied). The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	62_h Abort Code (8)	O
Enable Operate at Full Power - This command informs the transceiver that it may once again operate at full power. This command is optional, though it should be recognized even if no action is taken.	CPLR → XCVR	64_h	O

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Table 7-4 Control Protocol Definitions (cont'd)

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Enable Operate at Full Power Completed - This message informs the antenna coupler that the request for operation at full power has been completed.	CPLR ← XCVR	65_h	O
Enable Operate at Full Power Aborted - This message informs the antenna coupler that the request for operation at full power has been aborted. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	66_h Abort Code (8)	O
c-1 **Retune Request** - This command informs the transceiver that the coupler has observed VSWR in excess of the configured Retune Request VSWR Threshold. This command requires no action, but it is anticipated that the transceiver will eventually cause another tune operation by re-issuing a New Frequency command and Key command. Even if no action is taken this command should be recognized and completed.	CPLR → XCVR	68_h	O
Retune Request Completed - This message informs the antenna coupler that the retune request has been completed.	CPLR ← XCVR	69_h	O
Retune Request Aborted - This message informs the antenna coupler that the retune request has been aborted. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	$6A_h$ Abort Code (8)	O
Request Coupler Status - This command instructs the antenna coupler to provide its status information to the transceiver.	XCVR → CPLR	70_h	M

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Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Request Coupler Status Completed - This message informs the transceiver that the request for coupler status has been completed and also supplies the status to the transceiver. Each of the identified words is described as follows: Frequency: A 32 bit integer indicating the operating frequency in hertz. Op Mode Code: 1_h = Dual System Receive, 2_h = Tuned Simplex. Tune Status: 1_h = Tuned, 2_h = Tuning, 3_h = Not Tuned. Power Requested: 1_h = Operating Power, 2_h = Reduced Power, 3_h = Tune Power. Dual Sys Status: 1_h = This coupler controls the antenna, 2_h = Antenna available for dual receive operation, 3_h = This coupler interlocked. Key Status: 0_b = Not Keyed, 1_b = Keyed. Quick Tune Status: 0_b = Quick Tunes Enabled, 1_b = Quick Tunes Disabled. History Status: 0_b = History Storage Enabled, 1_b = History Storage Disabled. Ignore Freq OOR: 0_b = Report fault, 1_b = Do not report fault if frequency is out of range of the coupler. Silent Quick Tunes: 0_b = Check VSWR before tune complete. 1_b = Do not check VSWR during tune operation - mark quick tune invalid if FaultThr or RetuneThr are exceeded during operation. ContThr: n/100 = Contingency Tune VSWR Threshold (i.e. the value 235 means a VSWR of 2.35:1). FaultThr: 0 = VSWR Fault Disabled, otherwise n/100 = Fault VSWR Threshold (i.e., the value 235 means a VSWR of 2.35:1). RetuneThr: 0 = Retune Request Disabled, otherwise n/100 = Retune Request VSWR Threshold (i.e., the value 235 means a VSWR of 2.35:1). KeyStkTO: 0 = Key Stuck Timer Disabled, otherwise n = Key Stuck Time-Out limit, in Seconds. Fault Status: This value represents the number of faults declared. It is the number of subsequent words that are to be interpreted as Vendor specific fault codes.	XCVR ← CPLR	71_h Frequency (32) Op Mode Code (4) Tune Status (4) Power Requested (4) Dual Sys Status (4) Key Status (1) Quick Tune Status (1) History Status (1) Ignore Freq OOR (1) Silent Quick Tunes (1) ContThr Status (16) FaultThr Status (16) RetuneThr Status (16) KeyStkTO Status (16) Fault Status (8) (Vendor Codes)	M
Request Coupler Status Aborted - This message informs the transceiver that the coupler status request has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	72_h Abort Code (8)	M

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Table 7-4 Control Protocol Definitions (cont'd)

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Request Coupler Version - This command instructs the antenna coupler to provide its version data to the transceiver.	XCVR → CPLR	74_h	M
Request Coupler Version Completed - This message informs the Transceiver that the coupler version request has been completed. The second field is an 8 bit number that indicates the latest version of this protocol that the coupler recognizes. The version number representing the protocol defined in this document is 01_h. The third field should indicate the particular Vendor ID of the antenna coupler. Specific Vendor IDs are as follows: 01_h = Rockwell International 02_h = Rohde & Schwarz The fourth field indicates the hardware version ID of the antenna coupler. c-1 The fifth field indicates the current software version of the antenna coupler. Formats for the HW and SW Version IDs are vendor specific.	XCVR ← CPLR	75_h Protocol Version (8) Vendor ID (8) HW Version (64) SW Version (64)	M
Request Coupler Version Aborted - This message informs the transceiver that the coupler version request has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	76_h Abort Code (8)	M
Request Transceiver Version - This command instructs the transceiver to provide its version data to the coupler.	CPLR → XCVR	78_h	M
Request Transceiver Version Completed - This message informs the coupler that the Transceiver version request has been completed. The second field is an 8 bit number that indicates the latest version of this protocol that the transceiver recognizes. The version number representing the protocol defined in this document is 01_h. The third field should indicate the particular Vendor ID of the transceiver. Specific Vendor IDs are as follows: 01_h = Rockwell International 02_h = Rohde & Schwarz The fourth field indicates the hardware version ID of the transceiver. The fifth field indicates the current software version of the transceiver. Formats for the HW and SW Version IDs are vendor specific.	CPLR ← XCVR	79_h Protocol Version (8) Vendor ID (8) HW Version (64) SW Version (64)	M
Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional

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Request Transceiver Version Aborted - This message informs the coupler that the transceiver version request has been aborted. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	$7A_h$ Abort Code (8)	M
Coupler Fault Declaration - This message informs the transceiver that the coupler is declaring a fault condition. The fault class is a general classification of the type of fault the antenna coupler may have detected. 1_h - Coupler Fault. This implies that the coupler may have determined that the fault is internal to itself. 2_h - RF Fault. This declares that the fault is related to RF operations. 3_h - System Fault. This is a fault that the coupler has detected that applies to the radio system as a whole, or to an element external to itself. Upon reception of a fault, the transceiver should disable RF and then take any appropriate action. The particular fault(s) can be identified by a request for coupler status.	CPLR → XCVR	80_h Fault Class (4)	M
Coupler Fault Declaration Completed - This message informs the antenna coupler that the coupler fault declaration has been completed.	CPLR ← XCVR	81_h	M
Coupler Fault Declaration Aborted - This message informs the antenna coupler that the coupler fault declaration has been aborted. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	82_h Abort Code (8)	M
Clear Coupler Faults - This command instructs the antenna coupler to clear its fault status and return to normal operation. Faults are also cleared each time an Initialize Coupler command is received.	XCVR → CPLR	84_h	O
Clear Coupler Faults Completed - This message informs the transceiver that the clear coupler faults command has been successfully completed. The antenna coupler fault status should now be clear.	XCVR ← CPLR	85_h	O
Clear Coupler Faults Aborted - This message informs the transceiver that the clear coupler faults command has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	86_h Abort Code (8)	O

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Table 7-4 Control Protocol Definitions (cont'd)

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Enable History Storage - This command instructs the antenna coupler to record and store history information in its internal memory for later examination by the Central Maintenance Computer (through the radio) or ground based test equipment. This information includes the CMC data received from the radio upon request, the reason the history is being updated, and any other relevant information. History updates should occur on every fault condition and, optionally, upon other notable events.	XCVR → CPLR	$A0_h$	O
Enable History Storage Completed - This message informs the transceiver that the history storage enable command is completed and the antenna coupler's history data storage is enabled.	XCVR ← CPLR	$A1_h$	O
c-1 **Enable History Storage Aborted** - This message informs the transceiver that the history storage enable command has been aborted and the antenna coupler's history data storage status has reverted to that prior to the command. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$A2_h$ Abort Code (8)	O
Inhibit History Storage - This command instructs the antenna coupler *not* to record and store history information. It is intended mainly for use in a testing or maintenance environment as a means for preserving the memories where this information is stored.	XCVR → CPLR	$A4_h$	O
Inhibit History Storage Completed - This message informs the transceiver that the history storage inhibit command is completed and the antenna coupler's history data storage is disabled.	XCVR ← CPLR	$A5_h$	O
Inhibit History Storage Aborted - This message informs the transceiver that the history storage inhibit command has been aborted and the antenna coupler's history data storage status has reverted to that prior to the command. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$A6_h$ Abort Code (8)	O
Clear History Storage - This command instructs the antenna coupler to erase and reinitialize the internal memory where coupler history data is stored. This is intended for use in a testing or maintenance environment and the radio should not send this command while the aircraft is airborne.	XCVR → CPLR	$A8_h$	O
Clear History Storage Completed - This message informs the transceiver that the Clear Coupler History Storage command has been completed and the coupler history data has been erased.	XCVR ← CPLR	$A9_h$	O

Command codes AO_h through AA_h, CO_h through CA_h, and $D0_h$ through $D6_h$ are intended for maintenance use only.

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Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Clear History Storage Aborted - This message informs the transceiver that the Clear History Data Storage command has been aborted. The status of the history data storage is indeterminate at this time - some may have already been erased, some may be invalid, and some may be usable. The antenna coupler should be able to continue to operate and correctly store and retrieve history data acquired after this time. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	AA_h Abort Code (8)	O
Request History Data - This command instructs the antenna coupler to supply history data which it has stored in its history data memory. The second word of the command (described as Last "n" Events) represents the number of history events to be transferred (a value of 0 indicates that all stored history events are to be provided). Events are ordered in reverse order of occurrence, i.e., 1 = the most recent event (the last one stored). This message is intended for use in a testing or maintenance environment.	XCVR → CPLR	$B0_h$ Last "n" Events (8)	O
Request History Data Completed - This message informs the transceiver that the request for history data has been completed. All requested history data should have been made available to the transceiver in history data messages prior to this time.	XCVR ← CPLR	$B1_h$	O
Request History Data Aborted - This message informs the transceiver that the request for history data has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$B2_h$ Abort Code (8)	O
History Data - This message contains coupler history data which has been in its history data memory. The second word of the command (Event no. "n") is an integer and represents the index of the event. Events are ordered in reverse order of occurrence, i.e., 1 = the most recent event (the last one stored). The series of words referred to as CMC Flight Data is the data received from the transceiver (originally the CMC) when the event was logged. At present this data and its format is described in Attachment 11 . The series of data words referred to as Event Data is vendor specific event data. This message is intended for use in a testing or maintenance environment.	CPLR → XCVR	$B4_h$ Event no. "n" (8) CMC Flight Data Vendor Data	O
History Data Completed - This message informs the antenna coupler that the last history data packet has been completed.	CPLR ← XCVR	$B5_h$	O

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Command codes AO_h through AA_h, CO_h through CA_h, and $D0_h$ through $D6_h$ are intended for maintenance use only.

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Table 7-4 Control Protocol Definitions (cont'd)

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
History Data Aborted - This message informs the antenna coupler that the last history data packet has been aborted. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	$B6_h$ Abort Code (8)	O
Request CMC Flight Data - This command instructs the transceiver to supply CMC flight data which it has received via the aircraft maintenance bus. The coupler should issue this request each time it desires to log an event into its history data storage. If the transceiver has no flight data available, then it should abort this command.	CPLR → XCVR	$B8_h$	M
Request CMC Flight Data Completed - This message informs the antenna coupler that the request for CMC flight data has been completed. The second and subsequent words are the CMC flight data. This data and format are described in Attachment 11.	CPLR ← XCVR	$B9_h$ CMC Flight Data	M
Request CMC Flight Data Aborted - This message informs the antenna coupler that the request for CMC flight data has been aborted. The antenna coupler should log the history event with null data. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	BA_h Abort Code (8)	M
c-1 **Enable Coupler Quick Tunes** - This command instructs the antenna coupler to search its non-volatile memory for Quick Tune data whenever a tune cycle is initiated, and to store tune data in a Quick Tune whenever a tune sequence is successfully completed.	XCVR → CPLR	$C0_h$	O
Enable Coupler Quick Tunes Completed - This message informs the transceiver that the Enable Coupler Quick Tunes command is completed and the antenna coupler should both search for and store Quick Tune data during tune operations.	XCVR ← CPLR	$C1_h$	O
Enable Coupler Quick Tunes Aborted - This message informs the transceiver that the Enable Coupler Quick Tunes command has been aborted and the antenna coupler's Quick Tune status has reverted to that prior to the command. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$C2_h$ Abort Code (8)	O
Inhibit Coupler Quick Tunes - This command instructs the antenna coupler *not* to search for or store Quick Tune data during tunes. It is intended mainly for use in a testing or maintenance environment as a means for preserving the memories where this information is stored.	XCVR → CPLR	$C4_h$	O
Inhibit Coupler Quick Tunes Completed - This message informs the transceiver that the Inhibit Coupler Quick Tunes command is completed and the antenna coupler should *not* search for nor store Quick Tune data during tune operations.	XCVR ← CPLR	$C5_h$	O

Command codes AO_h through AA_h, CO_h through CA_h, and $D0_h$ through $D6_h$ are intended for maintenance use only.

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Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Inhibit Coupler Quick Tunes Aborted - This message informs the transceiver that the Inhibit coupler Quick Tunes command has been aborted and the antenna coupler's Quick Tune status has reverted to that prior to the command. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$C6_h$ Abort Code (8)	O
Clear Coupler Quick Tune - This command instructs the antenna coupler to erase and reinitialize the internal memory where coupler Quick Tune data is stored. Because of the extensive time delays in the erase procedure, the operational advantages of Quick Tune acquired over time, and the self-updating nature of the Quick Tune data, it is not anticipated that this command would be needed outside of the factory environment and the radio should not send this command while the aircraft is airborne.	XCVR → CPLR	$C8_h$	O
Clear Coupler Quick Tune Completed - This message informs the transceiver that the Clear coupler Quick Tunes command has been completed and the coupler Quick Tune data has been cleared.	XCVR ← CPLR	$C9_h$	O
Clear Coupler Quick Tune Aborted - This message informs the transceiver that the Clear coupler Quick Tune command has been aborted. The status of the Quick Tune tables is indeterminate at this time - some Quick Tune commands may have already been erased, some may be invalid, and some others may be usable. The antenna coupler should be able to continue to operate and correctly store newly acquired Quick Tunes and use those determined to be valid. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	CA_h Abort Code (8)	O
Request Quick Tune Data - This command instructs the antenna coupler to supply the Quick Tune data associated with the frequency indicated by the second word of this message. This message is intended for use in a testing or maintenance environment.	XCVR → CPLR	$D0_h$ Quick Tune Freq (32)	O
Request Quick Tune Data Completed - This message informs the transceiver that the request for Quick Tune data has been completed. Quick Tune Freq indicates the frequency of the Quick Tune data being supplied and should be the same as that in the original request. The third and subsequent words are vendor specific preset data.	XCVR ← CPLR	$D1_h$ Quick Tune Freq (32) Vendor Data	O
Request Quick Tune Data Aborted - This message informs the transceiver that the request for Quick Tune data has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$D2_h$ Abort Code (8)	O

Command codes AO_h through AA_h, CO_h through CA_h, and $D0_h$ through $D6_h$ are intended for maintenance use only.

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Table 7-4 Control Protocol Definitions (cont'd)

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Request Tune Data - This command instructs the antenna coupler to supply the tune data associated with the last tuned frequency. This message is intended for use in a testing or maintenance environment.	XCVR → CPLR	$D4_h$	O
Request Tune Data Completed - This message informs the transceiver that the request for tune data has been completed. Tune Freq indicates the frequency of the tune data being supplied. The third and subsequent words are vendor specific tune data.	XCVR ← CPLR	$D5_h$ Tune Freq (32) Vendor Data	O
Request Tune Data Aborted - This message informs the transceiver that the request for tune data has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$D6_h$ Abort Code (8)	O
Perform Coupler Local BIT - This command instructs the antenna coupler to perform any BIT functions that are possible without external intervention or response.	XCVR → CPLR	$E0_h$	O
c-1 **Perform Coupler Local BIT Completed** - This message informs the transceiver that the coupler Local BIT has been completed. The second word indicates whether the coupler Passed (00_h) or Failed (FF_h) the BIT. The third and subsequent words are vendor specific fault data or BIT status.	XCVR ← CPLR	$E1_h$ Passed/Faile d (8) Vendor Data	O
Perform Coupler Local BIT Aborted - This message informs the transceiver that the coupler Local BIT has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$E2_h$ Abort Code (8)	O
Perform Coupler System BIT - This command instructs the antenna coupler to perform BIT functions that use the services of or response from the transceiver, except those which use RF transmission.	XCVR → CPLR	$E4_h$	O
Perform Coupler System BIT Completed - This message informs the transceiver that the coupler System BIT has been completed. The second word indicates whether the coupler Passed (00_h) or Failed (FF_h) the BIT. The third and subsequent words are vendor specific fault data or BIT status.	XCVR ← CPLR	$E5_h$ Passed/Faile d (8) Vendor Data	O
Perform Coupler System BIT Aborted - This message informs the transceiver that the coupler System BIT has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$E6_h$ Abort Code (8)	O

Command codes AO_h through AA_h, CO_h through CA_h, and $D0_h$ through $D6_h$ are intended for maintenance use only.

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Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Perform Coupler Progressive BIT - This command instructs the antenna coupler to perform the local and system BIT functions as well as any BIT functions that may use RF transmission. Test Frequency indicates a frequency the antenna coupler may utilize for transmission (this frequency uses the same format as the New Frequency Command).	XCVR → CPLR	$E8_h$ Test Frequency (32)	M
Perform Coupler Progressive BIT Completed - This message informs the transceiver that the coupler Progressive BIT has been completed. The second word indicates whether the coupler Passed (00_h) or Failed (FF_h) the BIT. The third and subsequent words are vendor specific fault data or BIT status.	XCVR ← CPLR	$E9_h$ Passed/Fail ed (8) Vendor Data	M
Perform Coupler Progressive BIT Aborted - This message informs the transceiver that the coupler Progressive BIT has been aborted. The transceiver should turn RF OFF if it is presently ON. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	EA_h Abort Code (8)	M
Perform Coupler Transmit BIT - This command instructs the antenna coupler to perform the BIT functions that may use RF transmission. Test Frequency indicates a frequency the antenna coupler may utilize for transmission (this frequency uses the same format as the New Frequency Command).	XCVR → CPLR	EC_h Test Frequency (32)	O
Perform Coupler Transmit BIT Completed - This message informs the transceiver that the coupler Transmit BIT has been completed. The second word indicates whether the coupler Passed (00_h) or Failed (FF_h) the BIT. The third and subsequent words are vendor specific fault data or BIT status.	XCVR ← CPLR	ED_h Present/Fail ed (8) Vendor Data	O
Perform Coupler Transmit BIT Aborted - This message informs the transceiver that the coupler Transmit BIT has been aborted. The transceiver should turn RF OFF if it is presently ON. The abort code is described in paragraph 7.4.3.2.	XCVR ← CPLR	EE_h Abort Code (8)	O
Coupler Loop Test Message - This message is used to test the communications path between the transceiver and the coupler.	CPLR → XCVR	$F0_h$ Loop Test Data (16)	O
Coupler Loop Test Message Completed - With this message the transceiver completes the coupler Loop Test Message. The Test Data field should be an exact duplicate of the Loop Test Data field in the coupler Loop Test Message sent to the transceiver.	CPLR ← XCVR	$F1_h$ Loop Test Data (16)	O

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Table 7-4 Control Protocol Definitions (cont'd)

Command/Request Description	Direction	Code or Data	(M)andatory or (O)ptional
Coupler Loop Test Message Aborted - This message informs the antenna coupler that the coupler Loop Test Message has been aborted. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	$F2_h$ Abort Code (8)	O
Transceiver Loop Test Message - This message is used to test the communications path between the transceiver and the coupler.	XCVR → CPLR	$F4_h$ Loop Test Data (16)	O
Transceiver Loop Test Message Completed - With this message the coupler completes the Transceiver Loop Test Message. The Test Data field should be an exact duplicate of the Loop Test Data field in the Transceiver Loop Test Message sent to the coupler.	XCVR ← CPLR	$F5_h$ Loop Test Data (16)	O
Coupler Loop Test Message Aborted - This message informs the transceiver that the Transceiver Loop Test Message has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	$F6_h$ Abort Code (8)	O
c-1 **Coupler Free Form Message -** This message is a free form data message intended for use in a testing or maintenance environment. Other than acknowledge and completion, this message should be ignored by the transceiver.	XCVR → CPLR	$F8_h$ Vendor Data	O
Coupler Free Form Message Completed - This message informs the antenna coupler that the coupler Free Form Message has been completed.	CPLR ← XCVR	$F9_h$	O
Coupler Free Form Message Aborted - This message informs the antenna coupler that the coupler Free Form Message has been aborted. The abort code is as described in Section 7.4.3.2.	CPLR ← XCVR	FA_h Abort Code (8)	O
Transceiver Free Form Message - This message is a free form data message intended for use in a testing or maintenance environment. Other than acknowledge and completion, this message should be ignored by the coupler.	XCVR → CPLR	FC_h Vendor Data	O
Transceiver Free Form Message Completed - This message informs the transceiver that the Transceiver Free Form Message has been completed.	XCVR ← CPLR	FD_h	O
Transceiver Free Form Message Aborted - This message informs the transceiver that the Transceiver Free Form Message has been aborted. The abort code is as described in Section 7.4.3.2.	XCVR ← CPLR	FE_h Abort Code (8)	

7.4.3.5 Example Communication Sequence

The following message sequence is an illustrative example of the link layer and control protocols in action. The example shows a typical tune operation.

Initial situation: The radio system is in receive (Dual System Receive mode for the coupler). The current operating frequency is 6.789 MHz. The operator changes the operating frequency to 12.345 MHz.

The transceiver is commanded to change to a new frequency. The transceiver sends a New Frequency Message for 12.345 MHz to the Antenna Coupler.

Table 7-5 Transceiver Sends New Frequency Message

Transceiver Sends/Asserts The Following		Serial Data & Direction	Coupler Sends/Asserts The Following	
Interpretation of Serial Word	RTS CTS		RTS CTS	Interpretation of Serial Word
	Off		Off	
	RTS		Off	
	RTS		CTS	
Length Word	RTS	0000 0111 →	CTS	
New Frequency	RTS	0011 0000 →	CTS	
Freq (12.345 MHz) - LSW.LSB	RTS	1010 1000 →	CTS	
Freq (12.345 MHz) - LSW.MSB	RTS	0101 1110 →	CTS	
Freq (12.345 MHz) - MSW.LSB	RTS	1011 1100 →	CTS	
Freq (12.345 Mhz) - MSW.MSB	RTS	0000 0000 →	CTS	
Checksum Word	RTS	0100 0011 →	CTS	
	CTS		CTS	
	CTS	← 0100 1101	CTS	Acknowledge Word
	Off		CTS	
	Off		Off	

The coupler receives the New Frequency command and begins the frequency changing process. The HF system is in receive, so it is not necessary to turn the RF off. Likewise, there are no faults, so it is not necessary to clear them. The coupler sends an acknowledge word to the transceiver indicating that all coupler operations necessary for a frequency change are complete.

Table 7-6 Coupler Sends New Frequency Completed Message

Transceiver Sends/Asserts The Following		Serial Data & Direction	Coupler Sends/Asserts The Following	
Interpretation of Serial Word	RTS CTS		RTS CTS	Interpretation of Serial Word
	Off		Off	
	Off		RTS	
	CTS		RTS	
	CTS	← 0000 0011	RTS	Length Word
	CTS	← 0011 0001	RTS	New Frequency Completed
	CTS	← 0011 0100	RTS	Checksum Word
	CTS		CTS	
Acknowledge Word	CTS	0001 0111 →	CTS	
	CTS		Off	
	Off		Off	

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7.4.3.5 Example Communication Sequence (cont'd)

The transceiver can now complete any steps left in the frequency change operation. Since the transceiver is not yet in transmit, a Coupler Key command is sent to the coupler.

Table 7-7 Transceiver Sends Coupler Key Command

Transceiver Sends/Asserts The Following		Serial Data & Direction	Coupler Sends/Asserts The Following	
Interpretation of Serial Word	RTS CTS		RTS CTS	Interpretation of Serial Word
	Off		Off	
	RTS		Off	
	RTS		CTS	
Length Word	RTS	0000 0011 →	CTS	
Coupler Key	RTS	0010 0000 →	CTS	
Checksum Word	RTS	0010 0011 →	CTS	
	CTS		CTS	
	CTS	← 0100 1101	CTS	Acknowledge Word
	Off		CTS	
	Off		Off	

The coupler receives the Coupler Key command. The antenna coupler checks the dual system lines and determines that the antenna is available for transmit. The coupler then asserts its antenna interlock line to command the other coupler to disconnect from the antenna. The coupler should wait enough time to insure that the other unit has had time to disengage from the antenna before RF is allowed to be put on the antenna.

Since the operating frequency has changed since the last tune, a tuning operation is necessary.

The antenna coupler first checks to see if the frequency (12.345 MHz) has a Quick Tune available. In this example a Quick Tune is available so the coupler switches the network to the Quick Tune settings.

The coupler now requires Tune RF in order to verify that the Quick Tune is still good. Note that if Silent Quick Tunes were selected then the next several steps ↓ would not be implemented. The coupler requests RF from the transceiver.

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Table 7-8 Coupler Sends Request Tune RF Message

Transceiver Sends/Asserts The Following		Serial Data & Direction	Coupler Sends/Asserts The Following	
Interpretation of Serial Word	RTS CTS		RTS CTS	Interpretation of Serial Word
	Off		Off	
	Off		RTS	
	CTS		RTS	
	CTS	← 0000 0011	RTS	Length Word
	CTS	← 0101 0100	RTS	Request Tune RF
	CTS	← 0101 0111	RTS	Checksum Word
	CTS		CTS	
Acknowledge Word	CTS	0001 0111 →	CTS	
	CTS		Off	
	Off		Off	

The transceiver receives the Tune RF Request. Unless the transceiver is inhibited by fault or other conditions (not in this case) the transceiver should turn on RF. The RF should be at the operating frequency (12.345 MHz), at tune power level, and with a CW signal. The transceiver should allow sufficient time for the RF to stabilize before indicating command completed.

Table 7-9 Transceiver Sends Request Tune RF Completed Message

Transceiver Sends/Asserts The Following		Serial Data & Direction	Coupler Sends/Asserts The Following	
Interpretation of Serial Word	RTS CTS		RTS CTS	Interpretation of Serial Word
	Off		Off	
	RTS		Off	
	RTS		CTS	
Length Word	RTS	0000 0011 →	CTS	
Request Tune RF Completed	RTS	0101 0101 →	CTS	
Checksum Word	RTS	0101 1000 →	CTS	
	CTS		CTS	
	CTS	← 0100 1101	CTS	Acknowledge Word
	Off		CTS	
	Off		Off	

The antenna coupler should verify RF is available and take any readings used to determine if the Quick Tune is "good".

After the readings are taken the coupler requests the transceiver to shut the RF off. The RF should be shut off as soon as possible to avoid keeping the PA transmitting into a potentially high VSWR for extended periods of time as well as to minimize interference on the operating frequency.

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7.4.3.5 Example Communication Sequence (cont'd)

Table 7-10 Coupler Sends RF OFF Message

Transceiver Sends/Asserts The Following		Serial Data & Direction	Coupler Sends/Asserts The Following	
Interpretation of Serial Word	RTS CTS		RTS CTS	Interpretation of Serial Word
	Off		Off	
	Off		RTS	
	CTS		RTS	
	CTS	← 0000 0011	RTS	Length Word
	CTS	← 0101 0000	RTS	RF OFF
	CTS	← 0101 0011	RTS	Checksum Word
	CTS		CTS	
Acknowledge Word	CTS	0001 0111 →	CTS	
	CTS		Off	
	Off		Off	

The transceiver receives the RF OFF command. The transceiver should immediately turn the RF off and should allow sufficient time for the RF to actually go off before indicating command completed.

Table 7-11 Transceiver Sends RF OFF Completed Message

Transceiver Sends/Asserts The Following		Serial Data & Direction	Coupler Sends/Asserts The Following	
Interpretation of Serial Word	RTS CTS		RTS CTS	Interpretation of Serial Word
	Off		Off	
	RTS		Off	
	RTS		CTS	
Length Word	RTS	0000 0011 →	CTS	
RF OFF Completed	RTS	0101 0001 →	CTS	
Checksum Word	RTS	0101 0100 →	CTS	
	CTS		CTS	
	CTS	← 0100 1101	CTS	Acknowledge Word
	Off		CTS	
	Off		Off	

The antenna coupler should verify that RF is off.

In this example the Quick Tune has been determined to be valid (the VSWR is less than 1.3:1), thus the tune is now complete. The previous several steps ↑ would not have occurred had Silent Quick Tunes been selected.

The antenna coupler indicates that tuning is complete by sending a Coupler Key Acknowledge.

Table 7-12 Coupler Sends Coupler Key Complete Message

Transceiver Sends/Asserts The Following		Serial Data & Direction	Coupler Sends/Asserts The Following	
Interpretation of Serial Word	RTS CTS		RTS CTS	Interpretation of Serial Word
	Off		Off	
	Off		RTS	
	CTS		RTS	
	CTS	← 0000 0011	RTS	Length Word
	CTS	← 0010 0001	RTS	Coupler Key Complete
	CTS	← 0010 0100	RTS	Checksum Word
	CTS		CTS	
Acknowledge Word	CTS	0001 0111 →	CTS	
	CTS		Off	
	Off		Off	

The transceiver is now able to transmit. The transceiver turns on the RF and the radio system is now set to transmit at 12.345 MHz.

7.5 Tuning Time

The average tuning time should not exceed 5 seconds. The maximum tuning time should not exceed 7 seconds. Future protocols could require a frequency switching time mentioned in Section 4.2.1.1 without the exception for the coupler.

8.0 PROVISIONS FOR AUTOMATIC TEST EQUIPMENT

8.1 General

To enable Automatic Test Equipment (ATE) to be used in the bench maintenance of the HFDL equipment internal circuit functions, not available at the ARINC 600 unit service connector and considered by the equipment manufacturer necessary for automatic test purposes, may be brought to pins on an auxiliary connector of a type selected by the equipment manufacturer. The manufacturer should observe ARINC Specification 600 standards for unit projections, etc., when choosing the location for this auxiliary connector.

8.2 ATE Testing

The HFDL LRUs should be ATE testable and should have a test program written using the Abbreviated Test Language for All Systems (ATLAS) language elements of ARINC Specification 626, "Standard ATLAS Subset for Modular Test" developed in accordance with ARINC Report 627, "Programmers Guide for SMART™ Systems Using ARINC Specification 626 ATLAS."

The ATLAS test procedure should be demonstrated to execute without modification on "SMART Automatic Test Systems" which are defined in ARINC Specification 608A as "avionics test systems ... in conformance with ARINC Specification 608A, contain the hosted SMART™ software offered by Aeronautical Radio, Inc. and other licensed vendors."

9.0 PROVISIONS FOR BUILT-IN TEST EQUIPMENT

9.1 Introduction

The HFDL LRUs should contain BITE capabilities in accordance with ARINC Report 624, "Design Guidance for Onboard Maintenance System (OMS)", and ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment."

COMMENTARY

> The guidance in ARINC Report 624 regarding the BITE capability for detection and isolation of internal and external HFDL system faults or failures generally supersedes that in ARINC Report 604. Also, the general philosophy, basic guidance, and certain specific recommendations are described for the OMS in ARINC Report 624, and for the Centralized Fault Display System (CFDS) in ARINC Report 604.

The HFDL LRU's BITE should be capable of detecting and annunciating a minimum of 95% of the faults or failures which can occur within the HFDL LRU's and as many faults as possible associated with the HF antenna, coaxial cable, and interfaces with the CMU or MU.

COMMENTARY

> Whether the VSWR of the antenna and its associated cabling should be measured and judged "GOOD" has been a subject of considerable discussion in the past. It should be noted that the antenna cabling loss of 5.5 dB will yield a VSWR of not more than 1.9:1 regardless of the antenna system VSWR. Therefore, measuring the VSWR at the connector of the radio should at best only determine whether or not the antenna feed line is connected and not severely damaged near the transceiver. Under no circumstances should an antenna and its associated cabling be judged "BAD" if acceptable communications can be performed.

The HFDL LRU's BITE should operate continuously during flight. Monitoring of the results should be automatic. The BITE should automatically test, detect, isolate, and record both intermittent and steady state faults.

COMMENTARY

> It is not the intent that BITE operation interfere with the normal operation of the LRUs. The use of full BITE during initialization may not be practical during normal operation.
>
> Discussion - Users realize that 95% coverage may not be possible in operational environments except during very unique conditions. For example, the testing of RAM is not reasonable during operation, except at power-up.

The BITE should indicate its condition and any faulty inputs 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 system should interfere with the normal operation of the HFDL system.

COMMENTARY

> Sufficient margins should be used in choosing BITE parameters to preclude nuisance warnings. Discrepancies in HFDL operation caused by power bus transients, received noise, Electromagnetic Interference (EMI), servicing interference, abnormal accelerations, turbulence, etc. should not be recorded as faults.

9.2 BITE Interfaces

The HFDL LRUs should facilitate control and annunciation of the BITE information via one or more of the following:

a. OMS/CFDS Interfaces
b. MU/CMU Interfaces
c. HFDR Front Panel
d. HFDU Front Panel
e. HFDCF
f. CMS/CFDIU Interfaces

The CMS/CFDIU should communicate via one input and one output ARINC 429 port, both operating low speed. For data format and protocol ARINC Report 604 should apply.

COMMENTARY

> The HFDL system is intended to be compatible with newer aircraft which have either an OMS or CFDS, as well as older aircraft which have no centralized maintenance system. In order to ensure interchangeability of the HFDL system across the entire range of installations, it should be capable of supporting BITE on the various interfaces.

On the OMS/CFDS interfaces and the MU/CMU interfaces, the HFDL system 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. The philosophy expressed in ARINC Reports 604 and 624 is that avionic units such as the HFDL LRUs should provide an interactive, "user friendly" aid to maintenance.

COMMENTARY

> The interactive BITE capability which provides detailed failure information and fault isolation data is meant to be used by trained maintenance personnel while the aircraft is on the ground.

9.2.1 OMS Interfaces

The HFDL system should facilitate BITE control and fault reporting capability, including an interface with a Central Maintenance Computer (CMC) in accordance with ARINC Report 624. Attachment 7, Table 7-1 describes the list of BITE codes which should be used for HFDL fault reporting.

9.2.2 Character-Oriented CFDS Interfaces

The HFDL system should facilitate BITE control and readout, including interfaces with single or dual Centralized Fault Display Interface units (CFDIUs), in accordance with

9.0 PROVISIONS FOR BUILT-IN TEST EQUIPMENT

9.2.2 Character-Oriented CFDS Interfaces (cont'd)

the character oriented fault reporting protocol described in ARINC Report 604. Attachment 7, Table 7-4 contains the list of BITE fault messages which should be used for ARINC 753 HFDR fault reporting.

9.2.3 Bit-Oriented CFDS Interfaces

The HFDL system should facilitate BITE control and readout, including interfaces with single or dual CFDIUs, in accordance with the bit-oriented fault reporting protocol described in ARINC Report 604. Command and Fault summary words should be in accordance with Attachment 7, Tables 7-2 and 7-3.

9.2.4 MU/CMU BITE Interfaces

The HFDL system should facilitate BITE control and readout via the single or dual interfaces with the MU or CMU. Protocols for exchange of BITE data on these interfaces should be in accordance with the bit-oriented CFDIU protocol described in ARINC Report 604. Command and Fault summary words should be in accordance with Attachment 7, Tables 7-2 and 7-3.

9.2.5 HFDR/HFDU Equipment Identification Word

The ARINC Label 377 word is issued to transmit the HFDR equipment identification code to the MU/CMU and A/C monitoring tools. The format of the Label 377 word is defined in ARINC Specification 429. The equipment ID for the HFDR should be set to "019" which identifies the LRU as a "HF transceiver".

COMMENTARY

> To be compatible with current OMS installations, the equipment code should be the same in ARINC 719 and 753 radios, i.e. "019". This provides an interface with the OMC without modifying the HFDR installation in the event of retrofit.

The equipment ID for the HFDU should be set to 053.

9.3 BITE Presentation

BITE information provided on the data buses for the OMS/CFDS and CMU/MU should be presented to maintenance personnel on the display contained within the applicable system. Additionally, the HFDL system should present System/LRU fault status on its front panels in order to facilitate the use of BITE for local troubleshooting in the electronics equipment bay and for installations without a compatible OMS/CFDS or MU/CMU.

9.4 Fault Monitor

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

The contents of the monitor memory should be retrievable by BITE operation or by shop maintenance equipment. Refer to ARINC Report 624 for further guidance on fault recording.

The HFDL system should send BITE fault data to the OMS/CFDS and MU/CMU on the applicable Data Bus.

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 should 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.

9.5 Self-Test Initiation

At the time of equipment turn-on, a power-up self-test should be initiated automatically as described in ARINC Reports 604 and 624. In addition, the HFDL system should provide self-test capability for troubleshooting and installation verification. The initiation of the applicable test sequences should be possible from the control point(s) for the OMS, CFDS, MU, or CMU.

COMMENTARY

> It is desirable that the power-up self-test be completed in less than 15 seconds.

As an aid to shop maintenance and trouble-shooting on the aircraft, a mechanism should be provided on the HFDR and HFDU front panels for initiation and annunciation of a unit/system self-test results. The self-test routine should start with a test which verifies the correct operation of all elements of the annunciating mechanism. If the self-test routine detects a fault, the appropriate fault should be annunciated. If no fault is found, the contents of the intermittent fault memory should be reviewed; if an occurrence of a fault on one of the four earlier flight legs is detected, the appropriate fault should be annunciated. If no faults are detected, and none were recorded during the four earlier flight legs, a "normal" status should be annunciated. Fault annunciations should continue until the self-test control is activated a second time or a "time-out" period of approximately ten minutes expires.

COMMENTARY

> 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.

9.0 PROVISIONS FOR BUILT-IN TEST EQUIPMENT

9.6 Monitor Memory Output

The BITE Monitor Memory should provide an output of undefined format for shop read-out at the ATE reserved pins of the upper connector located on the HFDL LRUs.

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

9.7 HF Data Link to CMC Status Word

c-1 In order for the CMC to be aware of various modes and status's of the HF Data Link transceiver the Label 270 Status word as defined in Section 10.3.1 for the MU/CMU should also be output on the CMC bus Pins MP4C and MP4D.

10.0 ACARS MU/CMU - HFDL INTERFACE

10.1 Overview

An ARINC Specification 429 data bus provides communications between the HFDL and the ACARS MU/CMU system. There are two basic types of communications conducted over these circuits. The first type is transfer of messages exchanged with the terrestrial ends of the system. The second type is system and maintenance data requests and response messages used for command and control. Messages are identifiable when transferred through the use of the GFI filed in the file transfer protocol.

10.2 Physical Interface

Data rates, voltage thresholds, and electrical interface specifications are per ARINC Specification 429. Use of High or Low speed ARINC 429 is determined by a strapping option.

10.3 Link Layer - Broadcast

The HFDL and the ACARS MU/CMU should monitor each other's status by exchanging Label 270 status words one per second.

10.3.1 HFDL to ACARS MU/CMU Status Word

HFDL status words should be broadcast at 1 second intervals with the format shown in Table 10-1 below.

Bits 1-8 describe the Label. This field is set to Label 270 octal with the MSB first.

Bits 9 (SDI 0) - 10 (SDI 1) describe the SDI of the HFDL broadcasting the label. Installation number 1 indicates HFDL number 1 and installation number 2 indicates HFDL number 2.

Bit 11 indicates the HFDL availability. The MU/CMU should use Label 270 bit 11 to determine whether or not the HFDL is an acceptable choice for a data link mechanism. This bit reflects whether or not all elements are in place to support delivery of data. This includes hardware in the correct configuration, and a quality communication link to the MU/CMU. The value 0 indicates the HFDL is available. The value 1 indicates the HFDL is not available. The HFDL sets this bit to 0 only when selected to Data Mode as master and it has logged on and is therefore capable of transmitting/receiving data. The HFDL sets this field to 1 when it is selected to slave or Voice mode. If the HFDL system is in the Data Link mode as master and is transmit inhibited while in the air for several minutes, this field is set to 1 while the system continues to attempt establishment of a connection. The default value for this time should not be less than three minutes, or more than four minutes. This time delay prevents the MU/CMU from discontinuing usage of the HFDL after interruptions in service due to voice transmit on the opposite side radio. If the HFDL system is in the Data Link mode as master and is transmit inhibited while on the ground, this field is set to 1 and the system does not attempt establishment of a connection.

Bit 12 indicates the status of MU/CMU number 1 as perceived by the HFDL. The value 0 indicates that the Label 270 is currently being detected. The value 1 indicates that the Label 270 is not being detected. The HFDR should report a value of 1 when 5 consecutive Label 270 words were not received. The HFDR should report a value of 0 when 3 consecutive Label 270 words are received.

Bit 13 is used to indicate the voice/data selection of HFDR number 1. The value 0 indicates that HFDR is operating in data mode. The value 1 indicates that the HFDR is operating in either voice or analog non-HFDL data.

Bit 14 is used to indicate the Interlock Status based on discrete input MP-5H. The value 0 indicates the interlock status is active. The value 1 indicates the interlock status is inactive. This information is intended to be used only for debugging.

Bit 15 is a spare and should be set to zero.

Bit 16 is used to indicate the HFDL fault status. The value 0 indicates the HFDL is OK. The value 1 indicates the HFDL is not currently capable of supporting data transmit/receive due to a fault. Note that if the value is 1, then bit 11 and bit 17 must be 1. HFDL Fault Status is reported when HF data link is not possible due to an interface or internal failure. HF Voice may still be functional, but the HFDL returns a status of FAULT regardless. The HFDL transmitted Label 350 contains overall HF Radio status and health. HFDL should not assert link available when in HFDL fault status.

Bit 17 is used to indicate the HFDL logon status. The value 0 indicates the HFDL is currently logged on. The value 1 indicates the HFDL is not currently logged on. Since there is a time delay to indicate HFDL availability of 1 (HFDL Not Available), this bit may indicate logged off while the HFDL is indicating a value of 0 (HFDL Available). This would occur during a logon renewal. In this case the HFDL is logged off for a short amount of time, but continuously indicates HFDL availability. If the HFDL is declaring a fault by setting bit 16 to 1, then bit 17 is also set to 1.

Bit 18 is used to echo the master/slave status of the HFDL to the MU/CMU. The value 0 indicates the HFDL is master. The value 1 indicates the HFDL is slave. This information is intended to be used only for debugging purposes.

Bit 19 indicates the status of MU/CMU number 2 as perceived by the HFDR. The value 0 indicates that the Label 270 is currently being detected. The value 1 indicates that the Label 270 is not being detected. The HFDR should report a value of 1 when 5 consecutive Label 270 words were not received. The HFDR should report a value of 0 when 3 consecutive Label 270 words are received.

Bit 20 is used to indicate the COMM status of the HFDL. This COMM status bit is intended to indicate whether the HFDL is able to currently receive and should only be used in a debug situation. The MU/CMU should not use this bit as a determinant of selection of HFDL for a data link. The value 0 indicates squitters are being received. The value 1 indicates no squitters are being received. This bit indicates NO COMM status when the HFDL has been unable to receive a squitter on any frequency for 3 minutes. While the HFDL is receiving squitters this bit indicates OK COMM status.

Bit 21 indicates the Data Transmit Status of the HFDR. The value 0 indicates the HFDR is transmitting. The value 1 indicates that HFDR is not transmitting. Note that this information is intended to be used only for debugging, and should not be used as a precise indication of when the radio has the coupler interlock set to transmit.

Bit 22 is used to indicate the HFDL Transmit Inhibit Status. The value 0 indicates that it is not currently transmit inhibited. The value 1 indicates that it is currently transmit inhibited. The bit 22 is based on the Transmit Inhibit discrete (TP3G)(see Section 4.6.11), the Air/Ground Switch discrete (MP4G), and the HFDL Tx Inhibit Override (TP7J). The HFDL should indicate transmit inhibit when the (TP3G set - HFDL is Tx Inhibited) AND (MP4G set - aircraft is on the ground) AND (TP7J not set - no HFDL Tx
c-1 Override), otherwise the HFDL should indicate no transmit inhibit.

Bit 23 is used to indicate HFDL Transmit Inhibit Override status. This bit should simply be a reflection of the state of TP7J. The value 0 indicates that the TP7J is not set (the discrete is open) indicating the HFDL Transmit Inhibit state is currently overridden. The value 1 indicates that the TP7J is set (the discrete is grounded) indicating the HFDL Transmit Inhibit state is not currently overridden.

Bit 24 is used to indicate the ISO 8208 capability of the HFDL. The value 0 indicates that the HFDL is only capable of transmit/receive of enveloped messages. The value 1 indicates that the HFDL is capable of transmit/receive of ISO 8208 messages as well as enveloped messages. Note that the value 0 is indicated when the HFDL has not implemented the ISO 8208 protocol, or it has logged on to a ground station which has not implemented the ISO 8208 protocol. The value 1 is indicated by the HFDL when it has implemented the ISO 8208 protocol, and has either not logged on yet, or has logged on to an ISO 8208 capable ground station.

Bit 25 is used to indicate the voice/data selection of HFDR number 2. The value 0 indicates that HFDR is operating in Data mode. The value 1 indicates that the HFDR is operating in either voice or analog non-HFDL data.

Bit 26 is used to indicate whether or not the frequency which the HFDL is logged on to is loaded. The value “0” indicates that the frequency the HFDL is logged on to is not loaded. The value “1” indicates that the frequency the HFDL is logged on to is loaded. The HFDR should set bit 26 to “0” when the HFDL is not logged on, or is logged on to a frequency which is not heavily loaded. The HFDR should set bit 26 to “1” when the HFDL is logged on to a frequency which is heavily loaded. A frequency is known to be heavily loaded when the frequency utilization flag of the squitters broadcast on the frequency are set to “1”
c-2 (see ARINC Specification 635, Section 5.2.1.7, paragraph a., Bit 5.)

COMMENTARY

> When the HFDR indicates to the CMU that the current logged on frequency is ‘Heavily Loaded’ the CMU should consider other data links if available. Those aircraft able to use alternate data links will reduce the loading on the HF data link to a more optimal level.

Bit 27 is used to indicate the aircraft air/ground status determined from discrete inputs as defined in Sections 4.6.10 and 5.9.6. The value 0 indicates the aircraft is in the air. The value 1 indicates the aircraft is on the ground.

Bits 28-29 are spares and should be set to zero.

Bits 30-31 are an SSM field. The field definitions are as follows: 00 indicates normal operation; 10 indicates invalid data; 01 indicates a functional test in progress; 11 indicates a failure warning.

Bit 32 is used as a parity bit. This bit indicates odd parity of the bits 1-31.

The Data-Slave HFDL unit operates as described in ARINC Specification 635, Section 5.2.5.2. Both the Data-Master and the Data-Slave should provide and accept information about the signal quality of frequencies using Label 272 as indicated in Section 4.6.7.6. The Slave HFDL does not provide HFDL service independently and should report HFDL services unavailable in its own Label 270 word to the MU/CMU. The MU/CMU should direct its traffic to the HFDL indicating Data Link Available, which in this case is the master HFDL.

Bits	Function	Status Word Description
1-8	Label	270 octal (MSB first)
9-10	SDI	10 = HFDL #1 (for Installation Number 1); 1 = HFDL #2 (for Installation Number 2) c-2
11	HF Data Link Availability	0 = HF Data Link available; 1 = HF Data Link not available
12	MU/CMU #1 Status	0 = Label 270 detected 1 = Label 270 not detected
13	HFDR #1 Voice/Data	0 = Data mode; 1 = Voice mode or Analog non-HFDL Data
14	Interlock Status (Offside HF transmitting data or voice)	0 = Interlock active; 1 = Interlock not active
15	Spare	0
16	HFDL Fault Status	0 = OK; 1 = HFDL fault
17	HFDL Log-On Status	0 = Logged-On 1 = Not Logged-On
18	Master/Slave Status	0 = Master 1 = Slave
19	MU/CMU #2 Status	0 = Label 270 detected 1 = Label 270 not detected

c-1

10.3.1 HFDL to ACARS MU/CMU Status Word (cont'd)

Bits	Function	Status Word Description
20	COMM Status	0 = Squitters received; 1 = No squitters received
21	Data Transmit Status	0 = HFDL is transmitting 1 = HFDL is not transmitting
22	HFDL Tx Inhibit Status	0 = HFDL Tx is not Inhibited 1 = HFDL Tx Inhibited indicated when (TP3G set HFDL is TX inhibited) AND (MP4G set - aircraft is on the ground) AND (TP7J not set - no HFDL Tx Override)
23	HFDL Tx Inhibit Override	0 = HFDL Tx Inhibit is overridden; 1 = HFDL Tx Inhibit is not overridden;
24	Protocol Support	0 = Enveloped messages; 1 = ISO 8208 and enveloped messages
25	HFDR #2 Voice/Data	0 = Data mode; 1 = Voice mode or Analog non-HFDL Data
26	Frequency Loaded	0 = Frequency is Not Loaded; 1 = Frequency is Loaded
27	Air/Ground Status	0 = a/c in the air 1 = a/c on the ground
28-29	Spare	0
30-31	SSM	00 = Normal operation; 10 = Invalid data; 01 = Functional test; 11 = Fault warning
32	Parity	Odd Parity

c-2

Table 10-1
HFDL to ACARS MU/CMU Status Word Bit Formats

c-1

10.3.2 ACARS MU/CMU to HFDL Status Word

Once per second the ACARS MU/CMU should transmit a label 270 word as specified in ARINC Characteristics 724, 724B, and 758. For information only, this word is encoded as shown in Table 10-2 below.

Bits	Function	Status Word Description
1- 8	Label	270 octal, MSB first
9-10	SDI	10 = MU/CMU #1; 01 = MU/CMU # 2
11-15	Not applicable	
16	MU/CMU Status	0 = Normal 1 = MU/CMU Fault
17	SATCOM/HF Status	0 = SATCOM or HFDL Available 1 = Neither SATCOM nor HFDL Available
18-19	Not applicable	
20	Active/Standby	0 = Standby; 1 = Active
21-25	Not applicable	
26-29	Not applicable	
30-31	SSM	00 = Normal operation 10 = Invalid data; 01 = Functional test; 11 = Fault warning
32	Parity	Odd Parity

Table 10-2
ACARS MU/CMU to HFDL Status Word Bit Formats

10.3.3 HFDL to MU/CMU Join/Leave Event Message

The HFDL should transmit to the MU/CMU at least once per second a Label 271 Join/Leave Event broadcast message. The message contains the ground station address and the log-on status. Bit 29 indicates whether the data link to the ground station identified by the Ground Station ID field is Available (a Join Message) or Not Available (a Leave Message). c-1

Bits	Function	Status Word Description
1- 8	Label	271 octal, MSB first
9-16	SDI	Ground Station Address
17-28	Not applicable	Undefined; Always zero
29	Join/Leave	Data Link via MU/CMU Not Available 0 = Available 1 = Not Available 0 = Join Message 1 = Leave Message
30-31	SSM	00 = Normal operation; 10 = Invalid data; 01 = Functional test; 11 = Fault warning
32	Parity	Odd parity

Table 10-3
HFDL to MU/CMU Join Leave Event Message Word Bit Formats

NOTE: Bit 29 may be Set/Not Set synchronously with bit 11 of Label 270 status word as defined in Section 10.3.1 above.

10.3.4 HFDL to ACARS MU/CMU Subsystem Identifier Word

Once per second the HFDL should broadcast to the ACARS MU/CMU a Label 172 Subsystem Identifier word encoded as follows.

Bits	Function	Status Word Description
1- 8	Label	172 octal, MSB first
9-16	System Address	340 = HFDL #1; 344 = HFDL #2 (MSB = Bit 9)
17-29	Spare	
30-31	SSM	00 = Normal operation 01 = Functional test 10 = Invalid data 11 = Fault warning
32	Parity	Odd parity

Table 10-4
HFDL to ACARS MU/CMU Subsystem Identifier Word Bit Formats

NOTE: Refer to Section 4.6.13 for a definition of HFDL#1 and HFDL#2 systems.

10.4 Link Layer - Bit Oriented File Transfer Protocol

The Link Layer Protocol used is the “Bit-Oriented File Transfer Protocol (BOP)” as specified in ARINC Specification 429, Part 3, “Digital Information Transfer System (DITS),”Section 2.5 and Attachments 10, 11, 11A, 11B, 11C, 12, 13, 14, 15 and 16. The HFDR Low and High Speed timer values are also shown in Attachment 16, Tables 16-1 and 16-2.

In addition, the BOP options in Table 10-5 below should be used by the HFDL for the ACARS MU/CMU interface (reference ARINC Specification 429, Table 10-3) with the options specified in ARINC Specification 618.

Option	Value	Notes
01	Half	Half or Full Duplex
02	Low	High or Low Speed (Depends On Strapping Option
03	Not Used	Send Automatic CTS When Ready
04	Not Used	Accept Automatic CTS
05	HFDL	System Priority Resolution
06	200 ms	NAK Send Time After Error Detected
07	Spare	
08	LOOP/TST	Response To SOLO Words
09	No	Character Format Support
010	Yes	Destination Code Used
011	Yes	BOP Verification Response (ALR)

Table 10-5
Bit Oriented File Transfer Protocol Options

A reception of a <SYN> word should cause the receiving system to abort any reception or transmission in progress; in addition, if the system was transmitting, it should re-initiate transmission of the FILE that was aborted.

10.4.1 File Formats

The interface is used to pass ACARS messages, ISO 8208 packets, other messages that can be enveloped and command/control messages. To differentiate these types of traffic, the Williamsburg LDU General Format Identifier (GFI) contained in bits 25-28 of the Start of Transmission (SOT) word should be set as shown in Table 10-6 below.

File Type	To MU/CMU		To HFDL		
	SAL	Dest Code	SAL #1/#2	Dest Code	GFI
ACARS Block	304	“M”	340/344	“H”	1110_b (E_h)
8208 Packets					0100_b (4_h)
Command/ Contol					0010_b (2_h)
HFDL Message		“G”		“T”- Left “U”- Right	0011_b (3_h)

Table 10-6
General Format Identifier (GFI) of the Start of Header (SOH) Word

10.4.2 Enveloped Messages

A GFI of 1110_h indicates that the message is to be enveloped. No network protocol is used. One message is transferred per link layer ARINC Specification 429 “file”. (The enveloped message is passed transparently by the HFDL to the ground station.)

One type of enveloped message is an ACARS message “block”, as specified by ARINC Specification 618, starting with the <SOH> character and ending with the two octet computed Block Check Sequence (BCS) and <DEL> character as defined in ARINC Specification 618, Section 2.

If for any reason the HFDL is unable to deliver an enveloped message to its destination (ACARS MU/CMU or ground station), the HFDL should discard the message.

10.4.3 ISO 8208 Packets

A GFI of 0100_b (4_h) indicates that bits 5 and 6 in the first octet of the packet should be checked to determine whether an ISO 8208 packet, which uses the HF SubNetwork Access Protocol as defined in ARINC Specification 635, Section 6.2.2, is contained in the LDU. Table 10-7 should be used to route ISO 8208 packets to the ISO 8208 DCE processing function.

10.4.3 ISO 8208 Packets (cont'd)

1st Octet 87654321	Packet Type
xx01xxxx	ISO 8208 packet with modulo 8 sequence numbering
xx10xxxx	ISO 8208 packet with modulo 128 extended packet sequence numbering
xx11xxxx	ISO 8208 packet with GFI extension
xx00xxxx	Other protocols including those below
10000001	ISO 8473 packets
00001000	Q.931 protocol

c-2

Table 10-7 Packet Types

10.4.4 Command/Control File

A GFI of 0010$_h$ (2$_h$) indicates a Command/Control file.

10.5 Command/Control Interface

10.5.1 Command/Control Overview

The Command/Control interface between the HFDL and the ACARS MU/CMU should support the updating of the Requirements Table. The exchange between the ACARS MU/CMU and the HFDL should be in a form of a binary file transfer as defined by ARINC Specification 429, Section 2.5.

10.5.2 Command/Control Format

The Command/Control file format should be a binary format with the first octet as a type designation as defined in Table 10-8 below. The type designations are used to allow the HFDL or ACARS MU/CMU to differentiate the file contents.

HFDL		
Command Code	**Type Designations**	**Source**
00$_h$ to 02$_h$	Reserved	
03$_h$ to 06$_h$	Defined in Section 10.5.2.2	MU/CMU
07$_h$	Defined in Section 10.5.2.2	HFDL
08$_h$ to BF$_h$	Reserved	
C0$_h$ to DF$_h$	Reserved: Manufacturers /Users	HFDL or MU/CMU
E0$_h$ to FE$_h$	Reserved: Unassigned	
FF$_h$	Type designation continued in next octet	HFDL or MU/CMU

c-2

Table 10-8 Command/Control File Format

10.5.2.1 HFDL to MU/CMU Maintenance Data

The MU/CMU may be used to provide limited maintenance and installation support, particularly for installations without on-board maintenance computers. To support this, the HFDL should be capable of transmitting maintenance data, when requested, to the MU/CMU as a command/control message. The HFDL equipment designer should take into consideration what information would be valuable for either an equipment installer, or to support troubleshooting and maintenance. This Characteristic makes no specific requirements on contents of the maintenance data, other than providing the software part number. c-1

The MU/CMU may request any of four pages by issuing a command message with a type designation of 03$_h$, 04$_h$, 05$_h$ or 06$_h$ each of which should elicit a response message from the HFDL of 07$_h$ as the first octet of data**.** The second octet of each response message should contain the type designation (i.e., 03$_h$, 04$_h$, 05$_h$, or 06$_h$) of the page data for which the response is being prepared. c-2

Each 07$_h$ response report contains free text formatted for display on 22 characters by 10 lines. The free text should only contain displayable 7-bit ASCII characters and Carriage Returns as defined in ARINC Characteristic 739, "Multi-Purpose Control and Display Unit" (MCDU). Carriage Returns may be inserted if desired by the HFDL. The line is automatically wrapped at 22 characters by the MU/CMU if no Carriage Return is provided. Any labeling necessary for readability should be supplied in the text by the HFDL.

The MU/CMU is transparent to all text supplied by the HFDL, and merely provides a method to display, print, or even downlink the information. It may contain methods of periodically refreshing the display by periodically requesting a report, but it should not request a report faster than 1 report per second.

c-1

At a minimum, the HFDL should:

a. Respond to a request (03$_h$) with a 07$_h$ message containing its software part number and appropriate labeling suitable for display as described above.

b. Respond to any other request with the 07$_h$ message "NO HFDL DATA AVAILABLE", if the HFDL has no data available for any other requests.

The specific contents and formats of each of the four responses to the requests are left to the manufacturer. Potential information could include, but is not limited to:

a. Configuration data - software part numbers, database versions, hardware part numbers, vendor identification, serial number, ICAO address.

b. Performance data - current HFDL frequency, frequency table, ground station ID, service provider ID, data rate.

c. Installation data - data bus status, program pin status, discrete pin status.

10.6 HFDL Messages

HFDL Message file contents are manufacturer defined.

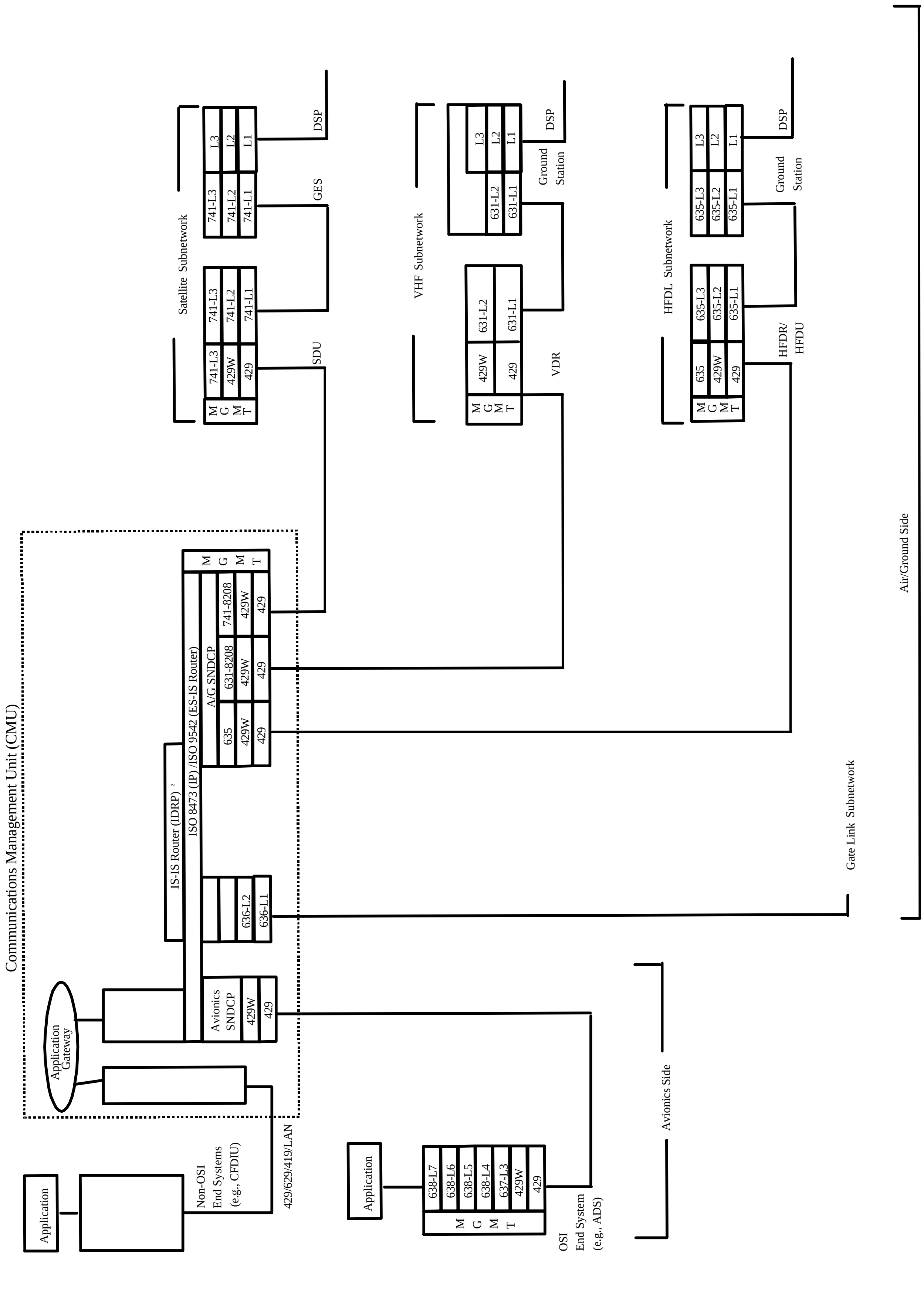
COMMENTARY

An example of an HFDL message is a Requirements Table Update. The actual contents of the Requirements Table Update File is specified by the manufacturer. The manufacturers are encouraged to use whatever means they desire to ensure accuracy of data.

c-2 The actual procedure for updating the Requirements Table makes use of an application gateway in the ACARS MU/CMU. The airline sends a message addressed to the CMU up through the network to the aircraft. The CMU determines that it is a message destined for the HFDL system. The CMU then forwards the file to the HFDL system for processing. Acknowledgements would take a reverse path through the ACARS MU/CMU to the ground.

The use of Requirements Tables is undefined at this time. Requirements Tables may be defined at a later date. Future uses of a Requirements Table may include selection of preferred ground stations/service providers.

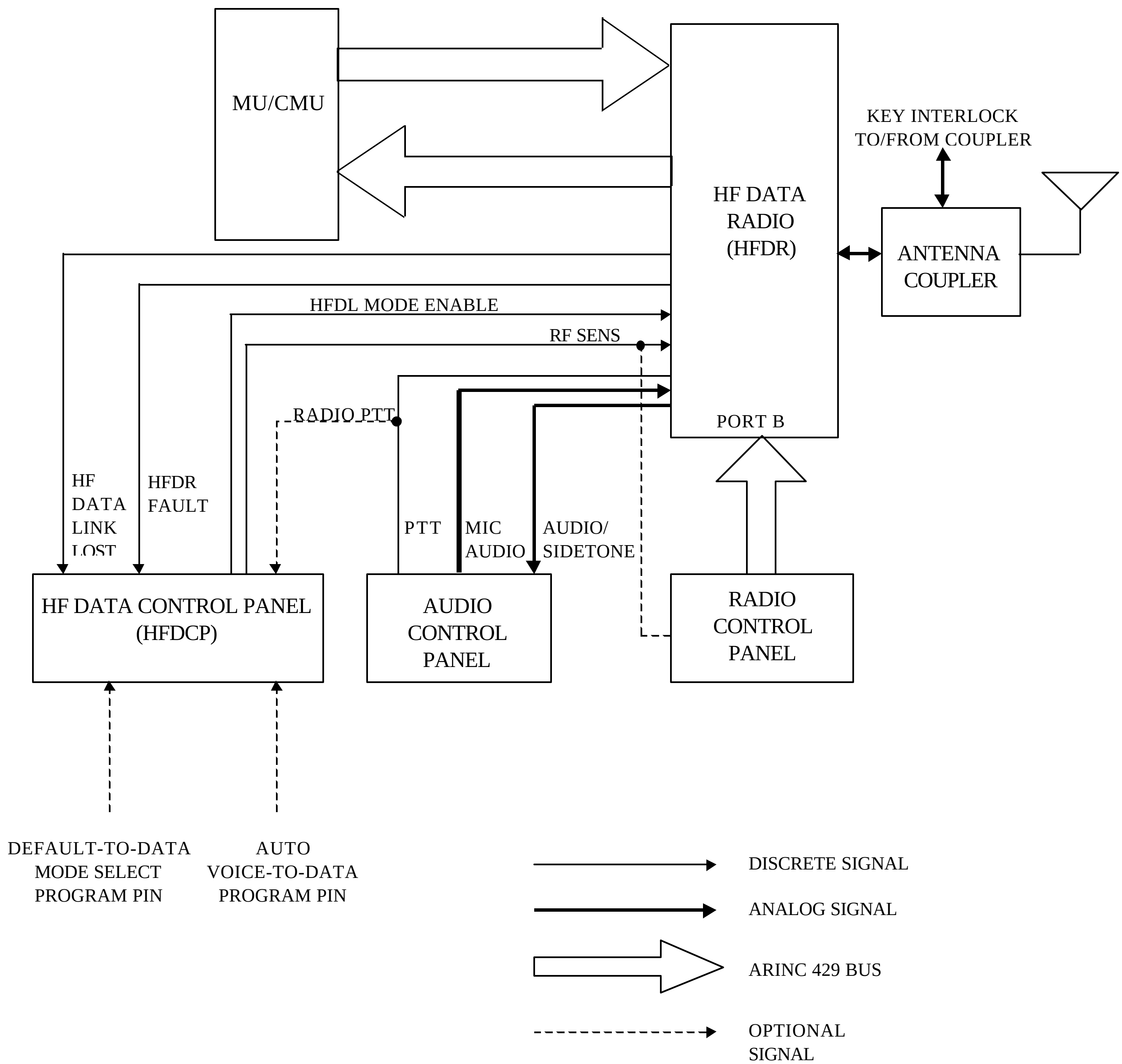
ATTACHMENT 1
AIRBORNE SUBSYSTEM BLOCK DIAGRAM



NOTES:

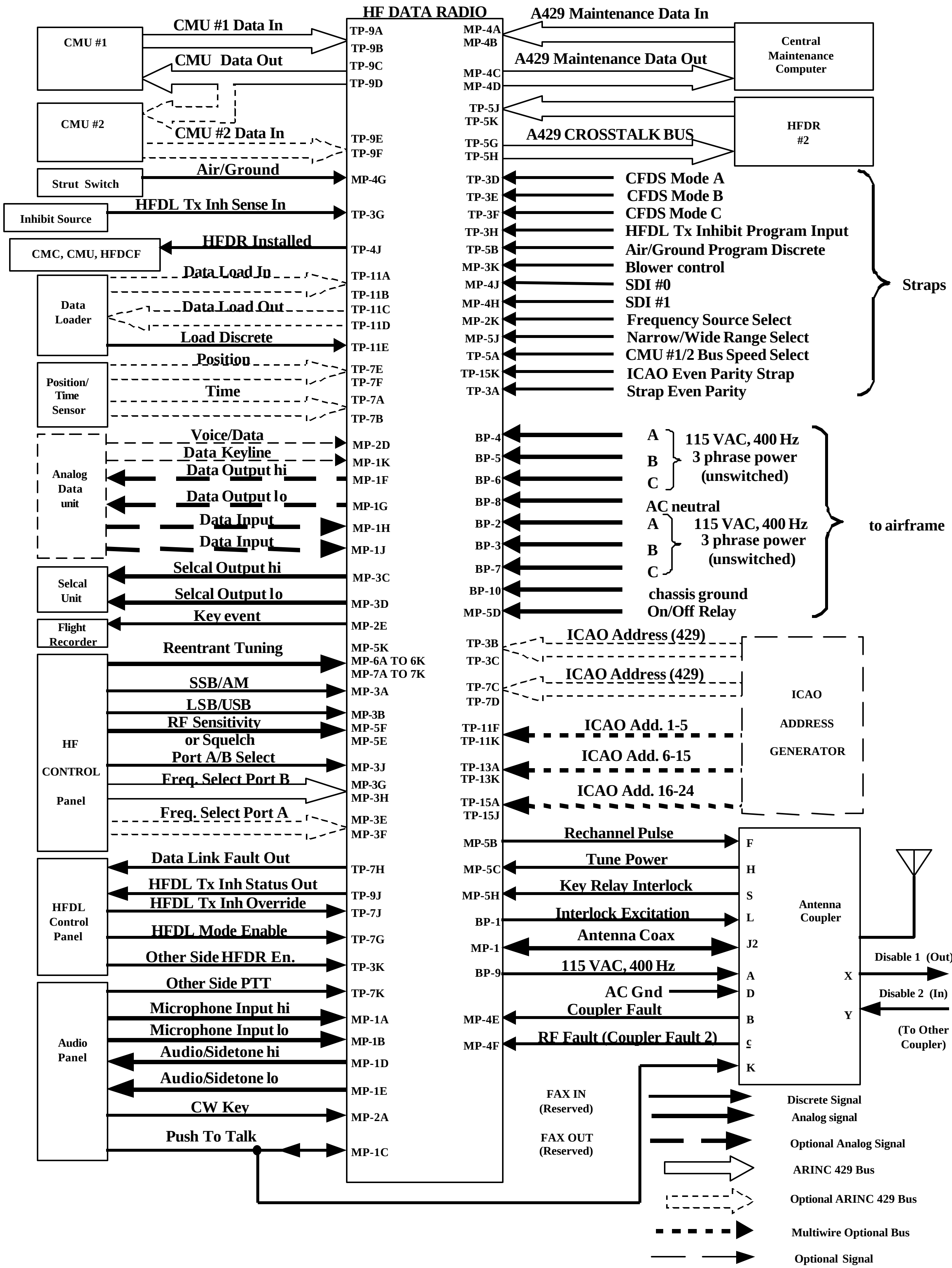
1. This figure also appears in other ARINC standards. Due to non-synchronous update of ARINC standards, differences in this figure between standards may arise. In all cases, the figure with the most recent date (see lower left hand corner) should have precedence.
2. Early air-ground links are not likely to support IDRP. IDRP is optional for air-ground links.

ATTACHMENT 2-1A
HFDR AVIONICS CONFIGURATION A



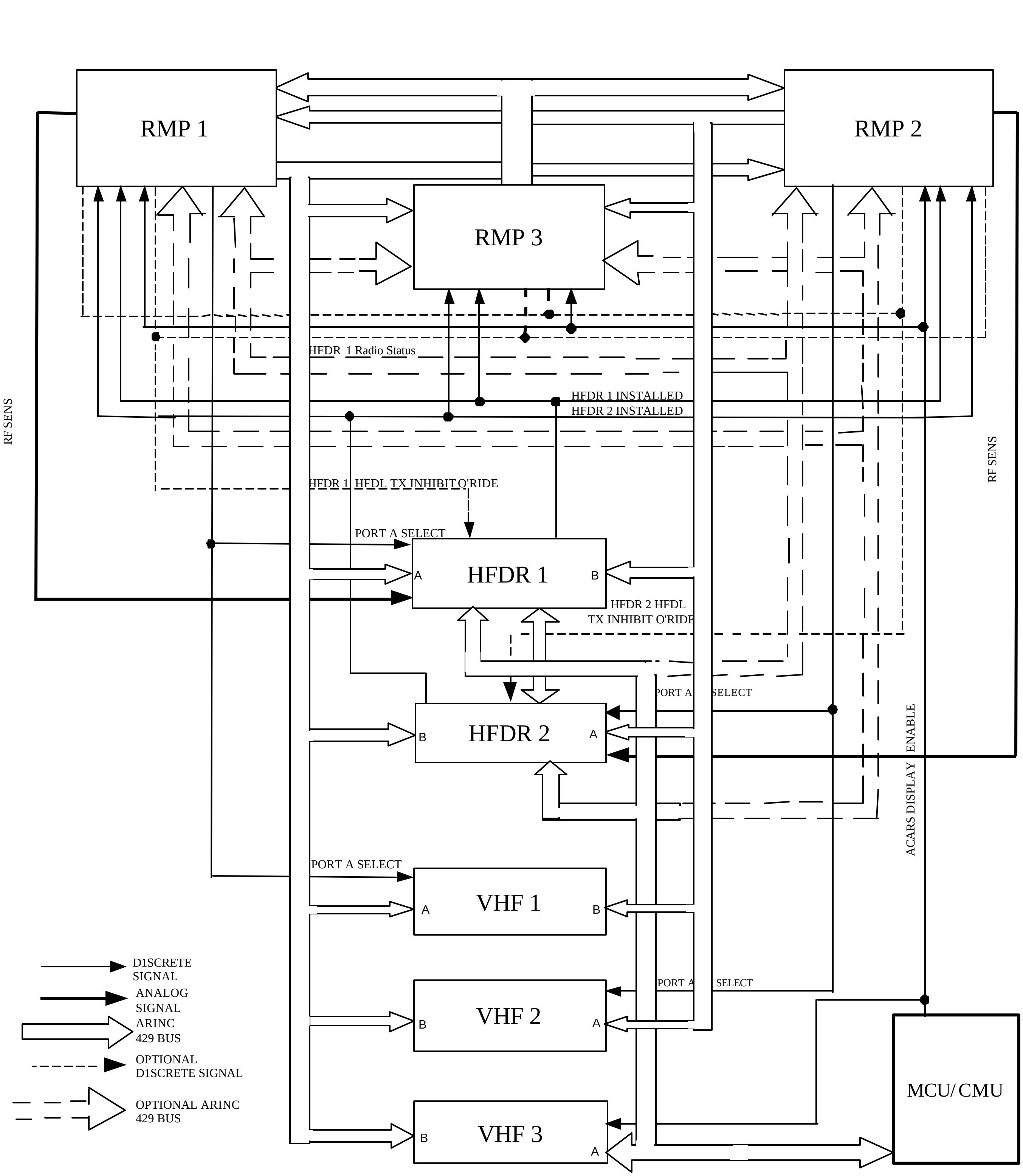
ATTACHMENT 2-1B
HFDR SYSTEM BLOCK DIAGRAM

c-1



In the event of differences between this Attachment and Attachment 2-2, HF Data Radio Standard Interwiring, the takes precedence.

ATTACHMENT 2-1C
DUAL HFDR AVIONICS CONFIGURATION A
(USING ARINC 429 VOICE/DATA CONTROL & FEEDBACK TO RMPS)

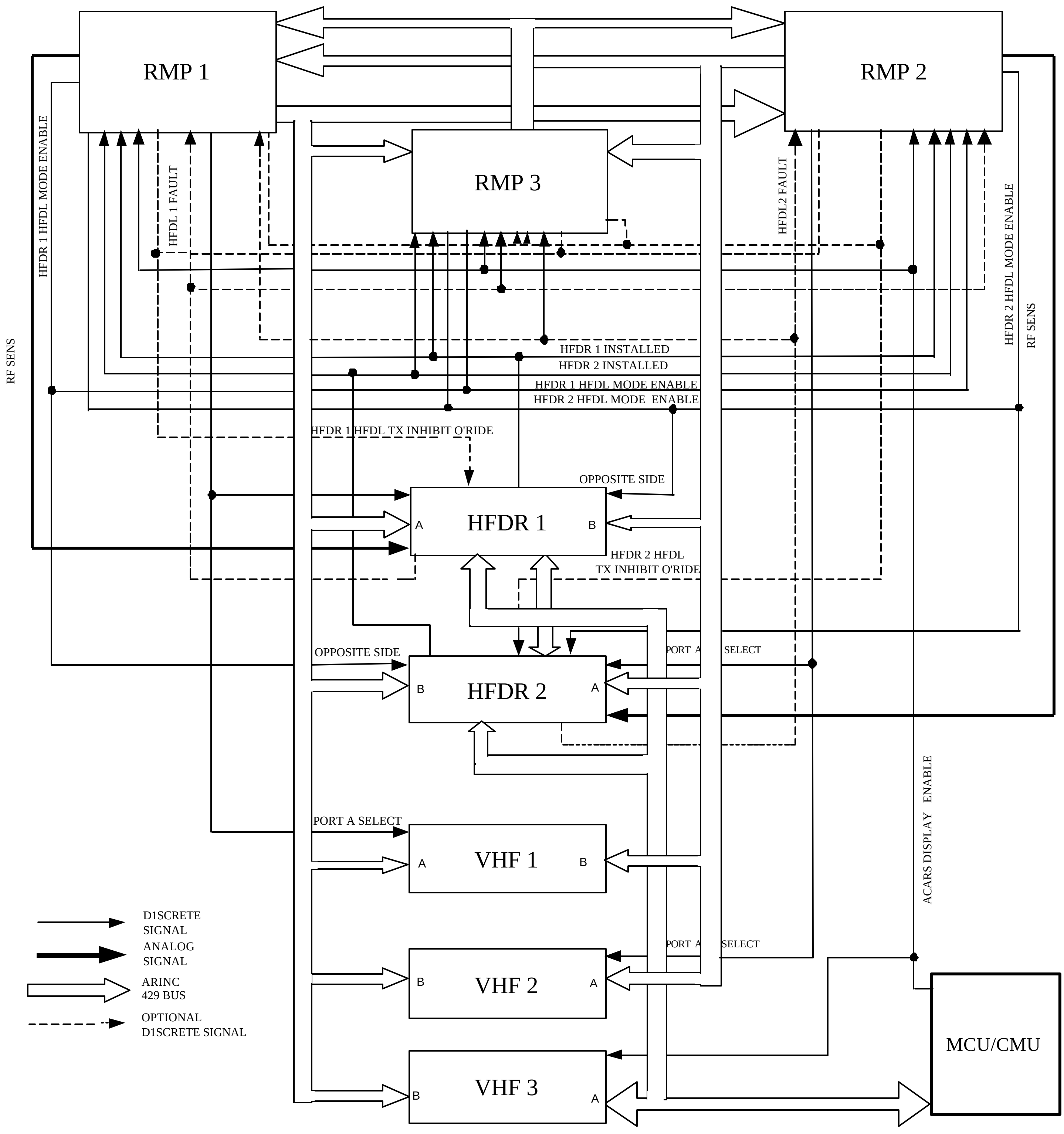


c-1

NOTE: THE HFDR1 & 2 INSTALLED discretes could as an option be strapped at the RCPs as program pins rather than a ground coming from the HFDRs in the radio equipment bay.

c-1

ATTACHMENT 2-1D
DUAL HFDR AVIONICS CONFIGURATION A
(USING DISCETE VOICE/ DATA CONTROL & FEEDBACK TO RMPS)



NOTE: THE HFDR1 & 2 INSTALLED discretes could as an an option be strapped at the RCPs as program pins rather than a ground coming from the HFDRs in the radio equipment bay.

ATTACHEMTN 2-2
HFDR STANDARD INTERWIRING

FUNCTION	Tx/Rx	CONTROL PANEL	ANTENNA [6] COUPLER	CMU/MU	OTHER	NOTES	
ATE ID	TP1A						
ATE ID	TP1B						
ATE ID	TP1C						
ATE ID	TP1D						
Mfg. Reserved	TP1E						
Mfg. Reserved	TP1F						
Mfg. Reserved	TP1G						
Mfg. Reserved	TP1H						
Mfg. Reserved	TP1J						
Mfg. Reserved	TP1K						
ATE ID	TP2A						
ATE ID	TP2B						
ATE ID	TP2C						
Mfg. Reserved	TP2D						
Mfg. Reserved	TP2E						
Mfg. Reserved	TP2F						
Mfg. Reserved	TP2G						
Mfg. Reserved	TP2H						
Mfg. Reserved	TP2J						
Mfg. Reserved	TP2K						
Strap Even Parity	TP3A						c-1
ICAO Digital ID #1 A	TP3B						
ICAO Digital ID #1 B	TP3C						
CFDS Mode A	TP3D						
CSDF Mode B	TP3E						
CSDF Mode C	TP3F						
HFDL TX Inhibit Sense Input	TP3G						
HFDL TX Inhibit Program Input	TP3H						c-1
Mfg. Reserved	TP3J						
Opposite Side Radio HFDL Mode Enable Select Input	TP3K	o			o HFDLCP #2		c-1
Mfg. Reserved	TP4A						
Mfg. Reserved	TP4B						
Mfg. Reserved	TP4C						
Mfg. Reserved	TP4D						
Mfg. Reserved	TP4E						
Mfg. Reserved	TP4F						
Mfg. Reserved	TP4G						
Mfg. Reserved	TP4H						
HFDR Installed Output	TP4J						c-1
Mfg. Reserved	TP4K						
CMU #1/2 429 Bus Speed Select	TP5A	o		o To/From CMU #1/2		26	c-1
Air/Ground Program Discrete	TP5B						
FAX Input Reserved	TP5C						
FAX Input Reserved	TP5D						
FAX Output Reserved	TP5E						
FAX Output reserved	TP5F						
HFDR Crosstalk Output	TP5G						
HFDR Crosstalk Output	TP5H						
HFDR Crosstalk Input	TP5J						
HFDR Crosstalk Input	TP5K						
Mfg. Reserved	TP6A						
Mfg. Reserved	TP6B						
Mfg. Reserved	TP6C						
Mfg. Reserved	TP6D						
Mfg. Reserved	TP6E						
Mfg. Reserved	TP6F						
Mfg. Reserved	TP6G						
Mfg. Reserved	TP6H						
Mfg. Reserved	TP6J						
Mfg. Reserved	TP6K						

ATTACHEMTN 2-2
HFDR STANDARD INTERWIRING

FUNCTION	[1]	Tx/Rx	CONTROL PANEL	ANTENNA [6] COUPLER	CMU/MU	OTHER	NOTES
Time	A	TP7A	o			o	
Input	B	TP7B	o			o To a/c	
ICAO Digital ID #2	A	TP7C	o			o Nav/Time	
Input	B	TP7D	o			o Systems	
Position	A	TP7E	o			o	
Input	B	TP7F	o			o	
HFDL Mode Enable Select Input		TP7G	o			o HFDLCP #1	
Data Link Fault Output		TP7H	o			o HFDLCP	17
HF TX Inhibit Override		TP7J	o				18
Other Side PTT		TP7K	o				19
Mfg. Reserved		TP8A					
Mfg. Reserved		TP8B					
Mfg. Reserved		TP8C					
Mfg. Reserved		TP8D					
Mfg. Reserved		TP8E					
Mfg. Reserved		TP8F					
Mfg. Reserved		TP8G					
Mfg. Reserved		TP8H					
Mfg. Reserved		TP8J					
Mfg. Reserved		TP8K					
CMU #1 Data	A	TP9A	o		o From		
Input	B	TP9B	o		o CMU #1		
CMU Data	A	TP9C	o		o To		
Output	B	TP9D	o		o CMU #1 & #2		
CMU #2 Data	A	TP9E	o		o From		
Input	B	TP9F	o		o CMU #2		
Mfg. Reserved	A	TP9G	o			o HFDLCP	
Mfg. Reserve	B	TP9H	o			o HFDLCP	
HFDL TX Inhibit Status		TP9J					17
		TP9K					
Mfg. Reserved		TP10A					
Mfg. Reserved		TP10B					
Mfg. Reserved		TP10C					
Mfg. Reserved		TP10D					
Mfg. Reserved		TP10E					
Mfg. Reserved		TP10F					
Mfg. Reserved		TP10G					
Mfg. Reserved		TP10H					
Mfg. Reserved		TP10J					
Mfg. Reserved		TP10K					
Data Loader	A	TP11A	o			o	
Input	B	TP11B	o			o	
Data Loader	A	TP11C	o			o	
Output	B	TP11D	o			o	
Data Loader Discrete Input		TP11E	o			o	
ICAO ID 1 (MSB)		TP11F	o				
ICAO ID 2		TP11G	o				
ICAO ID 3		TP11H	o				
ICAO ID 4		TP11J	o				
ICAO ID 5		TP11K	o				
Mfg. Reserved		TP12A					
Mfg. Reserved		TP12B					
Mfg. Reserved		TP12C					
Mfg. Reserved		TP12D					
Mfg. Reserved		TP12E					
Mfg. Reserved		TP12F					
Mfg. Reserved		TP12G					
Mfg. Reserved		TP12H					
Mfg. Reserved		TP12J					
Mfg. Reserved		TP12K					

ATTACHEMTN 2-2
HFDR STANDARD INTERWIRING

FUNCTION	Tx/Rx	CONTROL PANEL	ANTENNA [6] COUPLER	CMU/MU	OTHER	NOTES
ICAO ID 6	TP13A	o				
ICAO ID 7	TP13B	o				
ICAO ID 8	TP13C	o				
ICAO ID 9	TP13D	o				
ICAO ID10	TP13E	o				
ICAO ID 11	TP13F	o				
ICAO ID 12	TP13G	o				
ICAO ID 13	TP13H	o				
ICAO ID 14	TP13J	o				
ICAO ID 15	TP13K	o				
Mfg. Reserved	TP14A					
Mfg. Reserved	TP14B					
Mfg. Reserved	TP14C					
Mfg. Reserved	TP14D					
Mfg. Reserved	TP14E					
Mfg. Reserved	TP14F					
Mfg. Reserved	TP14G					
Mfg. Reserved	TP14H					
Mfg. Reserved	TP14J					
Mfg. Reserved	TP14K					
ICAO ID 16	TP15A	o				
ICAO ID 17	TP15B	o				
ICAO ID 18	TP15C	o				
ICAO ID 19	TP15D	o				
ICAO ID 20	TP15E	o				
ICAO ID 21	TP15F	o				
ICAO ID 22	TP15G	o				
ICAO ID 23	TP15H	o				
ICAO ID 24 (LSB)	TP15J	o				
ICAO Even Parity Strap	TP15K	o				c-1

ATTACHEMTN 2-2
HFDR STANDARD INTERWIRING

FUNCTION	[1]	Tx/Rx	CONTROL PANEL	ANTENNA [6] COUPLER	CMU/MU	OTHER	NOTES
Mic Input	Hi	MP1A				To Mic	
	Lo	MP1B					
PTT Hi		MP1C		K			
Audio/Sidetone Ouput	Hi	MP1D				Audio Circuits	4
	Lo	MP1E					4
Analog Data Output	Hi	MP1F				To Data Link	
	Lo	MP1G					
Analog Data Input	Hi	MP1H					
	Lo	MP1J					
Data Keyline		MP1K					
RESERVED (CW Keyline)		MP2A					12
Audio Ground		MP2B				Audio System	
Mic Input PTT	Lo	MP2C				To Mic	
Voice/Analog Data Mode Select		MP2D				Tuning System	
Key Event Output		MP2E				Flight Recorder	
Mic Input Ground		MP2F					15
Future Spares		MP2G					13
		MP2H					
Mfg. Reserved		MP2J	o				
Frequency Source Select		MP2K	o				
SSB/AM Discrete		MP3A				Mode	11
LSB/USB Discrete		MP3B				Select	11
SELCAL Output	Hi	MP3C				SELCAL Circuits	
	Lo	MP3D					
Frequency Select Port “A”	A	MP3E	o				
	B	MP3F	o				
Frequency Select Port “B”	A	MP3G					
	B	MP3H					
Frequency Port Select		MP3J					
Blower Control		MP3K	o				
CFDS Data Input		MP4A				CFDS Data	
CFDS Data Input		MP4B					
CFDS Data Ouput		MP4C					
CFDS Data Ouput		MP4D					
Coupler Fault #1		MP4E		B			
Coupler Fault #2		MP4F		C			
Air/Ground Input		MP4G				Strut Switch	
SDI Input #1		MP4H	o				
SDI Input #0		MP4J	o				
SDI/ICAO ID Common		MP4K	o				
Chopper Control		MP5A	o				
Rechannel Pulse		MP5B		F			
Tune Power		MP5C		H			8
On/Off Relay		MP5D					14
RF Squelch		MP5E					
RF Sense		MP5F					
Future Spare		MP5G					
Relay Interlock		MP5H		S		Interlock	5
Narrow/Wide Range Select		MP5J					10
RESERVED (Re-entrant Tuning)		MP5K	A				
. . .		MP6A	B				
. . .		MP6B	C				9
. . .		MP6C	D				
. . .		MP6D	E				
. . .		MP6E	F				
. . .		MP6F	G				
. . .		MP6G	H				
. . .		MP6H	J				
. . .		MP6J	K				
RESERVED (Re-entrant Tuning)		MP6K	L				

These pin assignments are used in conjunction with an ARINC 559A-type control panel employing a MS2133E20-39P connector.

ATTACHEMTN 2-2
HFDR STANDARD INTERWIRING

FUNCTION		Tx/Rx	CONTROL PANEL	ANTENNA [6] COUPLER	CMU/MU	OTHER	NOTES	
RESERVED (Re-entrant Tuning)		MP7A	o o M					
.		MP7B	o o N					
.		MP7C	o o P					
.		MP7D	o o R					
.		MP7E	o o S					
.		MP7F	o o T					
.		MP7G	o o W					
.		MP7H	o o X					
.		MP7J	o o r					
RESERVED (Re-entrant Tuning)		MP7K	o o j					
Interlock Exc.		BP1	o	o L Interlock				
Reserved (Switched Phase A)		BP2					14	c-1
Reserved (Switched Phase B)		BP3					14	c-1
115 Vac Unswitched Phase A		BP4	o o o			o 3 Phase Source		
115 Vac Unswitched Phase B		BP5	o o o			o		
115 Vac Unswitched Phase C		BP6	o o o			o		
Reserved (Switched Phase C)		BP7					14	c-1
ac Cold		BP8	o	o D o		o	3	
115 Vac Out		BP9	o	o A		o	2	
Chassis Ground		BP10	o					
+27.5 Vdc		BP11	o				7	
Spare		BP12						
Spare		BP13						
5 Vac Lighting	Hi		1 o			o Lighting		
	Lo		2 o			o		
115 Vac	Hi		3 o			o 115 Vac Source		
In	Lo		4 o			o		
RESERVED (Static Dis Play Test)			6 o				16	
RESERVED (Coupler Tune Ind.)			7 o					
RESERVED (Coupler Tune Ind. Ret.)			8 o					
Chassis Ground			15 o					

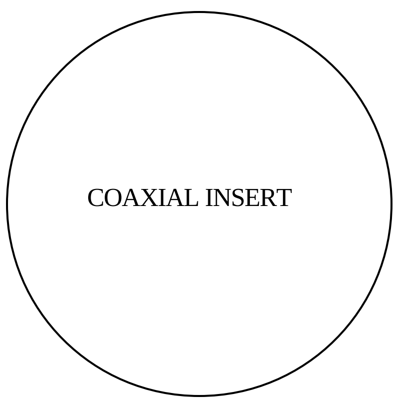
ATTACHMENT 2-3A
HFDR TOP CONNECTOR LAYOUT

		A	B	C	D	E	F	G	H	J	K
	1	ATE ID	ATE ID	ATE ID	ATE ID	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved
	2	ATE ID	ATE ID	ATE ID	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved
	3	Strap Even Parity	ICAO Digital ID #1 A	ICAO Digital ID #1 B	CFDS Mode A	CFDS Mode B	CFDS Mode C	HFDL TX Inhibit Sense Input	HFDL TX Inhibit Program Input	Mfg. Reserved	Opposite Side Radio HFDL Mode Enable Select Input
c-1	4	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	HFDR Installed Output	Mfg. Reserved
	5	CMU #1/2 429 Bus Speed Select	Air/Ground Program Discrete	FAX Input Reserved	FAX Input Reserved	FAX Output Reserved	FAX Output Reserved	HFDR Crosstalk Output	HFDR Crosstalk Output	HFDR Crosstalk Input	HFDR Crosstalk Input
	6	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved
c-1	7	Time Input A	Time Input B	ICAO Digital ID #2 A	ICAO Digital ID #2 B	Position Input A	Position Input B	HFDL Mode Enabled Input	Data Link Fault Output	HFDL TX Inhibit Override	Other Side PTT
	8	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved
c-1	9	CMU #1 Data Input A	CMU #1 Data Input B	CMU Data Output A	CMU Data Output B	CMU #2 Data Input A	CMU #2 Data Input B	Mfg. Reserved	Mfg. Reserved	HFDL TX Inhibit Status Output	
	10	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved
	11	Data Loader Input A	Data Loader Input B	Data Loader Output A	Data Loader Output B	Data Loader Discrete Input	ICAO ID (MSB) 1	ICAO ID 2	ICAO ID 3	ICAO ID 4	ICAO ID 5
	12	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved
	13	ICAO ID 6	ICAO ID 7	ICAO ID 8	ICAO ID 9	ICAO ID 10	ICAO ID 11	ICAO ID 12	ICAO ID 13	ICAO ID 14	ICAO ID 15
	14	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved	Mfg. Reserved
c-1	15	ICAO ID 16	ICAO ID 17	ICAO ID 18	ICAO ID 19	ICAO ID 20	ICAO ID 21	ICAO ID 22	ICAO ID 23	ICAO ID (LSB) 24	ICAO Even Parity Strap

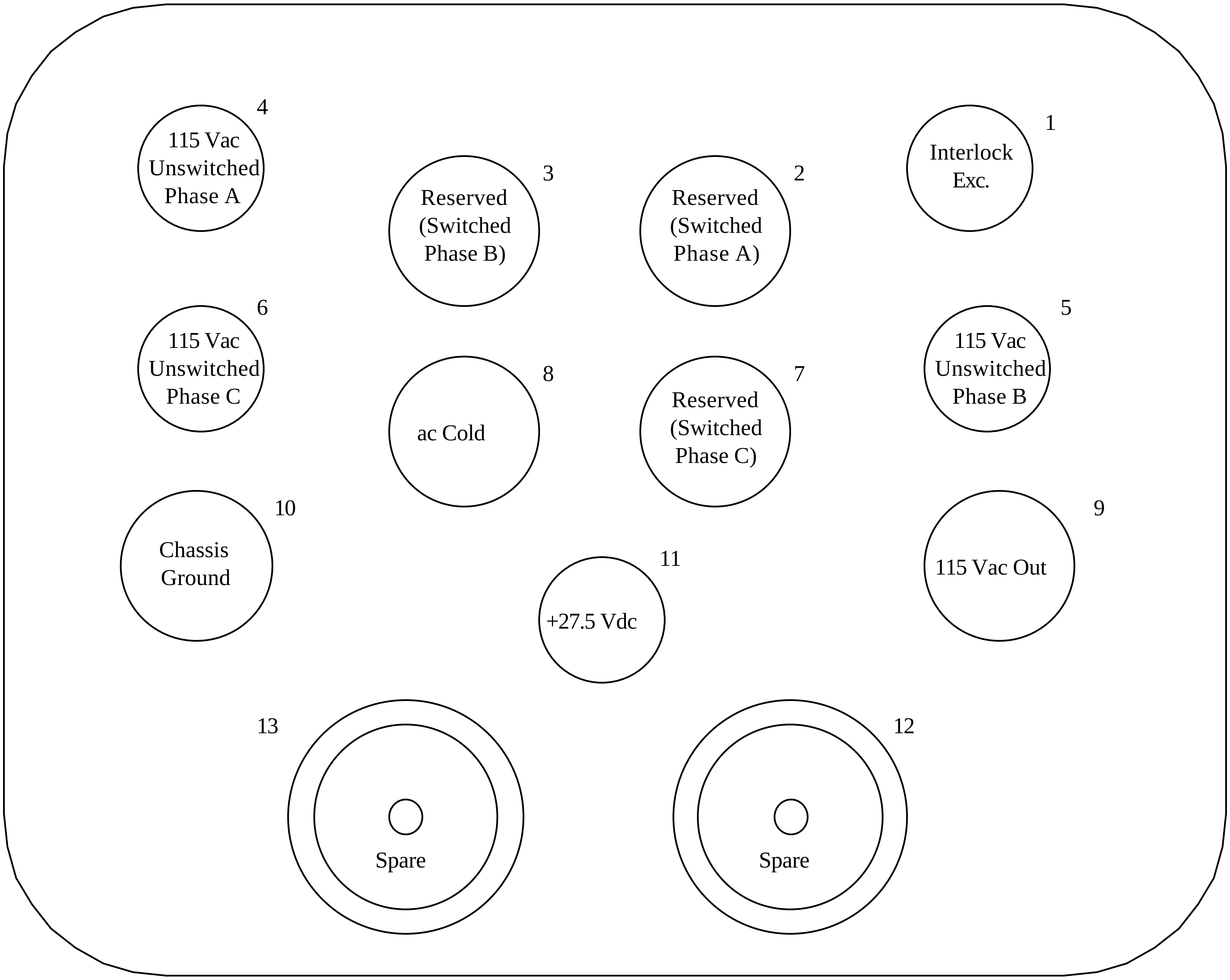
ATTACHMENT 2-3B
HFDR MIDDLE CONNECTOR LAYOUT

	A	B	C	D	E	F	G	H	J	K
1	Mic Input Hi	Lo	Mic PTT Hi	Audio/Sidetone Output Hi	Lo	Analog Data Output Hi	Lo	Analog Data Input Hi	Lo	Data Keyline
2	Reserved	Audio Ground	Mic PTT Lo	Voice/ Analog Data Mode Select	Key Event Output	Mic Input Ground	Spare	Spare	Mfg. Reserved	Freq. Source Select
3	SSB/AM Discrete Input	LSB/USB Discrete Input	SELCAL Output Hi	Lo	Freq. Select Port "A" Input A	B	Freq. Select Port "B" Input A	B	Frequency Port Select Input	Blower Control Input
4	CFDS Data Input A	CFDS Data Input B	CFDS Data Output A	CFDS Data Output B	Coupler Fault #1	Coupler Fault #2	Air/ Ground Discrete Input	SDI Input #1	SDI Input #0	SDI/ICAO ID Common
5	Chopper Control	Rechannel Pulse	Tune Power Input	On/Off Relay	RF Squelch	RF Sense	Spare	Key Relay Interlock	Narrow/ Wide Range Select	Reserved RE Tune A
6	Reserved RE Tune B	Reserved RE Tune C	Reserved RE Tune D	Reserved RE Tune E	Reserved RE Tune F	Reserved RE Tune G	Reserved RE Tune H	Reserved RE Tune J	Reserved RE Tune K	Reserved RE Tune L
7	Reserved RE Tune M	Reserved RE Tune N	Reserved RE Tune P	Reserved RE Tune R	Reserved RE Tune S	Reserved RE Tune T	Reserved RE Tune W	Reserved RE Tune X	Reserved RE Tune r	Reserved RE Tune j

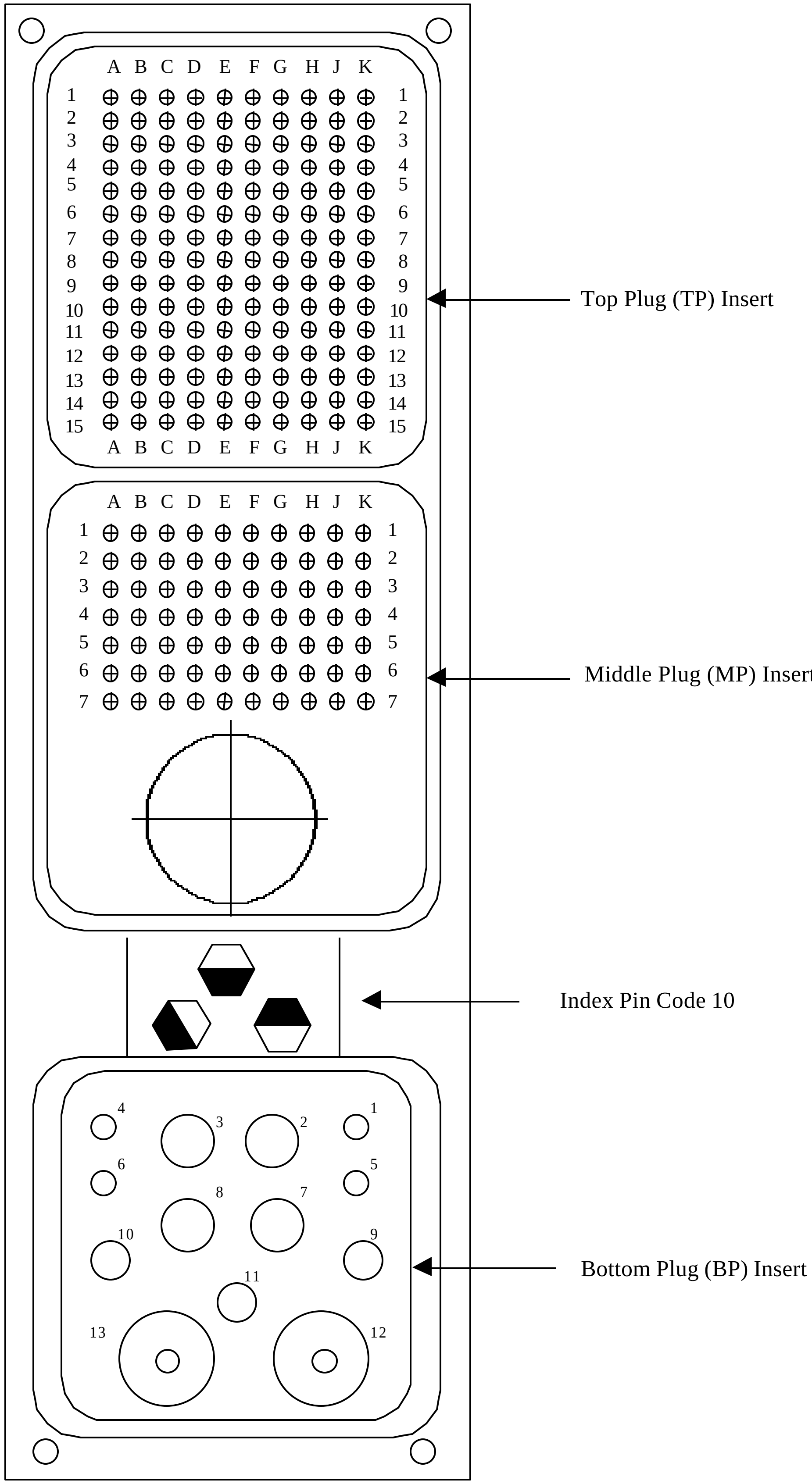
c-1



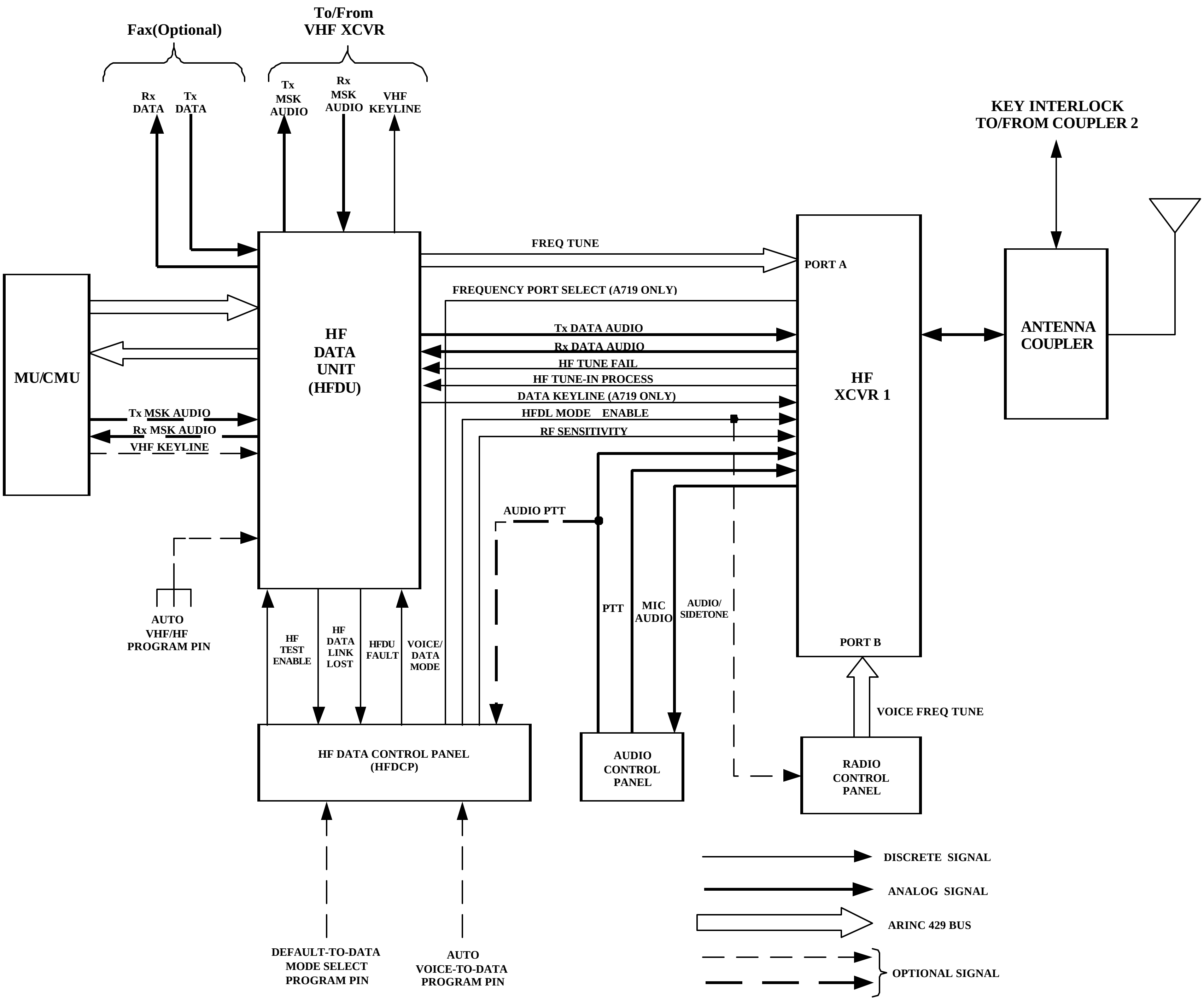
ATTACHMENT 2-3C
HFDR BOTTOM CONNECTOR LAYOUT



ATTACHMENT 2-3D
ARINC 600 SIZE 2 CONNECTOR - HFDR REAR VIEW



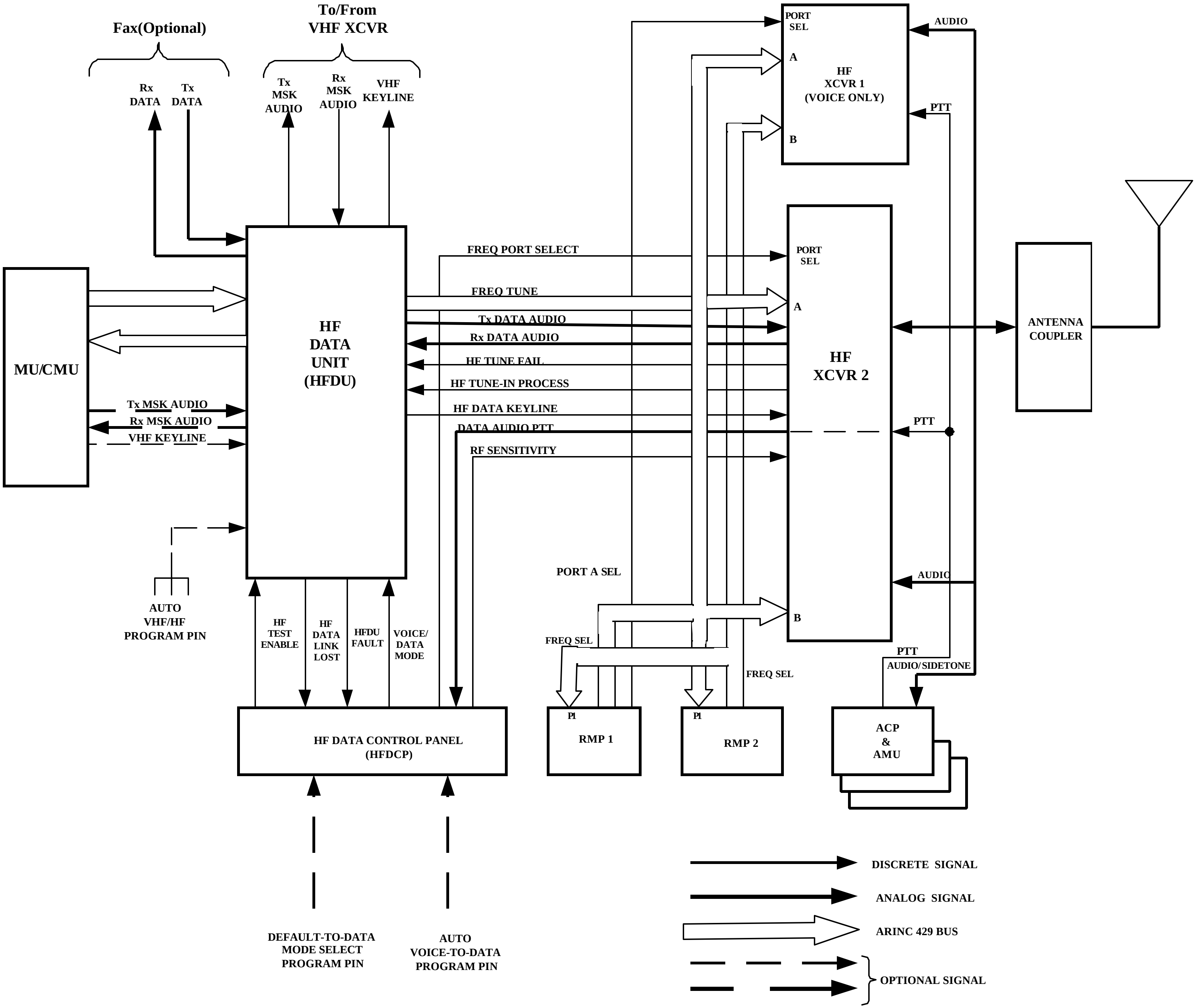
ATTACHMENT 3-1A
HFDU AVIONICS CONFIGURATION B
(USING ARINC 719 HF XCVR WITH ARINC 429 VOICE/DATA CONTROL)



ATTACHMENT 3-1B

HFDU AVIONICS CONFIGURATION B

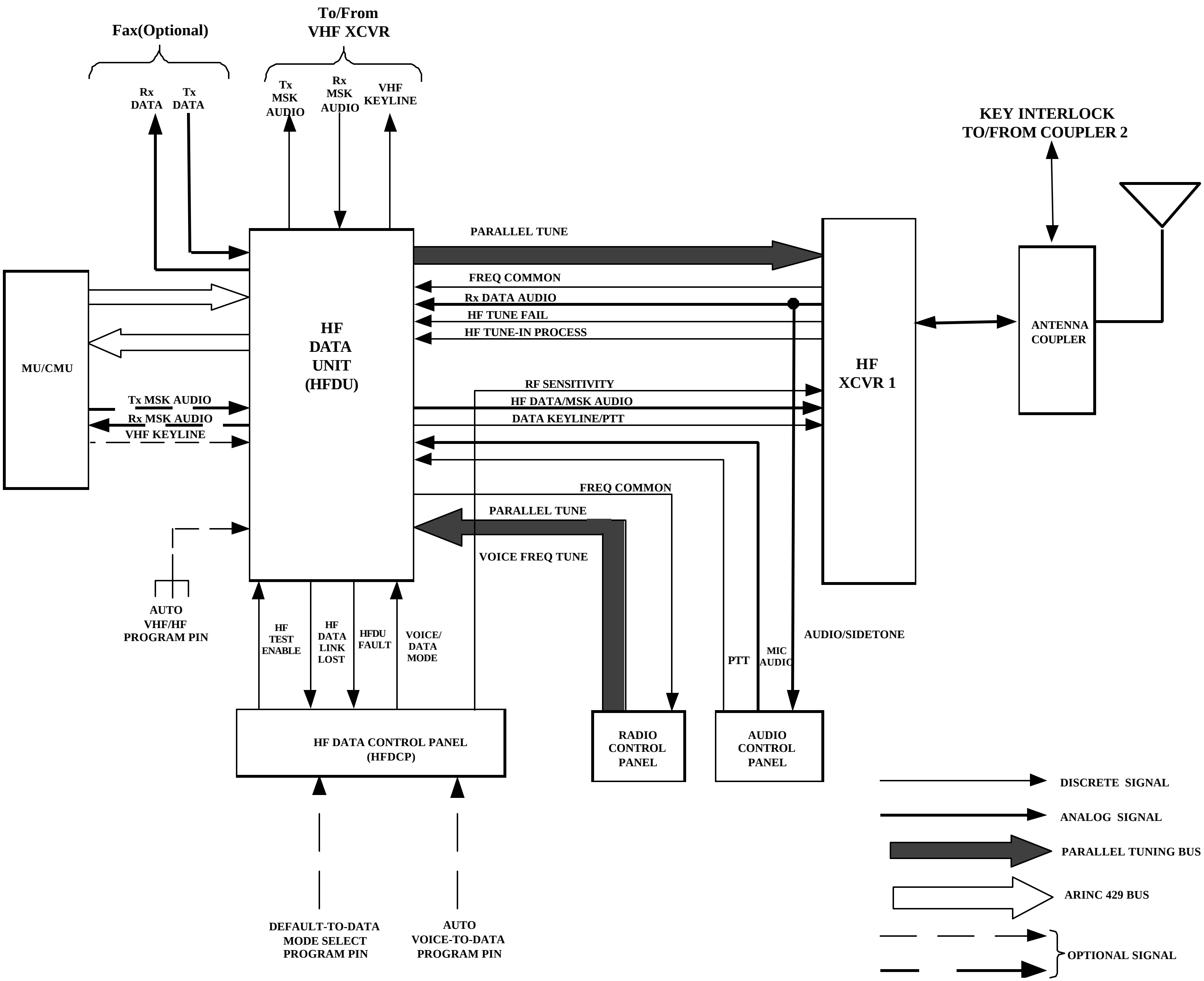
(USING ARINC 719 HF XCVR WITH ARINC 429 VOICE/DATA CONTROL)



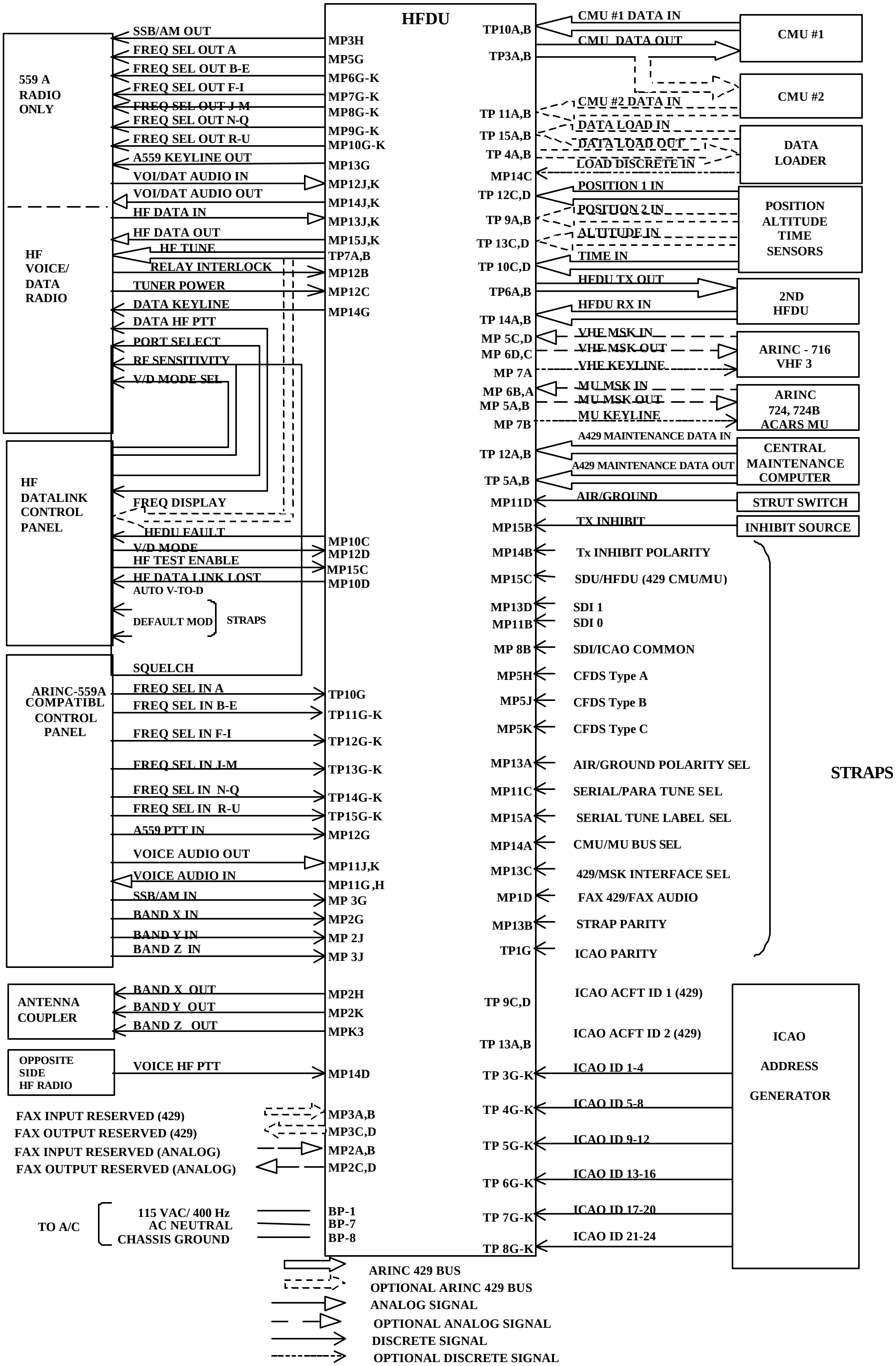
ATTACHMENT 3-1C

HFDU AVIONICS CONFIGURATION B

(USING HF XCVR ARINC 559A TYPE)



ATTACHMENT 3-1D
HFDU SYSTEM BLOCK DIAGRAM



In the event of differences between this Attachment and Attachment 3-2, HF Data Unit Standard Interwiring, the latter takes precedence.

ATTACHMENT 3-2
HFDR STANDARD INTERWIRING

FUNCTION	[1]	HFDU	ARINC 719 HF RADIO	HFDCP	CMU/MU	VHF	ARINC 559A HF RADIO	OTHER	NOTES
ATE Reserved		TP1A							
ATE Reserved		TP1B							
ATE Reserved		TP1C							
ATE Reserved		TP1D							
Mfg. Reserved		TP1E							
Mfg. Reserved		TP1F							
ICAO Parity		TP1G							23
		TP1H							
		TP1J							
		TP1K							
ATE Reserved		TP2A							
ATE Reserved		TP2B							
ATE Reserved		TP2C							
		TP2D							
Mfg. Reserved		TP2E							
Mfg. Reserved		TP2F							
		TP2G							
		TP2H							
		TP2J							
		TP2K							
CMU/MU 429 OUT	A	TP3A			TO				
CMU/MU 429 OUT	B	TP3B			CMU/MU 1&2				1, 24
		TP3C							
		TP3D							
Mfg. Reserved		TP3E							
Mfg. Reserved		TP3F							
ICAO ID 1		TP3G							
ICAO ID 2		TP3H							
ICAO ID 3		TP3J							
ICAO ID 4		TP3K							
Data Loader Out	A	TP4A						TO	
Data Loader Out	B	TP4B						ADL	1
		TP4C							
		TP4D							
ICAO ID 5		TP4E							
ICAO ID 6		TP4F							
ICAO ID 7		TP4G							
ICAO ID 8		TP4H							
		TP4J							
		TP4K							
OMS OUT	A	TP5A						TO	
OMS OUT	B	TP5B						OMS	1
		TP5C							
		TP5D							
Mfg. Reserved		TP5E							
Mfg. Reserved		TP5F							
ICAO ID 9		TP5G							
ICAO ID 10		TP5H							
ICAO ID 11		TP5J							
ICAO ID 12		TP5K							
HFDU TX OUT A		TP6A						TO 2nd	
HFDU TX OUT B		TP6B						HFDU	1
		TP6C							
		TP6D							
Mfg. Reserved		TP6E							
Mfg. Reserved		TP6F							
ICAO ID 13		TP6G							
ICAO ID 14		TP6H							
ICAO ID 15		TP6J							
ICAO ID 16		TP6K							

ATTACHMENT 3-2
HFDR STANDARD INTERWIRING

FUNCTION	[1]	HFDU	ARINC 719 HF RADIO	HFDCP	CMU/MU	VHF	ARINC 559A HF RADIO	OTHER	NOTES
HF Tune Out	A	TP7A	MP3E						1
HF Tune Out	B	TP7B	MP3F						1
		TP7C							
		TP7D							
Mfg. Reserved		TP7E							
Mfg. Reserved		TP7F							
ICAO ID 17		TP7G							
ICAO ID 18		TP7H							
ICAO ID 29		TP7J							
ICAO ID 20		TP7K							
		TP8A							
		TP8B							
		TP8C							
		TP8D							
Mfg. Reserved		TP8E							
Mfg. Reserved		TP8F							
ICAO ID 21		TP8G							
ICAO ID 22		TP8H							
ICAO ID 23		TP8J							
ICAO ID 24 (LSB)		TP8K							
Position 2 Input	B	TP9A						TO	1
Position 2 Input	A	TP9B						A/C	
ICAO ACFT ID 1	A	TP9C						From	
ICAO ACFT ID 1	B	TP9D						Mode-S	1
Mfg. Reserved		TP9E							
Mfg. Reserved		TP9F							
		TP9G							
		TP9H							
		TP9J							
		TP9K							
CMU/MU1 429 In	B	TP10A			FROM				
CMU/MU1 429 In	A	TP10B			CMU/MU 1				1, 24
Time Input	A	TP10C							
Time Input	B	TP10D							1, 9
Mfg. Reserved		TP10E							
Mfg. Reserved		TP10F							
Freq Select In A		TP10G						(A)	9
		TP10H							
		TP10J							
		TP10K							
CMU/MU2 429 In	B	TP11A			FROM				
CMU/MU2 429 In	A	TP11B			CMU/MU 2				1, 24
Mfg. Reserved		TP11C							
Mfg. Reserved		TP11D							
Mfg. Reserved		TP11E							
Mfg. Reserved		TP11F							
Freq Select In B		TP11G						(B)	9
Freq Select In C		TP11H						(C)	9
Freq Select In D		TP11J						(D)	9
Freq Select In E		TP11K						(E)	9
OMS Input	B	TP12A						FROM	1
OMS Input	A	TP12B						OMS	
Pos. 1 Input	A	TP12C							
Pos. 1 Input	B	TP12D							1
Mfg. Reserved		TP12E							
Mfg. Reserved		TP12F							
Freq Select In F		TP12G						(F)	9
Freq Select In G		TP12H						(G)	9
Freq Select In H		TP12J						(H)	9
Freq Select In I		TP12K						(J)	9

ATTACHMENT 3-2
HFDR STANDARD INTERWIRING

FUNCTION	[1]	HFDU	ARINC 719 HF RADIO	HFDCP	CMU/MU	VHF	ARINC 559A HF RADIO	OTHER	NOTES
ICCAO ID 2	B	TP13A						FROM	
ICAO ID 2	A	TP13B						MODE-S	1
ALTITUDE Input	A	TP13C							
ALTITUDE Input	B	TP13D							1
Mfg. Reserved		TP13E							
Mfg. Reserved		TP13F							
Freq Select In J		TP13G						(K)	9
Freq Select In K		TP13H						(L)	9
Freq Select In L		TP13J						(M)	9
Freq Select In M		TP13K						(N)	9
HFDU Rx Input	B	TP14A						FROM	1
HFDU Rx Input	A	TP14B						2ND HFDU	
		TP14C							
		TP14D							
Mfg. Reserved		TP14E							
Mfg. Reserved		TP14F							
Freq Select In N		TP14G						(P)	9
Freq Select In O		TP14H						(R)	9
Freq Select In P		TP14J						(S)	9
Freq Select In Q		TP14K						(T)	9
Data Loader In	B	TP15A						FROM	
Data Loader In	A	TP15B						ADL	1
Mfg. Reserved		TP15C							
Mfg. Reserved		TP15D							
Mfg. Reserved		TP15E							
Mfg. Reserved		TP15F							
Freq Select In R		TP15G						(W)	9
Freq Select In S		TP15H						(X)	9
Freq Select In T		TP15J						(r)	9
Freq Select In U		TP15K						(j)	9
		MP1A							
		MP1B							
		MP1C							
FAX 429/FAX Audio		MP1D							23
Mfg. Reserved		MP1E							
Mfg. Reserved		MP1F							
		MP1G							
		MP1H							
		MP1J							
		MP1K							
FAX Res In (Audio)		MP2A							
FAX Res In (Audio)		MP2B							
FAX Res Out (Audio)		MP2C							
FAX Res Out (Audio)		MP2D							
Mfg. Reserved		MP2E							
Mfg. Reserved		MP2F							
Band X In		MP2G						(f)	9
Band X Out		MP2H						(C)	6
Band Y In		MP2J						(g)	9
Band Y Out		MP2K						(B)	6
FAX Res In (429)		MP3A							
FAX Res In (429)		MP3B							
FAX Res Out (429)		MP3C							
FAX Res Out (429)		MP3D							
Mfg. Reserved		MP3E							
Mfg. Reserved		MP3F							
SSB/AM In		MP3G						(V)	9
SSB/AM Out		MP3H					BP - 40		
Band Z In		MP3J						(h)	9
Band Z Out		MP3K						(E)	6

ATTACHMENT 3-2
HFDR STANDARD INTERWIRING

FUNCTION	[1] HFDU	ARINC 719 HF RADIO	HFDCP	CMU/MU	VHF	ARINC 559A HF RADIO	OTHER	NOTES
	MP4A							
	MP4B							
	MP4C							
	MP4D							
Mfg. Reserved	MP4E							
Mfg. Reserved	MP4F							
	MP4G							
	MP4H							
	MP4J							
	MP4K							
MU MSK Out Hi	MP5A	o		o TP9C				1, 24
MU MSK Out Lo	MP5B	o		o TP9D				1, 24
VHF MSK In Hi	MP5C	o			o MP13A			1, 24
VHF MSK In Lo	MP5D	o			o MP13B			1, 24
Mfg. Reserved	MP5E							
Mfg. Reserved	MP5F							
Freq select Out A	MP5G	o				o BP - 18		
CFDS Type A	MP5H	o					o	23
CFDS Type B	MP5J	o					o	23
CFDS Type C	MP5K	o					o	23
MU MSK In Lo	MP6A	o		o TP9B				1, 24
MU MSK In Hi	MP6B	o		o TP9A				1, 24
VHF MSK Out Lo	MP6C	o			o MP5B			1, 24
VHF MSK Out Hi	MP6D	o			o MP5A			1, 24
Mfg. Reserved	MP6E							
Mfg. Reserved	MP6F							
Freq Select Out B	MP6G	o				o BP - 19		
Freq Select Out C	MP6H	o				o BP - 20		
Freq Select Out D	MP6J	o				o BP - 21		
Freq Select Out E	MP6K	o				o BP - 22		
VHF Keyline	MP7A	o			o MP7D			24
MU Keyline	MP7B	o		o TP5H				24
	MP7C							
	MP7D							
Mfg. Reserved	MP7E							
Mfg. Reserved	MP7F							
Freq Select Out F	MP7G	o				o BP - 23		
Freq Select Out G	MP7H	o				o BP - 24		
Freq Select Out H	MP7J	o				o BP - 25		
Freq Select Out I	MP7K	o				o BP - 26		
	MP8A							23
SDI/ICAO Common	MP8B	o					o	
	MP8C							
	MP8D							
Mfg. Reserved	MP8E							
Mfg. Reserved	MP8F							
Freq Select Out J	MP8G	o				o BP - 27		
Freq Select Out K	MP8H	o				o BP - 28		
Freq Select Out L	MP8J	o				o BP - 29		
Freq Select Out M	MP8K	o				o BP - 30		
	MP9A							
	MP9B							
	MP9C							
	MP9D							
Mfg. Reserved	MP9E							
Mfg. Reserved	MP9F							
Freq Select Out N	MP9G	o				o BP - 31		
Freq Select Out O	MP9H	o				o BP - 32		
Freq Select Out P	MP9J	o				o BP - 33		
Freq Select Out Q	MP9K	o				o BP - 34		

ATTACHMENT 3-2
HFDR STANDARD INTERWIRING

FUNCTION	HFDU [1]	ARINC 719 HF RADIO	HFDCP	CMU/MU	VHF	ARINC 559A HF RADIO	OTHER	NOTES
	MP10A							
	MP10B							
HFDU Fault	MP10C	o	o (4)					21
HF DATA LINK L LOST	MP10D	o	o (12)					21
Mfg. Reserved	MP10E							
Mfg. Reserved	MP10F							
Freq Select Out R	MP10G	o				o BP - 35		
Freq Select Out S	MP10H	o				o BP - 36		
Freq Select Out T	MP10J	o				o BP - 37		
Freq Select Out U	MP10K	o				o BP - 38		
	MP11A							
SDI 0	MP11B	o					o	23
S/P Tune Sel	MP11C	o					o	23
Air/Ground Input	MP11D	o					o STRUT SWITCH	
Mfg. Reserved	MP11E							
Mfg. Reserved	MP11F							
Voice Audio Out Hi	MP11G	o					o (X)	1,22,29
Voice Audio Out Lo	MP11H	o					o (X)	1,22,29
Voice Audio In Hi	MP11J	o					o (X)	1,22,29
Voice Audio In Lo	MP11K	o					o (X)	1,22,29
	MP12A							
Relay Interlock	MP12B	o MP5H						1
Tuner Power	MP12C	o MP5C						1
Voice/Data Mode	MP12D	o	o (18)					
Mfg. Reserved	MP12E							
Mfg. Reserved	MP12F							
A559 PTT In	MP12G	o					o (X)	22,29
	MP12H							
Voice/Data Aud In Hi	MP12J	o				o BP - 62		1
Voice/Data Aud In Lo	MP12K	o				o BP - 63		1
A/G Polarity Sel	MP13A	o					o	
Strap Parity	MP13B	o					o	
MSK/429 Interface	MP13C	o					o	
SDI 1	MP13D	o					o	
Mfg. Reserved	MP13E							
Mfg. Reserved	MP13F							
A559 Keyline Out	MP13G	o				o BP - 54		
	MP13H							
HF Data In Hi	MP13J	o MP1F						
HF Data In Lo	MP13K	o MP1G						
CMU/MU Speed Sel	MP14A	o					o	23
TX Inhibit Pol Sel	MP14B	o					o TO TX INHIBIT SWITCH	23
Data Loader Disc	MP14C	o					o TO ADL	
Voice HF PTT	MP14D	o					o 2ND HF PTT	
Mfg. Reserved	MP14E							
Mfg. Reserved	MP14F							
Data Keyline Hi	MP14G	o MP1K						
	MP14H							
Voice/Data Aud Out Hi	MP14J	o				o BP - 57		
Voice/Data Aud Out Lo	MP14K	o				o BP - 58		1
429 Tune Label	MP15A	o					o	23
TX Inhibit	MP15B	o					o	23
HF Test Enable	MP15C	o	o (1)					21
	MP15D	o					o	23
Mfg. Reserved	MP15E							
Mfg. Reserved	MP15F							
Data Keyline Lo	MP15G							
	MP15H							
HF Data Out Hi	MP15J	o MP1H						
HF Data Out Lo	MP15K	o MP1J						

ATTACHMENT 3-2
HFDR STANDARD INTERWIRING

FUNCTION	[1] HFDU	ARINC 719 HF RADIO	HFDCP	CMU/MU	VHF	ARINC 559A HF RADIO	OTHER	NOTES
115 Vac/400 Hz HI	BP1						A/C	
	BP2							
	BP3							
	BP4							
	BP5							
	BP6							
115 Vac/400 Hz Lo	BP7						A/C	
Chassis Ground	BP8						A/C	
	BP9							
	BP10							
	BP11							
	BP12							
	BP13							

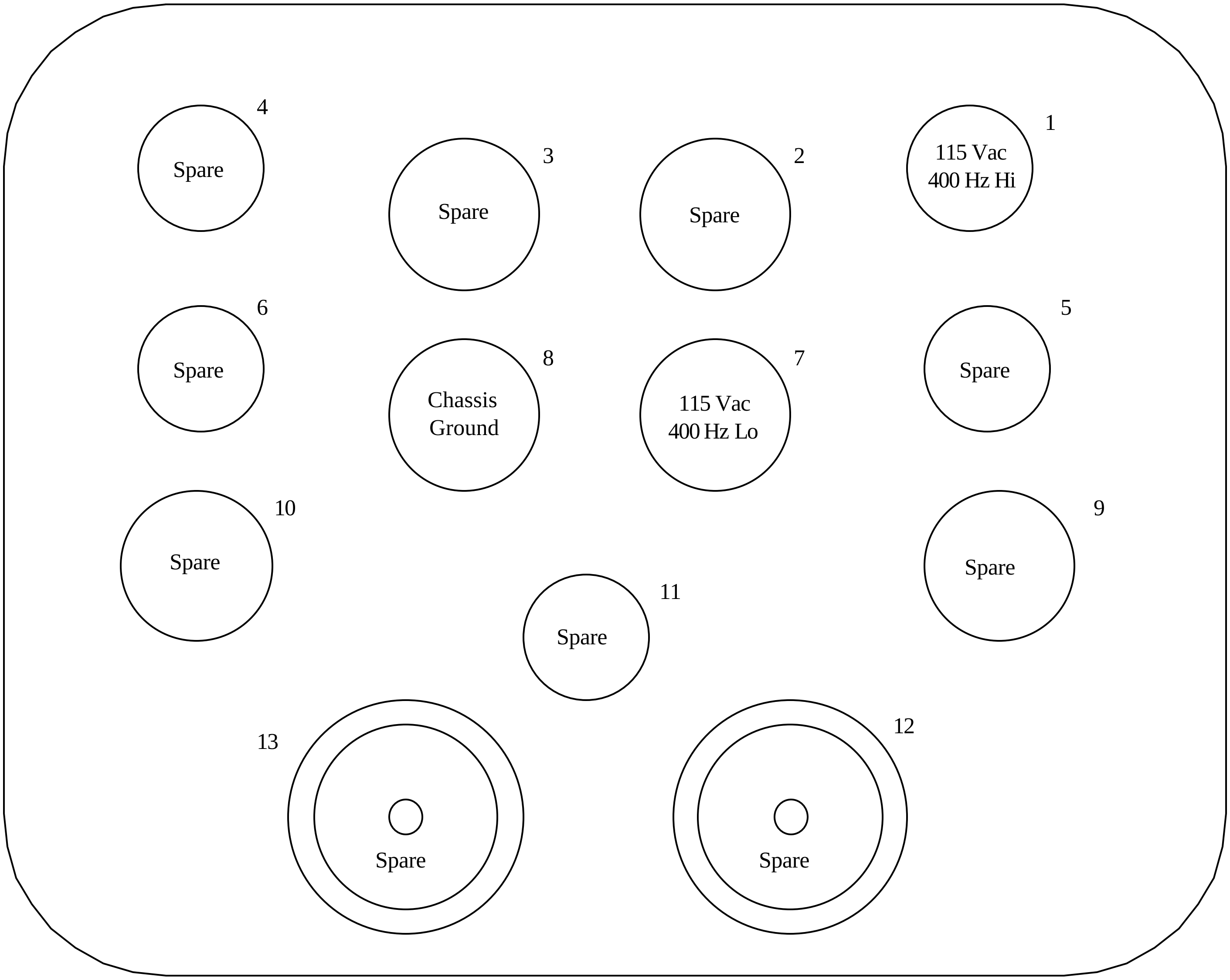
ATTACHMENT 3-3A
HFDU TOP CONNECTOR LAYOUT

	A	B	C	D	E	F	G	H	J	K
1	ATE ID	ATE ID	ATE ID	ATE ID	Mfg. Reserved	Mfg. Reserved	ICAO Parity			
2	ATE ID	ATE ID	ATE ID		Mfg. Reserved	Mfg. Reserved				
3	CMU/MU 429 Output A	CMU/MU 429 Output B			Mfg. Reserved	Mfg. Reserved	ICAO ID 1 (MSB)	ICAO ID 2	ICAO ID 3	ICAO ID 4
4	Data Loader Output A	Data Loader Output B			Mfg. Reserved	Mfg. Reserved	ICAO ID 5	ICAO ID 6	ICAO ID 7	ICAO ID 8
5	OMS Output A	OMS Output B			Mfg. Reserved	Mfg. Reserved	ICAO ID 9	ICAO ID 10	ICAO ID 11	ICAO ID 12
6	HFDU TX Output A	HFDU TX Output B			Mfg. Reserved	Mfg. Reserved	ICAO ID 13	ICAO ID 14	ICAO ID 15	ICAO ID 16
7	HF Tune Output A	HF Tune Output B			Mfg. Reserved	Mfg. Reserved	ICAO ID 17	ICAO ID 18	ICAO ID 19	ICAO ID 20
8					Mfg. Reserved	Mfg. Reserved	ICAO ID 21	ICAO ID 22	ICAO ID 23	ICAO ID 24 (LSB)
9	Position 2 Input B	Position 2 Input A	ICAO 1 Input A	ICAO 1 Input B	Mfg. Reserved	Mfg. Reserved				
10	CMU/MU1 429 Input B	CMU/MU1 429 Input A	Time Input A	Time Input B	Mfg. Reserved	Mfg. Reserved	Freq. Select Input A			
11	CMU/MU2 429 Input B	CMU/MU2 429 Input A			Mfg. Reserved	Mfg. Reserved	Freq. Select Input B	Freq. Select Input C	Freq. Select Input D	Freq. Select Input E
12	OMS Input B	OMS Input A	Position 1 Input A	Position 1 Input B	Mfg. Reserved	Mfg. Reserved	Freq. Select Input F	Freq. Select Input G	Freq. Select Input H	Freq. Select Input I
13	ICAO 2 Input B	ICAO 2 Input A	Altitude Input A	Altitude Input B	Mfg. Reserved	Mfg. Reserved	Freq. Select Input J	Freq. Select Input K	Freq. Select Input L	Freq. Select Input M
14	HFDU RX Input B	HFDU RX Input A			Mfg. Reserved	Mfg. Reserved	Freq. Select Input N	Freq. Select Input O	Freq. Select Input P	Freq. Select Input Q
15	Data Loader Input B	Data Loader Input A			Mfg. Reserved	Mfg. Reserved	Freq. Select Input R	Freq. Select Input S	Freq. Select Input T	Freq. Select Input U

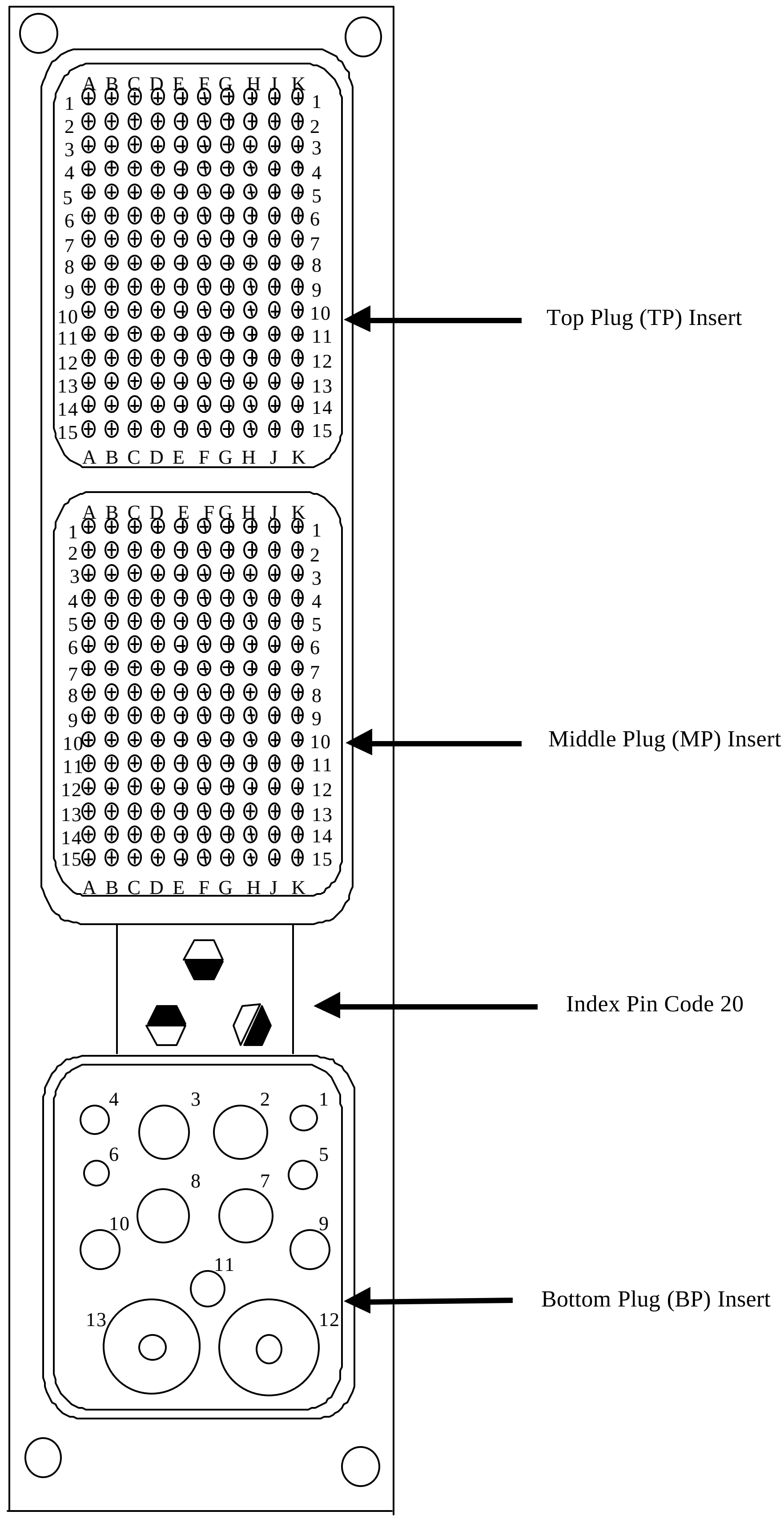
ATTACHMENT 3-3B
HFDU MIDDLE CONNECTOR LAYOUT

	A	B	C	D	E	F	G	H	J	K
1				FAX 429/Audio	Mfg. Reserved	Mfg. Reserved				
2	FAX Res. Input Audio	FAX Res. Input Audio	FAX Res. Output Audio	FAX Res. Output Audio	Mfg. Reserved	Mfg. Reserved	SSB/AM Input	SSB/AM Output	Band X Input	Band X Output
3	FAX Res. Input 429	FAX Res. Input 429	FAX Res. Output 429	FAX Res. Output 429	Mfg. Reserved	Mfg. Reserved	Band Y Input	Band Y Output	Band Z Input	Band Z Output
4					Mfg. Reserved	Mfg. Reserved				
5	MU MSK Output Hi	MU MSK Output Lo	VHF MSK Input Hi	VHF MSK Input Lo	Mfg. Reserved	Mfg. Reserved	Freq. Select Output A	CFDS Type A	CFDS Type B	CFDS Type C
6	MU MSK Input Lo	MU MSK Input Hi	VHF MSK Output Lo	VHF MSK Output Hi	Mfg. Reserved	Mfg. Reserved	Freq. Select Output B	Freq. Select Output C	Freq. Select Output D	Freq. Select Output E
7	VHF Keyline	MU Keyline			Mfg. Reserved	Mfg. Reserved	Freq. Select Output F	Freq. Select Output G	Freq. Select Output H	Freq. Select Output I
8		SDI/ ICAO Common			Mfg. Reserved	Mfg. Reserved	Freq. Select Output J	Freq. Select Output K	Freq. Select Output L	Freq. Select Output M
9					Mfg. Reserved	Mfg. Reserved	Freq. Select Output N	Freq. Select Output O	Freq. Select Output P	Freq. Select Output Q
10			HFDU Fault	HF DATA LINK LOST	Mfg. Reserved	Mfg. Reserved	Freq. Select Output R	Freq. Select Output S	Freq. Select Output T	Freq. Select Output U
11		SDI 0	S/P Tune Select	Air/ Ground Input	Mfg. Reserved	Mfg. Reserved	Voice Audio Output Hi	Voice Audio Output Lo	Voice Audio Input Hi	Voice Audio Input Lo
12		Relay Interlock	Tuner Power	Voice/ Data Mode	Mfg. Reserved	Mfg. Reserved	A559 PTT Input		Voice/ Data Input Hi	Voice/ Data Input Lo
13	A/G Polarity Select	Strap Polarity	MSK/MU Interface	SDI 1	Mfg. Reserved	Mfg. Reserved	A559 Keyline Output		HF Data Input Hi	HF Data Input Lo
14	CMU/MU Speed Select	TX Inhibit Pol Select	Data Loader Discrete	Voice HF PTT	Mfg. Reserved	Mfg. Reserved	Data Keyline Hi		Voice/ Data Output Hi	Voice/ Data Output Lo
15	429 Tune Label Select	TX Inhibit	HF Test Enable		Mfg. Reserved	Mfg. Reserved	Data Keyline Lo		HF Data Output Hi	HF Data Output Lo

ATTACHMENT 3-3C
HFDU BOTTOM CONNECTOR LAYOUT



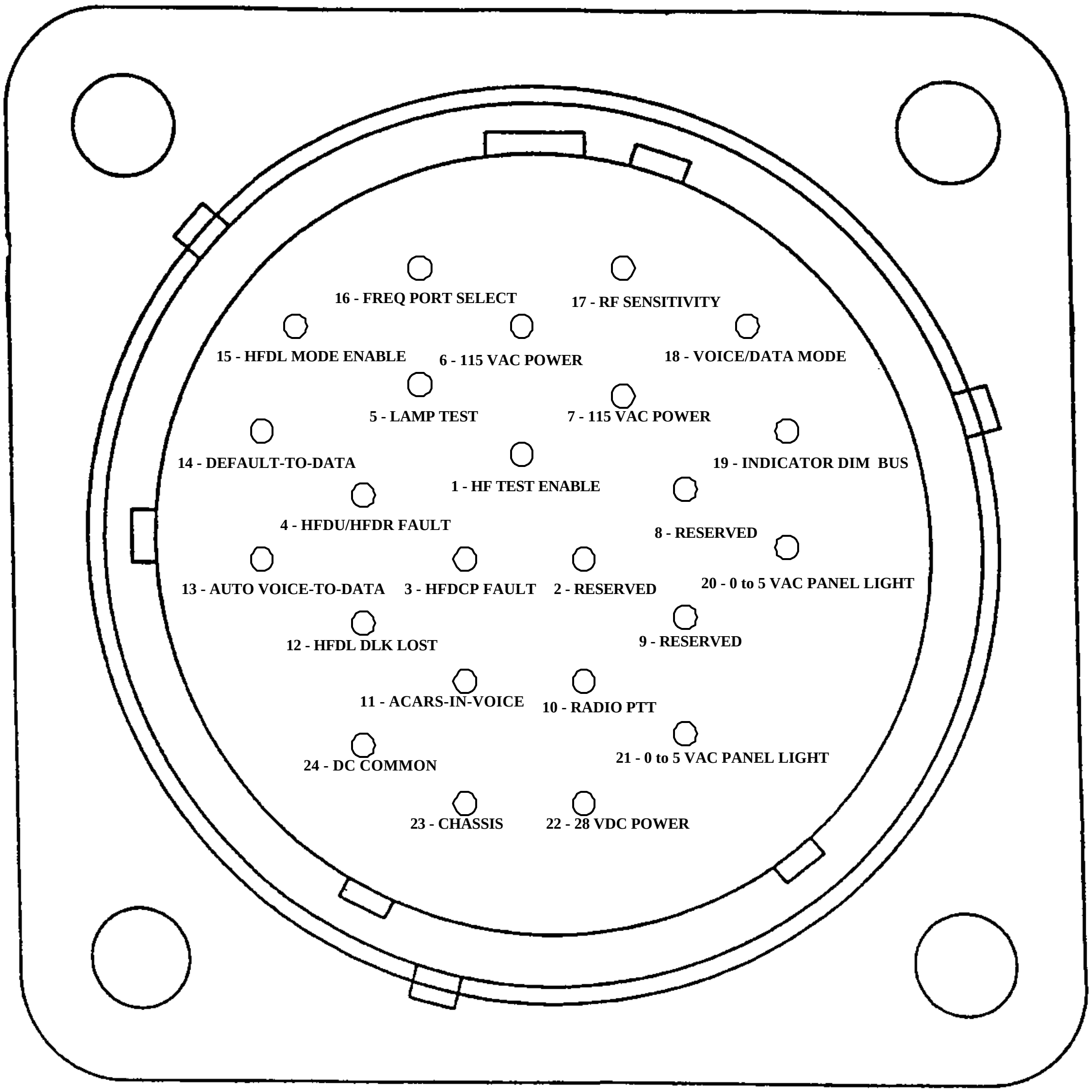
ATTACHMENT 3-3D
ARINC 600 SIZE 2 CONNECTOR – HFDU REAR VIEW



ATTACHMENT 4-1A
HF DATA CONTROL PANEL STANDARD INTERWIRING

	FUNCTION	HFDCP	[21]	HFDU	ARINC 719 HF RADIO	HFDR	CMU/MU	VHF	ARINC 559A HF RADIO	OTHER	NOTES
	HF Test Enable Out	1	o	o MP15C							
	Mfg. Reserved	2									
	HFDCP Fault Out	3	o							o A/C	
	HFDU/HFDR Fault In	4	o	o MP10C		o TP7H					
	Ext Lamp Test In	5	o							o A/C	
	115 Vac Panel Power Hi	6	o							o A/C	
	115 Vac Panel Power Lo	7	o							o A/C	
	Mfg. Reserved	8									
	Mfg. Reserved	9									
	Voice/Data Radio PTT In	10	o		o MP1C	o MP1C					OPT
	ACARS-In-Voice In	11	o				o TP5K				24
	HFDL DATA LINK LOST In	12	o	o MP10D		o TP9J					
c-1	Auto Voice-To-Data In	13									23
	Default-To-Data-Mode Select In	14									23
c-1	HFDL Mode Enable Out	15	o		o MP2D	o TP7G					
	Freq. Port Select Out	16	o		o MP3J						
	RF Sensitivity Out	17	o		o MP5F	o MP5F			o BP-42		25
c-1	Voice/Data Mode Out	18	o	o MP12D							
	26.5/12 Vdc Indicator Dim Bus Hi	19	o							o A/C Ind Bus	
	0-5 Vac Panel Light Power Hi	20	o							o A/C Ltg Bus	
	0-5 Vac Panel Light Power Lo	21	o							o A/C Ltg Bus	
	28 Vdc Panel Power	22	o							o OPT A/C	
	Chassis Ground	23	o							o A/C	
	dc Common	24	o								

ATTACHMENT 4-1B
HF DATA CONTROL PANEL CONNECTOR LAYOUT



c-1

The HF Data Control Panel should use a MIL-C-26500 type connector for the control and power interconnections identified by Part number M83723-72R16247 or equivalent. The HF Data Control panel connector should mate with a cable connector Identified by part number M83723-75R16247 or equivalent.

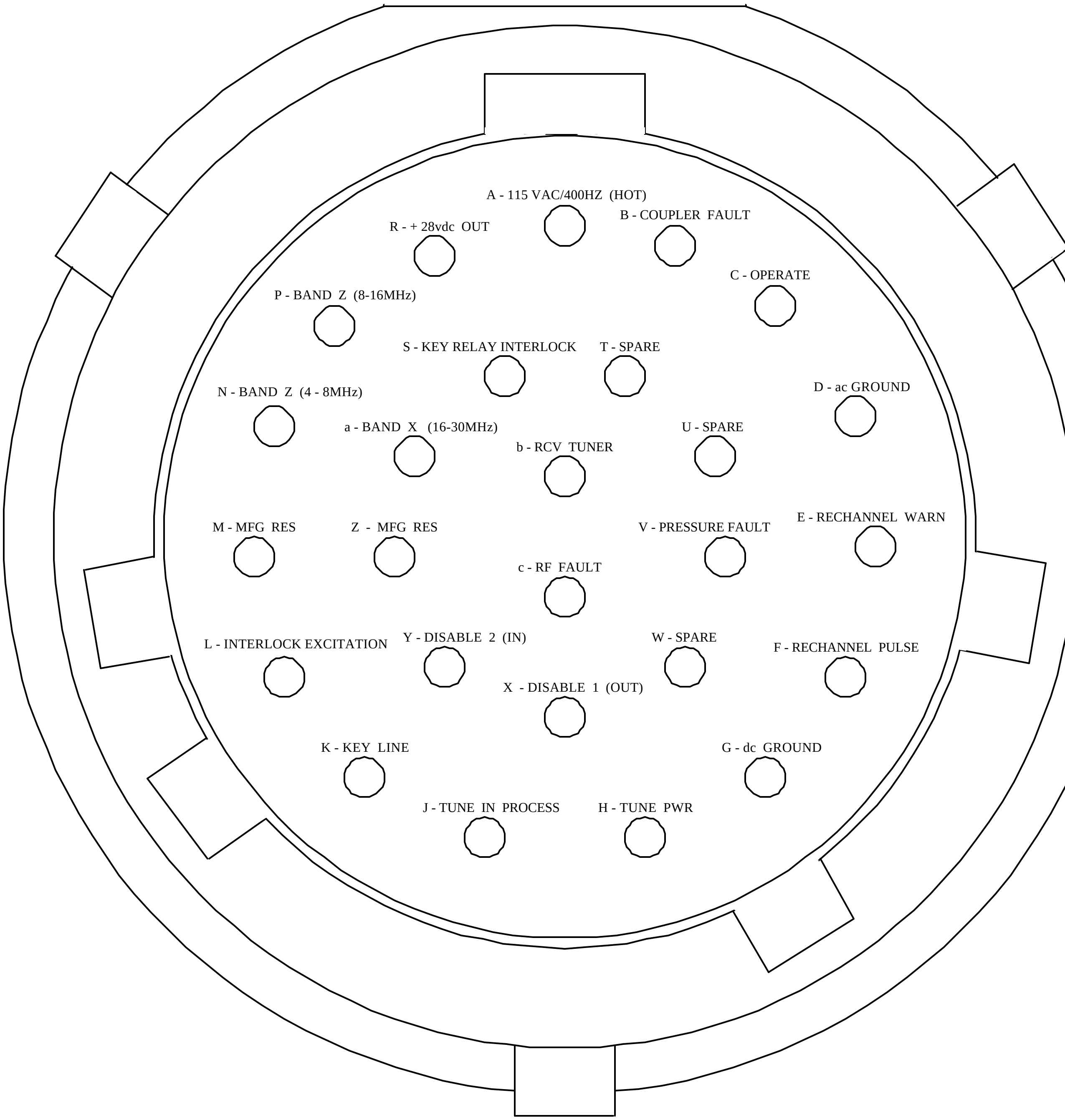
COMMENTARY

Connectors for the aircraft wiring should mate with those specified and meet or exceed the airframe requirements.

ATTACHMENT 4-2A
COUPLER STANDARD INTERWIRING

FUNCTION	COUPLER J1	OTHER
115 Vac/400 Hz (HOT)	A	BP - 9
Coupler Fault	B	MP - 4E
Operate	C	
ac Ground	D	Airframe
Rechannel Warn	E	
Rechannel Pulse	F	MP - 5B
dc Ground	G	Airframe
Tune PWR	H	MP - 5C
Tune In Process	J	
Key Line	K	MP - 1C
Interlock Excitation	L	BP - 1
Manufacturer Reserved	M	N/C
Band Z (4-8 MHz)	N	N/C
Band Y (8-16 MHz)	P	N/C
+28 Vdc Out	R	
Key Relay Interlock	S	MP - 5H
c-1 Spare	T	N/C
Spare	U	N/C
Pressure Fault	V	
Spare	W	N/C
Disable 1 (Out)	X	Disable 2 Other Coupler
Disable 2 (In)	Y	Disable 1 Other Coupler
Spare	Z	N/C
Band X (16-30 MHz)	a	N/C
RCV Tuner	b	
RF Fault	c	MP - 4H

ATTACHMENT 4-2B
COUPLER CONNECTOR LAYOUT



c-1

The Antenna Coupler should use a MIL-C-26482 type connector for the control and power interconnections identified by part number MS3449H-16-PN or equivalent. The Antenna Coupler connector should mate with a MIL-C-26482 type cable connector identified by part number MS3116E-16-26S or equivalent.

COMMENTARY

Connectors for the aircraft wiring should mate with those specified and meet or exceed the airframe requirements.

ATTACHMENT 5
NOTES APLLICABLE TO STANDARD INTERWIRING

[1] Wire Types should be sheilded, twisted, or twisted and shielded as indicated where protection from electromagnetic interference (EMI) is deemed appropriate. All shielded wires should have an insulating jacket over the shield to prevent intermittent grounds. All shields for analog circuits should be grounded at one end only and to the same ground stud. Shields for digital circuits should be grounded at every break point.

[2] The "115 Vac out" power circuits from the SSB R/T Unit provided on pin BP9, may be employed for the various functions within the antenna tuner. However, the maximum drain from the R/T Unit is not expected to exceed the values set forth in Attachment 2-1.

[3] A three-phase, 5 ampere, ganged circuit breaker should be provided in the standard HFDR installation. Equipment designers should, however, observe the guidance set forth concerning primary power failures in any one of the three phases that may not be protected by the circuit breaker.

[4] Inasmuch as audio and sidetone outputs from the receiver are fairly low impedance, the mixing circuit for the audio and sidetone should take into consideration any possible interaction due to squelch operation and audio volume control adjustment.

As pointed out in Note 5 below, any external relays required for sidetone or muting operation should be connected as explained in Note 5.

c-1

[5] The Attachment 2 interwiring does not show connections of the interlock with any other HF equipment in the aircraft. The keying relay in the R/T Unit cannot operate unless the Relay Interlock lead MP5H is energized external to the R/T Unit with 27 Vdc. With most antenna couplers, the 27 Vdc signal for the Relay Interlock lead is provided through functional lead (S). The coupler either supplies its own 27 Vdc to this lead through appropriate control circuitry, or it may employ function lead (L) to obtain 27 Vdc from the R/T at pin BP1.

When the antenna coupler does not provide such an interlock signal, the user should run a jumper (in the wiring harness) between pins BP1 and MP5H on the R/T Unit to energize the Relay Interlock lead. Such a jumper must not be used with a coupler that does provide the interlock signal. Doing so may allow the R/T to transmit into the coupler while the coupler is in the receive configuration or while it is switching from receive to transmit, and this will damage the coupler.

When external relays are employed to provide special interlock functions or to supply sidetone or audio muting in accordance with Note 4, all such relays in a particular installation should be designed to operate on a total current drain of less than 0.25 amperes at 27 Vdc and the coils of all such relays should be paralleled with the keyline lead MP1C and the Relay Interlock lead MP5H, noting the special case of couplers explained in Note 8 which draw a current pulse. c-1

[6] The numbers in parentheses under the column "Antenna Tuner" are not specific pin connections on any specific connector but are symbolic connections which are interpreted in terms of specific antenna tuners. <u>No attempt is made in the interwiring of Attachment 2 to show other circuitry and wiring to the antenna tuners other than the standardized interconnections with the SSB System which are apecifically shown for symbolic connections (A) through (P).</u> The installer should refer to the antenna tuner manufacturer's manuals and instructions for further information on the various applications of the specific antenna tuners.

Regarding the connection to the symbolic pin (M) on the Antenna Tuner, since none of the Antenna Tuners referenced in Attachment 5 to ARINC Characteristic 719 need 250 Vdc, no pin is assigned for this function on ARINC Characteristic 753 equipment.

[7] The 27 Vdc output on pin BP11 should supply an impulse relay in some antenna tuners. The average current drawn by the antenna tuner should not exceed ½ampere. However, the peak current may be as high as 8 amperes for a maximum duration of 20 milliseconds. The aircraft interwiring should take this peak load condition into consideration.

[8] The tune power provision is deemed necessary on this equipment. Pin MP5C on the R/T Unit should be connected to the functional lead A on the antenna coupler. A ground on this line while the antenna coupler is tuning should reduce the RF output power of the R/T Unit, operate the AM relay, and activate the tune tone circuit to supply a tuning tone to the aircraft audio system.

[9] Pin assignements are for ARINC 559A-compatible control panels. Details on pin functions for the optional re-entrant tuning system may be found in ARINC Characteristic 559A.

[10] Some certifying authorities may require that the transmitter be disabled and a warning tone generated in the audio system whenever the receiver is tuned to a radio frequency on which the transmitter is unable to transmit because of

ATTACHMENT 5
NOTES APPLICABLE TO STANDARD INTERWIRING

c-1

c-1 limtations to the aircraft tuning unit. Pin MP5J is reserved for selection of either a narrow (2.8 to 23.9999 MHz) range or a wide (2.0 to 29.9999 MHz) range of operation. An "open" pin selects the narrow range and a grounded pin selects the wide range. If the narrow range is selected and an attempt is made to operate the transceiver outside the 2.8 to 23.9999 MHz range, a warning tone is produced in the audio output and the transmitter is disabled.

c-1 [11] An "open" on pin MP3A selectes SSB operation and a "ground" selects AM operation. An "open" on pin MP3B selects USB operation and a "ground" selects LSB operation.

[12] Some specialized radios use pin MP2A as a CW keyline. However, none of these radios are expected to be used by airlines. Pin MP2A has been reserved to promote interchangeability.

[13] Future Spare (Contact) Contact positions in equipment-mounted service connectors labelled "Future Spare (Contact)" should be furnished with the contact hardware (pin or socket as appropriate) and provisions made within the equipment for their use. Contact positions labelled "Future Spare" may or may not be furnished with connector hardware at the equipment manufacturer's discretion. Contact hardware need not be provided in either type of connector position in aircraft-mounted rack connectors. The "Future Spare (Contact)" positions will be the first to be used if and when additional contact assignments are needed.

[14] When the three-phase power is supplied through these pins, the "state" of power control relay is controlled by pin MP5D. A "ground" on pin MP5D should turn the radio "on". An "open" on pin MP5D should turn the radio "off".

[15] Pin MP2F is connected internally to pin MP1B. Pin MP2F can be jumpered to pin MP2B to obtain internal grounding or it may be connected to an external ground.

[16] For control panels utilizing liquid crystal displays, a "ground" on pin 6 indicates a test of static displays.

[17] "Open" = 1 = True condition. "Short" = 0 = False condition.

[18] Reserved

c-1 [19] Connect to the appropriate HF system; e.g., if HF #2 is used for Data, then connect TP7K of HF #2 to MP1C (HF #1 PTT) or vice versa if HF #1 is used for Data. Maximum current draw should be less than 80 ma.

[20] Reserved

[21] A High Frequency DataLink Control Panel (HFDCP) or equivalent to be installed in a cockpit to provide the crew with the means to control HF Datalink operation.

[22] These wires should be connected to the Junction Box for ARINC 559A radio.

[23] Programming pins for HFDU anf HFDCP.

[24] MSK connections to MU and VHF radio should be used when the MU does not have provisions to communicate with the HFDU via 429 ports.

[25] This line should be connected to BP-41 of ARINC 559A radio if "Squelch" instead of "RF Sensitivity" is used on the Control Panel.

[26] ARINC 429 bus speed select discrete input. "Open" = 1 = Low speed. "Short" = 0 = High speed.

[27] ARINC 429 Low speed data bus.

[28] ARINC 429 High speed data bus.

[29] In an HF Datalink installation these connection between the Audio Control Panel and the ARINC 559A HF radio should be disconnected and connected instead to the HFDU.

ATTACHMENT 6
ENVIRONMENTAL TEST CATEGORIES PER DO-160C

The ARINC 753 HF Data Radio and HF Data Unit should meet as a minimum the RTCA/DO-160C categories shown in the table below. The categories are dependent on location in the airplane. The possible equipment locations are, E/E Rack (Transceiver), Flight Deck (Control Panels), and Fuselage (Antenna Coupler).

RTCA/ DO-160C Section	Environment	Rack Mounted Units	Flight Deck Panels	Fuselage (1) Antenna Coupler Environment	
				Pressurized	Non Pressurized
4	Temperature and Altitude	A2	A2	A2	D2
5	Temperature Variation	B	C	B	A
6	Humidity	A	A	A	B
7	Operational Shocks and Crash Safety	Required			
8	Vibration	Required			
9	Explosion Proofness	Per Airframe Requirements			
10	Water Proofness	X	X	X	S
11	Fluids Susceptibility	X	X	X	F
12	Sand and Dust	X	X	X	D
13	Fungus Resistance	X	X	X	F
14	Salt Spray	X	X	X	S
15	Magnetic Effect	A	A	A	B
16	Power Input	A	A	A	A
17	Voltage Spike	A	A	A	A
18	Audio Frequency	Z	Z	Z	Z
19	Induced Signal Susceptibility	Z	Z	Z	Z
20	Radio Frequency Susceptibility (2)	U or T	U or T	U or T	V
21	Emission of Radio Frequency Energy	Z	Z	Z	Z
22	Lightning Induced Transient Susceptibility	J	J	J	K
23	Lightning Direct Effects	Not Applicable			
24	Icing	X	X	X	C

NOTES:

(1) Antenna requirements depend on antenna type and location on the fuselage. Refer to airframe manufacturer requirements.

(2) For ATS the value U is the more stringent requirement.

ATTACHMENT 7
MAINTENANCE SYSTEM CODES

Table 7-1. OMS Fault Indication Codes

Fault Code ID	Nomenclature	Description
1	Power Interrupt Recovery	Power interrupt has occurred in the last 3 seconds
2	CMC Activity Fail	No data received from the CMC.
3	CMC Signal Fail	CMC data is invalid. (optional)
4	BITE Test Inhibit	Initiated test is inhibited.
5-9	Reserved	
10	HF Data LRU Failure	The HF Data LRU has failed.
11	Coupler Failure	Coupler has failed.
12	Antenna Failure	Antenna has failed.
13	CFDIU input bus	Bus is inactive.
14	Source Selection	Port A, Port B is selected.
15	Input Data	Input data is inactive.
16	Antenna/Coax Status	Antenna or Coax has failed.
17	MU/CMU Input 1	No data received from MU/CMU Input 1.
18	MU/CMU Input 2	No data received from MU/CMU Input 2.
19	Lat/Long Input	Lat/Long Input is inactive.
20	UTC Input	UTC Input is inactive.
21	ICAO 24-bit Aircraft Address ARINC 429 Input 1	Input 1 inactive.
22	ICAO 24-bit Aircraft Address ARINC 429 Input 2	Input 2 inactive.
23	Strap Odd Parity	Strap Odd Parity failed.
24	Opposite Side HFDL Input	Opposite Side inactive/failed.

Note: Fault ID Codes 1 thru 3 are assigned to generic faults, and Code 4 is assigned to BITE Test Inhibit, based on guidance material in ARINC Report 624.

ATTACHMENT 7
MAINTENANCE SYSTEM CODES

Table 7-2-a. Bit-Oriented CFDS BITE Command Summary Word for HFDR

BIT NO.	FUNCTION	BIT STATUS 1	BIT STATUS 0
1 2 3 4 5 6 7 8	Label 227 (Octal)		
9 10	SDI		
11 12	Pad		
13 14 15 16 17 18 19 20 21 22 23 24	Equipment ID (Hex) - 019		
25 26 27 28 29 30 31	(See Functional Select Table A7.1 in ARINC Report 604.)		
32	Parity (odd)		

NOTE: This Attachment supercedes ARINC Report 604, “Guidance for Design and Use of Built-In Test Equipment (BITE)”, dated 1988.

ATTACHMENT 7
MAINTENANCE SYSTEM CODES

Table 7-2-b. Bit-Oriented CFDS BITE Command Summary Word for HFDU

BIT NO.	FUNCTION	BIT STATUS 1	BIT STATUS 0
1 2	Label 227 (Octal)		
3 4 5			
6 7 8			
9 10	SDI		
11 12	Pad		
13 14 15 16	Equipment ID (Hex) - 053		
17 18 19 20			
21 22 23 24			
25 26 27 28 29 30 31	(See Functional Select Table A7.1 in ARINC Report 604.)		
32	Parity (odd)		

NOTE: This Attachment supercedes ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment (BITE)", dated 1988.

ATTACHMENT 7
MAINTENANCE SYSTEM CODES

Table 7-3-a. Bit-Oriented CFDS BITE Fault Summary Word for HFDR

BIT NO.	FUNCTION	BIT STATUS 1	BIT STATUS 0
1 2 3 4 5 6 7 8	Label (350) (Octal)		
9 10	SDI 00 = All Call 01 = One 10 = Two 11 = Three		
11	Transceiver Failure	Failed	OK
12	Coupler Failure	Failed	OK
13	Antenna Failure		(Always 0)
14	CFDIU Input Bus	Inactive	OK
15	Source Selection	Port A	Port B
c-1 16	Control Input	Inactive	OK
17	Antenna/Coax Status	Failed	OK
18	MU/CMU Input 1	Inactive	OK
19	MU/CMU Input 2	Inactive	OK
20	Lat/Long Input	Inactive	OK
21	UTC Input	Inactive	OK
22	ICAO Address ARINC 429 Input 1	Inactive	OK
23	ICAO Address ARINC 429 Input 2	Inactive	OK
24	Strap Parity	Failed	OK
c-1 25	Opposite Side HFDL Crosstalk Input	Inactive	OK
26	HF Radio Type	HFDR	HF Voice Only Radio
27	ICAO Address Determined	ICAO Address Not Available	ICAO Address Known
28	BITE Test Inhibit	Inhibit	Enable
29	Command Acknowledge	ACK	NAK
c-1 30 31	31 30 SSM Meaning 0 0 = Verified Data, Normal Operation 0 1 = No Computed Data 1 0 = Functional Test 1 1 = Failure Warning		
32	Parity		

NOTE: This Attachment supercedes ARINC Report 604, “Guidance for Design and Use of Built-In Test Equipment (BITE)”, dated 1988.

ATTACHMENT 7
MAINTENANCE SYSTEM CODES

Table 7-3-b. Bit-Oriented CFDS BITE Fault Summary Word for HFDU

BIT NO.	FUNCTION	BIT STATUS 1	BIT STATUS 0
1 2 3 4 5 6 7 8	Label (350) (Octal)		
9 10	SDI 00 = All Call 01 = One 10 = Two 11 = Three		
11			
12			
13			
14			
15			
16			
17			
18	MU/CMU Input 1	Inactive	OK
19	MU/CMU Input 2	Inactive	OK
20	Lat/Long Input	Inactive	OK
21	UTC Input	Inactive	OK
22	ICAO Address ARINC 429 Input 1	Inactive	OK
23	ICAO Address ARINC 429 Input 2	Inactive	OK
24	Strap Parity	Failed	OK
25	Opposite Side HFDL Crosstalk Input	Inactive	OK
26	HF Radio Type	HFDR	HF Voice Only Radio
27	ICAO Address Determined	ICAO Address Not Available	ICAO Address Known
28	BITE Test Inhibit	Inhibit	Enable
29	Command Acknowledge	ACK	NAK
30 31	31 30 SSM Meaning 0 0 = Verified Data, Normal Operation 0 1 = No Computed Data 1 0 = Functional Test 1 1 = Failure Warning		
32	Parity		

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NOTE: This Attachment supercedes ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment (BITE)", dated 1988.

ATTACHMENT 7
MAINTENANCE SYSTEM CODES

Table 7-4-a. Fault Messages for HFDR BITE (Airbus Aircraft) Transmitted on Label 356 to OMS

Type of Failure	EXT/INT	Message ATA	Class
Control Input Mode	EXT	RMP X (FIN) / HFDR X (FIN) 23-81-13 CMU X (FIN) / HFDR X (FIN) 23-24-34	1
ICAO Address	EXT	ICAO Address / HFDR X (FIN)	1
CFDS/CMS	EXT	CMC X (FIN) / HFDR X (FIN) 45-13-34	3
Strut Switch	EXT	LGCIU X (FIN) / HFDR X (FIN) 32-31-71	3
Internal LRU	INT	HFDR X (FIN) 23-11-33	1
Coupler	INT	HF CPLR X (FIN) 23-11-33	1
Antenna	INT	HF Antenna (FIN) / Feeder (FIN) CPLR (FIN)/COAX 23-11-11	1
Power Supply	EXT	Power Supply Interrupt 24-00-00	1

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NOTES:

[1] Side of the LRU (Ex: CMU1)

[2] FIN: Functional Item Number of the concerned LRU

[3] EX: CMC1 (1TM1), CMC2 (1TM2)

Power supply interruption or transients should not be reported as an LRU failure. When the power interruption is longer than 200 ms, the following fault message must be sent to the CMC at the return of the power supply: "POWER SUPPLY INTERRUPT" (external fault).

For electrical power interrupts between the transparency time and 200 ms, the message "POWER SUPPLY INTERRUPT" must only be generated by the transceivers having a refresh period on their ARINC 429 buses shorter than 60 ms.

c-1 This message may be deleted if transparency time is equal to or greater than 200 ms.

c-2 [4] Issue of maintenance message for External detected failures should be sufficiently confirmed before being reported by the system (Ex: 3 seconds for control source, 6 seconds for OMS, etc.)

ATTACHMENT 7
MAINTENANCE SYSTEM CODES

Table 7-4-b. Fault Messages for HFDR BITE (Douglas Aircraft)

Type of Failure	Message	Code	Class
Control Input Mode	CRP1/2/3/HFX	2311XX*	1
CFDS/CMC	CFDIU/HFX	2311XX*	3
Coupler	HFX COUPLER/FEEDER/ANTENNA	2311XX*	1
Tune Power	HFX/COAX	2311XX*	1
Internal LRU	HFX	2311XX*	1

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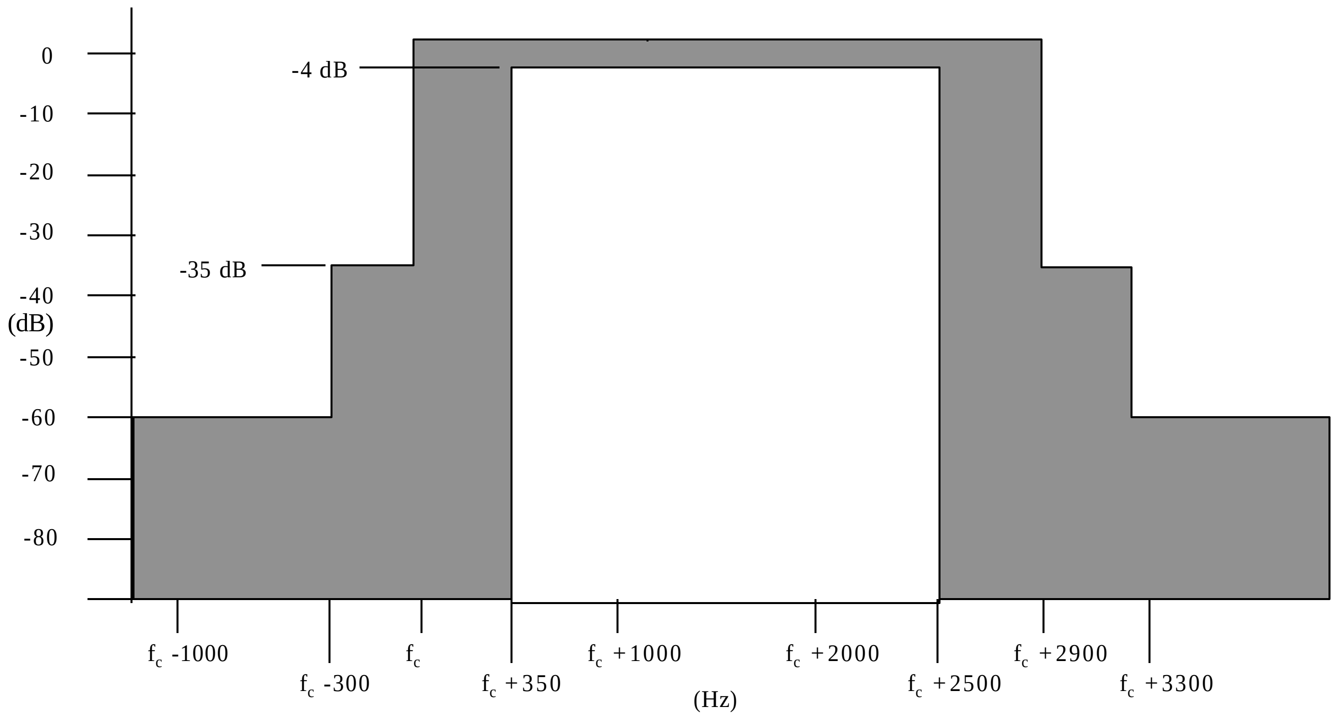
* Last two characters to be assigned by DAC

ATTACHMENT 7
MAINTENANCE SYSTEM CODES

Table 7-5. Maintenance System Type Identification

CFDS Type A	CFDS Type B	CFDS Type C	Type
Ground	Ground	Ground	Future Use
Ground	Ground	Open	McDonnell-Douglas CFDS
Ground	Open	Ground	Airbus CFDS
Ground	Open	Open	Future Use
Open	Ground	Ground	Boeing CFDS
Open	Ground	Open	Future Use
Open	Open	Ground	Future Use
Open	Open	Open	CFDS/OMS Not Installed

ATTACHMENT 8
USB SELECTIVITY



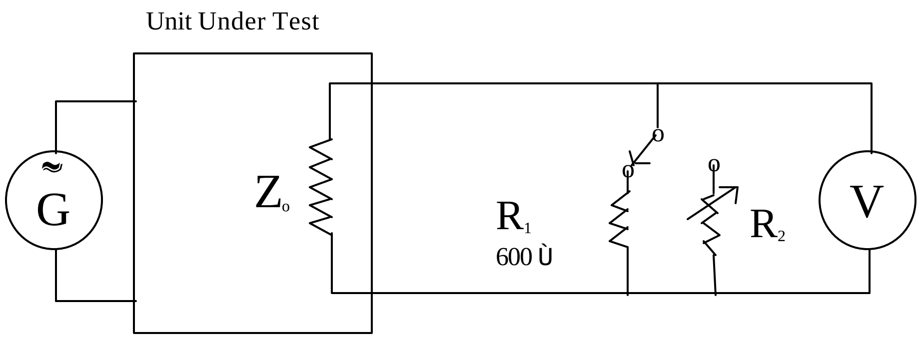
Notes:

1. Receive data input audio signal amplitude should be within shaded portion of curve.

2. f_c is the carrier frequency.

ATTACHMENT 9
TYPICAL TEST PROCEDURES

AUDIO OUTPUT

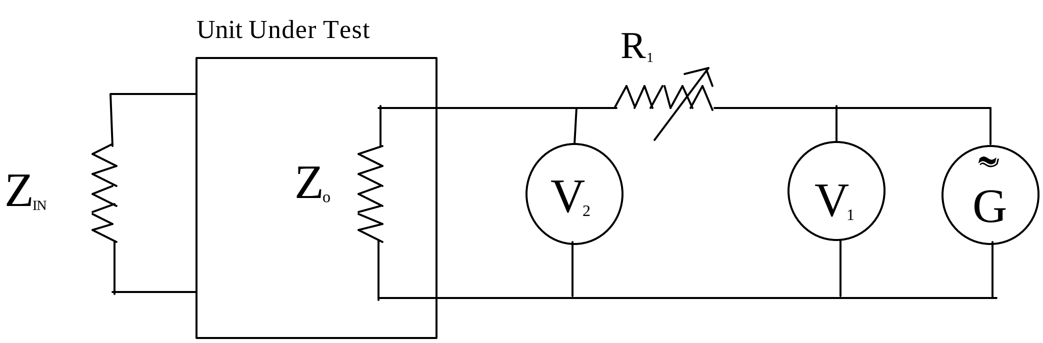


a. select R_1, adjust input and unit under test for desired output level V_1 (up to rated output)

b. select R_2, adjust R_2 for $V_2 = 0.9V_1$

c. $Z_o = \dfrac{60R_2}{540 - R_2}$

Figure 1



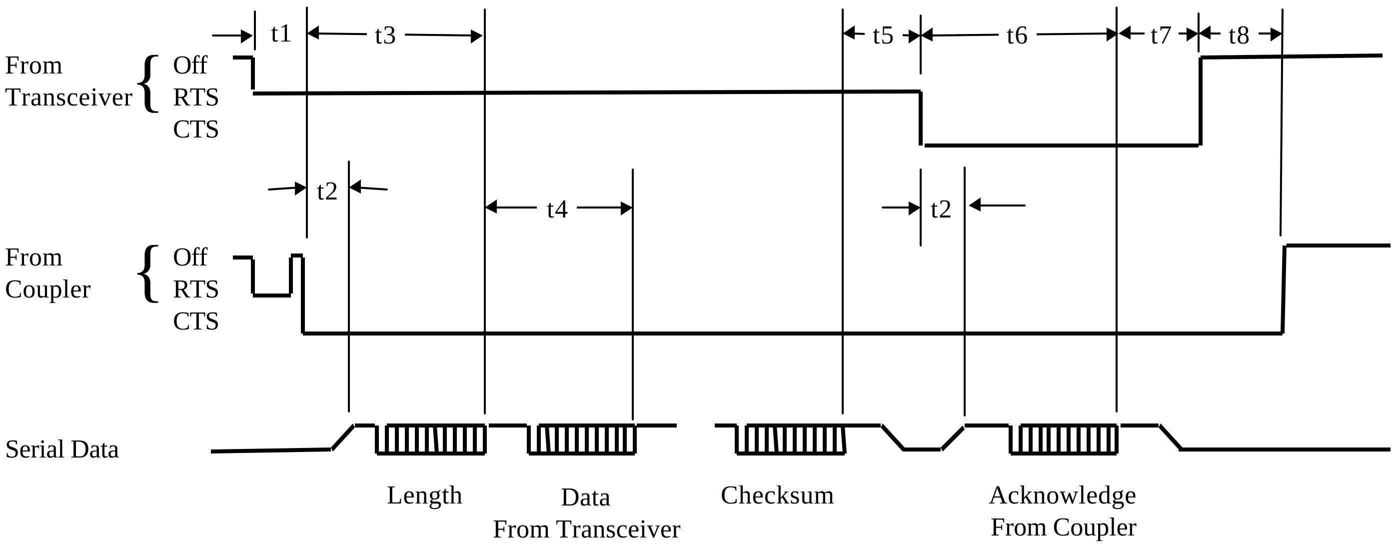
a. adjust and maintain signal source (G) at $V_1 = 30$ mV

b. adjust R_1 until $V_2 = 0.5V_1$

c. $Z_o = R_1$

Figure 2

ATTACHMENT 10
TYPICAL MESSAGE TRANSFER PROGRAM



ATTACHMENT 11
COUPLER CMC FLIGHT DATA

Function	Data
Flight Phase(8)	0: Ground, 1: Flight (DC2), 2: Flight (DC1)
Date (24)	Six BCD digits LSW: Tens of year, Units of year 2, Word: Tens of month, Units of month MSW: Tens of day, Units of day
Time (UTC)(16)	Four BCD digits LSW: Tens of minutes, Units of minutes MSW: Tens of hours, Units of hours
Flight Leg Number(8)	Integer 0 to 63
Aircraft Identification(56)	7 ISO #5 Character LSW: 1.Aircraft Tail Character 2.word: 2.Aircraft Tail Character 3.word: 3.Aircraft Tail Character 4.word: 4.Aircraft Tail Character 5.word: 5.Aircraft Tail Character 6.word: 6.Aircraft Tail Character MSW: 7.Aircraft Tail Character
Aircraft Type(8)	Integer 0 to 256 0: Aircraft without CMC/CFDS 1: MD-11 2: A340/330 3: A320 4: Boeing 747-400 5 to 255: Future spare
Frequency(32)	Binary coded frequency in hertz, LSW first, MSW last
Mode of Emission(8)	Integer: 0:SSB/USB, 1:SSB/LSB, 3:AM(E)

ATTACHMENT 12
HFDR OUTPUT LABELS

			System Users			
HFDR Output Label	Purpose	Repetition Rate	CMU	OMS	Other	HFDR 2
172	Subsystem Identifier Word	Once per second	X			
270	HFDL Status Word	Once per second	X	X	X	
271	Join/Leave Event Message	Once per second	X			
272	Link Management In Slave Mode	Once per second				X
350	Boeing Maintenance Word	Once per second	X	X		
354	Airbus Maintenance Word	Once per second	X	X		
356	Airbus Maintenance Word	Normal Mode 50 ms min 200-250 ms Nominal 3 sec max Interactive Mode 3-50 ms (min-max)		X		
356	Douglas Maintenance Word	Min. 50 ms Nominal 200-250 ms Max. 3 sec	X	X		
377	Equipment Identifier Word	Once per second	X	X		

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ATTACHMENT 13
HFDR ACTIVITY LABELS

	ARINC 429 Port	Input	Label	350 Label Bit Name	350 Label Bit Value
c-1	CFDS Data input	MP4A/B	227 (Boeing) and (McDonnell-Douglas) or 156 (Airbus)	CFDIU Input Bus	14
	Freq Select Port "A"	MP3E/F	207 or 037	Control Input	16
c-2	Freq Select Port "B"	MP3G/H	207 or 037		
c-1	CMU #1 Data Input	TP9A/B	270	MU/CMU Input 1	18
c-2	CMU #2 Data Input	TP9E/F	270	MU/CMU Input 2	19
c-1	Position Input	TP7E/F	BCD 010 lat BCD 011 long BNR 310 lat BNR 311 long BNR 110 lat BNR 120 long	Lat/Long Input	20
	Time Input	TP7A/B	125 or 150	UTC Input	21
	ICAO Digital ID #1 Input	TP3B/C	275/276 or 214/216	ICAO Addr 429 Input 1	22
c-2	ICAO Digital ID #2 Input	TP7C/D	275/276 or 214/216	ICAO Addr 429 Input 2	23
	HFDR Crosstalk Input	TP5J/K	272	Opposite Side HFDL Crosstalk Input	25

c-1 The table HFDR Activity Labels shown in Attachment 13 should be used when determining the bus activity of an ARINC 429 bus connected to the HFDR. A bus should be considered active after receiving three consecutive activity labels. Once active, a bus should be considered inactive after missing five consecutive activity labels. Note: This table should be used in the Label 350 word when setting activity bits.

ATTACHMENT 14
VOICE / ANALOG DATA / DATA LINK
MODE SELECTION MATRIX

Installation Number (See Section 4.6.13) MP4J MP4H	Voice/ Analog Data Mode Select MP2D	HFDL Mode Enable 0 = Enable 1 = Voice/ Analog Data TP7G	Freq. Source Select 1 = 037 0 = 205/207 MP2K	Voice/ Analog Data Label 207 0 = Voice 1 = Data Bit 11	HFDL #1 Data Mode Label 207 0 = Disabled 1 = Enabled Bit 18	HFDL #2 Data Mode Label 207 0 = Disabled 1 = Enabled Bit 19	MODE: Voice/ Analog Data/ Data Link
X	1	1	1	X	X	X	Voice
X	0	1	1	X	X	X	Analog Data
X	X	0	X	X	X	X	Data Link
X	X	1	0	0	0	0	Voice
X	X	1	0	1	0	0	Analog Data
1	X	1	0	X	1	X	Data Link
2	X	1	0	X	X	1	Data Link

c-1

Legend:

X = Don't Care
1 = Open (High)
0 = Ground (Low)

COMMENTARY

The HF Data Radio provides three modes of operation. These are the Voice Mode which includes conventional Single Sideband, AME and CW communications, Analog Data Mode that can operate with an external data modem, and the Data Link Mode that uses an internal data modem. The mode selection is governed by a combination of discrete pins and ARINC 429 data words.

ATTACHMENT 15
HFDR MASTER/SLAVE MODE SELECTION MATRIX

Program Discrete		Inputs from Selected CMU's ARINC 429 Bus				Inputs from Crosstalk ARINC 429 Bus			HFDL Voice/Data Mode		HFDR Oper/ Fault	HFDL Master/ Slave Mode
SDI 0 Discrete MP4J	SDI 1 Discrete MP4H	CMU Message Status Label 276 Active	CMU Message Status SSM Label 276 bits 31, 30	CMU Message Status, HFDR 1 Master/Slave bit in Label 276 bit 26	CMU Message Status HFDR 2 Master/ Slave bit in Label 276 bit 27	Link Mgmt. Label 272 Active	Link Mgmt. SSM in Label 272 bits 31, 30	Link Mgmt. Other HFDL Master/ Slave in Label 272 bit 11	Opposite Side	This HFDR		
Open	Gnd	Active	00 (Norm)	1 (Master)	0 (Slave)	X	X	X	X	X	X	Slave
Open	Gnd	Active	00	0 (Slave)	1 (Master)	X	X	X	X	X	X	Master
Gnd	Open	Active	00	0	1	X	X	X	X	X	X	Slave
Gnd	Open	Active	00	1	0	X	X	X	X	X	X	Master
X	X	Active	10 (Test)	X	X	X	X	X	X	X	X	no change
X	X	Active	00	0	0	X	X	X	X	X	X	handle as 276 Inactive
X	X	Active	00	1	1	X	X	X	X	X	X	handle as 276 Inactive
X	X	Active	01 (NCD)	X	X	X	X	X	X	X	X	handle as 276 Inactive
X	X	Active	11 (Fail)	X	X	X	X	X	X	X	X	handle as 276 Inactive
X	X	Inactive		X	X	X	X	X	X	X	Fault	Slave
X	X	Inactive		X	X	Inactive	X	X	X	X	Oper	Master
X	X	Inactive		X	X	Active	X	X	Data	Voice	Oper	Slave
X	X	Inactive		X	X	Active	X	X	Voice	Data	Oper	Master
X	X	Inactive		X	X	Active	01 (NCD)	X	<both the same>		Oper	no change
X	X	Inactive		X	X	Active	10 (Test)	X	<both the same>		Oper	no change
X	X	Inactive		X	X	Active	11 (Fail)	X	<both the same>		Oper	Master
X	X	Inactive		X	X	Active	00 (Norm)	0 (Master)	<both the same>		Oper	Slave
Open	Gnd	Inactive		X	X	Active	00	1	<both the same>		Oper	Master
Gnd	Open	Inactive		X	X	Active	00	1 (Slave)	<both the same>		Oper	no change

ATTACHEMENT 16
HFDR TABLES

Table 16-1 Variables of Low Speed Bit-Oriented Protocol – Version 1
HFDR and CMU Maximum Allowed WORD GAP (Minimum 4 Bit – Maximum 64 Bit)

TIME	DECRIPTION	MINIMUM VALUE	MAXIMUM VALUE	TIME OR DESIGN GOAL FOR SOURCE OR SINK
T1	CTS/NCTS Send Time	0 ms	100 ms	Goal for Sink
T2	RTS Repeat Time After Receipt Of NCTS	500 ms	700 ms	Timer for Source
T3	Busy Send Time	0 ms	100 ms	Goal for Sink
T4	RTS Repeat Time After Receipt Of Busy	15 sec	18 sec	Timer for Source
T5	RTS Repeat Time if No Response	500 ms	700 ms	Timer for Source
T6	Time of Random Timer to resolve RTS Conflicts	50 ms	500 ms	Goal for Source
T7	Increment of Time T6	10 ms	100 ms	Goal for Source
T8	ACK/NACK/SYN Send Time After EOT	0 ms	200 ms	Goal for Sink
T9	LDU Time-out Following CTS	2.5 sec	2.7 sec	Timer for Sink
T10	ACK/NACK Time-out after CTS	2.7 sec	3 sec	Timer for Source
T11	Loop Back Send time	0 ms	100 ms	Goal for Source
T12	ALO Repeat Time if No Response to ALO	200 ms	250 ms	Timer for Source
T13	SOT Send Time After Receipt of CTS	0 ms	200 ms	Goal for Source
T14	Incomplete File Time-out	2 min	2.2 min	Timer for Sink
T15	ALR send Time	0 ms	180 ms	Goal for Sink
T16	ACK/NACK Time-out After EOT	220 ms	330 ms	Timer for Source

c-3

ATTACHMENT 16
HFDR TABLES

Table 16-2 Variables of High Speed Bit-Oriented Protocol – Version 1
HFDR and CMU Maximum Allowed WORD GAP (Minimum 4 Bit – Maximum 64 Bit)

TIME	DECRIPTION	MINIMUM VALUE	MAXIMUM VALUE	TIME OR DESIGN GOAL FOR SOURCE OR SINK
T1	CTS/NCTS Send Time	0 ms	100 ms	Goal for Sink
T2	RTS Repeat Time After Receipt Of NCTS	100 ms	140 ms	Timer for Source
T3	Busy Send Time	0 ms	100 ms	Goal for Sink
T4	RTS Repeat Time After Receipt Of Busy	1 sec	1.2 sec	Timer for Source
T5	RTS Repeat Time if No Response	150 ms	200 ms	Timer for Source
T6	Time of Random Timer to resolve RTS Conflicts	50 ms	500 ms	Goal for Source
T7	Increment of Time T6	10 ms	100 ms	Goal for Source
T8	ACK/NACK/SYN Send Time After EOT	0 ms	200 ms	Goal for Sink
T9	LDU Time-out Following CTS	400 ms	440 ms	Timer for Sink
T10	ACK/NACK Time-out after CTS	600 ms	660 ms	Timer for Source
T11	Loop Back Send time	0 ms	100 ms	Goal for Source
T12	ALO Repeat Time if No Response to ALO	200 ms	250 ms	Timer for Source
T13	SOT Send Time After Receipt of CTS	0 ms	100 ms	Goal for Source
T14	Incomplete File Time-out	10 sec	11 sec	Timer for Sink
T15	ALR send Time	0 ms	180 ms	Goal for Sink
T16	ACK/NACK Time-out After EOT	220 ms	330 ms	Timer for Source

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APPENDIX A
HF TRANSMISSION REQUIREMENTS

1. General Description

This appendix provides a short introduction to the physical environment of the HFDL with a brief description how electromagnetic wave are propagating in HF range. The peculiarities of the HF channel are discussed because the properties of this channel have decisive influences to the system design of an HFDR.

The HFDL is an integral part of the ACARS/ATN communications subnetwork.

2. Requirements Concerning HF Transmission

The short wave or HF range in the electromagnetic spectrum is characterized by the frequencies from 2 MHz to 30 MHz or equivalently by the wavelengths from approximately 10 m to approximately 150 m. The operational possibilities of signal transmission methods depend on the physical properties of the radio channel. Therefore the main specifics applicable to the HF range are covered below.

3. Electromagnetic Wave Propagation

3.1 The Ionosphere

The ionosphere is that area of the atmosphere, at an altitude from 60 km through 400 km, which is conductive due to ionization. The degree of ionization is mainly determined by the intensity of solar radiation and particle density in the ionosphere. Hence the degree of ionization (as density of the free charge carrier per unit of volume) depends on altitude and the kind of elements in different layers. HF wave propagation is mainly influenced by four layers (D, E, F1, and F2).

The heights and densities of the ionospheric layers as well as their electron concentrations depend on:

a. Time of day

b. Season

c. Sunspot number

The sunspot number is subject to immense fluctuations. During the time of a sunspot number minimum the concentrations of free charge carriers in the ionosphere are in average distinctly less than the concentrations during a sunspot number maximum.

At lower level of charge carrier concentrations the reflecting ability of the ionospheric layers decreases, which means that electromagnetic wave penetrate and pass the layers more easily and are not reflected.

The frequency which is still reflected when perpendicularly incident to a layer is referred to as the critical frequency. If an electromagnetic wave strikes on ionospheric layer not perpendicularly, but obliquely, the electron density for that wave is effectively greater and it will therefore be more strongly reflected than the perpendicularly incident wave. At a fixed frequency the angle of reflection varies according to the angle of incidence and thus results in different propagation distances. The limit frequency, at which the ionospheric layer still reflects, also varies with the angle of incidence.

3.2 Peculiarities of Propagation in the Short Wave Range

Electromagnetic waves in the HF range propagate in form of ground waves as well as in form of sky waves. Due to the finite electrical conductivity of the earth's surface, energy from the ground wave penetrates it and is absorbed. This leads to a high attenuation and short ground wave's propagation. The attenuation is less over sea (high salt content, good conductivity) than over land. When skywave in the HF range are reflected by the ionosphere then return to the earth's surface at distant point. There are two regions around transmitter:

a. The ground wave zone

b. The sky wave zone

The extent of those zones depend on:

a. Transmitters, receivers, and antennas (power, frequency, radiation conditions)

b. Constitution of the ground (for the ground wave)

c. State of the ionosphere (for the sky wave)

Ground wave operation is extensively free of all other influences. Naturally the wave can be received only within the transmitter's ground wave distance, i.e. the intercept distance is limited as far as ground wave propagation is regarded.

Where skywave propagation is concerned the electromagnetic waves are reflected by the ionosphere as a function of angle of incidence and the frequency used. Multi-reflections also occur frequently thus covering long distances.

Electromagnetic waves are attenuated when passing the ionospheric layers; this applies particularly to the D-layer, which is present only during the day.

During skywave propagation in the HF range, transient fluctuations of the signals propagation time occur, which are due to changes in the altitude of the reflecting layer in the ionosphere and to multipath propagation. A short transmission signal appears as a series of signals at the receiver and a longer signals are extended.

Therefore the implementation of dedicated HF Modems with adaptive echo cancelers becomes necessary.

3.3 Propagation Predictions

The possibilities of transmitting HF signals from one location to another are determined by

a. The lowest usable frequency (LUF) and

b. The maximum usable frequency (MUF)

The LUF depends mainly on the state of the D and the E layers, it decreases with increasing transmitter power. The

APPENDIX A
HF TRANSMISSION REQUIREMENTS

variation of the LUF is mainly influenced by the sunspot number.

The Upper frequency, at which traffic between two radio stations is possible by sky wave operation, is the MUF. The MUF cannot be influenced by increasing transmitter power, it depends upon time of the day, season, and sunspot number.

The frequency of optimum traffic (FOT) is fixed empirically at 0.85 of the monthly median value of the MUF for a given link.

Propagation predictions contain details about ground wave distances, LUF, MUF, and about skywave distances to be expected.

On the basis of propagation prediction, modern HF communication systems use adaptive frequency management to select the optimum frequency for a link to be established.

3.4 Fading

Occasional reductions of received signal strength are referred to as fading. Fading may effect the complete radio channel or only some specific narrow frequencies within the channel. Single tone modems provide adequate robustness against fading.

3.5 Noise

Unavoidable random interference which affects communication is addressed as noise. Such random interferences are added to the signal and cause fluctuations of received signal.

Equipment internal generators, converters, or consumers of electrical power are sources for internal random noise.

External random noise is caused for example by interference fields at antenna sites. Electromagnetic interference fields are created by:

a. Industrial activities (man made noise)

b. Terrestrial thermal radiation

c. Atmospheric occurrences (thunderstorms, currents in the ionosphere), and

d. Cosmic radiation.

4. Frequency Selection

To ensure reliable connections, modern HF data radios use automatic channel selection, i.e. they operate with a frequency pool. Of course the frequency tables on-ground and on-board have to be identical.

Before link setup, the chosen frequency is sensed for the occupation by the sending station.

APPENDIX B
ACARS MU-HFDU MSK INTERFACE

1. Introduction

This appendix describes an alternate interface between the HF Data Unit (HFDU) and the ACARS Management Unit (MU) for aircraft equipped with ACARS MUs which do not have two spare ARINC 429 bus ports for HF downlink transmission and uplink reception. In these installations, the HFDU should interface to the MU via the Minimum Shift Key (MSK) audio ports and to the VHF and HF transceivers as shown in Attachment 3-1. Decisions regarding the switching between VHF ACARS and HFDL should be made in the HFDU.

COMMENTARY

> This type of installation is not intended to support the full range of AOC and ATC services available via HF Datalink. It may be used in the interim for AOC communications until the ACARS MU is replaced or upgraded with HF Datalink provisions.

2. MSK Audio Interface Definition

The HFDU may be installed in aircraft where the ACARS MU does not have the necessary HF Datalink provisions. In these installations the HFDU should communicate with the ACARS MU using a transmit/receive pair of MSK audio ports. These ports should be connected to the MSK audio receive and transmit ports normally used by the ACARS MU to communicate with the VHF transceiver. For a detailed definition of the MSK audio interface refer to Section 4.4 of ARINC Specification 618.

In these installations the only data exchanged via the MSK audio ports is ACARS data blocks since the ACARS MU will most likely not have HF Datalink provisions. The format of this data is defined in Appendix A of ARINC Specification 618.

3. HF/VHF Switching Functions

When the HFDU-MU interface is via MSK audio ports, the HFDU is responsible for deciding when ACARS data is to be exchanged via the VHF or HF Datalink subnetworks and for the routing of the data between the HF and VHF transceivers and the ACARS MU.

3.1 HF/VHF Mode Selection

The HFDU should be configurable via a discrete programming pin to switch between HF and VHF data modes either automatically based on aircraft position (latitude and longitude) information or manually based on crew selection.

3.1.1 Manual Switching Mode

When the HFDU is configured for manual switching mode, the cockpit crew should use the HF voice/data switch in the HF Datalink Control Function (HFDCF) to control when ACARS data is to be sent via HFDL and when it is to be sent via VHF. The HFDU should monitor the HF voice/data discrete input from the HFDCF and default to VHF Data mode when the HF voice/data discrete input is “high”. When the HF voice/data discrete is “low” it should default to HF Data mode.

3.1.2 Automatic Switching Mode

When the HFDU is configured for automatic switching, the HFDU should have stored in memory maps of HF and VHF coverage areas. The HFDU should switch between HF and VHF Data modes by comparing its current position (latitude and longitude) with the coverage maps.

3.2 MU-VHF Transceiver Interfaces Switching

The HFDU should intercept the MSK audio and the VHF data keyline connections between the ACARS MU and the VHF transceiver. When the HF voice/data discrete input is “high”, the MU-VHF transceiver connections should be closed. When the HF voice/data discrete input is “low”, the MU-VHF transceiver audio and data keyline connections should be closed if the HFDU is in VHF Data mode and open if it is in the HF Data mode. In the event of an HFDU failure, the MU-VHF connections should default to closed.

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

1.1 Frequency and Mode Control Serial Bus Inputs

ARINC Characteristic 719-5 Section 3.1, 3.2

The HFDR has 2 input ports to accept ARINC 429 Mark 33 DITS low speed serial data. The ARINC 429 bus uses two lines with return-to-zero bipolar modulation. The frequency and mode control bus inputs are received on the following pin numbers:

Frequency Select Port A line A MP-3E
Frequency Select Port A line B MP-3F

Frequency Select Port B line A MP-3G
Frequency Select Port B line B MP-3H

The HFDR responds to frequency and mode control words through Frequency Select Port A or B, depending on the state of the PORT SELECT discrete input. All data on the non-selected port is ignored.

1.1.1 Label 037 HF COM Frequency and Control Words

ARINC Specification 429 Section 3.1

When the FREQUENCY SOURCE SELECT discrete is open, the HFDR is controlled by ARINC 429 Label 037. Refer to ARINC Specification 429, Section 3.1, for a description of the Label 037 HF Communications control words. SSB and AME Mode information and BCD frequency information down to 0.001 MHz resolution is contained in Label 037 word #1. CW Enable and 100 Hz BCD frequency information is contained in Label 037 word #2. Label 037 word #1 and #2 need not come in any particular order.

CW mode is enabled only when Label 037 word #1 is set for SSB USB mode and the CW Enable bit is set in Label 037 word #2. CW mode is disabled if Label 037 word #1 is set for SSB LSB mode or AME mode, even if the CW Enable bit is
c-2 set in Label 037 word #2.

Label 037 word #2 is optional and needs to be sent to the HFDR only when the desired frequency has non-zero 100 Hz data, or when CW mode is desired. If Label 037 word #2 is not received for at least 5 refresh intervals (approximately 1.3 seconds), the HFDR assumes the 100 Hz frequency control data is zero, and it assumes CW mode is disabled. Thus, loss of Label 037 word #2 is considered a frequency change.

1.1.2 Label 205 & Label 206 HF COM Frequency Words

ARINC Specification 429 Section 3.1

When the FREQUENCY SOURCE SELECT discrete is grounded, the HFDR responds to Label 205 or 206 frequency control words. Only those words whose SDI matches the installation number of the HFDR as set by the SDI program pins or whose SDI is "all-call" are accepted by the HFDR. All other data is ignored.

BCD frequency information down to 0.001 MHz resolution is contained in Label 205 or 206 word #1. 100 Hz BCD frequency information is contained in Label 205 or 206 word #2. The Label 205 or 206 words #1 and #2 need not come in any particular order. The data fields in the Label 205 and 206 words are identical and the HFDR does not distinguish between the two. Naturally, the Label 205 and 206 words should never appear on the same bus with differing frequency control data.

Label 205 and 206 word #2 is optional and needs to be sent to the HFDR only when the desired frequency has non-zero 100 Hz data. As with the Label 037 word #2, if Label 205 or 206 word #2 is not received for at least 5 refresh intervals (approximately 1.3 seconds), the HFDR assumes the 100 Hz frequency control data is zero. Loss of Label 205 or 206 word #2 is considered a frequency change.

1.1.3 Label 207 HF COM Mode Control Word

ARINC Project Paper 736 Attachment 10

When the FREQUENCY SOURCE SELECT discrete is grounded, the HFDR responds to Label 207 mode control word. Only those words whose SDI matches the installation number of the HFDR as set by the SDI program pins or whose SDI is "all-call" are accepted by the HFDR. All other mode control data is ignored.

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

1.1.4 Control Input Faults for Label 037

The HFDR should report a Control Input Fault to the CFDS under any of the following four conditions:

1. Label 037 word #1 is not received over the selected input port for more than 10 seconds.
2. Label 037 word #1 has even parity.
3. The word gap between Label 037 word #1 and any preceding word is shorter than the minimum gap specified in ARINC Specification 429.
4. The frequency control data is not a valid BCD value, or is out of the range 2.0000 to 29.9999 MHz.

When a control input fault exists, the HFDR remains at the last selected frequency and mode, and the fault is reported until valid control data is received.

Loss of Label 037 word #2 is not reported as a Control Bus fault, although such a loss results in automatically tuning the 100 Hz data to zero and disabling CW mode as described in Section 2.7.1.

If the HFDR is strapped for the narrow band, 2.8000 to 23.9999 MHz, and it receives frequency control data that is between 2.0000 and 2.7999 MHz or between 24.0000 and 29.9999 MHz, it tunes to the selected frequency, but the transmitter is disabled and a 1 kHz tone is inserted in the sidetone audio output when the PTT is activated.

1.1.5 Control Input Faults for Labels 205/206/207

The HFDR should report a Control Input Fault to the CFDS under any of the following four conditions:

1. Label 205 or 206 word #1, or Label 207 is not received over the selected input port for more than 10 seconds.
2. Label 205 or 206 word #1, or Label 207 has even parity. c-2
3. The word gap between Label 205 or 206 word #1, or Label 207 and any preceding word is shorter than the minimum gap specified in ARINC Specification 429.
4. The frequency control data is not valid BCD value, or is out of the range 2.0000 to 29.9999 MHz.

When a control input fault exists, the HFDR remains at the last selected frequency and mode, and the fault is reported until valid control data is received.

Loss of Label 205 or 206 word #2 is not reported as a Control Bus fault, although such a loss results in automatically tuning the 100 Hz data to zero and disabling CW mode as described in Section 2.7.2.

If the HFDR is strapped for the narrow band, 2.8000 to 23.9999 MHz and it receives frequency control data that is between 2.0000 and 2.7999 MHz or between 24.0000 and 29.9999 MHz, it tunes to the selected frequency, but the transmitter is disabled and a 1 kHz tone is inserted in the sidetone audio output when the PTT is activated.

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-1 HF COMM Frequency Word #1 - Label 037 (BCD)

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**		A10		1				0.1				0.01				0.001							**Octal Label**		
			MHz		MHz				MHz				MHz				MHz							**037**		
																								1 1 1	1 1 0	0 0

	Bit	Function		Coding		Notes
	1	Label		0		
	2	.	0	0		
	3	.		0		
	4	.		1		
	5	.	3	1		
	6	.		1		
	7	.		1		
	8	Label	7	1		
	9	Word #1 Ident		0		
	10	SSB/AME Mode		1 = SSB	0 = AME	
	11	USB/LSB Mode		1 = USB	0 = LSB	
c-2	12	0.001 MHz		BCD least significant		
	13	.				
	14	.				
	15	0.001 MHz		BCD most significant		
	16	0.01 MHz		BCD least significant		
	17	.				
	18	.				
	19	0.01 MHz		BCD most significant		
	20	0.1 MHz		BCD least significant		
	21	.				
	22	.				
	23	0.1 MHz		BCD most significant		
	24	1 MHz		BCD least significant		
	25	.				
	26	.				
	27	1 MHz		BCD most significant		
	28	10 MHz		BCD least significant		
	29	10 MHz		BCD most significant		
	30	SSM				1
	31	SSM				1
	32	Parity		Odd		

NOTES:

[1] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal operation
0	1	NCD, HFDR ignores freq. and mode data
1	0	Functional Test (The HFDR will conduct a self test)
1	1	Normal operation

[2] Refresh interval: 100 - 200 milliseconds

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-2 HF COMM Frequency Word #2 - Label 037

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**		0.1																					**Octal Label**		
			kHz																					**037**		
																								1 1 1	1 1 0	0 0

Bit	Function		Coding		Notes
1	Label		0		
2	.	0	0		
3	.		0		
4	.		1		
5	.	3	1		
6	.		1		
7	.		1		
8	Label	7	1		
9	Word #2 Ident		1		
10	CW Enable		1 = enabled	0 = disabled	
11	PAD				
12	.				
13	.				
14	.				
15	.				
16	.				
17	.				
18	.				
19	.				
20	.				
21	.				
22	.				
23	.				
24	.				
25	PAD				
26	0.1 kHz		BCD least significant		
27	.				
28	.				
29	0.1 kHz		BCD most significant		
30	SSM				1
31	SSM				1
32	Parity		Odd		

c-2

NOTES:

[1] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal operation
0	1	NCD, HFDR ignores frequency data
1	0	Not ued by HFDR
1	1	Normal operation

[2] Refresh interval: optional - 0 when 100 Hz frequency control data is zero, 100 - 200 milliseconds when 100 Hz frequency control data is non-zero

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-3 HF COMM Frequency Word #1 - Label 205 (206)

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**		10		1				0.1				0.01				0.001					**SDI**		**Octal Label**		
			MHz		MHz				MHz				MHz				MHz							**205 (206)**		
																								1 0 1	0 0 0	0 1

c-2

Bit	Function		Coding	Notes
1	Label		1(1)	
2	.	2(2)	0(0)	
3	.		0(0)	
4	.		0(0)	
5	.	0(0)	0(0)	
6	.		1(1)	
7	.		0(1)	
8	Label	5(6)	1(0)	
9	SDI		least significant bit	
10	SDI		most significant bit	
11	Word #1 Ident		0	
12	0.001 MHz		BCD least significant	
13	.			
14	.			
15	0.001 MHz		BCD most significant	
16	0.01 MHz		BCD least significant	
17	.			
18	.			
19	0.01 MHz		BCD most significant	
20	0.1 MHz		BCD least significant	
21	.			
22	.			
23	0.1 MHz		BCD most significant	
24	1 MHz		BCD least significant	
25	.			
26	.			
27	1 MHz		BCD most significant	
28	10 MHz		BCD least significant	
29	10 MHz		BCD most significant	
30	SSM			1
31	SSM			1
32	Parity		Odd	

NOTES:

[1] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal operation
0	1	NCD, HFDR ignores frequency and mode data
1	0	Not used by HFDR
1	1	Normal operation

[2] Refresh interval: 100 - 200 milliseconds

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-4 HF COMM Frequency Word #2 - Label 205 (206)

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**		0.1																			**SDI**		**Octal Label**		
			kHz																					**205 (206)**		
																								1 0 1	0 0 0	0 1

Bit	Function		Coding	Notes	
1	Label		1(1)		
2	.	2(2)	0(0)		
3	.		0(0)		
4	.		0(0)		
5	.	0(0)	0(0)		
6	.		1(1)		
7	.		0(1)		
8	Label	5(6)	1(0)		
9	SDI		least significant bit		
10	SDI		most significant bit		
11	Word #2 Ident		1		
12	PAD				
13	.				c-2
14	.				
15	.				
16	.				
17	.				
18	.				
19	.				
20	.				
21	.				
22	.				
23	.				
24	.				
25	PAD				
26	0.1 kHz		BCD least significant		
27	.				
28	.				
29	0.1 kHz		BCD most significant		
30	SSM			1	
31	SSM			1	
32	Parity		Odd		

NOTES:

[1] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal operation
0	1	NCD, HFDR ignores frequency data
1	0	Not used by HFDR
1	1	Normal operation

[2] Refresh interval: optional - 0 when 0.1 kHz frequency control data is zero, 100 - 200 milliseconds when 0.1 kHz frequency control data is non-zero

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-5 HF COMM Mode Control Word - Label 207

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**		**SENS/SQUELCH CONTROL**																			**SDI**		**Octal Label**		
			MSB						**LSB**															**207**		
																								1 1 1	0 0 0	0 1

c-2

Bit	Function		Coding		Notes
1	Label		1		
2	.	2	0		
3	.		0		
4	.		0		
5	.	0	0		
6	.		1		
7	.		1		
8	Label	7	1		
9	SDI		Least Significant Bit		
10	SDI		Most Significant Bit		
11	Voice/Analog Data Mode		1 = Analog Data Mode	0 = Voice Mode,	3
12	Voice Mode Keying				1
13	(reserved), Data Mode Keying				1
14			1 = SSB Mode	0 = AME Mode	
15			1 = USB Mode	0 = LSB Mode	
16			1 = CW Mode On	0 = CW Mode off,	4
17	on/off control				1
18	HFDL 1 Data Mode		1 = Enabled	0 = Disabled	
19	HFDL 2 Data Mode		1 = Enabled	0 = Disabled	
20	SENS/SQUELCH		LSB		1
21	SENS/SQUELCH		MSB		1
22			1 = RF Sensitivity Control,	0 = Squelch Control	
23	SENS/SQUELCH Control,		Least Significant Bit,		1 & 2
24	.				
25	.				
26	.				
27	.				
28	.				
29	SENS/SQUELCH Control,		Most Significant Bit,		1 & 2
30	SSM				5
31	SSM				5
32	Parity		Odd		

NOTES:

[1] The HFDR does not use bits 12, 13, 17, 20 and 21 of the Label 207 control word which should be set to zero.

[2] All zeros = 0 ohms, all ones = 5000 ohms. 5000 ohms = minimum RF sensitivity or maximum squelch threshold, 0 ohms = maximum RF sensitivity or minimum squelch threshold.

[3] If the Frequency Source Select programming pin MP-2K is open, indicating Label 037 tuning, then voice/data mode selection is controlled by the VOICE/ANALOG DATA SELECT discrete at rear connector pin MP-2D. If MP-2K is grounded, indicating Label 205/206/207 tuning, then voice/analog data mode selection is controlled by bit 11 of Label 207.

[4] CW mode will be enabled only when SSB USB mode is also selected. CW mode will be disabled when SSB LSB mode or AME mode is selected.

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-5 HF COMM Mode Control Word - Label 207 (cont'd)

[5] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal operation
0	1	NCD, HFDR ignores frequency data
1	0	Functional Test (The HFDR will conduct a self-test)
1	1	Normal operation

c-2

[6] Refresh interval: 100 - 200 milliseconds

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-6 TCAS Control Discrete (Mode S Address Part 1) - Label 275

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							**275**	
																								1 0 1	1 1 1	0 1

Bit	Function		Coding	Notes
1	Label		1	
2	.	2	0	
3	.		1	
4	.		1	
5	.	7	1	
6	.		1	
7	.		0	
8	Label	5	1	
9	PAD			
10	.			
11	.			
12	.			
13	PAD			
c-2 14	Mode S Address (Part 1)		A1 (MSB)	
15	.		A2	
16	.		A3	
17	.		A4	
18	.		A5	
19	.		A6	
20	.		A7	
21	.		A8	
22	.		A9	
23	.		A10	
24	.		A11	
25	.		A12	
26	.		A13	
27	.		A14	
28	.		A15	
29	Mode S Address (Part 1)		A16	
30	SSM			1
31	SSM			1
32	Parity		Odd	

NOTES:

[1] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal Operation
0	1	NCD
1	0	Functional Test
1	1	Failure Warning

[2] Refresh interval: 200 milliseconds

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-7 TCAS Control Discrete (Mode S Address Part 2, Max A/S) - Label 276

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													**276**	
																								0 1 1	1 1 1	0 1

Bit	Function		Coding	Notes
1	Label		1	
2	.	2	0	
3	.		1	
4	.		1	
5	.	7	1	
6	.		1	
7	.		1	
8	Label	6	0	
9	Aural Advisory Cancel and Visual Annunciator		1 = cancel, 0 = normal	
10	R1 Echo			
11	PAD			
12	PAD			
13	Mode S Address (Part 2)		A17	
14	.		A18	
15	.		A19	
16	.		A20	
17	.		A21	
18	.		A22	
19	.		A23	
20	Mode S Address (Part 2)		A24 (LSB)	c-2
21	Maximum Airspeed		(MSB)	
22	.			
23	.			
24	Maximum Airspeed		(LSB)	
25	PAD			
26	.			
27	.			
28	.			
29	PAD			
30	SSM			1
31	SSM			1
32	Parity		Odd	

NOTES:

[1] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal Operation
0	1	NCD
1	0	Functional Test
1	1	Failure warning

[2] Refresh interval: 200 milliseconds

[3] Bits 9, 10, 21, 22, 23, and 24 are not applicable to HFDL

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-8 ICAO 24-Bit Aircraft Address Word #1 - Label 214

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						**214**		
																								0 0 1	1 0 0	0 1

Bit	Function		Coding	Notes
1	Label		1	
2	.	2	0	
3	.		0	
4	.		0	
5	.	1	1	
6	.		1	
7	.		0	
8	Label	4	0	
9	PAD			
10	.			
11	.			
12	.			
13	PAD			
14	ICAO 24-Bit Address (Part 1)		A1 (MSB)	
15	.		A2	
16	.		A3	
17	.		A4	
18	.		A5	
19	.		A6	
20	.		A7	
21	.		A8	
22	.		A9	
23	.		A10	
24	.		A11	
25	.		A12	
26	.		A13	
27	.		A14	
28	.		A15	
29	ICAO 24-Bit Address (Part 1)		A16	
30	SSM			1
31	SSM			1
32	Parity		Odd	

c-2

NOTES:

[1] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal Operation
0	1	NCD
1	0	Functional Test
1	1	Failure Warning

[2] Refresh interval: 200 milliseconds

APPENDIX C
ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

Table C-9 ICAO 24-Bit Aircraft Address Word #2 - Label 216

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												**216**		
																								0 1 1	1 0 0	0 1

Bit	Function		Coding	Notes	
1	Label		1		
2	.	2	0		
3	.		0		
4	.		0		
5	.	1	1		
6	.		1		
7	.		1		
8	Label	6	0		
9	PAD				
10	.				
11	.				
12	PAD				
13	ICAO 24-Bit Address (Part 2)		A17		
14	.		A18		
15	.		A19		
16	.		A20		c-2
17	.		A21		
18	.		A22		
19	.		A23		
20	ICAO 24-Bit Address (Part 2)		A24 (LSB)		
21	PAD				
22	.				
23	.				
24	.				
25	.				
26	.				
27	.				
28	.				
29	PAD				
30	SSM			1	
31	SSM			1	
32	Parity		Odd		

NOTES:

[1] Sign Status Matrix Definition

BIT		MEANING
31	30	
0	0	Normal Operation
0	1	NCD
1	0	Functional Test
1	1	Failure Warning

[2] Refresh interval: 200 milliseconds

APPENDIX D
DOCUMENTS LIST

The following documents are referenced in this Characteristic. Designers should be aware that many of these documents are in the continuing process of being supplemented.

	ARINC Characteristic	Title
	429	Mark 33 Digital Information Transfer System (DITS)"
	559A	Mark 2 HF SSB/AM System
	597	Mark 2 Aircraft Communications Addressing and Reporting System
	714	Mark 3 Airborne SELCAL System
	719	Airborne HF/SSB System
	720	Digital Frequency/Function Selection for Airborne Electronic Equipment
	724	Mark 2 Aircraft Communications Addressing and Reporting System
c-1	724B	Aircraft Communications Addressing and Reporting System (ACARS)
	758	Communications Management Unit (CMU) Mark 2

	ARINC Specification	Title
	404A	Air Transport Equipment Cases and Racking
	600	Air Transport Avionics Equipment Interfaces (NIC Phase 1)
	608A	Design Guidance for Avionics Test Equipment
	616	Avionics Subset of ATLAS
	618	Air-Ground Character-Oriented Protocol Specification
	626	Standard ATLAS Subset for Modular Test
	631	VHF Digital Link Implementation Provisions
	635	HF Data Link Protocols
c-3	637P1	Aeronautical Telecommunications Network (ATN) Implementation Provisions, Part 1, Protocols and Services
	638	Upper Layer Specifications (End System Communication Specifications)

ARINC Report	Title
413A	Guidance for Aircraft Electrical Power Utilization and Transient Protection
604	Guidance for Design and Use of Built-In Test Equipment (BITE)
609	Design Guidance for Aircraft Electrical Power Systems
615	Airborne Computer High-Speed Data Loader
624	Design Guidance for Onboard Maintenance System

	RTCA Document	Title
c-1		
	DO-160C	Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments
	DO-163	Minimum Performance Standards for Airborne HF Radio Communications Transmitting and Receiving Equipment Operation Within the Radio Frequency Range of 1.5 to 30 Mhz
	DO-170	Audio Systems Characteristics and Minimum Operational Performance Standards - Aircraft Microphones (Except Carbon), Aircraft Headsets and Speakers, Aircraft Audio Selector Panels and Amplifiers
	DO-178B	Software Considerations in Airborne Systems and Equipment Certification

APPENDIX E
ACRONYM LIST

	AAC	Airline Administrative Communications
	ac	alternating current
	ACARS	Aircraft Communications Addressing and Reporting System
	ACK	Acknowledge
	ACP	Audio Control Panel
	ADL	Airborne Data Loader
	ADLP	Airborne Data Link Processor
	AEEC	Airlines Electronic Engineering Committee
	AF	Audio Frequency
	A/G	Air-ground
	AGC	Automatic Gain Control
	AHLC	Aviation HF Link Control
c-1	ALC	Automatic Level Control
	AM	Amplitude Modulation
	AME	Amplitude Modulated Equivalent
	AOC	Airline Operational Control
	APC	Airline Passenger Communications
	ARINC	Aeronautical Radio, Inc.
	ATC	Air Traffic Control
	ATE	Automatic Test Equipment
	ATLAS	Abbreviated Test Language for Avionics Systems
	ATM	Air Traffic Management
	ATN	Aeronautical Telecommunications Network
	ATS	Air Traffic Services
	AVLC	Aviation HF Link Control
	AVPAC	Aviation (VHF) Packet Communication
	BCD	Binary Coded Decimal
	BER	Bit Error Rate
	BIT	Built-In Test
	BITE	Built-In Test Equipment
	BNR	Binary Number
	BOP	Bit-Oriented Protocol
	BP	Bottom Plug
	BW	Bandwidth
	CAA	Civil Aviation Authority
	CCIR	International Radio Consultative Committee
	CCITT	International Telephone and Telegraph Consultative Committee
	CCS	Cabin Communications System
	CFDIU	Centralized Fault Display Interface Unit
	CFDS	Centralized Fault Display System
	CMC	Central Maintenance Computer
	CMS	Central Maintenance System
	CMU	Communications Management Unit
	CPLR	Coupler
	CTS	Clear to Send
	CTU	Cabin Telecommunications Unit
	CW	Continuous Wave
	dB	Decibel
	dBm	Decibels relative to 1 milliwatt
	dc	direct current
	DCE	Data Circuit-terminating Equipment
	DITS	Digital Information Transfer System
	DTE	Data Terminal Equipment

APPENDIX E
ACRONYM LIST

DTS	Data Transfer State
DXE	Data Exchange Equipment
EMI	Electromagnetic Interference
EOM	End of Message
FAX	Facsimile
FCS	Frame Check Sequence
FMC	Flight Management Computer
FMS	Frequency Management System
FOT	Frequency of Optimum Transmission
GMT	Greenwich Mean Time
GPS	Global Positioning System
HF	High Frequency
HFDCF	High Frequency Data Control Function
HFDCP	High Frequency Data Control Panel
HFDL	High Frequency Data Link
HFDR	High Frequency Data Radio
HFDU	High Frequency Data Unit
HFPAC	HF Packet
HFRCP	HF Radio Control Panel
HW	Hardware
Hz	hertz
ICAO	International Civil Aviation Organization
ID	Identifier
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Organization for Standardization
kHz	kilohertz
kW	kilowatt
LED	Light Emitting Diode
LRU	Line Replaceable Unit
LSB	Least Significant Bit/Byte
LSB	Lower Sideband
LWS	Local Wait State
LUF	Lowest Usable Frequency
MAC	Media Access Control
MCDU	Multifunction Control Display Unit
MCU	Modular Concept Unit
MHz	Megahertz
MP	Middle Plug
ms	millisecond
MSB	Most Significant Bit/Byte
MSI	Multi-wire Serial Interface
MSK	Minimum Shift Keying
MU	Management Unit
MUF	Maximum Usable Frequency
NAK	Negative Acknowledge
NCTS	Not Clear to Send
OOR	Out of Range
OSI	Open Systems Interconnection
OMC	Onboard Maintenance Computer
OMS	Onboard Maintenance System
PEP	Peak Envelope Power

APPENDIX E
ACRONYM LIST

PSK	Phase Shift Keying
PTT	Push-to-Talk
RAM	Random Access Memory
RCP	Radio Control Panel
RF	Radio Frequency
RMP	Radio Management Panel
RMS	Root-mean-Square
RNR	Receive Not Ready
ROM	Read Only Memory
RR	Receive Ready
R/T	Receive/Transmit
RTS	Request to Send
SAL	System Address Label
SDI	Source Destination Identifier
SDU	Satellite Data Unit
SELCAL	Selective Calling
SITA	Societe Internationale de Telecommunications Aeronautiques
SNR	Signal-to-Noise Ratio
SQP	Signal Quality Parameter
SRU	Shop replaceable Unit
SSB	Single Sideband
SW	Software
SYN	Synchronization
TEST	Test Frame
TP	Top Plug
UTC	Universal Coordinated Time
USB	Upper Sideband
VDR	VHF Data Radio
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
W	watt
XCVR	Transceiver
XID	Exchange Identity

SUPPLEMENT 1

TO

ARINC CHARACTERISTIC 753©

HF DATA LINK SYSTEM

Published: January 20, 1997

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 22, 1996

A. PURPOSE OF THIS SUPPLEMENT

This Supplement includes updates primarily to the HF Data Radio Design and Data Link Control Functions. Updates were also made to the Antenna Systems Control Protocol and Request Messages. A new Section on ACARS MU/CMU - HFDL Interface was added. Several attachments related to the HFDR, HF Data Control Panel, and Coupler Standard Interwiring were revised. The Maintenance System Codes were revised. New attachments on Dual HFDR Avionics Configurations (using ARINC 429 and Discrete Voice/Data Control & Feedback to RMPs), HFDR Output Labels, HFDR Activity Labels, and a Voice/Analog Data/Data Link Mode Selection Matrix were added. For a complete tabulation of changes see Section C below.

B. ORGANIZATION OF THIS SUPPLEMENT

This Supplement introduces a rework of Characteristic 753 to reflect an evolving HF Data Link System. The normal practice of publishing a separate Supplement to update the existing document has not been followed. The changes introduced by Supplement 1 resulted in the impracticality of producing a separate set of replacement pages. Supplement 1 is therefore available only as an integral part of ARINC Characteristic 735-1. The modified and added material on each page is identified by a c-1 in the margins.

C. CHANGES TO ARINC CHARACTERISTIC 753 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to the Characteristic introduced by this Supplement. Each change or addition is defined by the section number and the title currently employed in the Characteristic or by the section name and title that will be employed when the Supplement is eventually incorporated. In each case a brief description of the change or addition is included.

1.3.1 Airborne HFDL System Configuration

Changed "CMU" to "CMU Mark 2" and "748" to "758".

3.2 System Design

References to Attachments 2-1C and 2-1D were added in the first paragraph.

3.3.3 HF Data Link Control Functions

Added sentence at end of second paragraph.

3.6.1 HFDR Mode Select

Section rewritten for clarity.

4.2.1.1 Frequency Switching Time

Added clarifying text to second sentence in first paragraph. Changed "transceiver" to "transmitter" in second sentence under Data Mode.

4.2.2.1 Transmit to Receive Turnaround Time

Changed "Data Mode" to Analog Data Mode".

4.2.2.2 Receive to Transmit Turnaround Time

Changed "Data Mode" to Analog Data Mode". Changed "125 ms" to "200 ms" in first commentary.

4.4.1 Sensitivity

Changed "$\leq$" to "$\geq$".

4.4.6.2 Analog Data and Data Link Mode

Changed title from "Data Mode" to "Analog Data and Data Link Mode".

4.4.7 RF Sensitivity Control and/or Squelch Control

The preference for "digital" to prevail was changed to "analog" in the next to last sentence in the last paragraph. This was done because aircraft already in the field are receiving both analog and digital information at the present time. However, the Label 207 word may have all the squelch or sensitivity bits set to either all 0's or 1's depending on how the control panel vendor set the unused bits. If implemented as stated in the last paragraph prior to this change all the existing aircraft would lose sensitivity or squelch control.

4.6.1 Voice/Analog Data/Data Link Selection

Changed title from "HF Voice/Data Mode Switching" to "Voice/Analog Data/Data Link Mode Selection". Section replaced with new text on how the HFDR determines its operating mode.

4.6.1.1 Data Link

Section added.

4.6.1.2 Voice or Analog Data

Section added.

4.6.2.1 ARINC 719 Style HF Transceiver Tuning

The last paragraph beginning with "The HFDR should respond to ..." was deleted.

4.6.2.2 ARINC 559A Style HF Transceiver Tuning

A reference to Attachment 6 was changed to Attachment 5.

4.6.3 HF Transceiver Keying

Changed title from "HF Voice Transceiver Keying" to "HF Transceiver Keying". Deleted text and/or reorganized into new subsections 4.6.3.1, 4.6.3.2, and 4.6.3.3.

4.6.3.1 Voice Mode

Section added.

4.6.3.2 Analog Data Mode

Section added.

4.6.3.3 Data Link Mode

Section added.

4.6.4 <u>HF Antenna Coupler Tuning Initiation</u>

Changed "Tune Fail" to "Coupler Fault#1 (MP4E)" in the second paragraph.

4.6.5 <u>ACARS MU/CMU Interface Functions</u>

Changed a reference and made editorial change.

4.6.6 <u>Voice/Data Mode Switching Function</u>

Text deleted. Referenced Section 4.6.1.

4.6.7.1 <u>Aircraft Position Data</u>

Text was added to the end of the first paragraph explaining the priority order of obtaining the position data if more than one source of position data is available.

4.6.7.2 <u>Universal Coordinated Time (UTC) Data</u>

Text was added to the end of the first paragraph explaining the priority order of obtaining the time data if more than one source of Universal Coordinated Time (UTC) data is available.

4.6.7.3 <u>ICAO 24-Bit Address Data</u>

Changed title from "ICAO Address Data" to "ICAO 24-Bit Address Data". Section was rewritten to show the order of precedence for selecting the source of ICAO address data. The various sources of ICAO address were expanded. A commentary was added.

4.6.7.5 <u>Data Loader</u>

Added sentence indicating that HFDR #1 and #2 should use SAL 340. Added commentary.

4.6.8 <u>Status Indication</u>

Changed title from "Status Indication Discretes" to "Status Indication". Added ARINC 429 output bus as a source of status.

4.6.8.1 <u>HF DATA LINK LOST Bit</u>

Changed title from "HF DATA LINK LOST Indication Discrete" to "HF DATA LINK LOST Bit". Added HFDR Status should be indicated in the ARINC 429 label 270 word bit 11, as defined in Section 10 of this document.

4.6.8.2 <u>HFDR Fault Indication Discrete and Bit</u>

Changed title from "HFDR FAULT indication Discrete" to "HFDR FAULT Indication Discrete and Bit". Added bit 16 and made editorial changes.

4.6.8.3 <u>HFDL Transmit Inhibit Status Indication Discrete and Bit</u>

Section added.

4.6.11 <u>Transmit Inhibit Discrete Input</u>

The first sentence was replaced with two new sentences. The word "strut" was removed as an example of Inhibit Discrete source from the third sentence. The new text provides a better way to determine if the data radio should be allowed to make data transmissions. Wiring the strut to the inhibit discrete was considered a poor example as it would complicate the wiring without any effect to functionality.

4.6.12 <u>Key Event Output</u>

Changed "cockpit voice recorder" to "flight data recorder".

4.6.13 <u>SDI Input Pin Definition</u>

Added commentary.

4.6.14 <u>HF Test Enable Discrete Definition</u>

Section rewritten.

4.6.18 <u>CMU #1/#2 Speed Select</u>

Section added.

4.6.19 <u>HFDR Installed Discrete Output</u>

Section added.

4.6.20 <u>Ruthless Preemption</u>

Section added.

6.1 <u>Introduction</u>

A sentence outlining how the HFDCF can monitor the HFDR status was added to end of first paragraph.

6.2 <u>HFDCF Functions</u>

HFDR Installed and HFDL Transmit Inhibit status added to item d.

6.2.2 <u>Programmable Functions</u>

Commentary added.

6.2.4 <u>HF DATA LINK LOST Indication</u>

Monitoring of Label 270 bit 11 was added.

6.2.5 <u>HFDL FAULT Indication</u>

Changed title from "HFDU/HFDR FAULT Indication" to "HFDL FAULT Indication". Added monitoring of Label 270 bit 16.

6.2.10 <u>HFDR Installed Function</u>

Section added.

6.2.11 <u>HFDL Transmit Inhibit Status Indication</u>

Section added.

7.3 <u>HF Antenna Coupler</u>

Deleted last sentence of first paragraph before the commentary.

7.3.3 Power Handling Capability

The coupler power handling capability was changed, in the text and commentary, from "650" watts peak envelope power (PEP) to "504" watts (PEP) to be consistent with the radio.

7.4.3.4 Control Protocol Command and Request Messages

The COMMAND REQUEST descriptions for Perform Coupler System BIT, Perform Coupler Progressive BIT, Perform Coupler Progressive BIT Completed, Perform Coupler Progressive Bit Aborted, Request Coupler Version Completed, and Request Transceiver Version Complete**d** were revised. The COMMAND REQUEST descriptions for Perform Coupler Transmit BIT, Perform Coupler Transmit BIT Completed, and Perform Coupler Transmit BIT Aborted were added. Added a (M)andatory or (O)ptional column to the table.

9.7 HF Data Link to CMC Status Word

Section added.

10.0 ACARS MU/CMU - HFDL INTERFACE

On October 6, 1995, this new Section 10.0 and its subsections were moved from Draft 5 of Project Paper 635, "HF Data Link Protocols" Section 7.0 and its subsections. ARINC Specification 635 was subsequently adopted by the AEEC on October 31, 1995 and Published on December 22, 1995. Additional edits were then made to Section 10.0 during the drafting of this Supplement 1 to ARINC Characteristic 753 as follows:

10.3.1 Link Layer - Broadcast

Added text definitions of bits and replaced Table 10-1.

10.3.3 HFDL to MU/CMU Join/Leave Event Message

Added MSB first to the word description for bits 1-8 in Table 10-3.

10.3.4 HFDL to ACARS MU/CMU Subsystem Identifier Word

Added MSB first to the word description for bits 1-8 in Table 10-4.

10.4 Link Layer - bit Oriented File Transfer Protocol

Editorial change to note for option 010 in Table 10-5.

10.4.3 ISO 8208 Packets

Changed a reference.

10.5.2.1 Requirements Table Update Format

Added commentary regarding requirements table.

10.5.2.2 HFDL to MU/CMU Maintenance Data

Section added.

ATTACHMENT 2-1B HFDR SYSTEM BLOCK DIAGRAM

Updated Diagram.

ATTACHMENT 2-1C DUAL HFDR AVIONICS CONFIGURATION A (USING ARINC 429 VOICE/DATA CONTROL & FEEDBACK TO RMPs)

Attachment added.

ATTACHMENT 2-1D DUAL HFDR AVIONICS CONFIGURATION A (USING DISCRETE VOICE/DATA CONTROL & FEEDBACK TO RMPs)

Attachment added.

ATTACHMENT 2-2 HFDR STANDARD INTERWIRING

TP3A, TP3G, TP3H, TP3K, TP4J, TP5A, TP7G, TP7H, TP7J, TP9G, TP9H, TP9J, TP15K, MP2D, MP2F, MP3G, MP3H, MP4F, MP5D, MP5E, BP2, BP3, and BP7 were revised.

ATTACHMENT 2-3A HFDR TOP CONNECTOR LAYOUT

TP3A, TP3G, TP3H, TP3K, TP4J, TP5A, TP7G, TP7H, TP7J, TP9G, TP9H, TP9J, and TP15K were revised.

ATTACHMENT 2-3B HFDR MIDDLE CONNECTOR LAYOUT

MP2D was revised.

ATTACHMENT 4-1A HF DATA CONTROL PANEL STANDARD INTERWIRING

HFDCP pins 13, 15, and 17 were revised.

ATTACHMENT 4-1B HF DATA CONTROL PANEL CONNECTOR LAYOUT

Changed Pin 12 label from "DATA LINK LOST" to "HFDL DLK LOST".

ATTACHMENT 4-2A COUPLER STANDARD INTERWIRING

Coupler J1 Pins T and U were changed from "Spare" to "Manufacturer Reserved" for depot/bench test purposes.

ATTACHMENT 4-2B COUPLER CONNECTOR LAYOUT

Coupler J1 Pins T and U were changed from "Spare" to "Manufacturer Reserved" for depot/bench test purposes.

ATTACHMENT 5 NOTES TO STANDARD INTERWIRING

Note 5 was revised. Editorial change made to note 10. Note 11 was revised. The last sentence was deleted. Note 19 was revised.

ATTACHMENT 7 MAINTENANCE SYSTEM CODES

Table 7-3a. Bit-Oriented CFDS BITE Fault Summary Word for HFDR

Bit 16: Changed "Input Data" to "Control Input".
Bit 25: Changed "Opposite Side HFDL Input" to "Opposite Side HFDL Crosstalk Input". Changed bit status "0" from "Failed" to "OK".

Bit 26: Changed "X" to "HF Radio Type".

Bit 27: Changed "X" to "ICAO Address Determined".

Bits 30-31: Corrected the SSM.

Table 7-3b. Bit-Oriented CFDS BITE Fault Summary Word for HFDU

Bit 16-17: Deleted Function and Bit Status.

Bit 25: Changed "Opposite Side HFDL Input" to "Opposite Side HFDL Crosstalk Input". Changed bit status "0" from "Failed" to "OK".

Bit 26: Changed "X" to "HF Radio Type".

Bit 27: Changed "X" to "ICAO Address Determined".

Bits 30-31: Corrected the SSM.

Table 7-4-a. Fault Messages for HFDR BITE (Airbus Aircraft) transmitted on Label 365 to OMS.

Modified Table for Airbus aircraft.

Table 7-4-b. Fault Messages for HFDR BITE (Douglas Aircraft).

Added Table for Douglas aircraft.

ATTACHMENT 12 HFDR OUTPUT LABELS

Attachment was added.

ATTACHMENT 13 HFDR ACTIVITY LABELS

Attachment was added.

ATTACHMENT 14 VOICE/ANALOG DATA/DATA LINK MODE SELECTION MATRIX

Attachment was added.

APPENDIX C ARINC 429 CONTROL WORD FORMATS FOR THE HFDR

1.1 Frequency and Mode Control Serial Bus Inputs

Deleted last sentence.

1.1.3 207 HF COM Mode Control Word
Changed Note 1 to be consistent with the change in Section 4.4.7. In Note 3, changed "voice/data" to voice/analog data" in two places.

1.1.4 Control Input Faults for label 037
Revised first sentence to report fault to CFDS rather than to the maintenance processor and front CONTROL INPUT FAIL LED. Changed "at least 270 msec" to "more than 10 sec". Deleted "as described in Section 2.7.1" in next to last paragraph.

1.1.5 Control Input Faults for Labels 205/206/207

Revised first sentence to report fault to CFDS rather than to the maintenance processor and front CONTROL INPUT FAIL LED. Changed "at least 270 msec" to "more than 10 sec". Deleted "as described in Section 2.7.2" in next to last paragraph.

Label 037: Changed "Squelch is open" to "The HFDR will conduct a self test" in the SSM definition.

Label 207: **Bit 1** noted as MSB.

Bit 8 noted as LSB.

Bit 18 changed from "not used" to "HFDL1 Data Mode 1=Enabled 0=Disabled".

Bit 19 changed from "not used" to "HFDL2 Data Mode 1=Enabled 0=Disabled".

Changed "Squelch is open" to "The HFDR will conduct a self test" in the SSM definition.

Label 275: Added ICAO 24-Bit Address Word #1.

Label 276: Added ICAO 24-Bit Address Word #2.

APPENDIX D DOCUMENT LIST

Reformatted list.

APPENDIX E ACRONYM LIST

ALC added to acronym list.

SUPPLEMENT 2
TO
ARINC CHARACTERISTIC 753©
HF DATA LINK SYSTEM

Published: February 20, 1998

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: November 26, 1997

A. PURPOSE OF THIS SUPPLEMENT

This Supplement includes updates primarily to the ACARS MU/CMU - HFDL interface and the ARINC 429 Control Word Formats for the HFDR. New material on the Master/Slave mode selection and Cross-Talk bus data was added.

B. ORGANIZATION OF THIS SUPPLEMENT

This Supplement introduces a rework of Characteristic 753 to reflect an evolving HF Data Link System. The normal practice of publishing a separate Supplement to update the existing document has not been followed. The changes introduced by Supplement 2 resulted in the impracticality of producing a separate set of replacement pages. Supplement 2 is therefore available only as an integral part of ARINC Characteristic 753-2. The modified and added material on each page is identified by a c-2 in the margins.

C. CHANGES TO ARINC CHARACTERISTIC 753 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to Characteristic 753 introduced by Supplement 2. Each change or addition is defined by the section number and title currently employed in Characteristic 753. In each case a brief description of the change or addition is included.

4.3.7 Tone Tuning Signal

Added Commentary.

4.5.3 Phase Shift

Corrected phase shift values.

4.6.1.1.1 Master/Slave Mode Selection

Section added.

4.6.7.3 ICAO 24-Bit Aircraft Address Data

Added aircraft to section title. Added Labels 214 and 216 to subparagraphs c and d.

4.6.7.6 Cross-Talk Bus Data

Section added.

4.6.13 SDI Input Pin Definition

Added paragraph after table.

10.3.1 HFDL to ACARS MU/CMU Status Word

Revised bits 9, 10, 12, and 19 definitions. Changed bit 26 from “spare” to “frequency loaded” and added commentary. Revised Table 10-1, HFDL To ACARS MU/CMU Status Word Bit Formats. Added bit 27 Air/Ground Status definition. Editorial changes were also made.

10.3.4 HFDL to ACARS MU/CMU Subsystem Identifier Word

Corrected Table 10-4, HFDL to ACARS MU/CMU Subsystem Identifier Word Bit Formats.

10.4 Link Layer - Bit Oriented File Transfer Protocol

Editorial changes made.

10.4.1 File Formats

Added HFDL message file type to Table 10-6.

10.4.3 ISO 8208 Packets

Reformatted table.

10.5.2 Command/Control Format

Changed table number and added text to Table 10-8, Command/Control File Format, to clarify the usage of the command and control structure. Changed Command Codes 01_h and 02_h to reserved.

10.5.2.1 HFDL to MU/CMU Maintenance Data

This was formerly Section 10.5.2.2. Added type designation for each response to aid the MU/CMU in providing a more responsive MCDU interface to the crew. The former Section 10.5.2.1 Requirements Table Update Format was revised and moved to Section 10.6 HFDL Messages.

10.5.2.2 HFDL to MU/CMU Maintenance Data

Changed to Section 10.5.2.1

10.6 HFDL Messages

Section added. The former Section 10.5.2.1, Requirements Table Update Format, was moved to this location and revised to indicate that the HFDL Message file contents are manufacturer defined. The commentaries were revised.

ATTACHMENT 7 - MAINTENANCE SHIPPING CODES

Editorial changes made to notes for Table 7-4a.

ATTACHMENT 13 - HFDR ACTIVITY LABELS

Added Labels “207 or 037” for Frequency Select Port “B.” Added Label “270” for CMU #2 Data Input. Added Labels “214/216” for ICAO Digital ID #1 Input. Added Labels “275/276 or” ICAO Digital ID #2 Input.

ATTACHMENT 15 - HFDR MASTER/SLAVE MODE SELECTION MATRIX

Attachment added.

Appendix C ARINC 429 Control Word Formats for the HFDR

Reformatted Tables. Editorial revisions. Corrected Labels 275 and 276 SSM definitions and changed refresh interval from “TBD” to “200 ms”.

SUPPLEMENT 3

TO

ARINC CHARACTERISTIC 753©

HF DATA LINK SYSTEM

Published: February 16, 2001

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: August 11, 2000

A. PURPOSE OF THIS SUPPLEMENT

This Supplement adds the HF Voice and HFDL classes of emission and updates the receiver selectivity for the Single Side Band (SSB) suppressed carrier. The Label 272 SDI bits 9-10, Label 270 HF Data Link Availability bit 11, and the Airborne Subsystem Block Diagram have been updated as well. Tables containing timer variables of the Low and High Speed Bit-oriented Protocol – Version 1 have been added in a new Attachment 16.

B. ORGANIZATION OF THIS SUPPLEMENT

The first part of this document, printed on golden-rod paper contains descriptions of changes introduced into this Characteristic by this Supplement. The second part consists of replacement white pages for the Specification, modified to reflect the changes. The modified and added material on each page is identified by a "c-3" in the margins. Existing copies of ARINC Characteristic 753 may be updated by simply inserting the replacement white pages where necessary and discarding the pages they replace. The golden-rod pages are inserted inside the rear cover of the Specification.

C. CHANGES TO ARINC CHARACTERISTIC 753 INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to the Characteristic introduced by this Supplement. Each change or addition is defined by the section number and the title that will be employed when the Supplement is eventually incorporated. In each case a brief description of the change or addition is included.

4.3 Transmitter

New Section added.

4.4.2.1 SSB Suppressed Carrier

Revised receiver passband attenuation specification to be in alignment with Attachment 8 and the draft ICAO SARPs.

4.6.7.6 Cross-Talk Bus Data

Revised values for SDI Bits 9-10.

4.6.8.1 HF Data Link Lost Bit

Changed reference. Deleted the phrase "has been in a frequency search mode longer than 3 minutes, or if the HFDL system". Deleted the phrase "while the system continues to attempt establishment of a connection".

4.6.18 CMU #1 #2 Speed Select

Editorial revisions. Deleted last sentence in commentary.

4.6.20 Ruthless Preemption

Revised fourth paragraph to include reference to the other transmit inhibit conditions and to avoid the impression that transmit inhibit should be removed unconditionally when the 30 to 90 second timer expires.

10.3.1 HFDL to ACARS MU/CMU Status Word

Revised fourth paragraph to include more detail regarding the setting of Bit 11 HFDL Available.

10.4 Link Layer – Bit Oriented File Transfer Protocol

Editorial revisions to reference new Attachment 16.

ATTACHMENT 1 - AIRBORNE SUBSYSTEM BLOCK DIAGRAM.

Replaced with updated diagram and changed from "Attachment 1-1" to "Attachment 1".

ATTACHMENT 16 - HFDR TABLES

New attachment added.