Component Maintenance Publication

HFS-2200 High Frequency System

Component Maintenance Publication

RCA2CNS-0EFD0-CA249-01

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Rockwell Collins

HFS-2200 High Frequency System

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Component Maintenance Publication

This publication includes data for the equipment that follows:

Unit	Part No.
HFS-2200 High Frequency System	822-2764-050

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Cedar Rapids, Iowa 52498
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Introduction - HFS-2200

General

1. The HFS-2200 High Frequency System processes transmit and receive data as well as analog voice. The HFS-2200 operates on frequencies spaced 100 Hz apart in the 2 to 30 MHz band. For compatibility with existing ARINC 719 installations, the HFS-2200 provides:

   - Single Side Band (SSB) suppressed carrier voice
   - Amplitude Modulation Equivalent (AME) voice
   - Selective Calling (SELCAL)
   - Analog data functions

   In addition to providing traditional HF radio functionality, the unit contains an internal data modem and controller for ARINC 753 compatibility. Voice transmission is compatible with current single sideband HF transceivers. Data transmission is compatible with ground HF transmitting and receiving systems, which use conventional HF transceivers and ARINC 635 compliant modems and controllers.

2. Refer to Fig 1 for a full view of the equipment. Table 1 gives the equipment included in this publication. Table 2 gives the related equipment necessary but not supplied with the HFS-2200.

Table 1 Equipment covered

Equipment type	Description	Rockwell Collins Part Number
HFS-2200	The HFS-2200 is a High Frequency (HF) receiver-transmitter that provides voice and HF data link communication. The unit contains a direct conversion receiver/transmitter translator, linear transmit power amplifier, modem and variable frequency AC power supply.	822-2764-050

Table 2 Related equipment

Equipment	Type or description
CPL-920D	A digitally tuned HF antenna coupler in accordance with ARINC 719/753 to transform antenna impedance to provide a 50 ohm resistive load for the HFS-2200.
RAIMS	Radio and Audio Integrated Management System (RAIMS) provides flight crew radio/audio management functions including tuning, voice/data switching, status indications and audio distribution.
ACR	Avionics Communications Router (ACR) provides the airborne part of the Aircraft Communications Addressing and Reporting System (ACARS) (data link) system.

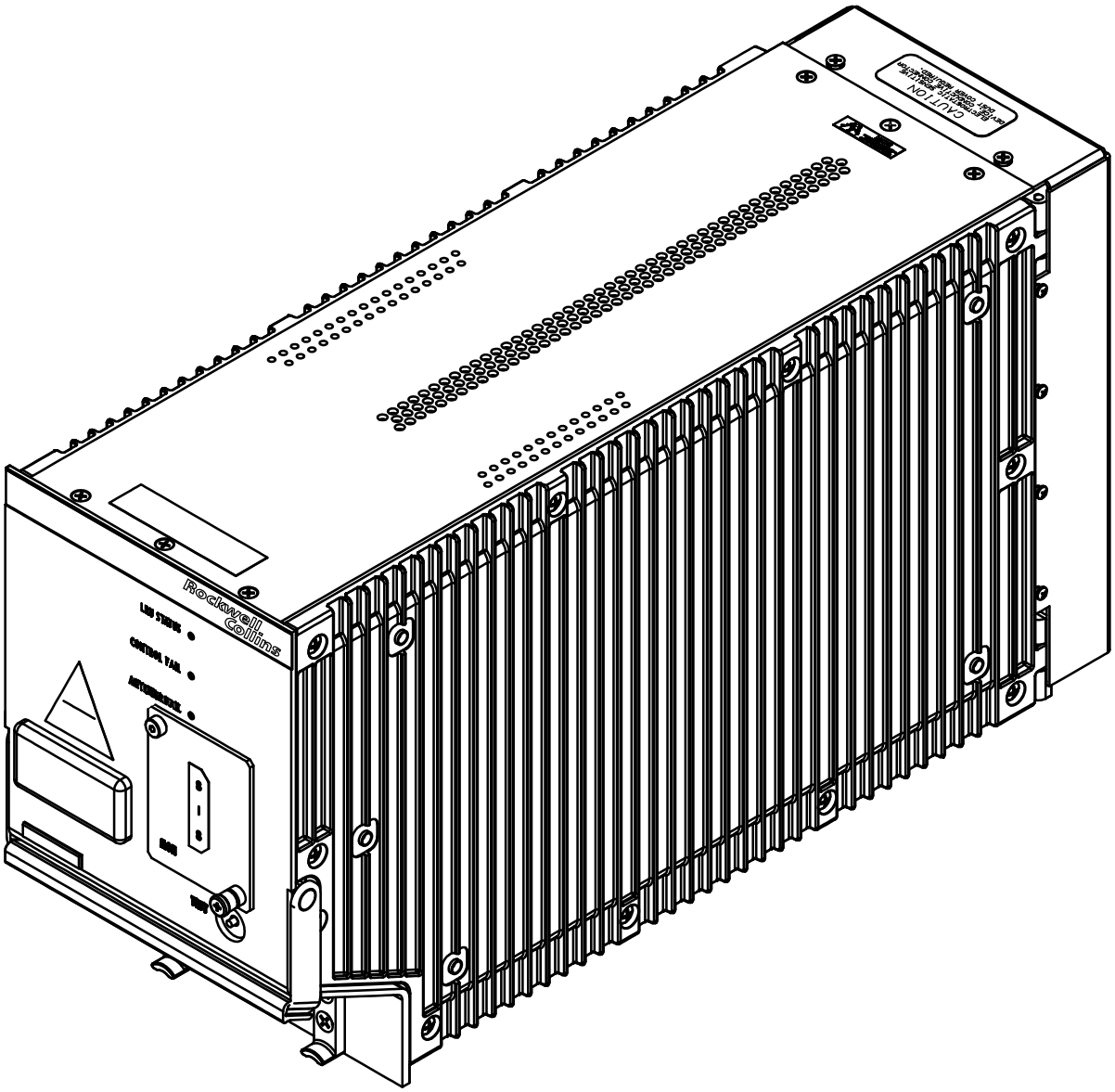

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Figure 1 HFS-2200 High Frequency System

Description of function - System theory

1. General description

   A. The High Frequency (HF) communications system provides two-way air-to-ground voice and data communications capability for Air Traffic Services (ATS) and Aircraft Operational Control (AOC).

   B. The HFS-2200 has ground and airborne sub-systems and uses Radio Frequency (RF) channels in the HF aeronautical communications bands. The communications range can be world-wide dependent upon HF propagation characteristics. The HFS-2200 gives communications that operate in the frequency band from 2.000 to 29.999 MHz. Refer to Fig 1 for a system block diagram.

   C. The HFS-2200 provides simplex (i.e. one at a time over the same channel) transmit and receive capability for conventional analog voice/data and HF Data Link (HFDL). The HFS-2200 communications sub-system may be controlled and operated manually for voice operation or independently for message exchanges using digital data. Single Side Band (SSB) and Amplitude Modulation Equivalent (AME) voice modes are used for both ATS and AOC communication based on frequency assignment. The HFDL gives AOC data communication, is set by the operator and operates independently.

   D. One or two HFS-2200 units may be installed in an aircraft. Each HFS-2200 has low speed ARINC 429 serial input and output crosstalk ports for exchanging data with the other radio in a dual installation.

2. ACR interface

   A. The Avionics Communications Router (ACR) provides the Aeronautical Telecommunications Network (ATN) router function, network management provisions for ATN air-to-ground data links ATN compatible interfaces with on-board end-systems (from ARINC 748). The link layer interface between the HFS-2200 and the ACR is a pair of ARINC 429 and data buses. The HFS-2200 accepts ARINC 429 data from a second ACR. The buses may be configured for high or low speed operation by the ACR (#1 or #2) Bus Speed strap.

   Note

   ATN is a civilian / global packet data communications web. The ACR is also known as the Communications Management Unit (CMU)

3. LGERS interface

   A. The Landing Gear Extension and Retraction System (LGERS) supplies an air/ground discrete to the HFS-2200. The HFS-2200 uses this discrete to determine the aircraft's flight status, to mark flight leg transitions, enable or disable self–tests and to condition the storage of fault data in internal nonvolatile memory. The polarity of this discrete is determined by the Air/Ground Program strap. The LGERS system also supplies the TX Inhibit discrete to the HFS-2200 to lock out transmissions while on the ground. Inhibiting transmissions prevents arcing and exposing the flight line maintenance crew to the powerful electromagnetic fields produced during transmission. The TX Inhibit Sense discrete is active when the aircraft is on the ground. The TX Inhibit Program strap selects the polarity of the TX Inhibit Sense discrete.

4. FQMS interface

   A. The HFS-2200 accepts a discrete from the Fuel Quantity Management System (FQMS) via the Common Remote Data Concentrator that gives the refuel status of the aircraft. Transmissions are prevented to eliminate the risk of arcs while the aircraft is refueled.

5. ICP interface

   A. The Integrated Control Panel (ICP) allows the transmitter key inhibit function of the HFS-2200 to be overridden to allow the pilot or service personnel to test data link operation while on the ground.

6. DLCS and gateway interface

   A. The Data Loading and Configuration System (DLCS) connects to a gateway which provides the discrete signal and ARINC 429 interface required to upload data and operational programs into the HFS-2200 while installed in an aircraft. The HFS-2200 has an ARINC 429 high speed data loader in receive port and a high speed data loader out transmit port to interface to the data loader. The HFS-2200 data loader discrete input must be grounded to enable data loading.

7. ADIRS interface

   A. After power up in data link mode, the HFS-2200 attempts to log on to the HFDL network. It does so by tuning to an HFDL ground station frequency selected from a table stored in nonvolatile memory and listening for a squitter message from the station. If a squitter message is not received, or the channel is not usable due to poor RF propagation, the HFS-2200 tunes to another ground station frequency and listens again for the squitter. The selection of a ground station frequency likely to have satisfactory RF propagation characteristics can be improved with knowledge of time and current aircraft position. The HFS-2200 has two low speed ARINC 429 serial input ports for this purpose, to accept latitude, longitude, altitude and Universal Time Coordinate from the Air Data Inertial Reference System (ADIRS).

8. Analog data unit interface

   A. The analog data unit is a modem that uses the HFS-2200 and antenna coupler system as the RF link with a ground station. The HFS-2200 has audio input and output ports to interface to the modem. The HFS-2200 analog data output port has a source impedance of 100 ohms or less and its output level is adjustable from -10 to +10 dBm in 600 ohms. This output is active when the HFS-2200 is not in data link or transmit mode. The analog data input port accepts a voice band signal from the modem to modulate the transmitted signal. When using a parallel Radio Control Panel (RCP) or a serial RCP with label 037, the Voice/Data discrete input to the HFS-2200 must be grounded to enable transmit keying from the analog data input. The HFS-2200 automatically keys it's transmitter when a signal is present at the analog data input, or the Data key line may be used to key the transmitter.

9. SELCAL interface

   A. Aircraft Selective Calling (SELCAL) is handled in the Radio and Audio Integrated Management System (RAIMS). This function consists of a tone decoder that accepts audio signals from the radio and provides a visual or aural indication in the cockpit to advise the crew of an upcoming voice transmission from a ground station. SELCAL is described in ARINC Characteristic 714.

10. Flight recorder interface

   A. The HDST-2200 headset supplies a Key Event signal to the flight recorder. The flight recorder registers the state of the microphone key. The Key Event is a replica of the Push-To-Talk (PTT) signal to the HFS-2200.

11. Radio management interface

   A. The HFS-2200 operates in conventional or data link mode. Conventional mode includes voice communication and an analog data mode that is a remnant of older HF equipment and retained in the HFS-2200 for use with an external modem. Data link mode refers to packet communications over the ATN HF sub-network. Associated with each mode is equipment for managing the operation of the system from the cockpit.

12. RAIMS interface

   A. The Radio and Audio Integrated Management System consist of a Radio and Audio Management Panel (RMP) and Audio Management Unit (AMU). The RMP tunes and configures the HFS-2200 and the AMU controls the PTT discrete and routes audio to-and-from the HFS-2200.

   B. HFS-2200 conventional voice-mode receive/transmit switching is controlled by the crew with a PTT switch. The PTT switch is routed through the audio system to the HFS-2200 and antenna coupler. The PTT switch is normally open to select receive mode and closed to ground to select transmit. The PTT is ignored by the HFS-2200 when in data link mode or when the voice/data discrete is grounded, or when analog data transmission is selected from the RMPs.

   C. The HFS-2200 receives PTT status from the offside HFS-2200 by way of the other side PTT. In a dual HFS-2200 installation sharing a single antenna, one radio may be configured for data link operation and the other for voice operation, but only one system at a time may transmit. The data link HFS-2200 may monopolize the use of the antenna for significant periods of time to transmit a large data stream. To allow immediate voice access to the antenna, the data link HFS-2200 will release control of the antenna when the other side PTT is activated. It will not resume any data link transmission until the other side PTT is inactive for a certain length of time.

D. The conventional voice input signal to the HFS-2200 transmitter is supplied by a crew member microphone which converts sound to an electrical signal. The signal is routed through the audio system AMU to the microphone input on the HFS-2200. The HFS-2200 microphone input impedance is nominally 150 ohms and the circuit supplies 16 V DC through 200 ohms for microphone excitation. The HFS-2200 microphone input circuit is adjustable to allow audio input levels from 0.1 to 5.5 V rms to produce the rated transmitter Peak Envelope Power (PEP). This circuit also contains a speech processor for improved intelligibility of the transmitted speech signal.

E. The HFS-2200 receiver analog audio output signal is delivered to the audio system AMU. The audio output signal also contains sidetone, which is the HFS-2200 microphone input signal at the output of the speech processor. The audio system converts the electrical signal to sound in crew headphones or speakers. The HFS-2200 audio output circuit is adjustable from 5 mW to 40 mW into 600 ohms and is not affected by short or open circuit conditions. Source impedance of the audio output circuit is 20 ohms during power-on.

13. Central Maintenance System interface

A. The HFS-2200 and antenna coupler contain Built-In Test Equipment (BITE) to monitor their health and the health of connected systems. The HFS-2200 collects the health information and provides periodic reports to the Central Maintenance System (CMS) via its Centralized Fault Display System (CFDS) output, a low speed ARINC 429 serial data bus. The CMS manages the collection, analysis and display of fault information from all aircraft constituent systems that have BITE and health reporting capability. The CMS uses a low speed ARINC 429 serial data bus to transmit commands and data to the CFDS input port on the HFS-2200. These commands include marking the beginning of flight legs, requesting the system to conduct a self-test and gaining access to the fault history data stored in the system. The HFS-2200 takes data from the CMS such as date, time, aircraft identification and flight number and appends it to the stored fault information to aid in fault isolation and troubleshooting. The interface to the CMS varies among airframe manufacturers. The HFS-2200 CFDS Mode A, B and C straps determine which interface is in use.

14. ICAO address generator interface

A. International Civil Aviation Organization (ICAO) address refers to the aircraft's unique 24-bit SSR Mode S identifier (as defined in ICAO Annex 10 [9], Volume 1, Part 1, Appendix C, pages 150I-150L). The HFS-2200 uses the address in data link messages and receives the ICAO address from one of four sources, listed in order of precedence:

- ACR #1, via labels 214 and 216 on the ARINC 429 high or low speed bus.
- ACR #2, via labels 214 and 216 on the ARINC 429 high or low speed bus.
- A source such as the Mode S transponder, via labels 275 and 276 on the ARINC 429 high or low speed bus.
- Twenty four discrete straps, plus one strap for even parity.

15. HF antenna interface

A. The system receives (or transmits) the RF signal from (or to) the ground station via the HF antenna. In commercial transport aircraft, the HF antenna is generally one of the following four types: fixed wire, probe, cap, or shunt/notch. System retrofit installations can expect to find any of the four antenna types in use. In aircraft with dual HF installations, the radios often must share a single antenna. The antenna coupler is installed near the antenna feed point.

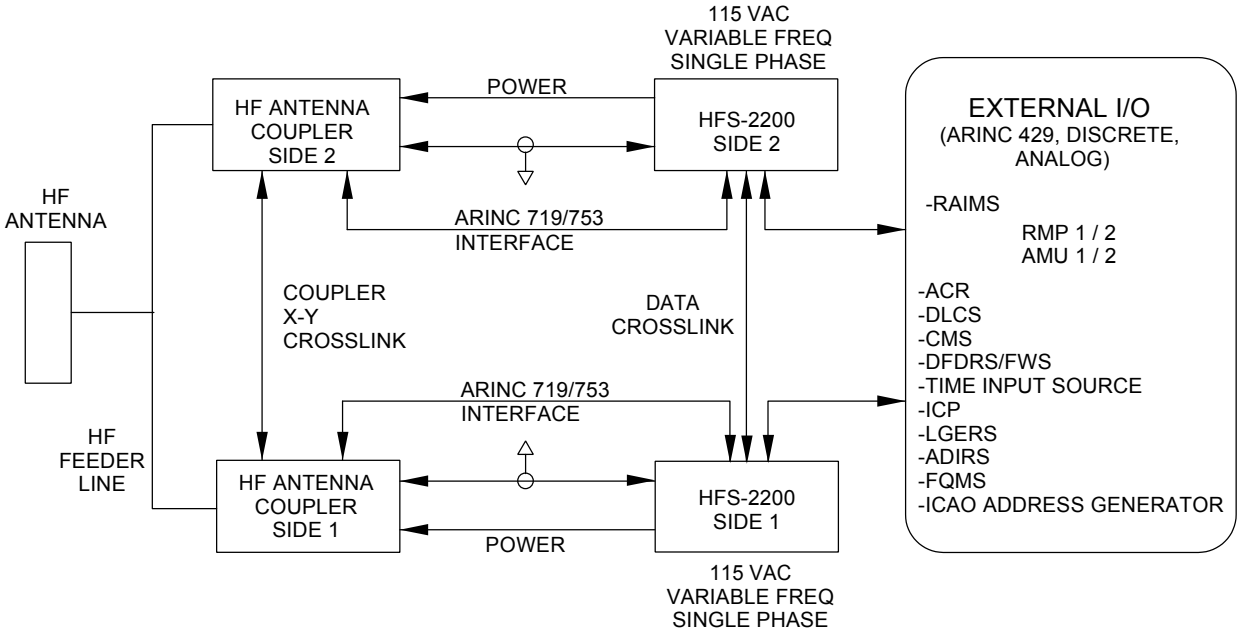

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Figure 1 System block diagram

End of Description of function - System theory

B. Driver amplifier

(1) The driver amplifier is a single stage 50 volt amplifier (MRF6V2010NBR1) with a minimum gain of 23 dB. The maximum input to this stage is 17 dBm. The amplifier is capable of 40 dBm or 10 W output. It's input has minimum input return loss of 15 dB from 2 to 30 MHz. The output is matched into a 4:1 RF transformer. The DC bias is supplied by a buffer voltage control input from the HF modem. Current is monitored by current sense resistor R61. The voltage drop across R61 is buffered before being returned to the HF modem.

C. Final amplifier

(1) The final amplifier is a push-pull stage that uses (Q4, MRFP11KHR6) dual FET in a single package. This dual transistor is rated for 1000 watts output. RF from the driver is coupled to the final amplifier through T1. T1 converts the driver output from a single ended signal to dual signals, 180º apart. The low impedance output of Q4 is raised through T2, a 4:1 transformer and fed to the low-pass filter section of the power amplifier. The DC bias is supplied by a buffer voltage control input from the HF modem. Current is monitored by current sense resistor R62. The voltage drop across R62 is buffered before being sent back to the HF modem. Capacitors C235 and C236 supply lightning protection for transients that are not clamped by the gas discharge tube on the rear interconnect assembly.

D. Low-pass filter

(1) The output of the power amplifier is connected to a seven band low-pass filter. Each band is relay selectable. The relays are commanded from the HF modem through a SPI bus to relay drivers on the power amplifier. These relay drivers have internal protection circuitry to protect against inductive voltage spikes generated when a relay is de-energized. The relays have 28 V DC relay voltage applied at all times and the driver selects the desired relays by grounding the other end of the coil. Table 7 shows the low-pass filter band frequencies.

Table 7 Low-pass filter band frequency

Band	Frequency range (MHz)
1	2.000 to 2.950
2	2.950 to 4.400
3	4.400 to 6.450
4	6.450 to 9.390
5	9.390 to 13.100
6	13.100 to 20.300
7	20.300 to 30.000

E. Built-in test circuitry

Technical data - Equipment specifications

1. Table 1 shows the equipment specifications for the HFS-2200. Table 2 shows the environmental specifications for the HFS-2200.

2. Fig 1 shows the service bulletin matrix and assembly revision level. The data in the service bulletin matrix is used to interpret the modification markings on the equipment subassemblies. The service bulletin matrix lists the top level unit part numbers and applicable service bulletins. Each service bulletin has the applicable modification mark annotated under the subassembly in the table.

Table 1 Equipment specifications

Characteristic	**Specification**
Certification/Related documents	
FAA TSO / EASA ETSO	C158, C170
EUROCAE	ED-14E, ED-12B
RTCA	DO-160E, DO-178B
Airbus	ABD0100.1.2, Issue G
Physical	
Height	200 mm (7.87 in)
Width	128.5 mm (5.06 in)
Length	378.12 mm (14.89 in)
Weight	6.99 kg (15.38 lb)
Outline and physical dimension	Refer to Data module RCA2CNS-A-23-10-94-02003-030B-C HFS-2200 Description of function - Mechanical description
Cooling	Forced air cooling in accordance with ARINC 600.
Maintenance tasks	On condition
Electrical	
Input power	115 V AC, 360 Hz to 800 Hz, single phase
Receive mode power input	35 W maximum
Transmit mode power input	650 W maximum
Frequency range	Wide range select (MP-5J) grounded: 2.0000 to 29.9999 MHz. Wide range select open: 2.8000 to 23.9999 MHz. Out-of-range selection indicated by aural tone when Push-To-Talk (PTT) is keyed.
Frequency channels	Wide: 280 000 for 100-Hz spacing 28 000 for 1-kHz spacing. Narrow: 212 000 for 100-Hz spacing 21 200 for 1-kHz spacing.

Table 1 Equipment specifications (Continued)

Characteristic	Specification
RF power output	RF power output is measured at the end of a 5 foot length of RG-8U transmission line when terminated with a 50 ohm resistive load.
Single Side Band (SSB)	400 W nominal peak envelope power +1.0, -1.5 dB (voice or data mode).
Amplitude Modulation Equivalent (AME)	125 W average, +1.0, -1.5 dB
Tune	70 to 100 W average
Data	125 W average, +1.0, -1.5 dB
Duty cycle	20 % maximum
RF output load impedance	50 ohms
Audio input	
Microphone input	0.1 to 5.5 V rms, gives rated power, 150 ohms balanced.
Analog data input	0.1 to 5.5 V rms, 600 ohms balanced. An audio input greater than 500 mV keys the transmitter. A 300 ms delay occurs after the analog data is removed.
Speech processing	Modulation limiting is provided so the input signal can be increased to a level 10 dB above the preset value without the transmitter exceeding the spectrum limits and without distortion of the data signals.
Modulation capability	
SSB	Power output of 400 W peak envelope power +1.0, -1.5 dB (voice or data mode) with input tones of 400, 1000, 1450 and 1800 Hz, four tone audio input at 0.2 V rms/tone.
AME	The HFS-2200 supplies a minimum of 75% modulation with the signal at the adjusted level into the microphone input.
Carrier level	

Table 1 Equipment specifications (Continued)

Characteristic	Specification
SSB	The carrier is suppressed at least 40 dB below the rated peak envelope power with equal 0.25 V rms 1800 Hz and 400 Hz tones at microphone input. **Note** The average power Automatic Level Control (ALC) circuit is disabled during this test to reach the 400 W peak envelope power nominal level.
AME	The carrier level is not more than 6 dB below the peak envelope power of the transmitter when the transmitter is modulated with a single 1 kHz tone.
Noise level	Peak amplitude of noise is not more than 5% of the RF amplitude for an audio input of 2000 Hz at a level that supplies an RF output 6 dB below 400 W peak envelope power in SSB mode.
Frequency response	No more than +2.5, -6 dB with respect to level at 1 kHz, maximum variation in transmitter output power, at 6 dB below rated peak envelope power, with input audio varied from 350 to 2500 Hz.
Harmonics	All harmonically related spurious emissions are at least 43 dB below full rated output when measured into a 50 ohm resistive load at full rated output power.
Non-harmonics	All non-harmonically related spurious emissions are less than 25 microwatts when measured into a 50 ohm resistive load at full rated output power and more than 20 kHz frequency offset.
Frequency stability	Frequency Center (fc) ±20 Hz maximum over all environmental conditions.
Audio frequency distortion	In band harmonics not less than 20 dB below 400 Hz test tone with RF output 6 dB below 400 W peak envelope power.
Sidetone	There are two sidetones supplied by the HFDR: tune tone and transmit audio. The received audio/sidetone output (MP-1D, 1E) is factory adjustable from 5 to 40 mW maximum into 600 ohms. The factory setting of this output is 10 mW with a 1 kHz tone applied to the transmitter input.

Table 1 Equipment specifications (Continued)

Characteristic	Specification
Transmit-to-receive recovery time	With the squelch threshold set for 3 microvolts, the receiver will supply 90% of its output with an input level of 10 microvolts modulated 30% at 1000 Hz within 100 ms after the transmitter is unkeyed.
Receive-to-transmit delay time	No more than 200 ms after the mic key line and key interlock become active, the transmitter power output is a minimum of 90% of rated output.
Sensitivity	
SSB	1 microvolt for 10-dB (s+n)/n
AM	4 microvolt modulated 30% at 1000 Hz for a 10-dB (s+n)/n
Selectivity	
SSB	2-dB passband: fc + 350 Hz to fc + 2500 Hz; 35-dB stopband: fc to fc - 300 Hz and fc + 2900 Hz to fc + 3300 Hz; 60 dB stopband: below fc -300 Hz and above fc + 3300 Hz.
AM	6-dB passband: fc 2750 Hz min; 60-dB stopband: fc ±6000 Hz.
AGC characteristics	
AGC signal handling capability	Maximum 6-dB audio output variation for 5-microvolt to 100-mV RF input. Maximum 2 dB variation of audio output for 100 mV to 1 V RF input level.
AGC time constraints	Voice (SSB): Less than 50 ms attack time for 60 dB increase, 1.0 to 2.0 s decay time for 60 dB decrease. Data: Less than 10 ms attack time for 60 dB increase, 20-25 ms decay time for a 60 dB decrease.
SELCAL Output	
Frequency response	Maximum 3-dB difference in levels between any two SELCAL tones between 300 to 1500 Hz.
Output power	0.1 to 40 mW into 600 ohms.
Harmonic distortion	No more than 5% SELCAL audio distortion at 0.5 V output into 600 ohms with 1000 microvolt RF input signal modulated 30% at 1000 Hz.

Table 1 Equipment specifications (Continued)

Characteristic	Specification
Main audio output	Factory adjustable, 0.1 to 40 mW into 600 ohms ±20% ohms. The output is isolated from ground and is open and short circuit protected. Output will operate normally after removal of the short or open. The factory sets the output to 10 mW at 1 kHz.
Source impedance	The audio output supplies less than 100 ohms impedance to the load circuit with power on. The output supplies less than 1000 ohms impedance to the load circuit with power off. The source limits apply with the frequency range of 100 Hz to 6000 Hz.
Output load level regulation	When the output signal is adjusted to 10 mW into 600 ohms at 1 kHz, the output voltage does not change more than 2 dB with the load changed between 450 ohms and 2400 ohms and by not more than 6 dB when the load is changed between 200 ohms and 20,000 ohms. This is also true when tested with 350 Hz and 2500 Hz signals.
Gain	A standard input signal of not more than 2 microvolts supplies a receiver output not less than 10 mW into a 600 ohm ±20% resistive load.
Frequency response	Not more than 4 dB variation (with a 1 kHz reference level) in audio output when 1000 microvolts AM signal is modulated 30% from 300 to 2500 Hz. Frequencies above 3750 Hz are attenuated at least 20 dB.
Distortion (AME mode)	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 does not exceed 5% with 30% modulation or 10% with 90% modulation (with the gain control reset to maintain the output at 10 mW), including effects of the noise limiter.
Distortion (SSB mode)	Not more than 12% audio output harmonic distortion for 1000 microvolts USB single tone input signal in audio band 350 Hz to 2500 Hz.
Analog data output	The analog data output is supplied on pins MP-1F and MP-1G. This output is not used for HF Data Link (HFDL) data. It is provided only for compatibility with previous ARINC 719 transceivers. Output specifications are as follows.

Table 1 Equipment specifications (Continued)

Characteristic	Specification
Output power	Factory adjustable, 0.1 mW to 40 mW into 600 ±20% ohms. The output is isolated from ground and is open and short circuit protected. The output operates normally after the short or open is removed. The nominal output is set to 0 dBm at 1 kHz.
Source impedance	The analog data output supplies less than 20 ohms impedance to the load circuit with power on. The output presents less than 1000 ohms impedance to the load circuit with power off. The source limits are for the frequency range of 100 Hz to 6000 Hz.
Output load level regulation	The output level is independent of the effects of the squelch and noise limiter circuits.
Frequency response	Not more than 4 dB change (to a 1 kHz reference level) in audio output when 1000 microvolts AM signal is modulated 30% from 300 to 2500 Hz. Frequencies above 3750 Hz are attenuated at least 20 dB.
Distortion	With an input signal of 1 mV and the output level adjusted to 0 dBm into a 600 ohm resistive load, the total distortion is not more than 5% in the SSB mode.
SSB intermodulation distortion	Third order products at least 50 dB below each of two test tones, from 1 microvolt/tone to 20,000 microvolts/tone, with audio level within 10 dB of rated output. For tone levels up to 100,000 microvolts/tone the third order product is at least 30 dB below each of the test tones. With a 1.2 kHz 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 is possible to increase the level of this interfering carrier to a level corresponding to 100 mV before the 1.8 kHz intermodulation product equals the level of the 1.2 kHz desired signal output.

Table 1 Equipment specifications (Continued)

Characteristic	Specification
Cross-modulation distortion	When operating in the SSB suppressed carrier mode, with the simultaneous application of an SSB input signal at fc + 1000 Hz and an undesired signal displaced 10 kHz from the desired signal, with 85% modulation at 400 Hz, the 400 Hz receiver output due to cross-modulation is at least 10 dB below the reference tone under the following conditions: Desired signal level = 20 microvolts, undesired signal level = 1,000 microvolts. Desired signal level = 2,000 microvolts, undesired signal level = 100,000 microvolts.
Image and spurious response	The input signal level required to produce an output signal plus noise-to-noise ratio of 6 dB must be at least 60 dB greater than that required with a standard SSB signal when the frequency of the input signal is varied over the range of 0.190 to 1260 MHz, excluding the range of fc - 1500 Hz to fc + 4500 Hz.
Desensitization	Not more than 6 dB reduction in rated output for 10 microvolts desired in the presence of a 10,000 microvolts unmodulated carrier with a frequency varied between 1.5 and 30 MHz, but excluding the range of fc - 3000 Hz to fc + 6000 Hz.
RF sensitivity control	The RF sensitivity control has a range of at least 50 dB.
Receiver frequency switching time	Changing from one receive frequency to another frequency does not require more than 250 ms.
Squelch control	USB threshold range adjustable from 2 to 50 microvolts. AM threshold range adjustable from 5 to 50 microvolts.
HF data link operation	
User data rate	300, 600, 1200 and 1800 bps.
Modulation	Phase Shift Keying (PSK) depending on data rate of a carrier (RF +1440 Hz).
Forward error correction	1/2 for data rates 600 to 1800 bps. 1/4 for data rate 300 bps.
Interleaver time period	1.8 s or 4.2 s, all data rates.

Table 1 Equipment specifications (Continued)

Characteristic	Specification
Equalizer	Implemented, trained by preamble and probe data.
Bit scrambler	15 stage shift register.
Prekey	249 ms, 448 2 PSK symbols.
Preamble	295 ms, 531 2 PSK symbols.
Data	3240 M-PSK symbols - 1.8 s interleaver.
Frame structure	Time Division Multiple Access (TDMA) protocol.

Table 2 Environmental specifications

Conditions	DO-160E para no.	Specification
Temperature and altitude	4.0	
Low temperature	4.5.1, 4.5.2	Category A2
High temperature	4.5.3, 4.5.4	Category A2
In-flight loss of cooling	4.5.5	Category Z. (20 hours at 40 °C + 55 °C (104 °F + 131 °F) for 30 minutes)
Altitude	4.6.1	Category A2
Decompression	4.6.2	Category A2
Overpressure	4.6.3	Category A2
Temperature variation	5.0	Category A
Humidity	6.0	Category A
Operational shock and crash safety	7.0	Category E
Vibration	8.0	Equipment tested to random vibration Category H using curve R. Equipment tested to sinusoidal vibration Category S using curves C and L.
Explosive atmosphere	9.0	Equipment not tested (Category X)
Waterproofness	10.0	Equipment not tested (Category X)
Fluids susceptibility	11.0	Category F (Spray Method: Cleaning Agents, Extinguishing Agents & Disinfectants).

Table 2 Environmental specifications (Continued)

Conditions	DO-160E para no.	Specification
Sand and dust	12.0	Category D
Fungus	13.0	Category F
Salt fog	14.0	Equipment not tested (Category X)
Magnetic effect	15.0	Category Z
Power input	16.0	Category A(WF)H
Voltage spike	17.0	Category A
Audio frequency susceptibility	18.0	Category K(WF)
Induced signal susceptibility	19.0	Category CW
Radio frequency susceptibility	20.0	Category RR
Radio frequency emission	21.0	Category M Conducted emissions on cables tested to Category H.
Lightning induced transient susceptibility	22.0	Category B3K33
Lightning direct effects	23.0	Equipment not tested (Category X)
Icing	24.0	Equipment not tested (Category X)
Electrostatic discharge	25.0	Category A
Fire, flammability	26.0	Equipment not tested (Category X) Equipment parts analyzed to the requirements of Category C.