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Minimum Operational Performance Standards for Aircraft VDL Mode 3 Transceiver Operating in the Frequency Range 117.975 - 137.000 MHz

RTCA DO-271C
Supersedes DO-271B
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Prepared by: SC-172

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FOREWORD

This document was prepared by RTCA Special Committee 172 (SC-172) and approved by the RTCA Program Management Committee on November 8, 2005.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal Advisory Committee and develops consensus based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

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- Analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency.

- Developing consensus on the application of pertinent technology to fulfil user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation.

- Assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunications Union and other appropriate international organizations can be based.

The organization's recommendations are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration Technical Standard Orders.

Since RTCA is not an official agency of the United States Government, its recommendations may not be regarded as statements of official government policy unless so enunciated by the U. S. government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

The physical layer material of this document is based on the Physical Layer MOPS for Airborne VDL Mode 2 (EUROCAE Working Group 47 document, ED-92, dated March 2000), since the physical layer is largely in common to both VDL Mode 2 and VDL Mode 3. Development of this document and ED-92 were coordinated with EUROCAE Working Group 47.

Appendix B is a Normative Appendix.

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1 PURPOSE AND SCOPE

1.1 Introduction

This document contains the minimum operational performance standards (MOPS) and verification procedures for an aircraft Very High Frequency (VHF) Digital Link (VDL) Mode 3 transceiver, intended to be used for air-ground (A/G) voice and data communications. The document is designed so that equipment certified to its standards will be compatible with the VDL Mode 3 Minimum Aviation System Performance Standards (MASPS) in RTCA DO-224B.

Compliance with these standards is one means of assuring that VDL Mode 3 equipment will function satisfactorily under all conditions normally encountered in air traffic control (ATC) A/G operations and that data formats will be compatible with the Aeronautical Telecommunications Network (ATN). These standards specify characteristics useful to designers, manufacturers, installers, and users of the VDL Mode 3 A/G communications system equipment.

This document is organized in four major technical sections and appendices as follows:

Section 1 describes the purpose and scope.

Section 2 contains minimum performance requirements under both standard and environmental test conditions with equipment performance verification procedures.

Section 3 describes installed equipment performance tests.

Section 4 describes operational performance tests.

Appendix A contains a list of acronyms used in this document.

Appendix B contains matrices that cross reference requirements to verification testing and equipment architecture classes under environmental conditions and for standard conditions. This appendix is normative in the sense that it specifically identifies which requirements make up the minimum set for the standard classes of equipment.

Appendix C defines the assumed functional partitioning of VDL Mode 3 protocol functions for the separated equipment architecture.

Appendix D provides an example of the Data/Management Interface for the separated equipment architecture. This example is described at a high level. No protocol details (e.g., bit definition, data rate, physical layer details, etc.) for the Data/Management Interface are given.

Appendix E defines test vectors for evaluation of the vocoder audio levels and a silence test vector for BER testing.

1.2 System Overview

The VDL Mode 3 A/G communications system provides functionally simultaneous voice and data communications between aircraft and ground-based users. The VDL Mode 3 A/G communications system architecture is defined to provide coverage similar to today's analog-based Double Sideband-Amplitude Modulation (DSB-AM) system as a minimum. In addition, VDL Mode 3 uses Time Division Multiple Access (TDMA) technology to provide integrated voice and data communications between aircraft users and ground-based users and operates in the standard VHF Aeronautical Mobile (Route) Service (AM(R)S) band.

The VDL Mode 3 system is capable of operating in today's sectorized airspace. The ground controller and the associated aircraft users form a user group that is assigned dedicated communications resources (a frequency and time slots) for voice and data communications under control of the ground station. The VDL Mode 3 system can be configured for voice only time slots per frequency assignment or for voice and a data link in separate time slots for each user group on that frequency assignment. Voice communication is based on a low rate voice-encoding algorithm to achieve high bandwidth efficiency and, for most of the system configurations, uses listen-before-push-to-talk (LBPTT) protocol similar to today's analog-based system.

The VDL Mode 3 data subsystem is designed to be a subnetwork of the ATN and is organized according to the Open Systems Interconnection (OSI) model of the International Standards Organization (ISO). Data communications are reservation-based to provide contention-free data service. Point-to-point data communications between an aircraft ATN router and a ground ATN router are provided through the VDL Mode 3 system via the Aircraft Network Interface (ANI) and Ground Network Interface (GNI), respectively. Point-to-multi-point data communication is also provided as one way data broadcast from the ground station to the aircraft stations.

The VDL Mode 3 system is related to the three lower layers of the OSI model (illustrated in Figure 1-1) providing services described as follows:

Layer 1 (Physical layer): The Physical layer provides transceiver frequency control, bit exchanges over the radio media, and notification functions. These functions are known as "radio" and "modulation" functions.

VDL Mode 3 uses differentially encoded eight phase shift keying (D8PSK) modulation with a raised cosine filter (α = 0.6). The information to be transmitted is encoded with 3 bits/symbol. The transmitted symbol rate is 10,500 symbols/s, resulting in a nominal bit rate of 31,500 bits/s.

Layer 2 (Link layer): The Link layer is split into two sublayers and a management entity.

The Media Access Control (MAC) sublayer provides access control to the Physical layer using TDMA and is based on a centralized ground-based reservation system for data link access.

The Data Link Services (DLS) sublayer is composed of an Acknowledged-Connectionless Data Link (A-CLDL) protocol whose main functions are frame exchanges, frame processing, priority queuing, error detection, and error recovery.

The Link Management Entity (LME) is in charge of link establishment and release services between the aircraft and ground DLS sublayers. It also delivers link status information to the subnetwork, DLS, and the Voice Unit.

Layer 3 (Network layer): The VDL Mode 3 MASPS in RTCA DO-224B define only the lowest sublayer of the Network layer, the Subnetwork Access Protocol (SNAcP) sublayer.

The SNAcP sublayer provides transport of VDL Mode 3 subnetwork packets through the use of a payload field similar to what is used in links today such as Ethernet. The subnetwork layer provides packet exchanges, header compression, and subnetwork connection management functions, and can provide error recovery, flow control, and packet fragmentation. The VDL Mode 3 subnetwork layer can be configured to send Connectionless Network Protocol (CLNP) packets and connection-oriented ISO 8208 packets.

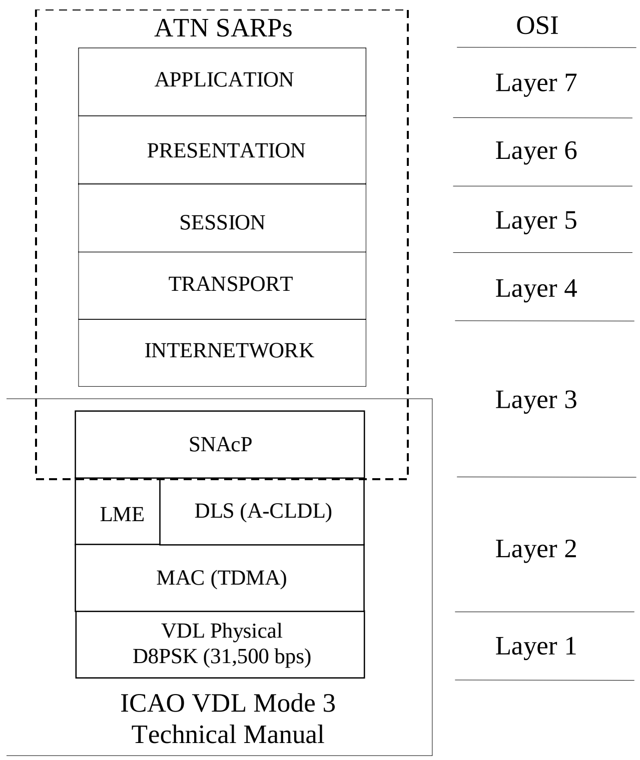


Figure 1-1: VDL Mode 3 Protocol Layers Using ATN/OSI Nomenclature

1.3 Aircraft Equipment Architectures

VDL Mode 3 avionics equipment may be implemented in several differing physical architectures. This paragraph describes two possible types of aircraft equipment architectures: one type is composed of integrated equipment and the other is composed of separated equipment. Although these architectures are not the only possible architectures, they are representative of the most common equipment architectures expected in the marketplace.

1.3.1 Integrated Equipment Archhitecture

According to the services provided, the integrated equipment architecture is divided into either a combined voice and data architecture (shown in Figure 1-2a) or a voice only architecture (shown in Figure 1-2b).

1.3.1.1 Voice and Data Capable

In the integrated equipment architecture that provides both voice and data applications, all VDL Mode 3 functions associated with an aircraft radio are integrated into a common physical unit of equipment. Throughout this document this integrated equipment architecture for voice and data is generically referred to as equipment architecture ID (**I**ntegrated equipment with **D**ata capability in addition to voice capability). Other equipment required for operation in the integrated equipment architecture for voice and data includes a VHF antenna, as illustrated in Figure 1-2a. In equipment architecture ID, the radio control/management functions may be internal or external. Note that equipment architecture ID is further defined and classified in Section 2.1.9, depending upon the subnetwork interfaces implemented.

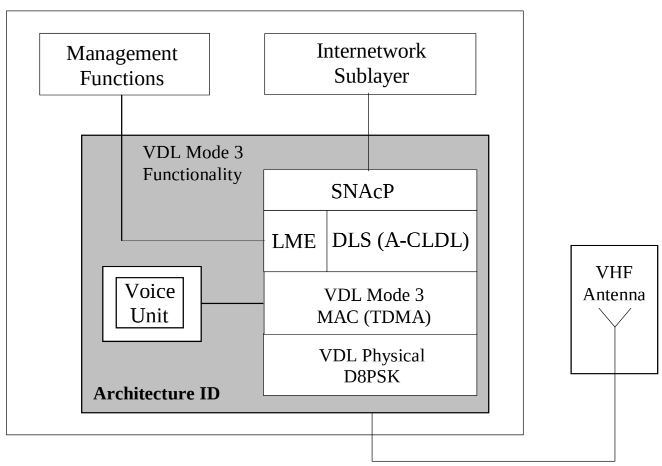


Figure 1-2a: VDL Mode 3 Functions in Integrated Equipment Architecture (Voice and Data)

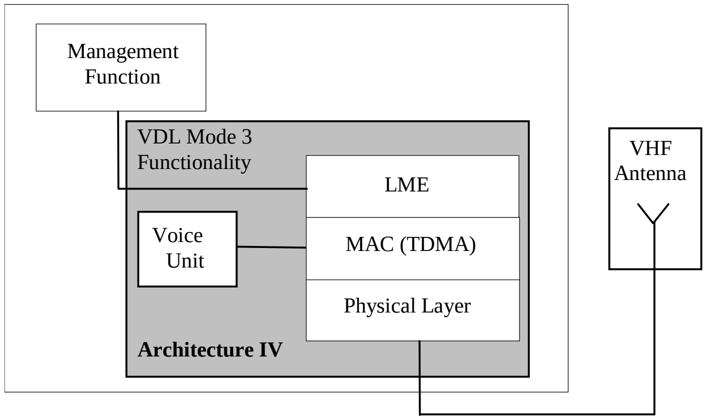


Figure 1-2b: VDL Mode 3 Functions in Integrated Equipment Architecture (Voice Only)

1.3.1.2 Voice Capable Only

In the architectures that provide voice-only service, all VDL Mode 3 functions required to support voice-only operations are integrated into a common physical unit of equipment. Throughout this document these integrated voice-only architectures are referred to as architecture **IB** (**I**ntegrated equipment with **B**asic voice-only capability) and architecture **IV** (**I**ntegrated equipment with **V**oice-only capability). Other equipment required for operation in architecture IB or IV includes a VHF antenna, as illustrated in Figure 1-2b. In voice-only architectures, the radio control/management functions may be internal or external. Note that voice-only architectures are further defined in Section 2.1.9.

1.3.2 Separated Equipment Architectures

For the separated equipment architecture it is assumed that both voice and data services are provided. In the separated equipment architecture (shown in Figure 1-3) the VDL Mode 3 functionality is divided between the VHF Digital Radio (VDR) and the Communication Management Unit (CMU). The VDL Mode 3 functional allocation between the VDR and CMU and the interface characteristics assumed in this document are given in Appendices C and D. The VDR implements the lower layer protocols in the VDL Mode 3 protocol stack while the CMU implements the upper layers in the VDL Mode 3 protocol stack. The VDR is classified as architecture SL (**S**eparated equipment with **L**ower layer protocols) while the CMU is classified as architecture SU (**S**eparated equipment with **U**pper layer protocols). Architectures SL and SU are further defined and classified in Section 2.1.9, depending upon the subnetwork interfaces implemented.

Architecture SL (VDR) implements the Physical layer, the MAC sublayer, the Voice Unit, most of the DLS sublayer, a portion of the LME, and a function providing the data and management information transfer between the VDR and the CMU.

Architecture SU (CMU) implements the SNAcP sublayer, a subset of the DLS sublayer, a portion of the LME and a function providing the data and management information transfer between the CMU and the VDR.

Note: This example illustrates one possible way of allocating the functionality between the VDR and CMU. Other functional allocations can be considered.

Other equipment required for operation in the separated equipment architecture includes a VHF antenna, as illustrated in Figure 1-3. The separated equipment architecture assumes that the radio control/management functions are performed via the CMU and/or an external Radio Tuning Panel.

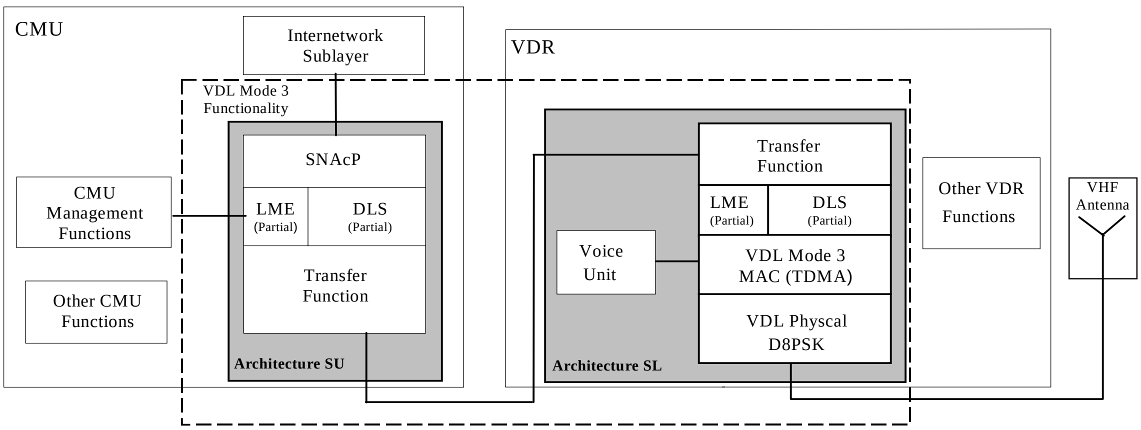


Figure 1-3: VDL Mode 3 Functions in Separated Equipment Architecture

1.4 Operational Applications

While operational applications will evolve with time, this document defines minimum standards to support implementation of anticipated applications. The specific applications to be served can be classified under the following general categories:

a. Air Traffic Control (ATC)
b. Flight Information Services (FIS)
c. Aeronautical Operational Control (AOC)

1.5 Operational Goals

The operational goals of the VDL Mode 3 system are to:

a. improve spectrum utilization
b. enhance voice operational capabilities with equal or better voice quality and increased voice capacity, compared to the 25 kHz DSB AM system
c. add new data link capability
d. support A/G communications for sector-oriented user groups.

1.6 Equipment Performance Verification

To test the equipment for compliance with the performance requirements, four types of tests are specified. These include:

a. Bench Tests
b. Environmental Tests

c. Installed Equipment Tests
d. Operational Tests

The performance requirements for each type of tests and the corresponding test procedures are specified in this document. The order of tests suggests that the avionics transceiver be subjected to a succession of tests as it moves from design into design validation, equipment qualification, and operation. The objectives of these tests are described in the following subsections.

1.6.1 Bench Tests

The equipment will be subjected to bench tests to verify compliance to the performance requirements under controlled environment. The test results may be used as the basis for approval of equipment design, equipment qualification, and acceptance. The bench test procedures are specified in Section 2.4. Appendix B contains cross-references of tests to equipment architecture classes.

1.6.2 Environmental Tests

Upon successful completion of bench tests, the equipment will be subjected to environmental tests to verify compliance to the performance requirements under extreme environmental conditions expected in actual operations and abnormal conditions. The test results may be applied to equipment qualification and acceptance. The environmental tests are specified in Section 2.3. Table B-1 contains cross-references of environmental tests to equipment architecture classes.

1.6.3 Installed Equipment Tests

After successful environmental tests, the equipment will be installed in the aircraft for further testing to verify compliance to the performance specifications of Section 3 in the aircraft environment. The installed equipment tests will be conducted primarily with the aircraft on the ground using simulated or operational system inputs and may be supplemented with flight tests. The test results may be used to isolate design faults that are traceable to the general aircraft environment, e.g., radio frequency interference (RFI) and the aircraft power supply system. As in the case of bench and environmental tests, the installed equipment tests are critical to equipment qualification and acceptance. The installed equipment tests are specified in Section 3.

1.6.4 Operational Tests

After successful completion of the installed equipment tests, the equipment will be subjected to operational tests conducted by operating personnel to ensure that the equipment, as a part of the overall A/G communications system, operates satisfactorily end-to-end in real operational environments. The operational tests are specified in Section 4.

1.7 Definitions of Terms

1.7.1 Adjacent Channel

In VDL Mode 3, an adjacent channel is a channel that has a bandwidth of 25 kHz and whose frequency assignment is adjacent to that of a desired reference channel. A first adjacent channel is a channel whose center frequency is 25 kHz above or below that of the desired VDL Mode 3 channel. The n^{th} adjacent channel is a channel whose center frequency is 25n kHz above or below that of the desired VDL Mode 3 channel.

1.7.2 Adjacent Channel Power

Adjacent channel power is the amount of radio frequency (RF) signal power that falls within a given adjacent channel.

Adjacent channel power includes discrete spurious signals, signal sidebands, and noise density (including phase noise) at the transmitter output.

1.7.3 Adjacent Channel Rejection (ACR)

ACR corresponds to the receiver's ability to demodulate the desired signal and meet the BER requirement in the presence of an adjacent channel interfering signal.

The ACR ratio, expressed in decibels (dB), is the maximum power difference between the adjacent channel interfering signal and the desired signal that allows the specified BER performance to be met.

1.7.4 Bit Error Rate (BER)

BER is expressed as the ratio between the number of erroneous bits received and the total number of bits received. The uncorrected BER represents the BER without the benefit of Forward Error Correction (FEC).

1.7.5 Co-channel Interference (CCI)

CCI protection is the overall capability of a receiver to demodulate the desired signal and achieve the specified bit error rate (BER) performance in the presence of an unwanted signal at the same assigned frequency.

The CCI ratio is the power ratio between the desired signal and the unwanted signal expressed in dB.

1.7.6 Error Vector Magnitude (EVM)

Error Vector Magnitude (EVM) is defined as the root mean square (rms) error in the in phase-quadrature phase (I-Q) vector magnitude measured at the ideal sampling points, expressed as a percentage. Mathematically, this can be written as

$$EVM = 100 \cdot \sqrt{Expectation\left(\left(\Delta I^2 + \Delta Q^2\right) / \left(I^2 + Q^2\right)\right)}.$$

At the ideal sampling points, the I-Q values are on the unit circle so that $I^2 + Q^2 = 1$, and

$$EVM = 100 \cdot \sqrt{Expectation\left(\Delta I^2 + \Delta Q^2\right)}.$$

Methods that use more than one sample per symbol to determine EVM are acceptable, provided the measurements can be related to the definition above.

1.7.7 Reference Signal Level

The reference signal level is the desired signal level used in the receiver performance specifications unless otherwise stated.

1.7.8 Transmitter Reference Burst Sequence

For tests, which require stressing the transmitter, a reference burst sequence is defined and is illustrated in Section 2.4.1.8.

1.7.9 Undesired VDL Mode 3 Test Signal

An undesired signal is a simulated VDL Mode 3 signal generated on a valid VDL Mode 3 frequency channel by means of a continuous wave (CW) signal frequency modulated by a 400 Hz tone with a peak frequency deviation of 5.25 kHz.

Note: *This test signal represents an idealized VDL Mode 3 signal, with adjacent channel spectral characteristics that are significantly better than those permitted for a VDL Mode 3 transmitter that marginally meets the requirements of Section 2.2.1.3.7 of this MOPS.*

1.7.10 Basic Voice Service

The provision of push-to-talk voice services without the support of using discretely addressable Local User IDs for signaling between the ground station and aircraft stations (aircraft stations use the dummy Aircraft ID, i.e., 61). The Basic Voice service is available to aircraft stations in TS1, TS2, or TS3 timing state.

1.7.11 Enhanced Voice Service

Enhanced Voice service, which provides operational enhancements to the Basic Voice service, relies on signaling between the ground station and the aircraft stations using Local User IDs for aircraft station addressing. The Enhanced Voice service features are defined in RTCA/DO-279 Next Generation Air/Ground Communications (NEXCOM) Principles of Operations VDL Mode 3. The Enhanced Voice service is available to aircraft stations that have received discrete Local User IDs by successfully completing the net entry process (see RTCA DO-224B, Section 3.3.2.3.2.1.2) and are in TS1 timing state. The ground station has the option not to support certain Enhanced Voice features through the Supported Options message signaling during the net entry process (see RTCA DO-224B, Section 3.3.2.3.2.1.2.1).

1.7.12 Enhanced Voice and Data Service

Provides all the Enhanced Voice functions described above in addition to a data link capability employing at least one of the protocol stacks described in this specification. (These services are available after the successful completion of the net entry procedure and Initial Link Negotiation.)

1.8 Reference Documents

This document uses shorthand references to other documents. The references and full identification of the applicable documents are as given in Table 1-1 below. The reference documents of the exact date and issue, including the indicated changes, apply unless otherwise noted.

Table 1-1: Reference Documents

Identifier	Date	Title
DO-160D	July 29, 1997 including Change 1, Dec. 14, 2000, Change 2, June 12, 2001, and Change 3, Dec. 5, 2002	Environmental Conditions and Test Procedures for Airborne Equipment
DO-178B	Dec.1, 1992 including Errata, Mar 26, 1999	Software Considerations in Airborne Systems and Equipment Certification
DO-186B	Nov 8, 2005	Minimum Operational Performance Standards for airborne Radio Communications Equipment Operating within the Radio Frequency Range 117.975 – 137.000 MHz
DO-224B	Aug 3, 2005	Signal-in-Space Minimum Aviation System Performance Standards (MASPS) for Advanced VHF Digital Data Communications Including Compatibility with Digital Voice Techniques
ICAO Doc 9705	Third Edition, 2002	Manual of Technical Provisions for the Aeronautical Telecommunications Network (ATN)
ISO/IEC 8208	Mar 15, 1990	Information Processing Systems – Data Communications – X.25 Packet Level Protocol for Data Terminal Equipment
ISO 8885	Dec, 1993	HDLC Procedures – General Purpose XID Frame Information Field Content and Format

1.9 Assumptions

This MOPS assumes an antenna that meets the requirements of DO-186B and DO-224B.

2 MINIMUM PERFORMANCE STANDARDS FOR EQUIPMENT

2.1 General Design Requirements

Note: *Appendix B presents a matrix correlating MASPS requirements of RTCA DO-224B with MOPS tests for equipment architecture classes.*

2.1.1 Airworthiness

The equipment shall not, under either normal or faulty conditions, impair the airworthiness of the aircraft in which it is installed.

2.1.2 Intended Function

The equipment shall perform its intended function, as defined by the manufacturer, and its proper use shall not create a hazard to users of the airspace.

2.1.3 ITU and FCC Rules and Regulations

The equipment shall comply with the relevant International Telecommunications Union (ITU) Radio Regulations, Federal Communications Commission (FCC) Rules and Regulations, and applicable electromagnetic interference (EMI) and electromagnetic compatibility (EMC) standards or such other requirements as are applicable.

2.1.4 Fire Protection

All materials used shall be self-extinguishing except for small parts (such as knobs, fasteners, seals, grommets and small electrical parts) that would not contribute significantly to the propagation of a fire. Furthermore, plenum cable shall be used, where appropriate, to prevent toxic fumes in case of a fire.

Note: *One means of showing compliance is contained in Federal Aviation Regulations (FAR), Part 25, Appendix F.*

2.1.5 Operation of Controls

The operation of controls intended for use during flight, in all possible positions, combinations and sequences, shall not result in a condition whose presence or continuation would be detrimental to the continued performance of the equipment. Controls shall be designed to maximize operational suitability and minimize pilot workload. Reliance on pilot memory for operational procedures shall be minimized.

2.1.6 Accessibility of Controls

Controls that are not intended for adjustment by the flight crew shall not be readily accessible. Controls that are normally adjusted in flight shall be readily accessible and properly labeled as to their intended function. The controls shall be operable with the use of only one hand.

2.1.7 Effects of Test

Unless otherwise provided, the design of the equipment shall be such that, subsequent to the application of the specified tests, no condition exists which would be detrimental to the continued performance of the equipment.

2.1.8 Equipment Classes

2.1.8.1 Receivers

One class of VDL Mode 3 receiver is defined as follows:

Class G: Receivers used in a 25 kilohertz (kHz) channel separation environment.

Note: *Classes A through E are DSB-AM receivers defined in RTCA DO-186B. Class F is the VDL Mode 2 receiver defined in EUROCAE ED-92 and in RTCA DO-281A (VDL Mode 2 MOPS).*

2.1.8.2 Transmitters

Two classes of VDL Mode 3 transmitters are defined as follows:

Class 9: Transmitters designed to operate in a 25 kHz channel separation environment with a maximum range of 200 nautical miles.

Class 10: Transmitters designed to operate in a 25 kHz channel separation environment with a maximum range of 100 nautical miles.

Note: *Classes 1 through 6 are DSB-AM transmitters defined in RTCA DO-186B. Classes 7 and 8 are VDL Mode 2 transmitters defined in EUROCAE ED-92 and in RTCA DO-281A (VDL Mode 2 MOPS).*

2.1.9 VDL Mode 3 Avionics Equipment Classes

This MOPS defines seven (7) VDL Mode 3 equipment classes. These classes will provide flexibility for manufacturers in equipment implementation to meet the market needs and allow testing for certification of avionics equipment implemented in different equipment architectures. The VDL Mode 3 avionics equipment classes are classified in accordance with the following:

- services provided (basic voice only, enhanced voice only, or data/voice)
- equipment architecture (integrated or separated)
- subnetwork interface protocols implemented (ISO 8208 or CLNP)

Throughout this document the equipment architecture nomenclature is based on using the letter “I” to indicate integrated equipment and “S” to indicate separated equipment; a second letter is used to indicate services provided in the case of integrated equipment, “B” for basic voice only, “V” for enhanced voice only, and “D” for data in addition to enhanced voice. Note that enhanced voice includes basic voice. In the case of separated equipment, the second letter is used to indicate the layers of protocols implemented, “L” for the lower layers and "U" for the upper layers. Furthermore, the lower protocol stack designated by "L" shall include all protocol functions necessary to support enhanced voice operation. By combining these two letters:

- IB is used to designate an equipment architecture with basic voice capability only.
- IV is used to designate an integrated equipment architecture with enhanced voice capability only.
- ID is used to designate an integrated equipment architecture with both enhanced voice and data capabilities.
- SL is used to designate a separated equipment architecture that implements the lower layer protocols in the VDL Mode 3 protocol stack. By itself SL supports enhanced voice and, in conjunction with SU, provides both enhanced voice and data capabilities.
- SU is used to designate a separated equipment architecture that implements the upper layer protocols in the VDL Mode 3 protocol stack and, in conjunction with SL, provides both enhanced voice and data capabilities.

The 2-letter equipment architecture designators described above is followed by a single digit numerical designator to identify the specific subnetwork interface protocols implemented. A "0" after the letter designator is used to indicate that a subnetwork interface is not relevant and is not implemented; a "1" is used to indicate the ISO 8208 subnetwork interface with compression, and a "2" is used to indicate the CLNP subnetwork interface with compression. As indicated in Section 2.2.3.1.2 the ground station is not required to support the Raw, ISO 8208 without compression, CLNP without compression, or ATN Frame Mode subnetwork interface, and therefore, no separate subnetwork designator is assigned for these subnetwork interfaces in this MOPS. Furthermore, as indicated in 2.2.3.1.1, aircraft stations supporting data link services must provide the raw interface or some other means for direct access to data information at the subnetwork access protocol interface.

By combining the two letter designators and the numerical designators, a total of 7 equipment classes are defined in Table 2-1 for VDL Mode 3 avionics radios.

Table 2-1: Equipment Architecture Class for VDL Mode 3 Avionics Radio

Equipment Class	Equipment Architecture	Services	Subnetwork Interface
IB0	Integrated (Transceiver)	Basic V only	N/A
IV0	Integrated (Transceiver)	Enhanced V only	N/A
ID1	Integrated (Transceiver)	Enhanced V and D	ISO 8208
ID2	Integrated (Transceiver)	Enhanced V and D	CLNP
SL0	Separated (VDR)	Enhanced V and D	N/A
SU1	Separated (CMU)	Enhanced V and D	ISO 8208
SU2	Separated (CMU)	Enhanced V and D	CLNP

To facilitate referencing to a group of equipment classes the first two designators followed by a single asterisk "*" is used to represent all equipment classes that initiated with the same two designators, i.e.,

- ID* represents the group of Equipment Classes ID1 and ID2
- SU* represents the group of Equipment Classes SU1 and SU2

2.1.10 Software Management

If the equipment design is implemented using digital computer techniques, the computer software package shall follow guidelines contained in RTCA document DO-178B "Software Considerations in Airborne Systems and Equipment Certification." The equivalent or later editions of DO-178B may be used with the agreement of the authority.

2.2 Minimum Performance Requirements - Standard Conditions

2.2.1 VDL Mode 3 Subnetwork Physical Layer Requirements

Unless otherwise stated, all physical layer requirements specified in the subsections of Section 2.2.1 shall be applicable to Equipment Classes IB0, IV0, ID*, and SL0. Furthermore, these Equipment Classes shall meet the physical layer requirements as specified in Section 3.3.1 of DO-224B, including all applicable subsections, tables, figures, and appendices.

2.2.1.1 Transceiver Requirements

Unless otherwise stated, all transceiver requirements shall be applicable under room temperature (25^{o} C) condition and with the transceiver tuned to any 25 kHz channel from 118.000 megahertz (MHz) to 136.975 MHz.

2.2.1.1.1 Tuning Range and Channel Increments

The transceiver shall be tunable to any 25 kHz channel, from 118.000 MHz to 136.975 MHz (760 channels), as defined in RTCA DO-224B. The transceiver shall limit its operation to specific time slot(s) on a specific frequency channel defined by the channel label per Appendix M of RTCA DO-224B and the VDL Mode 3 system configuration in use.

Note: *Manufacturers should note that in the future, part or all of the frequency band 108.000 to 117.975 MHz may become available for air-ground communications.*

2.2.1.1.2 Modulation

The transceiver shall use D8PSK modulation as defined in RTCA DO-224B.

2.2.1.1.3 Tuning Time

The transceiver shall tune from one channel to another within 100 ms of the receipt of the "frequency change" command from the transceiver tuning control, when the transceiver is not transmitting.

Note: *The tuning time is measured starting from the command to tune to the new frequency to the point that the radio starts receiving Mode 3 bursts on its new net.*

2.2.1.1.4 Receive to Transmit Turnaround Time

The transceiver shall complete turnaround from reception to transmission within 17 symbol periods. This time can be relaxed to 33 symbol periods for aircraft radios which do not implement functions requiring discrete addressing (i.e., IB0).

Notes:

1. *Receive to transmit turnaround time is defined as the time between the middle of the last information symbol of one receive burst and the middle of the first symbol of the synchronization sequence of the subsequent transmit burst.*

2. *The shortest receive to transmit turnaround time for an aircraft radio occurs when the reception of an uplink management burst (M burst) beacon is followed by a downlink voice or data (V/D) transmission in the same time slot.*

2.2.1.1.5 Transmit to Receive Turnaround Time

The transceiver shall complete turnaround from transmission to reception within 32 symbol periods.

Notes:

1. *Transmit to receive turnaround time is defined as the time between the middle of the last information symbol of one transmit burst and the middle of the first symbol of the synchronization sequence of the subsequent receive burst.*

2. *The worst case transmit to receive turnaround time for an aircraft radio occurs when it transmits a downlink M burst message and receives a V/D message in the same time slot.*

2.2.1.1.6 Uplink Voice Delay Requirement

The end-to-end voice delay of the communications link consisting of a reference ground station transmitter and the avionics receiver Equipment Under Test (EUT), connected back-to-back, shall be less than 236 ms. Reference Ground Station 1 (GS1) is part of the Ground Station Emulator (GSE), defined in Section 2.4.3.2.3, in the Lower Tester of the VDL Mode 3 Test Set.

2.2.1.1.7 Downlink Voice Delay Requirement

The end-to-end voice delay of the communications link consisting of the avionics EUT transmitter and the reference ground station GS1 receiver, connected back-to-back, shall be less than 236 ms. GS1 is part of the GSE, defined in Section 2.4.3.2.3, in the lower Tester of the VDL Mode 3 Test Set.

2.2.1.2 Receiver Requirements

Unless otherwise stated, all receiver requirements shall be applicable to Class G receivers under room temperature (25^{o} C) conditions, at the stated nominal data rate, and with the receiver tuned to any 25 kHz channel over the entire frequency range of 118.000 to 136.975 MHz.

The receiver performance shall be based on an uncorrected BER of no greater than 10^{-3}.

Unless stated otherwise, the reference signal level of the desired signal defined in Section 1.7.7 shall be minus 87 dBm.

2.2.1.2.1 Sensitivity

A signal level of minus 98 dBm at the input of the receiver from a VDL Mode 3 signal source shall produce a BER that meets the BER requirement specified in Section 2.2.1.2.

2.2.1.2.2 Adjacent Channel Rejection (ACR)

The BER requirement (Section 2.2.1.2) shall be achieved when a desired signal at the reference signal level is applied in the presence of a single undesired VDL Mode 3 signal operating on the first to third upper or lower adjacent channel and at a level 40 dB above the desired signal level. Furthermore, the ACR for the fourth adjacent channel and beyond shall be 60 dB.

2.2.1.2.3 Receiver Performance in the Presence of Strong Signals Within the VHF Aeronautical Communications Band

The BER requirement (Section 2.2.1.2) shall be achieved when a CW interfering signal of minus 33 dBm and the desired signal at the reference signal level (defined in Section 2.2.1.2) are present at the receiver input. The frequency range of the interfering signal shall be 118.000 to 136.975 MHz, including the in-band frequencies of the second upper and second lower adjacent channels to which the receiver is tuned but excluding the frequency range between these two adjacent channels.

2.2.1.2.4 Receiver Performance in the Presence of Strong Signals Outside the VHF Aeronautical Communications Band

The BER requirement (Section 2.2.1.2) shall be achieved when one of the specified unwanted signals listed below is applied in addition to the desired signal at the reference signal level (Section 2.2.1.2).

<u>Unwanted signal A</u>

Level	Minus 33 dBm
Modulation	None
Frequency range	108 to 156 MHz (excluding 117.950 to 137.025 MHz)

<u>Unwanted signal B</u>

Level	Minus 7 dBm, except at the receiver IF frequencies, where the maximum level permitted is minus 33 dBm
Modulation	None
Frequency range	50 kHz to 1215 MHz (excluding the range 87.5 to 156 MHz)

<u>Unwanted signal C</u>

Level	Minus 5 dBm
Modulation	None
Frequency range	87.5 to 107.9 MHz

2.2.1.2.5 Desired Signal Dynamic Range

The receiver shall continue to achieve the BER requirement (Section 2.2.1.2) when the desired signal level is increased from the sensitivity level (Section 2.2.1.2.1) to minus 7 dBm.

2.2.1.2.6 Symbol Rate Capture Range

The BER requirement (Section 2.2.1.2) shall be achieved when the desired signal at the reference signal level (Section 2.2.1.2) is subject to a symbol rate offset of ± 50 parts per million (ppm).

2.2.1.2.7 Frequency Capture Range

The BER requirement (Section 2.2.1.2) shall be achieved when the desired signal at the reference level (Section 2.2.1.2) is subject to a frequency offset of ± 967 Hz.

Note: *This value is composed of the maximum transmitter frequency error at 136.975 MHz (± 685 Hz) and the maximum Doppler shift (± 282 Hz).*

When tested over the range of environmental conditions specified in Section 2.3, frequency capture range performance shall be measured with a signal level 6 dB above the reference level (Section 2.2.1.2).

2.2.1.2.8 Phase Acceleration

The BER requirement (Section 2.2.1.2) shall be achieved when a desired VDL Mode 3 signal operating at the reference signal level (Section 2.2.1.2) is subject to a phase acceleration of 1000 Hz/s or less, provided the frequency offset of the signal remains 685 Hz or less from the frequency of the tuned channel.

Note: *Phase Acceleration is related to frequency modulation processes, in both Doppler scenarios and VDL transmitter residual frequency modulation. The frequency modulation produced in Doppler scenarios is characterized by low modulation rates and low peak frequency deviations. DO-224B specifies maximum phase accelerations permissible in VDL transmitters that swamp those produced in Doppler scenarios. The rate in the test has been set to reflect both Doppler and VDL transmitter phase acceleration specifications to ensure VDL receivers will correctly demodulate signals modulated by Doppler and residual FM mechanisms.*

2.2.1.2.9 Co-channel Interference (CCI)

The BER requirement (Section 2.2.1.2) shall be achieved when an on channel undesired VDL Mode 3 signal, which is at least 20 dB below the desired signal is applied in addition to the desired signal operating at the reference signal level (Section 2.2.1.2).

2.2.1.2.10 Conducted Spurious Emission

When the receiver input is terminated in a resistive load that is equal to the receiver nominal input impedance, the level of any spurious emission appearing across the load shall not exceed minus 57 dBm over the frequency range of 50 kHz to 1215 MHz, with the exception of the range of 108 to 137 MHz, where it shall not exceed minus 64 dBm.

Note: If other receiving systems are installed, receiver conducted spurious emission may interfere with those systems. See Section 3.2.2, especially Table 3-1 for additional information.

2.2.1.2.11 FM Broadcast Intermodulation

The BER requirement (Section 2.2.1.2) shall be achieved in the presence of two unmodulated interfering signals within the frequency range of 87.5 to 107.9 MHz. Each interfering signal shall separately present a level of minus 5 dBm at the receiver input. The combined interfering signals shall be simultaneously applied to the receiver input in the presence of the desired signal at the reference signal level (Section 2.2.1.2).

2.2.1.2.12 In-band Intermodulation

The BER requirement (Section 2.2.1.2) shall be achieved in the presence of two undesired signals displaced in frequency from the desired signal as defined below.

Desired signal	
Level	minus 75 dBm
Modulation	VDL Mode 3
Frequency	test frequency
Unwanted signal A	
Level	minus 32 dBm
Modulation	none
Frequency	test frequency ± 1 MHz
Unwanted signal B	
Level	minus 32 dBm
Modulation	Undesired VDL Mode 3 Test Signal (Section 1.7.9)
Frequency	test frequency ± 2 MHz

Note: The objective of this requirement is to specify the receiver linearity in order to guarantee that the 3rd order intercept point (IP3) is at least 0 dBm. This is the minimum acceptable value and manufacturers are encouraged to design their receiver to withstand an unwanted level of minus 29 dBm. (This corresponds to an IP3 value of plus 5 dBm.)

2.2.1.3 Transmitter Requirements

Unless otherwise stated, all transmitter requirements shall be applicable to both Class 9 and Class 10 transmitters under room temperature (25^{o} C) conditions and with the transmitter tuned to any 25 kHz channel over the frequency range of 118.000 to 136.975 MHz. Furthermore, unless otherwise stated all requirements shall be met with the transmitter output terminated in a resistive load matching the output impedance of the transmitter.

2.2.1.3.1 Channel Bit Rate

The channel bit rate shall be 31.5 kbits/s ± 50 ppm.

2.2.1.3.2 RF Output Power

The RF output power of the transmitter shall be the average power measured over an output burst.

Class 9: The RF output power, measured at the transmitter antenna port, on all frequencies for which the transmitter is designed, shall not be less than 15 watts.

Class 10: The output power, measured at the transmitter antenna port, on all frequencies for which the transmitter is designed, shall not be less than 4 watts.

Note: *To achieve the requirements of Section 2.2.1.3.6 and Section 2.2.1.3.7, it is recommended that the maximum output power be limited to 25 watts.*

2.2.1.3.3 RF Power Rise Time

The transmitter ramp-up and power stabilization component of the training sequence shall be defined over the time interval t = -5.5 to t = -0.5, where t = 0 is the middle of the first symbol of the synchronization sequence (refer to Figure 2-14). The RF power shall be equal to or less than minus 40 dB relative to the carrier (dBc) prior to time t = -5.5 and equal to or greater than 90% of the manufacturer stated output power for the entire time interval between t = -3.0 and t = -0.5. Time (t) is measured in symbol periods (approximately 95.24 microseconds (μsec) per symbol period).

Notes:

1. *It is recommended that symbols transmitted during the ramp-up and power stabilization segment represent the information 000.*

2. *In order to minimize the effect of power in an adjacent channel, careful attention must be paid to the profile of the RF signal during the ramp-up period.*

3. *The relative timing associated with the RF rise time is shown in Figure 2-14 in Section 2.4.4.2.3.*

4. *Minus 40 dB relative to the carrier (dBc) is 40 dB below the manufacturer stated output power*

2.2.1.3.4 RF Power Release Time

The transmitter output power shall decay at least 20 dB below the rated RF output power level (Section 2.2.1.3.2) within 2.5 symbol periods (approximately 238.1 μsec) after the middle of the final information symbol. The transmitter power leakage when the transmitter is in the "off" state shall be less than minus 83 dBm.

Note: *In order to minimize the effect of power in an adjacent channel during power ramp-down, careful attention must be paid to the profile of the RF signal during the ramp-down period.*

2.2.1.3.5 Symbol Constellation Error

The EVM (Section 1.7.6), when measured over the first 100 symbols of the reference burst sequence (Section 2.4.1.8), shall be less than 6%.

2.2.1.3.6 Spurious Emissions

When the transmitter is "active" (e.g., transceiver in transmit mode) and is terminated in a resistive load equal to the nominal output impedance, the power of any spurious emission at the output of the transmitter shall not exceed the limits listed in items a through g below.

a. 0.25 microwatts (μW) (minus 36 dBm) within a bandwidth of 1 kHz, on any frequency in the range 9 kHz to 150 kHz.
b. 0.25 microwatts (minus 36 dBm) within a bandwidth of 10 kHz, on any frequency in the range 150 kHz to 30 MHz.
c. 0.25 microwatts (minus 36 dBm) within a bandwidth of 100 kHz, on any frequency in the range 30 MHz to 108 MHz.
d. 0.25 microwatts (minus 36 dBm) within a bandwidth of 100 kHz, on any frequency in the range 108 MHz to 117.5 MHz.
e. 0.25 microwatts (minus 36 dBm) within a bandwidth of 10 kHz, on any frequency in the range 117.5 MHz to 117.8 MHz.
f. 0.25 microwatts (minus 36 dBm) within a bandwidth of 10 kHz, on any frequency in the range 137.175 MHz to 137.475 MHz.
g. 0.25 microwatts (minus 36 dBm) within a bandwidth of 100 kHz, on any frequency in the range 137.475 MHz to 1.7 gigahertz (GHz).

Additionally, the level of spurious emissions at discrete frequencies (excluding harmonics) shall not exceed 4 nanowatts (nW) (minus 54 dBm) in the following bands.

h. 47 to 68 MHz
i. 88 to 108 MHz
j. 162 to 244 MHz
k. 328 to 336 MHz
l. 470 to 862 MHz

Harmonic emission products shall be at least 60 dB below the rated RF output power, i.e., minus 60 dBc. Harmonic emission products in the ICAO Global Navigation Satellite System (GNSS) band extending from 1559 to 1610 MHz shall be no greater than minus 60 dBm. The level of the N-th harmonic emission product shall be measured in a bandwidth that is N times 25 kHz.

When the transmitter is "idle" (i.e., transceiver is in receive mode) and is terminated in a resistive load equal to its nominal output impedance, the power of any spurious emission at the output of the transmitter shall not exceed the limits listed below in items m through o.

m. 2 nW (minus 57 dBm) within a bandwidth of 1 kHz, on any frequency in the range 9 kHz to 150 kHz.
n. 2 nW (minus 57 dBm) within a bandwidth of 10 kHz, on any frequency in the range 150 kHz to 30 MHz.
o. 2 nW (minus 57 dBm) within a bandwidth of 100 kHz, on any frequency in the range 30 MHz to 1 GHz.

Notes:

1. *Spurious emissions are power emissions that are outside the desired bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include parasitic emissions, intermodulation products and frequency conversion products.*

2. *In order to provide adequate protection for a GNSS receiver when a VDL Mode 3 transceiver is operated on the same aircraft, the manufacturers should ensure that the transmitter harmonic filter remains effective at frequencies in the band 1559 - 1610 MHz. See Section 3.2.2.*

3. *If other receiving systems are installed, transmitter harmonics may interfere with those systems. See Section 3.2.2, Note 2.*

2.2.1.3.7 Adjacent Channel Power

First adjacent channel

The RF power measured over a 16 kHz channel bandwidth centered on the first adjacent channel shall not exceed minus 18 dBm under all operating conditions (including transmitter attack and decay).

The RF power measured over a 25 kHz channel bandwidth centered on the first adjacent channel shall not exceed plus 2 dBm under all operating conditions (including transmitter attack and decay).

Second and third adjacent channel

The RF power measured over a 25 kHz channel bandwidth when centered on either the second adjacent channel or the third adjacent channel shall not exceed minus 28 dBm under all operating conditions (including transmitter attack and decay).

Fourth adjacent channel

The RF power measured over a 25 kHz channel bandwidth centered on the fourth adjacent channel shall not exceed minus 38 dBm under all operating conditions (including transmitter attack and decay).

Beyond the fourth adjacent channel

Beyond the fourth adjacent channel, the RF power measured in a 25 kHz channel bandwidth shall decrease at a rate of no less than 5 dB per octave of channel offset (e.g., minus 43 dBm or less at the eighth adjacent channel, minus 48 dBm or less at the sixteenth adjacent channel, and minus 53 dBm or less at the thirty-second adjacent channel) to minus 53 dBm or less under all operating conditions (including transmitter attack and decay).

Note: *The adjacent channel power requirements apply over the entire 117.8 MHz to 137.175 MHz band.*

2.2.1.3.8 RESERVED

2.2.1.3.9 Load VSWR Capability

When a 2:1 mismatch is applied to the transmitter output terminal by a length of feeder cable, which is varied in electrical length by up to half a wave length, the requirements of Sections 2.2.1.3.6 and 2.2.1.3.7 shall be met. In addition, the power output shall not be reduced by more than 3 dB from the rated RF output power (Section 2.2.1.3.2).

2.2.1.3.10 Frequency Tolerance

The frequency of the RF carrier shall be within ±5 ppm of the selected frequency.

2.2.1.4 RESERVED

2.2.2 Link Layer Requirements

The link layer requirements, as specified in Section 3.3.2 of RTCA DO-224B, including all applicable subsections, tables, figures, and appendices, shall apply to the appropriate VDL Mode 3 classes of equipment in accordance with Table B-2 of Appendix B.

2.2.3 Subnetwork Layer Requirements

Class ID** and Class SU** equipment shall meet the subnetwork layer requirements, as specified in Sections 3.3.3 and 3.3.4 (except 3.3.4.3) of RTCA DO-224B, including all applicable subsections, tables, figures, and appendices, as appropriate for the subnetwork interfaces implemented, modified per the subsections below.

Table B-2 of Appendix B provides cross references for specific subnetwork requirements of DO-224B to equipment classes.

2.2.3.1 Subnetwork Interface Support

2.2.3.1.1 Aircraft Subnetwork Interface Support

Class ID* and SU* equipment shall provide the raw interface for MOPS testing purposes to provide direct access to data information at the subnetwork access protocol interface.

Class ID* and SU* equipment shall provide the ATN/ISO 8208/VDL Mode 3 PLP Compression subnetwork interface and/or the ATN/ISO 8473/ISO 9542/VDL Mode 3 CLNP Compression subnetwork interface as specified in Appendix J and K, respectively, of DO-224B.

2.2.3.1.2 Ground Station Subnetwork Interface Support

The Ground Station will support the ATN/ISO 8208/VDL Mode 3 PLP Compression subnetwork interface.

Note 1: It should be noted that the above requires the ground system to compress all ISO 8208 communications per DO-224B, Appendix J.

The Ground Station will support the ATN/ISO 8473/ISO 9542/VDL Mode 3 CLNP Compression subnetwork interfaces.

Note 2: It should be noted that the ATN/ISO 8473/ISO 9542/VDL Mode 3 CLNP Compression subnetwork interface utilizes uncompressed CLNP data transfer as indicated in DO-224B, Section K.2 for certain protocol data units, but that compression is to be used where possible according to DO-224B, Appendix K.

Note 3: The above requirements indicate that the Ground Station is required to accept only a Network Type of 0 or 1 for the Network Initialization XID per DO-224B, Table 3-72b.

2.2.3.2 RESERVED

2.2.4 Voice Unit Requirements

Class IB0, IV0, ID*, and SL0 equipment shall meet the Voice Unit requirements for VDL Mode 3, as specified in Section 3.3.5 of RTCA DO-224B, including all applicable subsections, tables, figures, and appendices. Table B-2 of Appendix B cross references specific DO-224B requirements to these equipment classes

2.2.4.1 Avionics Radio Voice Quality Requirements

Note 1: The mean opinion score (MOS) of the air/ground link is measured using an objective voice quality measurement system which has been calibrated against the mean opinion score of subjective voice quality test scores.

Note 2: An audio test vector providing a 400Hz tone and silence vectors are defined in Appendix E for use in assisting manufacturers in building and testing their radios.

2.2.4.1.1 Ground-to-Air Voice Quality Requirement

The voice quality Mean Opinion Score (MOS) of the ground-to-air test link shall be within 0.2 of the MOS achieved with the ground-to-air reference link of Figure 2-1. The ground-to-air reference link comprises Ground Station 1 (GS1) of the Ground Station Emulator (GSE) (Section 2.4.3.2.3) and the Aircraft Station 1 (AC1) of the Aircraft Station Emulator (ASE) (see Section 2.4.3.2.4) connected back-to-back. Both GSE and ASE are part of the Lower Tester (Section 2.4.3.2) in the VDL Mode 3 Test Set (Section 2.4.3). The ground-to-air test link is defined as the ground-to-air reference link with AC1 replaced by the avionics radio Equipment Under Test (EUT).

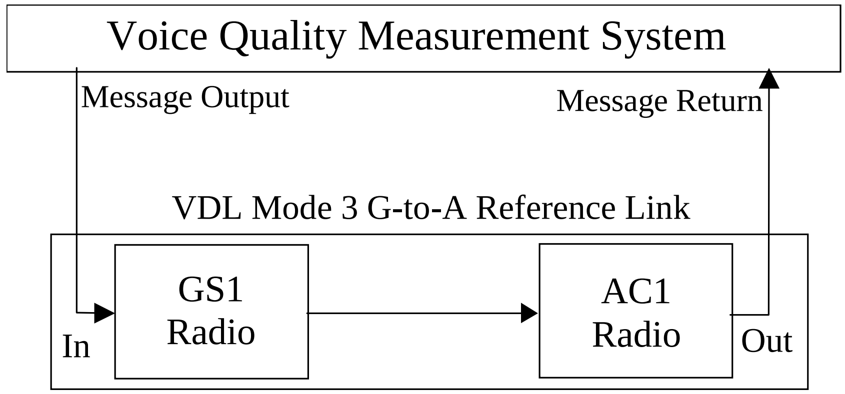


Figure 2-1: Ground-to-Air Reference Link Voice Quality Measurement

2.2.4.1.2 Air-to-Ground Voice Quality Requirement

The MOS of the air-to-ground test link shall be within 0.2 of the MOS achieved with the air-to-ground reference link of Figure 2-2. The air-to-ground reference link comprises AC1 and GS1 connected back-to-back. The air-to-ground test link is defined as the air-to-ground reference link with AC1 replaced by the avionics radio Equipment Under Test (EUT). Note that AC1 and GS1 are defined in Section 2.2.4.11 and explained in the subsections of Section 2.4.3 which describe the VDL Mode 3 Test Set.

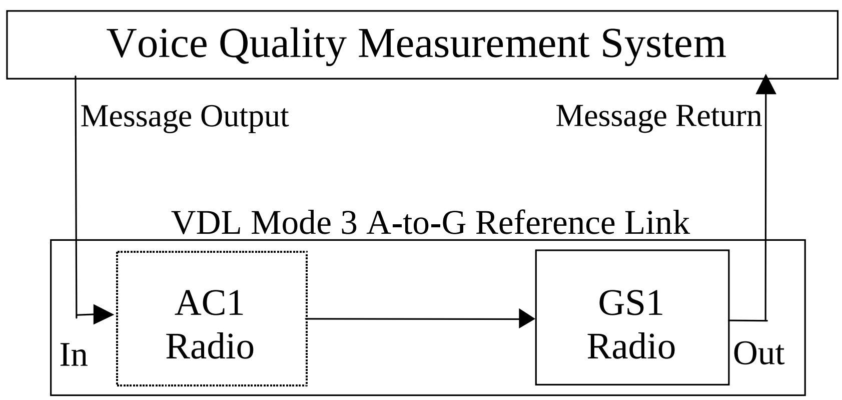


Figure 2-2: Air-to-Ground Reference Link Voice Quality Measurement

2.2.5 Requirements for Format and Usage of the System Data and Header Segment

The requirements of format and usage of the system data segment of the management bursts (M bursts) and the header segment of the V/D bursts shall be as specified in Section 3.3.1.3 and Appendix G of RTCA DO-224B, including all applicable tables and figures.

2.2.6 Data/Management Interface

Class SL0 equipment shall provide a Data/Management interface for the purpose of exchanging data and control information between the lower VDL Mode 3 protocol stack implemented in the Class SL0 equipment and the upper VDL Mode 3 protocol stack implemented in Class SU* equipment.

Class SU* equipment shall provide a Data/Management interface for the purpose of exchanging data and control information between the upper VDL Mode 3 protocol stack implemented in Class SU* equipment and the lower VDL Mode 3 protocol stack implemented in Class SL0 equipment.

An example of the Data/Management interface between Class SL0 and Class SU* equipment is given in Appendix D.

2.3 Minimum Performance Requirements - Environmental Conditions

The minimum performance requirements for environmental conditions shall be applicable to Classes IB0, IV0, ID*, SL0, SU* equipment. For each architecture class, only those requirements that are pertinent to that particular architecture class of equipment shall be applicable. For Class SU* (SL0) EUT, the class SL0 (SU*) equipment function is provided by the Test Set.

2.3.1 Introduction

The environmental tests and performance requirements referenced in this section provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those that may be encountered in actual operations.

Some of the environmental tests listed in Table 2-2 and in Table 2-3 in this section do not have to be performed unless the manufacturer wishes to qualify the equipment for that particular environmental condition. These tests are identified by the phrase "if required." If the manufacturer wishes to qualify the equipment to these additional environmental conditions, then these "if required" tests shall be performed.

Unless otherwise specified, the test procedures applicable to a determination of equipment performance under environmental test conditions are contained in documents RTCA DO-160D/EUROCAE ED-14D "Environmental Conditions and Test Procedures for Airborne Equipment," July 1997. The use of later editions of these documents must be agreed with the appropriate approval authority.

The tests in Table 2-2 and Table 2-3 shall, in general, be conducted only at the mid-band frequency, 127.500 MHz. However, tests conducted to ascertain equipment performance at extreme temperatures must be conducted also at the lowest and highest channel assignments of the AM(R)S band.

2.3.2 Receiver

Note: Some of the performance requirements in Section 2.2.1.2 are not required to be tested to all of the conditions contained in RTCA DO-160D/EUROCAE ED-14D.

Judgment and experience have indicated that these particular performance parameters are not susceptible to certain environmental conditions and that the level of performance specified in Section 2.2.1.2 will not be measurably degraded by exposure to these conditions.

2.3.3 Transmitter

Note: *Some of the performance requirements in Section 2.2.1.3 are not required to be tested to all of the conditions contained in RTCA DO-160D/EUROCAE ED-14D. Judgment and experience have indicated that these particular performance parameters are not susceptible to certain environmental conditions and that the level of performance specified in Section 2.2.1.3 will not be measurably degraded by exposure to these conditions.*

Table 2-2: Receiver Environmental Test Conditions Matrix

Receiver Subsystem		**RTCA / DO-160D Compliance Sections**										
DO-160D Section	Function	2.2.1.1.5 Tx to Rx Turnaround time	2.2.1.2.1 Sensitivity	2.2.1.2.2 Adj. Channel Rej.	2.2.1.2.3 Rx Performance in Strong Signals within VHF band	2.2.1.2.4 Rx Performance in Strong Signals outside VHF band	2.2.1.2.5 Desired Signal Dynamic Range	2.2.1.2.6 Symbol Rate Capture Range	2.2.1.2.7 Frequency Capture Range	Voice Test: 2.4.5.4.1 (Test 2-1)	Data Test: 2.4.5.10.1.2 (Test 8-2) or. 2.4.5.11.2.1 (Test 9-2)	Notes
4.5.1	Low Temperature	X	X	X	X	X	X	X		X	X	(5)
4.5.2, 4.5.4	High Temperature	X	X							X	X	(5)
4.5.3	High Temperature	X	X	X	X	X		X		X	X	
4.6.1	Altitude		X	X						X	X	
4.6.2	Decompression (if required)		X	X						X	X	(5)
4.6.3	Overpressure (if required)		X	X						X	X	(5)
5.0	Temperature Variation		X	X					X	X	X	
6.0	Humidity		X	X						X	X	(5)
7.0	Shock		X	X						X	X	(1) (5)
8.0	Vibration		X	X					X	X	X	(5)
9.0	Explosion proof (if required)											(2) (3)
10.0	Waterproof (if required)		X	X						X	X	
11.0	Fluids Susceptibility (if required)		X	X						X	X	
12.0	Sand and Dust (if required)		X	X						X	X	
13.0	Fungus Resistance (if required)		X	X						X	X	
14.0	Salt Spray (if required)		X	X						X	X	
15.0	Magnetic Effect											(3)
16.5.1, 16.5.2	Power Input (Normal Operating Conditions)		X	X					X	X	X	

Table 2-2: Receiver Environmental Test Conditions Matrix

Receiver Subsystem		**RTCA / DO-160D Compliance Sections**										
16.5.3, 16.5.4	Power Input (Abnormal Operating Conditions)		X							X	X	
17.0	Voltage Spike		X	X						X	X	
18.0	Audio Frequency Conducted Susceptibility – Power Inputs		X	X					X	X	X	
19.0	Induced Signal Susceptibility		X							X	X	
20.0	Radio Frequency Susceptibility (Radiated and Conducted)		X	X					X	X	X	(4)
21.0	Emission of Radio Frequency Energy											(3)
22.0	Lightning Induced Transient Susceptibility (if required)		X	X					X	X	X	
23.0	Lightning Direct Effects (if required)		X	X					X	X	X	
24.0	Icing (if required)		X	X					X	X	X	
25.0	Electrostatic Discharge (ESD) (if required)		X	X					X	X	X	

(1) The application of this test may result in damage to the equipment. It may, therefore, be conducted after the other tests. Furthermore, paragraph 2.1.7 of this document -"Effects of Tests" - does not apply following crash safety shocks.

(2) The application of this test may result in damage to the equipment. It may, therefore, be conducted after the other tests. Furthermore, paragraph 2.1.7 of this document -"Effects of Tests" - does not apply.

(3) Equipment performance requirements for this function of the EUT are defined within DO-160D.

(4) Tailor the conducted and radiated RF susceptibility tests in RTCA/DO-160 Section 20 as follows. From 112 MHz to 143 MHz excluding the tuned frequency plus and minus 200 kHz, perform the radiated RF susceptibility tests using a calibrated field strength of 25 millivolts per meter, and perform the conducted RF susceptibility using a calibrated cable bundle current of 40 microamperes. The frequency band of the tuned frequency plus and minus 200 kHz is excluded from this test. Use the calibration and test procedures in DO-160 Section 20.4, 20.5, and 20.6 that apply to Category T. For frequencies below 112 MHz and above 143 MHz use a category from RTCA/DO-160 Section 20 appropriate for the intended application of this radio. The tests should be performed with the antenna coaxial cable terminated in a matched load. This exclusion supersedes the exclusion frequencies specified in RTCA/DO-160 Section 20.3.d.

(5) All mechanical devices shall perform their intended functions.

Table 2-3: Transmitter Environmental Test Conditions Matrix

Transmitter Subsystem		RTCA / DO-160D Compliance Sections										
DO-160D Section	Function	2.2.1.1.4 Rx to Tx Turnaround Time	2.2.1.3.1 Channel Bit Rate	2.2.1.3.2 RF Output Power	2.2.1.3.3 RF Power Rise Time	2.2.1.3.5 Symbol Constellation Error	2.2.1.3.6 Spurious Emissions	2.2.1.3.7 Adjacent Channel Power	2.2.1.3.10 Frequency Tolerance	Voice Test 2.4.5.4.2 (Test 2-2) 2.4.5.5.4 (Test 3-4/ Subtest 9)	Data Test 2.4.5.10.1.2 (Test 8-2) or 2.4.5.11.2.1 (Test 9-2)	Notes
4.5.1	Low Temperature	X	X	X	X	X	X	X	X	X	X	(10)
4.5.2, 4.5.4	High Temperature			X		X		X		X	X	(1) (10)
4.5.3	High Temperature	X	X	X	X	X	X	X	X	X	X	
4.6.1	Altitude			X		X		X		X	X	(2)
4.6.2	Decompression (if required)			X		X		X		X	X	(3) (10)
4.6.3	Overpressure (if required)			X		X		X		X	X	(10)
5.0	Temperature Variation		X	X		X		X	X	X	X	
6.0	Humidity			X		X		X		X	X	(10)
7.0	Shock			X		X		X		X	X	(4) (10)
8.0	Vibration			X		X		X	X	X	X	(9) (10)
9.0	Explosion proof (if required)											(5) (6)
10.0	Waterproof (if required)			X		X		X		X	X	
11.0	Fluids Susceptibility (if required)			X		X		X		X	X	
12.0	Sand and Dust (if required)			X		X		X		X	X	
13.0	Fungus Resistance (if required)			X		X		X		X	X	
14.0	Salt Spray (if required)			X		X		X		X	X	
15.0	Magnetic Effect											(6)

Table 2-3. Transmitter Environmental Test Conditions Matrix (Continued)

Transmitter Subsystem		**RTCA / DO-160D Compliance Sections**										
DO-160D Section	Function	2.2.1.1.4 Rx to Tx Turnaround Time	2.2.1.3.1 Channel Bit Rate	2.2.1.3.2 RF Output Power	2.2.1.3.3 RF Power Rise Time	2.2.1.3.5 Symbol Constellation Error	2.2.1.3.6 Spurious Emissions	2.2.1.3.7 Adjacent Channel Power	2.2.1.3.10 Frequency Tolerance	Voice Test 2.4.5.4.2 (Test 2-2) 2.4.5.5.4 (Test 3-4/ Subtest 9)	Data Test 2.4.5.10.1.2 (Test 8-2) or 2.4.5.11.2.1 (Test 9-2)	Notes
16.5.1, 16.5.2	Power Input (Normal Operating Conditions)			X		X		X	X	X	X	(7)
16.5.3, 16.5.4	Power Input (Abnormal Operating Conditions)			X		X				X	X	(8)
17.0	Voltage Spike			X		X		X		X	X	
18.0	Audio Frequency Conducted Susceptibility – Power Inputs			X		X		X	X	X	X	
19.0	Induced Signal Susceptibility			X		X		X	X	X	X	
20.0	Radio Frequency Susceptibility (Radiated and Conducted)			X		X		X		X	X	
21.0	Emission of Radio Frequency Energy											(6)
22.0	Lightning Induced Transient Susceptibility (if required)			X		X		X	X	X	X	
23.0	Lightning Direct Effects (if required)			X		X		X	X	X	X	
24.0	Icing (if required)			X		X		X	X	X	X	
25.0	Electrostatic Discharge (if required)			X		X		X	X	X	X	

(1) Under the conditions of these tests, the specified output power of 2.2.1.3.2 may be degraded by up to 6 dB. There shall be no evidence of materials exuding or dripping from the equipment components.

(2) Ensure that there is no evidence of corona or arcing without modulation and with modulation.

Table 2-3. Transmitter Environmental Test Conditions Matrix (Continued)

(3) Under the conditions of these tests, the specified output power of 2.2.1.3.2 may be degraded by up to 1.5 dB.

(4) The application of this test may result in damage to the equipment. It may therefore, be conducted after the other tests. Furthermore, Section 2.1.7 of this document, "Effects of Tests" - does not apply following crash safety shocks.

(5) The application of this test may result in damage to the equipment. It may, therefore, be conducted after the other tests. Furthermore, Section 2.1.7 - "Effects of Tests" - does not apply.

(6) Equipment performance requirements for this function of the EUT are defined within DO-160D.

(7) In respect to Sections 16.5.2.3 and 16.5.2.4 (Momentary power interruptions), the tests may be carried out following the power interruptions.

(8) Under the conditions of these tests, the specified output power of 2.2.1.3.2 may be degraded by up to 3 dB. For equipment operating on DC power, the gradual reduction to zero of the primary power voltage(s) should produce no detrimental effects (see Section 2.1.7- "Effects of Tests").

(9) EVM may degrade up to 10%.

(10) All mechanical devices shall perform their intended functions.

2.4 Equipment Test Procedures

The following procedures provide guidelines for tests to ensure compliance with the MOPS performance requirements. Alternative procedures or analyses providing equivalent performance documentation may be used; and if so, they shall be accompanied with detailed documentation of the method used. Therefore, the procedures cited herein should be used as one criterion in evaluating acceptability of the alternate procedures.

2.4.1 Definition of Terms and Conditions of Tests

2.4.1.1 Warm-up and Stabilization of Test Equipment/Equipment Under Test

The equipment under test and the associated test equipment shall be powered up for a period of no less than one hour prior to the start of each test session to ensure that the unit under test and the test equipment are sufficiently stabilized under the test environment.

2.4.1.2 Alignment, Adjustment and Calibration for Equipment Under Test

All alignment, adjustment and calibration of the test equipment and equipment under test shall be performed prior to commencement of the test. Once the test starts, no further manual alignment, adjustment, and calibration of test equipment and the equipment under test shall be allowed throughout the duration of the test. Automatic re-calibration of the test equipment, if used, shall be permitted.

2.4.1.3 Equipment Termination

Unless otherwise specified, all tests shall be performed with the equipment RF terminal(s) terminated with a load matching the nominal characteristic impedance of the equipment.

2.4.1.4 Test Equipment Calibration and Replacement

All test equipment used for MOPS testing shall be properly calibrated. All test equipment calibration shall remain valid throughout the entire duration of the test. In the case that test equipment needs to be replaced due to equipment failure, the replacement equipment shall be of the same make and model as the equipment it replaces.

2.4.1.5 Failure of the Equipment Under Test

In the event that the equipment under test fails during the course of the test, a report shall be generated by the manufacturer of the failed equipment to detail the cause of the failure and the fixes proposed. Test shall not be resumed until it has been determined that the failure was not due to a design fault. Test shall not be continued, if engineering judgment indicates that the changes made to correct the failure would affect any of the previously run tests.

2.4.1.6 Measurement Error Due to Test Equipment and Test Setup

Good engineering practices should be exercised to minimize measurement error contributed by the test equipment and test setup. Precautions shall be taken to minimize measurement errors due to contributions from noise sidebands of signal generators and impedance mismatches. Whenever practical, measurement error due to test setup, including cable contributions, shall be compensated for.

Note: Test equipment, particularly the VHF signal generators, used in the MOPS tests should be chosen with reasonably low noise floor and noise sidebands to ensure that the test equipment contributions to the measurement errors are negligible.

2.4.1.7 Default RF Signal Level for Avionics Testing

Unless otherwise stated, the desired RF signal level presented to the RF input of the intended aircraft and ground radios shall be adjusted to a level of minus 50 dBm ± 5 dB.

2.4.1.8 Transmitter Reference Burst Sequence

For tests that require stressing the transmitter, a reference burst sequence is defined and is illustrated in Figure 2-3. In this figure, **M** represents a downlink M burst, **V** represents a downlink V/D (voice) burst, and **D** represents a downlink V/D (data) burst. This sequence shall be repeated 24 times, i.e., for slightly less than 35 seconds.

Time Slot								
A	B	C	D	A	B	C	D	
V	**D**	**D**	**D**	**V**	**D**	**D**	**D**	Cycle 1
V	**D**	**D**	**D**	**V**	**D**	**D**	**D**	Cycle 2
V	**D**	**D**	**D**	**V**				Cycle 3
V				**V**				Cycle 4
V	**M**			**V**				Cycle 5
V				**V**				Cycle 6

Figure 2-3: Transmitter Reference Test Sequence (One Period of 24 Shown)

Note: The highest aircraft transmitter duty factor occurs in the 1V3D configuration. The recommended sequence is meant to simulate a scenario where an aircraft radio is transmitting a voice message using the A slots while "simultaneously" transmitting a string of data message, each of which is 15 bursts long. The M burst in the B slot represents a Reservation Request. It is assumed that an uplink Acknowledgment message is sent in cycle 4 and a Reservation is delivered in cycle 6. This corresponds to an overall duty factor of approximately 39%. Poll responses and other infrequent downlink M bursts would add a negligible amount to the duty factor. For the purposes of this test, the V and D bursts can be replaced by special BER measurement bursts (see Section 2.4.2.1).

2.4.2 Special Test Mode and Test Equipment for Physical Layer Tests

To facilitate testing of the VDL transceiver for compliance with the requirements stated in Section 2.3, a special BER test mode of the VDL transceiver is required if specific test procedures stated in Section 2.4 are utilized. Custom test equipment/fixtures also may be required. The BER mode and the custom test equipment/fixtures are described in the following Sections.

2.4.2.1 BER Mode

Many test procedures in Section 2.4 require the use of a BER mode, which is distinct from the operating mode, for measuring the BER of the Physical layer. The BER mode provides a means of isolating the Physical layer from the upper layers to allow performance measurement of the Physical layer alone. Without a BER mode, the manufacturer will need to develop equivalent procedures for the tests requiring BER mode. The alternative test method used for verification shall be traceable back to the minimum operational performance objectives for the transceiver.

To facilitate the determination that the VDL Mode 3 equipment satisfies the allocated performance requirements for its intended operation, the implementation of the BER mode must be traceable to the implementation of the operational mode. Thus, verification of the BER mode will provide a useful performance measure for determination that the VDL Mode 3 equipment is a viable communication system element for a given operational environment.

In the BER mode, the receiver shall forward each burst payload to the external BER test fixture prior to error detection or correction procedures.

2.4.2.2 VHF Signal Generators

Physical layer test procedures require the use of a high performance VHF signal generator, which shall be capable of generating and processing the specified modulation format and transmission format and of supporting the following functions:

1. Transmission of VDL Mode 3 test bursts consisting of the ramp up period followed by the standard 16-symbol synchronization sequence, variable burst length test payload, and ramp down period.

2. Interface to an external BER test fixture for inputting and outputting test payload data.

2.4.2.3 Undesired Signal Source

VHF signal generators are required to generate the undesired signals for the purpose of verifying performance under various interference conditions. Tests for CCI and ACR require the generation of an Undesired VDL Mode 3 Signal, as defined in Section 1.7.9. A VHF signal generator also capable of generating CW and externally modulated FM signals is required.

2.4.2.4 External BER Test Fixture

1. The external BER Test Fixture shall include a message generator/processor to generate test payloads for the desired and undesired signals in both burst and non-burst (continuous) forms. In either form, appropriate ramp up sequence shall be added to the test payload and mapped directly into the Mode 3 TDMA frame structure. The formatting shall include cyclic redundancy check (CRC), scrambling, and header.

2. The external BER test fixture generating the transmitted burst payload and receiving and processing the received burst payload must be synchronized with the transceiver under test either explicitly (via some direct connection) or implicitly (via the known sequencing of the pseudorandom test payload).

3. Calculation of cumulative BER statistics shall begin once synchronization of the external BER test fixture between the transmitting and receiving burst payload has been accomplished. The external BER test fixture shall detect the loss of an entire burst implicitly by lack of a burst payload message in the given burst period. Each test shall also include a running count of synchronization failures in addition to the cumulative BER.

2.4.2.5 Test Payload

Test payloads used in all BER tests shall be pseudorandom sequences. Unless otherwise stated, the desired signal payload shall be transmitted in burst form.

For BER tests, the minimum length of the pseudorandom test sequence used shall be 100,000 bits in order to provide statistically meaningful bit error rate measurement at 10^{-3} BER. If required, any pseudorandom test sequence used for the undesired signal shall be uncorrelated in content and timing with the pseudorandom test sequence used for the desired signal.

2.4.2.6 Unmodulated Carrier Mode

To facilitate the test procedures of Section 2.4.4.2.10, the VDL Mode 3 transceiver shall provide a means of transmitting an unmodulated continuous wave signal in a VDL Mode 3 burst. Alternatively, the transceiver may provide a means of measuring the selected carrier frequency, prior to modulation, from a test point that is externally accessible on the VDL Mode 3 transceiver. The unmodulated carrier signal need not be available at the same output power levels required for the modulated output.

2.4.3 VDL Mode 3 Test Set

The VDL Mode 3 Test Set, hereafter referred to as the Test Set, is customized test equipment with the functionality required for verifying the voice, link layer, and subnetwork operations of VDL Mode 3 avionics.

In order to standardize testing of the various protocol layers above the Physical layer across the range of VDL Mode 3 avionics equipment classes defined in Section 2.1.9, this document adopts the nomenclature of ISO-9646. Figure 2-4 illustrates a high-level functional block diagram of the ISO-9646 Test Configuration for the VDL Mode 3 avionics testing. Figure 2-4 shows the VDL Mode 3 Test Set to consist of an Upper Tester (UT), a Lower Tester (LT), and a set of peripheral functions. Depending upon the classes of equipment to be tested, the UT and LT will need to be configured accordingly. This section and its subsections give an overview of the major components involved in the ISO-9646 Test Configuration. Specifically, the terms System Under Test (SUT), Equipment Under Test (EUT), and the major elements of the Test Set are defined.

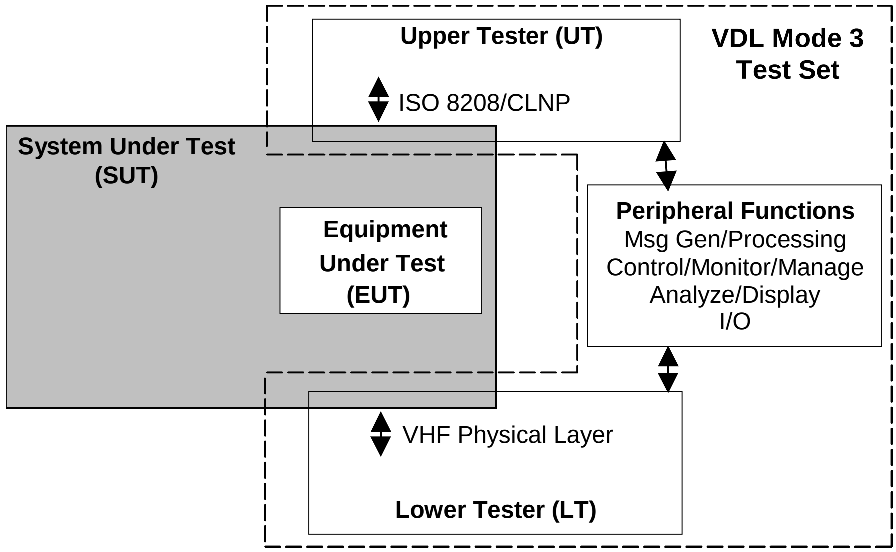


Figure 2-4: ISO 9646 Test Configuration

The **System Under Test** (SUT) is a complete implementation of the VDL Mode 3 avionics system necessary for the service provided. For equipment providing voice and data services, the SUT is a complete implementation from the VHF Physical layer through the Subnetwork Access Protocol. For equipment providing voice-only service, the SUT is an implementation of the VHF Physical layer through that part of the link layer that is required to support voice service.

The **Equipment Under Test** (EUT) is that part of the SUT to be tested. Note that EUT is synonymous with SUT for equipment classes in the integrated equipment architecture and EUT is a subset of the SUT for the separated equipment architecture.

The **Upper Tester** (UT) is the means of providing, during test execution, for the control and observation of the upper service boundary of the EUT and of any relevant abstract local primitives. For Class ID* and Class SU* equipment, the upper service boundary is the ISO 8208 or CLNP SNAcP interface. Note that this may require the insertion of a test point within the SU1 equipment to access the ISO8208 SNAcP and DCE interfaces to conduct the Test Group 9 tests, as the equipment may be integrated with the ATN router. For Class SL0 equipment, the upper service boundary is the Data/Management Interface defined in Section 2.2.6. Note that the UT does not interface with Class IB0 and Class IV0 equipment.

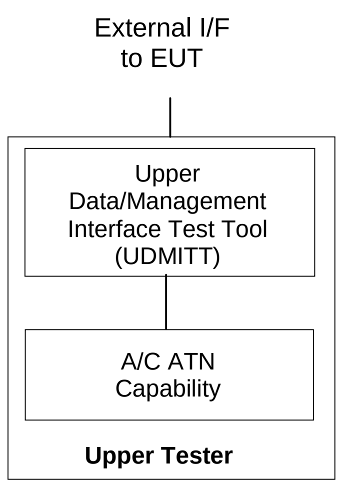
The **Lower Tester** (LT) is the means of providing, during test execution, for the control and observation at the appropriate Point of Control and Observation either below the EUT or remote from the EUT, as defined by the chosen test method. For Class IB0, Class IV0, Class ID*, and Class SL0 equipment, the lower service boundary between the EUT and the LT is the VHF Physical Layer. For Class SU* equipment, the lower service boundary between the EUT and the LT is the Data/Management Interface defined in Section 2.2.6.

The **Peripheral Functions** of the Test Set include, as a minimum the following functions:

- Generation of voice and data test messages for use as input to the UT, LT, and the EUT,
- Processing of the received voice and data messages
- Providing Input/Output (I/O) functions
- Providing human machine interface for the tester to control and configure the Test Set

2.4.3.1 Upper Tester (UT) Configuration

The UT is not necessarily a single definable piece of test instrumentation, but will likely be comprised of an assemblage of test equipment appropriate for a given test procedure that is capable of providing the functions necessary for that test. Figure 2-5 shows the functional blocks of a UT required to test the classes of equipment defined in Section 2.1.9. Note that the interface between the EUT and UT may differ, such as for Classes SL0 and SU*, depending upon the specific architecture classes of the equipment being tested, and the UT will need to be configured accordingly. In the case of testing IB0 and IV0 equipment, the UT is not used and will be bypassed. The major elements of the UT are defined in the subsections that follow.



Note: The configurations of the Upper Tester and the external interface to the EUT vary with the equipment classes of the EUT. See Section 2.4.3.4 for the Standard Test Configurations defined for the different equipment classes of this MOPS.

Figure 2-5: Upper Tester Functional Block Diagram

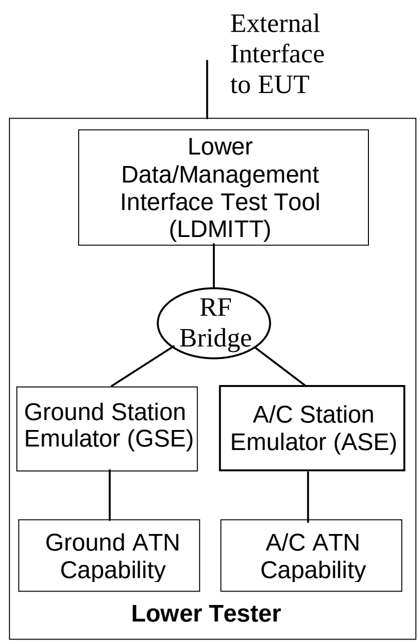
2.4.3.1.1 Upper Data/Management Interface Test Tool (UDMITT)

The Upper Data/Management Interface Test Tool (UDMITT) is a subset of the UT and it implements the protocol layer functions associated with architecture Class SU* equipment. To test Class SL0 equipment, the UDMITT must include functionality to emulate the upper layers of the VDL Mode 3 protocol stack between the SNAcP interface and the Data/Management Interface. The UDMITT, when connected to a Class SL0 EUT, implements the full VDL Mode 3 protocol stack. The purpose of a UDMITT is to complement a Class SL0 EUT to function as a complete VDL Mode 3 avionics radio and, thus, make the UDMITT/Class SL0 EUT combination an SUT. The UDMITT function includes a means of bi-directional communications with a Class SL0 EUT by way of the Data/Management Interface defined in Section 2.2.6. Class ID* equipment has all the necessary VDL Mode 3 protocol functions and does not require the UDMITT for testing. The Test Set will be configured such that the UDMITT bypasses its separated equipment functions when testing Class ID* equipment. As indicated earlier, the UT, including the UDMITT, will be bypassed for testing Class IB0 and IV0 equipment.

Note: *An acceptable implementation of a UDMITT for testing Class SL0 equipment could be a certified Class SU* equipment (e.g. a CMU implementing VDL Mode 3 functionality).*

2.4.3.2 Lower Tester (LT) Configuration

The LT is not necessarily a single definable piece of test instrumentation, but will likely be comprised of an assemblage of test equipment appropriate for a given test procedure that is capable of providing the functions necessary for that test. Figure 2-6 shows the functional blocks of an LT required to test the classes of equipment defined in Section 2.1.9. Note that the interface between the EUT and LT may differ, depending upon the specific architecture classes of the equipment being tested. The LT will need to be configured accordingly. The major elements of an LT are defined in the sections below.



Note: *The configurations of the Lower Tester and the external interface to the EUT vary with the equipment classes of the EUT. See Section 2.4.3.4 for the Standard Test Configurations defined for the different equipment classes of this MOPS.*

Figure 2-6: Lower Tester Functional Block Diagram

2.4.3.2.1 Lower Data/Management Interface Test Tool (LDMITT)

The Lower Data/Management Interface Test Tool (LDMITT) is a subset of the Lower Tester and it implements the protocol layer functions associated with architecture Class SL0 equipment. For Class SU* equipment, the LDMITT must include functionality to emulate the lower layers of the VDL Mode 3 protocol stack between the Data/Management Interface and the physical layer. The LDMITT when connected to a Class SU* equipment implements the full VDL Mode 3 protocol stack. The purpose of an LDMITT is to complement a Class SU* EUT to function together as a complete VDL Mode 3 avionics radio and, thus, make the LDMITT/SU* EUT combination an SUT. The LDMITT function includes a means of bi-directional communications with Class SU* EUT by means of the Data/Management Interface defined in Section 2.2.6. Class ID*, IB0, and IV0 equipment, on the other hand, have all the necessary lower layer VDL

Mode 3 protocol functions implemented internally and do not require the LDMITT functionality for testing. The LT will be configured with the LDMITT bypassed.

Note: *An acceptable implementation of an LDMITT for testing Class SU* equipment could be a combination of a GSE emulating one or more ground stations, as specified in Section 2.4.3.2.3; an ASE emulating one or more aircraft stations, as specified in Section 2.4.3.2.4; and Class SL0 equipment.*

2.4.3.2.2 RF Bridge

An RF Bridge is provided to interconnect the RF signals from the GSE, the ASE, the LDMITT, and the EUT over the VHF A/G communications band to emulate the common shared channel operation of the A/G communications environment.

2.4.3.2.3 Ground Station Emulator (GSE)

The GSE emulates all the ground station functions in a VDL Mode 3 network. Some VDL Mode 3 functions and characteristics can be verified only when a VDL Mode 3 EUT is coupled through an RF link with its VDL Mode 3 Ground Station (GS) counterpart, each controlling or reacting to various states (or changes of state) of each other. The GSE is used in conjunction with other elements of the Test Set, e.g., the ASE, to form a VDL Mode 3 subnetwork to support MOPS testing.

The GSE is not necessarily a single definable piece of test instrumentation, but will likely comprise an assemblage of equipment appropriate for a given test procedure capable of providing the functions necessary for that test. The following is a minimal list to be incorporated as part of the GSE:

- The GSE must be compliant with the applicable requirements set for VDL Mode 3 in RTCA DO-224B.
- The GSE must be able to establish a “link” with the EUT by transmitting and receiving properly modulated RF signals in compliance with DO-224B.
- The GSE must be able to establish an ISO 8208 link with its peer entity in the aircraft radio for applicable equipment classes, and to emulate air-ground subnetwork operations via this link.
- The GSE must be able to establish a CLNP link with its peer entity in the aircraft radio for applicable equipment classes, and to emulate air-ground subnetwork operations via this link.
- The GSE must have the ability to control the signaling and communications protocols embodied as part of the VDL Mode 3 and ATN manual standards, and to verify correct operation of these protocols.
- The GSE must be capable of emulating two independent ground stations, designated as Ground Station 1 (GS1) and Ground Station 2 (GS2), operating in separate VHF channels.
- Each ground station must be independently configurable to support any of the standard VDL Mode 3 system configurations.

- Each ground station must be capable of corrupting selected uplink Management (M) bursts and Voice/Data (V/D) bursts prior to transmission and selected downlink bursts after demodulation.

- Each ground station must be capable of selectively suppressing the transmission of specified uplink bursts to each connected aircraft station, or discarding specific received bursts in the downlink.

- Each ground station must be capable of advancing or retarding the timing of its bursts relative to the timing reference of the net independently.

- The transmit signal level of each ground station at the destination radio must be independently adjustable from its rated output down to minus 98 dBm in 1 dB steps.

- The two ground stations must be able to synchronize their timings to each other or to a common timing source.

2.4.3.2.4 Aircraft Station Emulator (ASE)

The Aircraft Station Emulator (ASE) emulates all aircraft radio functions required to operate in a VDL Mode 3 subnetwork. The ASE is used in conjunction with other elements of the Test Set, e.g., the GSE, to form a VDL Mode 3 subnetwork to support MOPS testing. The following is a minimal list of functions that should be incorporated as part of the ASE:

- The ASE must be compliant with the minimum requirements set for VDL Mode 3 in DO-224B.

- The ASE must be able to establish a “link” with the EUT and GSE.

- The ASE must be capable of emulating up to two independent aircraft stations designated as Aircraft Station 1 (AC1) and Aircraft Station 2 (AC2).

- Each aircraft station in the ASE must be capable of advancing or retarding the timing of its bursts relative to its timing reference point.

- The transmit signal level of each aircraft station in the ASE must be independently adjustable from its rated output down to minus 98 dBm in 1 dB steps.

2.4.3.2.5 ATN Capability

Ground ATN capable and aircraft ATN capable devices are required for end-to-end test of the data link. This may be accomplished by including within the Message Generator/Processor an ATN capability. Alternately, ATN routers and/or end-systems may be attached to the Message Generator/Processor. The key functional requirements of the ground and aircraft ATN capabilities are:

- An ATN capability must include the ability to operate transport protocol class 4 (TP4) connections over connectionless network protocol (CLNP), connectionless transport protocol (CLTP) connections over CLNP, and perform the CLNP echo request/response protocol.

- The TP4, CLTP, and CLNP code must originate from an independent source other than that of the VDL Mode 3 CLNP compression code.

- The maximum transmission unit (MTU) size for the CLNP interface must be set to 923 bytes.

- Any CLNP packets received by the EUT, or the GSE, in either direction, to or from the ground, must be passed through compression processing.

- A means must be provided at the Test Set radios to examine subnetwork packets before and/or after compression processing.

2.4.3.3 Test Set Peripheral Functions

In addition to the UT and LT, peripheral functions are required to provide the capabilities to:

- Generate voice and data messages
- Process received voice and data messages
- Monitor VDL Mode 3 burst timing and header information
- Control of Test Set functions
- Human Machine Interface

Some of these functions are described below.

2.4.3.3.1 Message Generator/Processor

The Message Generator/Processor is used to generate voice and data message stimuli and measure voice and data message response to and from the EUT, Aircraft Station Emulator (ASE), and Ground Station Emulator (GSE) in the Test Set.

2.4.3.3.1.1 Voice Message Generation and Processing

The key functional requirements of the voice message generation and processing are:

- Voice message generation must be controlled by PTT signaling from the ground and aircraft radios of the Test Set and the avionics EUT.

- The voice message generation and processing function must have the capability to measure end-to-end voice quality objectively (See Note below.).

- The Test Set must be capable of input and output voice messages to all radios independently.

- The Message Generator/Processor must be capable of accommodating real-time or pre-recorded voice messages.

<u>Note:</u> *The Message Generator/Processor may be integrated with a commercially available voice quality measurement system for evaluating the voice quality of an air-ground test link objectively. The test link refers to the reference ground station and the avionics radio EUT connected back-to-back. Even though there is currently no objective voice quality requirement specified in the MASPS, such a requirement is deemed appropriate for the MOPS in order to guarantee that the vocoder has been integrated properly into the avionics radio and the end-to-end voice quality is of acceptable quality. Such an objective voice quality requirement is included in Section 2.2.4.1.*

2.4.3.3.1.2 Data Message Generation and Processing

The Data Message Generation and Processing functions include a means of bi-directional communications with the VDL Mode 3 EUT by way of CLNP and ISO 8208 packets. The Data Message Generation and Processing functions shall permit user control of data content and message timing for transmitted messages. The Data Message Generation and Processing functions shall permit user storage, retrieval and examination of incoming and outgoing messages on both octet and packet levels, in accordance with the appropriate SNAcP interfaces and DO-224B. Data fields within packets will also be capable of being loaded with either live data emulating operational scenarios or pseudorandom or arbitrary test data. The Data Message Generation and Processing functions shall provide a means of validating and documenting the information content of any message transmitted to or received from the EUT and the GSE and ASE elements. The key functional requirements of the data message generation and processing functions are:

- The Data Message Generator/Processor must be capable of generating pseudorandom sequences with user-selectable lengths and priority levels for use as input data messages to the radios.

- The Data Message Generator/Processor must allow user generated messages of selected length and priorities to be used as data input to the radios.

- The rate of data message generation must be selectable by the tester.

- The Data Message Generator/Processor must be capable of injecting multiple data messages of specified lengths and priorities at a specified rate to all radios of the Test Set and the EUT independently to originate point-to-point data transmission or uplink data broadcast.

2.4.3.3.2 Monitoring Facility

The Test Set must include a monitoring facility that is capable of measuring and displaying pertinent system timing information, equipment status, and signal characteristics. The key functional requirements of the Monitoring Facility are:

- The Monitoring Facility must monitor the timing of all transmission bursts in a given net in reference to the ground station timing reference.

- The Monitoring Facility must log the timing information of bursts onto a data file for post analysis.

- The Monitoring Facility must provide an indication when a burst violates the timing rule.

- The Monitoring Facility must have the capability to examine the burst header format.

- The Monitoring Facility must display all aircraft radio timing states of the Test Set and the EUT.

The Test Set must also include a human machine interface (HMI) for the tester to configure the Test Set, to input commands to the Test Set, and to receive and display response or test results from the Test Set. The key functional requirements of the HMI are:

- A keyboard for input commands

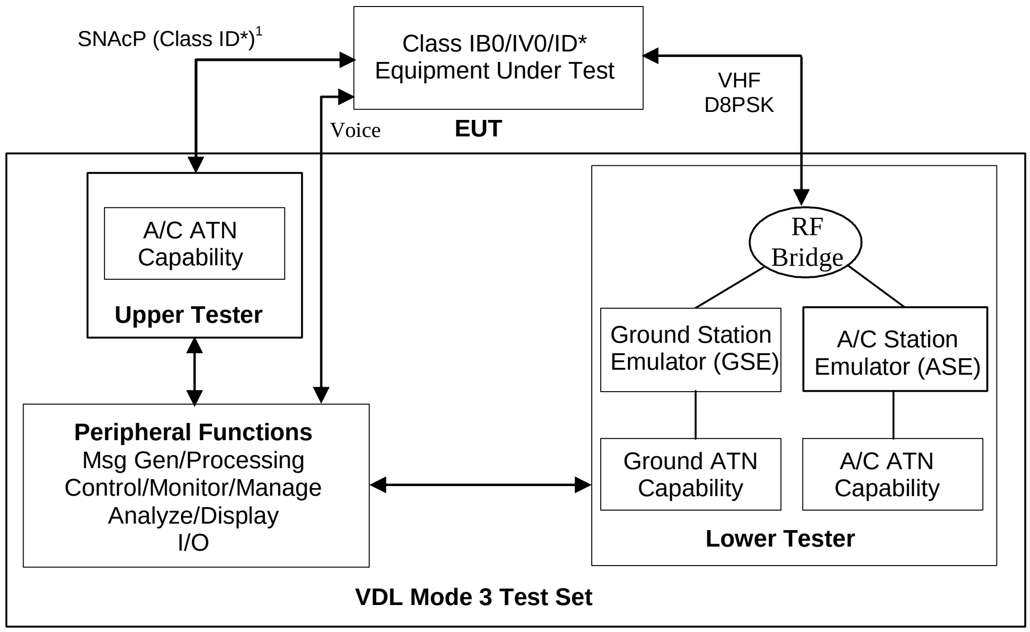
- A CRT or equivalent monitor for display

2.4.3.4 Standard Test Set Configurations

Based on the equipment classes being tested, three standard Test Set configurations are anticipated. The three standard Test Set configurations are defined for IB0/IV0/ID*, SL0, and SU* equipment, respectively, to facilitate description of the testing to be performed in the test procedures. For each Standard Test Set Configuration, the EUT consists of a single unit of the designated classes of equipment.

2.4.3.4.1 Standard Test Set Configuration 1 for Class IB0/IV0/Class ID* Equipment

The standard Test Set configuration 1 is for testing Class IB0, Class IV0, and Class ID* equipment in both Single Radio and Multiple Radio testing and is shown in Figure 2-7, with its major functional blocks identified.



Note:
1. Ground and A/C ATN Capabilities are not required for Class IB0 and Class IV0 equipment.

Figure 2-7: Standard Test Set Configuration 1 - for Class IB0, Class IV0, and Class ID* Equipment

2.4.3.4.2 Standard Test Set Configuration 2 for Class SL0 Equipment

The standard Test Set configuration 2 is for testing Class SL0 equipment and is shown in Figure 2-8, with its major functional blocks identified.

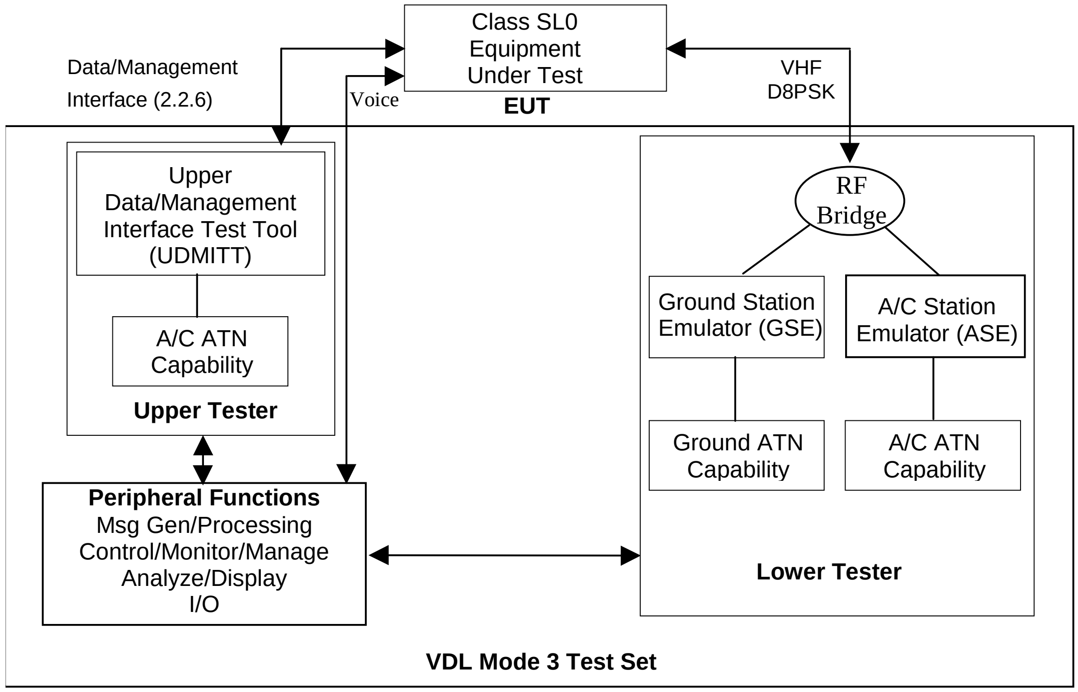


Figure 2-8: Standard Test Set Configuration 2 - for Class SL0 Equipment

2.4.3.4.3 Standard Test Set Configuration 3 for Class SU* Equipment

The standard Test Set configuration 3 is for testing Class SU* equipment and is shown in Figure 2-9 with its major functional blocks identified.

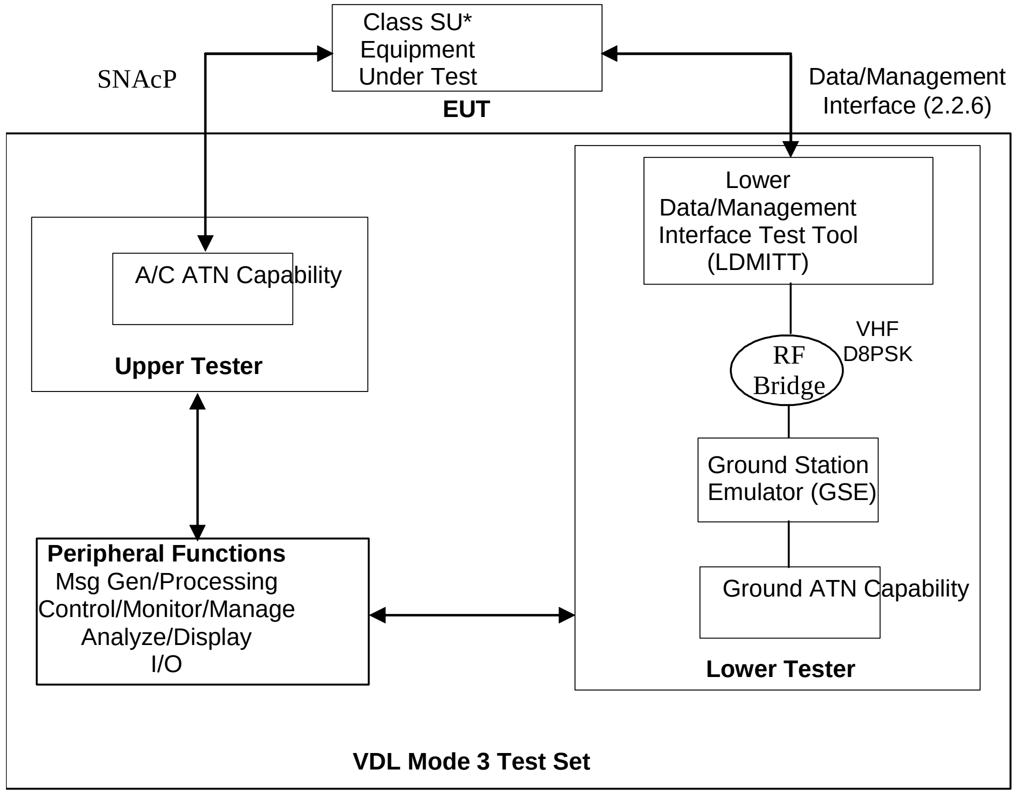


Figure 2-9: Standard Test Set Configuration 3 - for Class SU* Equipment

2.4.4 Physical Layer Tests

The standard test configurations described in section 2.4.3.4 above are intended for testing avionics for compliance with link layer, subnetwork layer, and voice requirements. The Physical layer tests do not normally require the use of the Test Set. The Physical layer of the avionics is typically conducted as a bench test using primarily commercial-off-the-shelf (COTS) RF test equipment. The test equipment and test setup may vary from test to test and will be specified as part of the test procedures for each test.

The following test procedures are considered to be satisfactory means of establishing compliance with the Physical layer requirements of Section 2 of this document. However, alternative procedures, which provide equivalent information may be used. To reduce the number of test cases, the number of frequencies at which the VDL transmitter and receiver are to be tested shall include a low frequency (for example, 118.000 MHz), a mid frequency (for example 127.500 MHz), and a high frequency (for example 136.975 MHz).

The Physical layer test procedures of this section are applicable only to Class IB0, IV0, ID*, and SL0 equipment.

2.4.4.1 Receiver Test Procedures

Unless otherwise stated, for tests of receiver BER performance, the receiver will be placed in the BER Mode and the GSE set in the complementary BER mode. Figure 2-10 shows the basic test setup for receiver BER tests, where the definitions for the BER

Mode, desired VDL Mode 3 source, external BER test fixture, and interfering (or undesired) VDL Mode 3 sources can be found in Section 2.4.2.

2.4.4.1.1 Sensitivity (Section 2.2.1.2.1)

Equipment Required

VHF Signal Generator
External BER Test Fixture

Procedure

Step 1 Connect the equipment as shown in Figure 2-10 and set the receiver to BER mode. Notice that Generator B and the RF combiner are not used for this test.

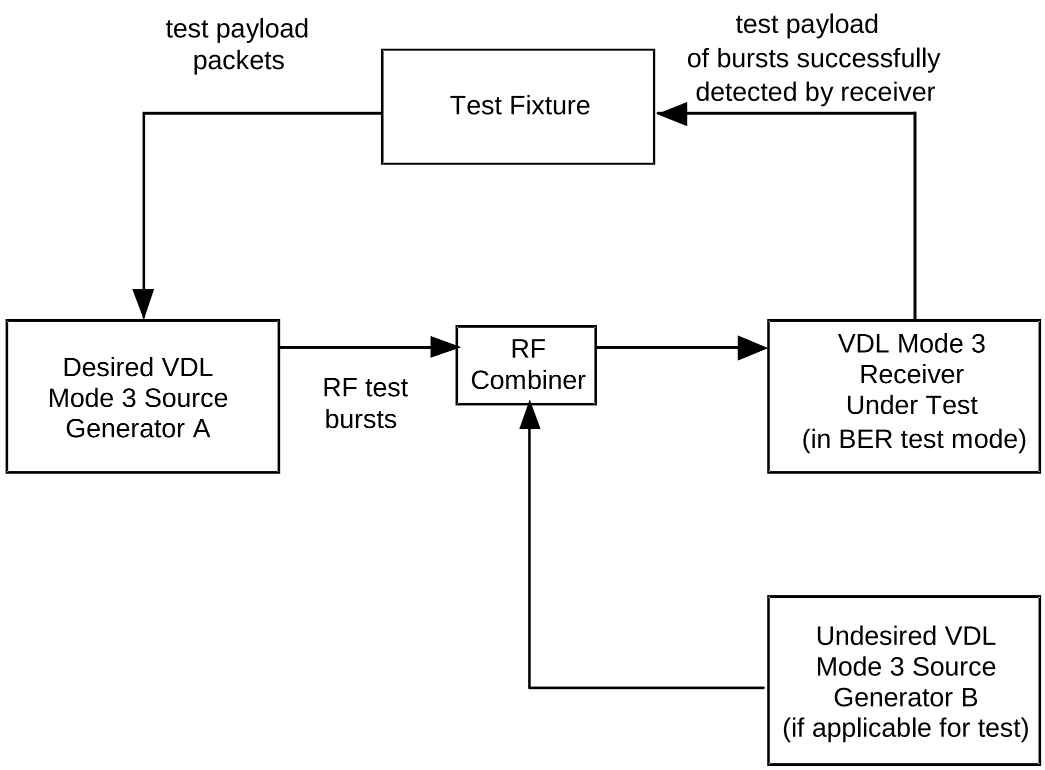


Figure 2-10: Receiver BER Measurement

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune both generator A and the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Modulate the desired signal with an appropriate test payload in burst form provided by the BER test fixture. Adjust the level of the signal generator to produce the signal level (Section 2.2.1.2.1) at the receiver input.

Step 4 Use the BER test fixture to measure the BER of the demodulated data at the receiver output.

Step 5 Verify compliance of the measured BER with the BER requirement.

Step 6 Repeat Steps 2 to 5 for the other two test frequencies (Section 2.4.4).

2.4.4.1.2 Adjacent Channel Rejection (Section 2.2.1.2.2)

Equipment Required

2 VHF Signal Generators
External BER Test Fixture
RF Combiner

Procedure

Step 1 Connect the equipment as shown in Figure 2-10 and set the receiver to BER mode.

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3. Tune both generator A and the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Modulate generator A with an appropriate test payload in burst form provided by the BER test fixture. Adjust signal generator A to produce the reference signal level (Section 2.2.1.2) at the receiver input.

Step 4 Tune generator B to the first upper adjacent channel frequency to generate an undesired VDL Mode 3 test signal (Section 1.7.9). Set the signal level of Generator B to 40 dB above the reference signal level established in Step 3.

Step 5 Apply the desired input signal and the adjacent interfering signal to the receiver input via the RF combiner.

Step 6 Using the BER test fixture, measure the BER and verify its compliance with the uncorrected BER requirement (Section 2.2.1.2).

Step 7 Repeat Steps 4 to 6 for the lower adjacent channel.

Step 8 Repeat Steps 4 to 7 for the second adjacent channel.

Step 9 Repeat Steps 4 to 7 for the third adjacent channel.

Step 10 Repeat Steps 4 to 7 for the fourth adjacent channel, but set the signal level of Generator B to 60 dB above the reference signal level established in Step 3.

Step 11 Repeat Steps 4 to 7 for the 10th adjacent channel, but set the signal level of Generator B to 60 dB above the reference signal level established in Step 3.

Step 12 Repeat Steps 2 to 11 for the other two test frequencies (Section 2.4.4).

Note: The noise sidebands of the interfering signal must not interfere with the desired signal in the receiver passband. The isolation, offered by the RF combiner, must be sufficient to prevent intermodulation between the VHF generators.

2.4.4.1.3 Rejection of Signals Within the VHF Aeronautical Communications Band (Section 2.2.1.2.3)

Equipment Required

2 VHF Signal Generators
External BER Test Fixture
RF Combiner

Procedure

Step 1 Connect the equipment as shown in Figure 2-10 and set the receiver to BER mode.

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune both generator A and the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Modulate generator A with an appropriate test payload in burst form using the BER test fixture. Adjust the level of signal generator A to produce the reference signal level (Section 2.2.1.2) at the receiver input.

Step 4 Tune generator B to the upper second adjacent channel frequency of the desired signal and generate an unmodulated (CW) interfering signal.

Step 5 Adjust the level of signal generator B to the unmodulated interfering signal power value, defined in Section 2.2.1.2.3, at the receiver input.

Step 6 Apply the desired input signal and the unmodulated interfering signal to the receiver input via the RF combiner and determine the BER of the demodulated data with the external BER test fixture.

Step 7 Verify compliance of the measured BER with the BER requirement.

Step 8 Repeat Steps 4 to 7 but tune generator B to the lower second adjacent channel of the desired signal.

Step 9 Repeat Steps 2 to 8 for the other two test frequencies (Section 2.4.4).

Note: The noise sidebands of the interfering signal must not interfere with the desired signal in the receiver passband. The isolation, offered by the RF combiner, must be sufficient to prevent intermodulation between the VHF generators.

2.4.4.1.4 Rejection of Signals Outside the VHF Aeronautical Communications Band (Section 2.2.1.2.4)

Equipment Required

2 VHF Signal Generators
External BER Test Fixture
RF Combiner

Procedure

Step 1 Connect the equipment as shown in Figure 2-10 and set the receiver to BER mode.

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune both generator A and the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Modulate generator A with an appropriate test payload in burst form using the external BER test fixture. Adjust the level of signal generator A to the reference signal level (Section 2.2.1.2) at the receiver input.

Step 4 Tune generator B to a low-band frequency in one of the sub-bands defined for unwanted signal A in Section 2.2.1.2.4 and generate one of the specified CW interfering signals at the receiver input.

Step 5 Adjust the level of generator B to provide the interfering signal level, defined in Section 2.2.1.2.4, at the receiver input.

Step 6 Apply the desired signal and the interfering signal to the receiver input via the RF combiner and determine the BER with the external BER test fixture.

Step 7 Verify compliance of the measured BER with the BER requirement.

Step 8 Repeat Steps 4 to 7 by tuning generator B to a mid-band frequency for the same sub-band as in Step 4.

Step 9 Repeat Steps 4 to 7 by tuning generator B to an upper-band frequency for the same sub-band as in Step 4.

Step 10 Repeat Steps 4 to 9 for the other sub-bands defined for unwanted signal A in Section 2.2.1.2.4.

Step 11 Repeat Steps 2 to 10 for the bands defined for unwanted signals B and C in Section 2.2.1.2.4.

Step 12 Repeat Steps 2 to 11 for the other two test frequencies (Section 2.4.4).

Notes:

1. *The noise sidebands of the interfering signal must not interfere with the desired signal in the receiver passband. The isolation, offered by the RF combiner, must be sufficient to prevent intermodulation between the VHF generators.*

2. *Any interfering signal found to increase the BER above the reference BER should be investigated using a spectrum analyzer connected to the combiner output. This should determine whether the RF combiner/test setup is producing an on-channel signal into the receiver under test.*

3. *Alternative procedures or theoretical calculation may be used to reduce the number of discrete frequencies at which the equipment needs to be tested.*

2.4.4.1.5 Desired Signal Dynamic Range (Section 2.2.1.2.5)

Equipment Required

VHF Signal Generator
External BER Test Fixture

Procedure

Step 1 Connect the equipment as shown in Figure 2-10 and set the receiver to BER mode. Notice that Generator B and the RF combiner are not used for this test

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune both generator A and the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Modulate generator A with an appropriate test payload in burst form using the BER test fixture. Adjust the level of generator A to produce the maximum reference signal level (Section 2.2.1.2.5) at the receiver input.

Step 4 Apply the modulated signal to the receiver and determine the BER of the demodulated data at the receiver output with the external BER test fixture.

Step 5 Verify compliance of the measured BER with the BER requirement.

Step 6 Repeat Steps 2 to 5 for the other two test frequencies (Section 2.4.4).

2.4.4.1.6 Symbol Rate Capture Range (Section 2.2.1.2.6)

Equipment Required

VHF Signal Generator
External BER Test Fixture

Procedure

Step 1 Connect the equipment as shown in Figure 2-10 and set the receiver to BER mode. Notice that Generator B and the RF combiner are not used for this test.

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune both generator A and the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Modulate the carrier of generator A with an appropriate test payload in burst form provided by the external BER test fixture. Adjust generator A to produce the reference signal level (Section 2.2.1.2) at the receiver input.

Step 4 Adjust the transmitted data clock offset of the external BER test fixture to the maximum positive offset specified in Section 2.2.1.2.6.

Step 5 Apply the modulated signal to the receiver and determine the BER of the demodulated data at the receiver output with the external BER test fixture.

Step 6 Verify compliance of the measured BER with the BER requirement.

Step 7 Repeat Steps 4 to 6 after adjusting the transmitted data clock offset to the maximum negative offset specified in Section 2.2.1.2.6.

Step 8 Repeat Steps 2 to 7 for the other two test frequencies (Section 2.4.4).

2.4.4.1.7 Frequency Capture Range (Section 2.2.1.2.7)

Equipment Required

VHF Signal Generator
External BER Test Fixture

Procedure

Step 1 Connect the equipment as shown in Figure 2-10 and set the receiver to BER mode. Notice that Generator B and the RF combiner are not used for this test.

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Tune generator A to the selected test frequency plus the positive frequency offset (defined in Section 2.2.1.2.7), and modulate the carrier with an appropriate test payload in burst form provided by the BER test fixture. Adjust generator A to produce the reference signal level (Section 2.2.1.2) at the receiver input.

Step 4 Apply the modulated signal to the receiver, and determine the BER of the demodulated data at the receiver output with the external BER test fixture.

Step 5 Verify compliance of the measured BER with the BER requirement.

Step 6 Repeat Steps 3 to 5 for the negative frequency offset (Section 2.2.1.2.7).

Step 7 Repeat Steps 2 to 6 for the other two test frequencies (Section 2.4.4).

2.4.4.1.8 Phase Acceleration (Section 2.2.1.2.8)

Equipment Required

RF Signal Generator (HP8644A or equivalent)
Programmable Function Generator (HP3325A or equivalent)
Desired VDL Mode 3 Signal Source
Mixer (WJN9B or equivalent)
External BER Test Fixture

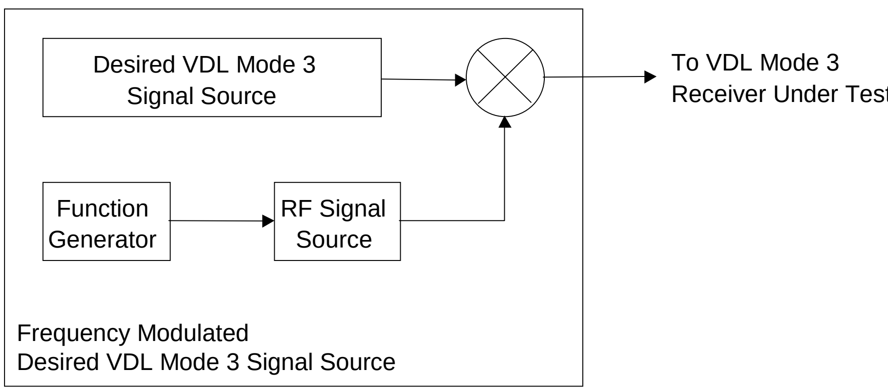


Figure 2-10a: Frequency Modulated VDL Mode 3 Source

Step 1 In the standard BER test setup of Figure 2-10 replace the desired VDL Mode 3 Signal Source with a frequency modulated signal source, as shown in Figure 2-10a. Set the Function Generator to create a sine wave at a rate of 0.8 Hz. Use the function generator output to frequency modulate the RF signal source at a peak frequency deviation of 200 Hz. Set the RF signal source to generate a carrier frequency of 2 MHz.

Step 2 Set the desired VDL Mode 3 Signal Source to generate an input signal to the receiver at 2 MHz below one of the test-frequencies (Section 2.4.4) plus the frequency offset (Section 2.2.1.2.7). Set the receiver under test for the associated test frequency.

Step 3 Modulate the desired signal with an appropriate test payload from the External BER Test Fixture. Adjust the level of the signal generator to produce the reference signal level (Section 2.2.1.2) at the receiver input.

Step 4 Apply the data and frequency modulated signal to the receiver under test. Perform bit error rate measurement.

Step 5 Verify compliance with the BER requirements of Section 2.2.1.2.

Step 6 Repeat Steps 2 to 5 for the other two test frequencies (Section 2.4.4).

2.4.4.1.9 Co-Channel Interference (Section 2.2.1.2.9)

Equipment Required

2 VHF Signal Generators
External BER Test Fixture
RF Combiner

Procedure

Step 1 Connect the equipment as shown in Figure 2-10 and set the receiver to BER mode.

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune both generator A and the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Modulate the carrier of signal generator A with an appropriate test payload in burst form provided by the BER test fixture. Adjust generator A to produce the reference signal level (Section 2.2.1.2) at the receiver input.

Step 4 Tune generator B to the selected test frequency to generate an undesired VDL Mode 3 test signal (Section 1.7.9).

Step 5 Adjust generator B to produce a signal level 20 dB below the reference signal level (Section 2.2.1.2) at the receiver input.

Step 6 Apply the desired signal and the undesired co-channel signal to the receiver input via the RF combiner and measure the BER of the demodulated data at the receiver output with the BER test fixture.

Step 7 Verify compliance of the measured BER with the BER requirement.

Step 8 Repeat Steps 2 to 7 for the other two test frequencies (Section 2.4.4).

2.4.4.1.10 Conducted Spurious Emission (Section 2.2.1.2.10)

Equipment Required

Spectrum Analyzer

Procedure

Step 1 Connect the RF output of the equipment under test directly into the RF input of the spectrum analyzer. **Exercise caution:** do not allow the transmitter to radiate.

Step 2 Tune the transceiver to one of the test frequencies (Section 2.4.4).

Step 3 Use the spectrum analyzer to measure the power level of spurious emissions over the frequency range defined in Section 2.2.1.2.10.

Step 4 Record the frequency and power level of all spurious emissions, which are stronger than 20 dB below the limits specified in Section 2.2.1.2.10.

Step 5 Verify compliance of the spurious signals with the conducted spurious emission requirement.

Step 6 Repeat Steps 2 to 5 for the other two test frequencies (Section 2.4.4).

2.4.4.1.11 FM Broadcast Intermodulation (Section 2.2.1.2.11)

Equipment Required

3 VHF Signal Generators
External BER Test Fixture
RF Combiner

Procedure

Step 1 Connect the equipment as shown in Figure 2-11 and set the receiver to BER mode.

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune both generator A and the receiver under test to a low test frequency (Section 2.4.4) ending with an odd multiple of 100 kHz value (e.g., 118.300 MHz).

Step 3 Modulate the carrier of generator A with an appropriate test payload in burst form provided by the BER test fixture. Adjust the level of generator A to produce the reference signal level (Section 2.2.1.2) at the receiver input.

Step 4 Determine the appropriate third order intermodulation frequencies F_b and F_c in Note 2 below and tune signal generators B and C to the frequencies F_b and F_c to produce unmodulated signals. Adjust generators B and C to produce the signal levels specified in Section 2.2.1.2.11 at the receiver input.

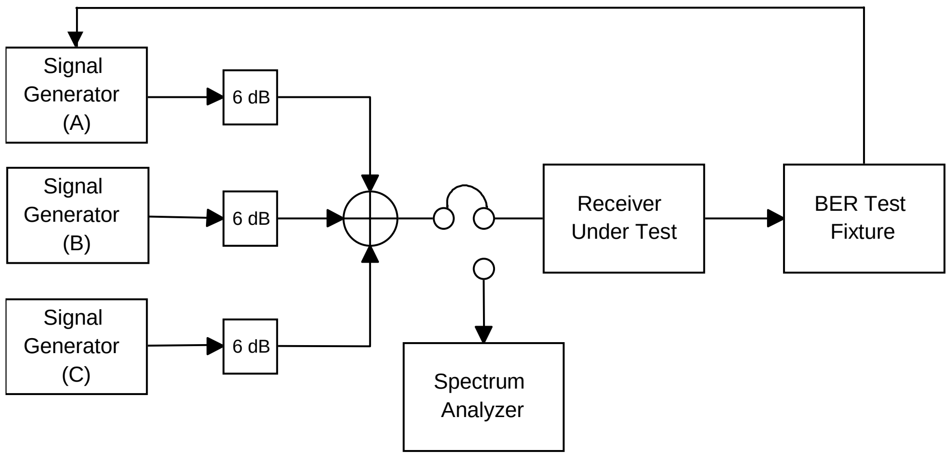


Figure 2-11: Intermodulation Measurement

Step 5 Apply the desired signal and the two interfering signals to the receiver input via the RF combiner and determine the BER of the demodulated data at the receiver output with the external BER test fixture.

Step 6 Verify compliance of the measured BER with the BER requirement.

Step 7 Repeat Steps 2 to 6 for the middle test frequency (Section 2.4.4) ending with an odd multiple of 100 kHz value (e.g., 127.900 MHz).

Notes:

1. *The noise sidebands of the interfering FM modulated signals must not interfere with the desired signal in the receiver passband. The isolation, offered by the RF combiner, must be such that it prevents intermodulation between the generators. Significant additional filtering and isolation may be required.*

2. *Third order intermodulation frequencies are defined as:*

$$F_A = 2F_B - F_C \qquad \textbf{or} \qquad F_A = 2F_C - F_B$$

2.4.4.1.12 In-Band Intermodulation/Desense (Section 2.2.1.2.12)

Equipment Required

3 VHF Signal Generators
External BER Test Fixture
RF Combiner

Procedure

Step 1 Connect the equipment as shown in Figure 2-11 and set the receiver to BER mode.

Step 2 Use VHF signal generator A to produce a desired VDL Mode 3 signal. Tune both generator A and the receiver under test to one of the test frequencies (Section 2.4.4).

Step 3 Modulate the carrier of generator A with an appropriate test payload in burst form provided by the BER test fixture. Adjust the level of generator A to produce minus 75 dBm at the receiver input.

Step 4 Tune interfering signal generator B to a frequency 1 MHz above the selected channel frequency. Set signal generator B to produce an unmodulated carrier to be applied to the input of the receiver at minus 32 dBm.

Step 5 Tune the interfering signal generator C to a frequency 2 MHz above the selected test frequency. Modulate signal generator C with an appropriate test payload to produce a continuous D8PSK signal at 10,500 symbols/s to be applied to the input of the receiver at minus 32 dBm.

Step 6 Apply the desired signal and the two interfering signals to the receiver input via the RF combiner and determine the BER of the demodulated data at the receiver output with the external BER test fixture.

Step 7 Verify compliance of the measured BER with the BER requirement.

Step 8 Repeat Steps 2 to 7 for the other two test frequencies (Section 2.4.4).

Note: *In the absence of the desired signal (i.e., Generator A switched "off"), the intermodulation products produced by any interaction between the interfering signal generators B & C, must be less than minus 105 dBm at the receiver input. Additional band-pass filters, inserted between each generator and the R.F combiner, may be necessary to reduce the intermodulation product.*

2.4.4.2 Transmitter Test Procedures

Note: *A vector signal analyzer is required in some of the following test procedures. Vector signal analyzers integrate frequency-domain and time domain analyses to provide advanced measurements of complex signals. These analyzers offer complex signal analysis such as digital modulation (i.e. D8PSK for VDL Mode 3) plus AM/FM/PM demodulation, vector spectrum analysis, and time-gated spectrum analysis.*

2.4.4.2.1 Bit Rate (Section 2.2.1.3.1)

This requirement may be satisfied by written evidence.

In this case, the manufacturer must declare crystal stability, aging and temperature coefficients.

Note: *The evidence must demonstrate that consideration has been given to the temperature variation to which the equipment will be subjected (See Section 2.3, "Environmental Test Conditions") and the frequency range for which the equipment is designed to operate.*

2.4.4.2.2 RF Output Power (Section 2.2.1.3.2)

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)
Power Meter (with pulse power measurement capability) or Vector Signal Analyzer.

Procedure

Step 1 Connect the equipment as shown in Figure 2-12.

Step 2 Tune the transmitter to one of the test frequencies (Section 2.4.4).

Step 3 Key the transmitter under test "on" and modulate the carrier with an appropriate test payload in burst form from the transmission generator.

Step 4 Set the power meter (or vector signal analyzer) to capture the VDL Mode 3 transmitted signal and determine the average transmitter output power during the message period.

Step 5 Verify compliance of the measured output power with the transmitter output power requirement (Section 2.2.1.3.2) for the appropriate class of transmitter.

Step 6 Repeat Steps 2 to 5 for the other two test frequencies (Section 2.4.4).

Note: *The output power must not be averaged over the time intervals between signal transmissions, i.e., output power delivered into the 50 ohm load should be measured during signal transmission.*

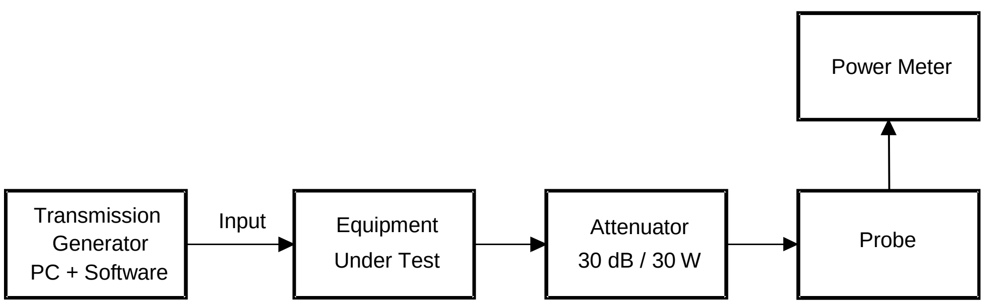


Figure 2-12: Output Power Measurement

2.4.4.2.3 RF Power Rise Time (Section 2.2.1.3.3)

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)
Vector Signal Analyzer

Procedure

Step 1 Connect the equipment as shown in Figure 2-13.

Step 2 Configure the vector signal analyzer to display both constellation diagram and power versus time charts.

Step 3 Tune the transmitter and the vector signal analyzer to one of the test frequencies (Section 2.4.4).

Step 4 Use the transmission generator to generate a single test-burst.

Step 5 Capture the start of the test-burst using both constellation and power versus time display and identify the first symbol of the synchronization sequence.

Step 6 Verify that the RF power level at 5.5 symbol periods before the middle of the first synchronization symbol is compliant with the RF power rise time requirement (Section 2.2.1.3.3).

Step 7 Verify that the RF power level for the 3 symbol periods before the middle of the first synchronization symbol is compliant with the RF power rise time requirement (Section 2.2.1.3.3).

Step 8 Repeat Steps 3 to 7 for the other two test frequencies (Section 2.4.4).

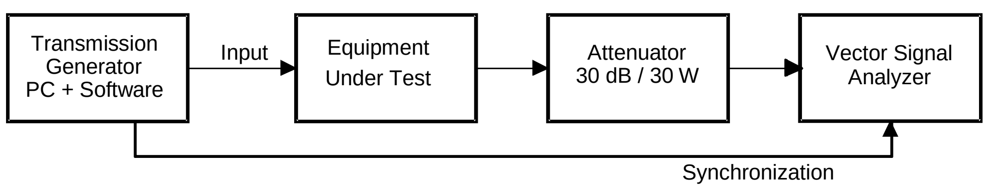
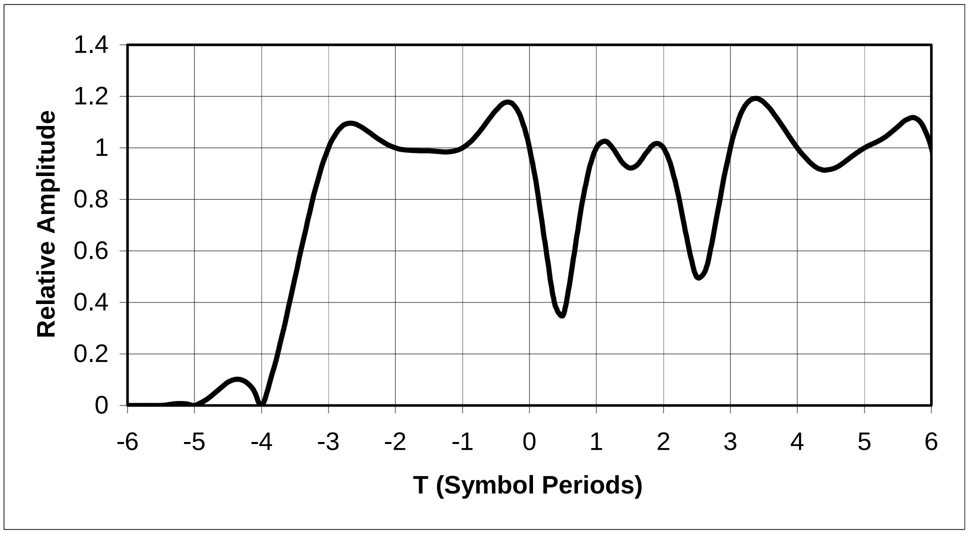


Figure 2-13: RF Power Rise and Release Time Measurement Also Suitable for Symbol Constellation Error

Note: *The training sequence for each type of burst has a characteristic amplitude profile. For V/D bursts, with synchronization sequence S_2, the profile appears as shown in Figure 2-14. The point labeled T=0 is the middle (ideal sampling point) of the first symbol of the synchronization sequence. There is a pronounced notch in the profile at T=0.5, which provides a convenient marker. This makes it easy to check the power level at the appropriate time, which is 3.5 symbol periods prior to the notch, i.e., at T=-3. This could constitute an alternative method using a standard spectrum analyzer or fast storage oscilloscope. For VDL Mode 3 synchronization sequences other than S_2, the profile shape will be different.*



T=0 is the Middle of the First Symbol of the Synchronization Sequence.

Figure 2-14: Ramp Up and Beginning of VDL Mode 3 Burst with Synchronization Sequence S_2 (Illustrating RF Rise Time)

2.4.4.2.4 RF Power Release Time (Section 2.2.1.3.4)

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)
Vector Signal Analyzer

Procedure

Step 1 Connect the equipment as shown in Figure 2-13.

Step 2 Configure the vector signal analyzer in digital demodulation mode to display log magnitude of I & Q vectors, with normalization disabled. Set the Y-axis to read “dBm”. The symbol times are displayed on the resultant profile of power versus time. Use of the trigger hold off function will aid signal acquisition.

Step 3 Tune the transmitter and the vector signal analyzer to one of the test frequencies (Section 2.4.4).

Step 4 Use the transmission generator to produce a single burst message. Capture the end of this message on the vector signal analyzer.

Step 5 Use the power versus time display to determine the corresponding profile for each symbol of the “power down” ramp.

Step 6 Measure the RF power level at 2.5 symbol periods after the middle of the final information symbol of the transmitted burst.

Step 7 Verify compliance of the measured power level with the RF power release time requirement (Section 2.2.1.3.4)

Step 8 Repeat Steps 3 to 7 for the other two test frequencies (Section 2.4.4)

Caution: *While performing Steps 9 to 13 below, ensure that the transmitter is not keyed or transmitting to prevent damage to the Vector Signal Analyzer.*

Step 9 Reconfigure the test setup with the Vector Signal Analyzer connected directly to the RF output of the transmitter under test.

Step 10 Tune the transmitter to one of the test frequencies (Section 2.4.4).

Step 11 With the transmitter idle (i.e., transceiver in receive mode, powered on but not transmitting) measure the transmitter RF output with the Vector Signal Analyzer referenced to an RF bandwidth of 25 kHz.

Step 12 Verify compliance of the measured power level with the transmitter power leakage requirement (Section 2.2.1.3.4).

Step 13 Repeat steps 10 to 12 for the other two test frequencies (Section 2.4.4).

2.4.4.2.5 Symbol Constellation Error (Section 2.2.1.3.5)

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)
Vector Signal Analyzer (with EVM capability)

Procedure

Step 1 Connect the equipment as shown in Figure 2-13.

Step 2 Tune the vector signal analyzer and the transmitter to one of the test frequencies (Section 2.4.4) and the correct modulation scheme, and select a suitable level range.

Step 3 Key the transmitter under test “on” and modulate it with an appropriate test payload in continuous form produced by the transmission generator.

Step 4 Measure the EVM and verify compliance with the EVM requirement.

Step 5 Repeat Steps 2 to 4 for the other two test frequencies (Section 2.4.4).

2.4.4.2.6 Spurious Emissions (Section 2.2.1.3.6 and Section 2.2.1.3.9)

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)

Notch Filters at the test frequencies (capable of suppressing the on-channel signal by at least 60 dB)
Spectrum Analyzer (with power band marker function)
Adjustable Delay Line
2:1 VSWR Resistive Load

Procedure

Step 1 Connect the equipment as shown in Figure 2-15.

Step 2 Use a notch filter centered on one of the test frequencies (Section 2.4.4) to attenuate the on-channel signal in order to increase the dynamic range of the measurement without overloading the spectrum analyzer. Measure the frequency response of the filter and take this into account when calculating spurious measurement results.

Step 3 Tune the transmitter to the selected test frequency.

Step 4 Set the transmission generator to produce an appropriate test payload in burst form and key the transmitter under test “on”.

Step 5 Adjust the spectrum analyzer reference level to provide the maximum dynamic range for display and set the input attenuator to the minimum required to ensure that no signal at the analyzer input exceeds the maximum allowable level.

Step 6 Measure the power level of each visible spurious signal using power band markers appropriate to the bandwidths specified in (Section 2.2.1.3.6). Use the filter to reject the carrier in order to increase the dynamic range of the measurement without overloading the spectrum analyzer. Make proper compensation for the frequency response of the filter to determine the transmitter spurious signal level.

Step 7 Verify compliance of the compensated spurious signal level with the spurious emission requirement.

Step 8 Repeat Steps 2 to 7 for the other two test frequencies (Section 2.4.4).

Step 9 Insert the 2:1 VSWR resistive load and delay into the equipment setup as shown in Figure 2-15a.

Step 10 Vary the VSWR phase angle of the load with the delay line and measure the spurious emissions from the transmitter as in Step 6.

Step 11 Verify compliance of the compensated spurious signal level under VSWR load with the spurious requirement (Section 2.2.1.3.6/2.2.1.3.9).

Step 12 Repeat Steps 10 to 12 for the other two test frequencies (Section 2.4.4).

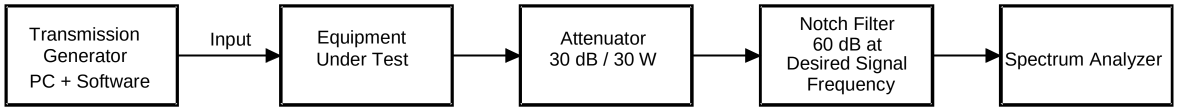


Figure 2-15: Spurious Emissions Measurement

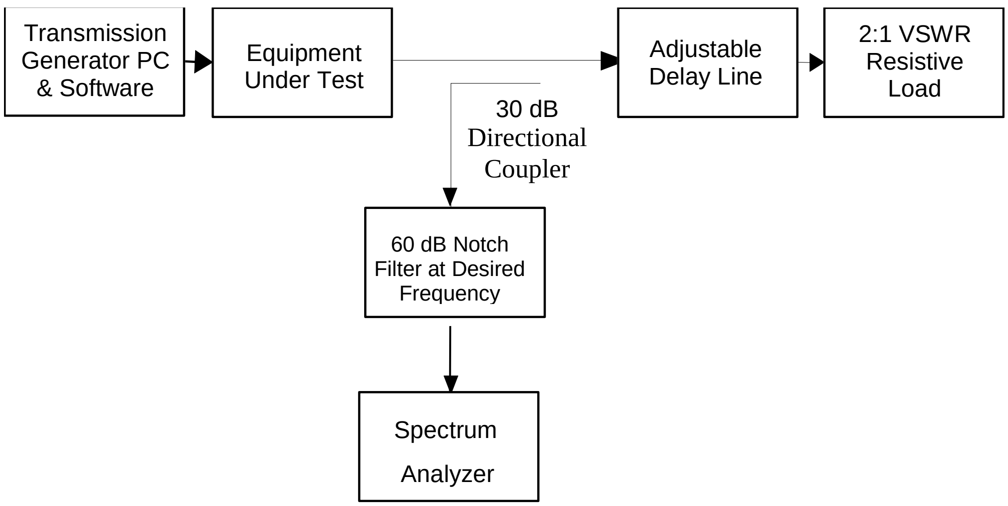


Figure 2-15a: Spurious Emissions Measurement Under VSWR Load

2.4.4.2.7 Adjacent Channel Power (Section 2.2.1.3.7)

Method of Measurement for the First Adjacent Channel

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)
Spectrum Analyzer (with power band marker function)

Procedure

Step 1 Connect the equipment as shown in Figure 2-16.

Step 2 Tune the transmitter to one of the test frequencies (Section 2.4.4).

Step 3 Key the transmitter under test "on" and modulate it with the transmission generator to produce an appropriate test payload in burst form.

Step 4 Adjust the attenuator in the analyzer to the minimum value, which does not overload the input stage of the unit.

Step 5 Use 100 kHz span to display the VDL Mode 3 signal envelope. Use the analyzer IF signal as the trigger source for the display and set averaging to 10.

Step 6 Use the power band marker function of the analyzer to measure the power in a 16 kHz bandwidth of the first upper adjacent channel.

Step 7 Repeat Step 6, except measure the power in a 25 kHz bandwidth of the first upper adjacent channel.

Step 8 Repeat Steps 3 to 7 for the first lower adjacent channel.

Step 9 Verify compliance of the first adjacent channel powers in 16 kHz and 25 kHz bandwidths with the first adjacent channel power requirements (Section 2.2.1.3.7).

Step 10 Repeat Steps 2 to 9 for the other two test frequencies (Section 2.4.4).

Step 11 Repeat Steps 2 through 10 with the spectrum analyzer set to peak hold and verify that the adjacent channel power measurements satisfy the requirements of Section 2.2.1.3.7 when compensating for the increased power measurement due to peak measurement versus average measurement

Note 1: *As an example, Agilent Application Note 1303, page 18, shows that the peak measurement can be 10 dB greater than the average value under some circumstances. Manufacturers are cautioned to verify the appropriate peak to average ratio for their test setup*

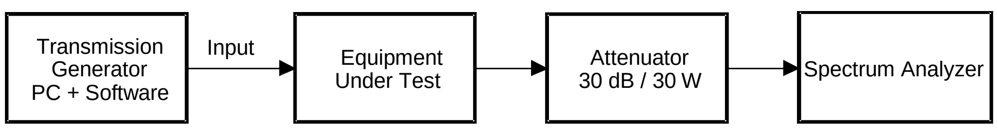


Figure 2-16: First Adjacent Channel Power Measurement

Method of Measurement for the Second and Third Adjacent Channel

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)
VHF Bandpass Filters (each with a 3 dB bandwidth of 25 kHz and attenuation in excess of 50 dB at ±50 kHz) each with a center frequency at one of the 2nd or 3rd adjacent channels of the test frequencies (Section 2.4.4)
Spectrum Analyzer (with power band marker function)

Procedure

***Caution:* To protect the analyzer, ensure that the transmitter is not keyed "on" at the frequency of the bandpass filter used for this test.**

Step 1 Connect the equipment as shown in Figure 2-17 using a VHF bandpass filter with a center frequency that is 50 kHz above one of the test frequencies (Section 2.4.4).

Step 2 Tune the transmitter to the test frequency in Step 1.

Step 3 Start the transmission generator that produces test payload in burst form, and key the transmitter under test "on".

Step 4 Set the analyzer span to 50 kHz, and tune the analyzer to the center frequency of the VHF bandpass filter. Decrease the analyzer input attenuator to the minimum level at which the attenuated RF signal from the transmitter under test does not overload the analyzer. Use the analyzer IF signal as the trigger source for the display and set averaging to 10.

Step 5 Set the analyzer's power band marker function to 40 kHz and determine the second upper adjacent channel power. Notice that the measurement bandwidth is defined by the VHF bandpass filter, so setting the power band marker to the same bandwidth will give erroneous results.

Step 6 Repeat Steps 1 to 5, except replace the VHF bandpass filter with one whose center frequency is 50 kHz below the test frequency, to determine the lower second adjacent channel power.

Step 7 Verify compliance of the upper and lower adjacent channel power with the second adjacent channel power requirement.

Step 8 Repeat Steps 1 to 6, except replace the VHF bandpass filter with one that has a center frequency that is 75 kHz above the test frequency to determine the upper 3^{rd} adjacent channel power.

Step 9 Repeat Steps 1 to 6, except replace the VHF bandpass filter with one that has a center frequency that is 75 kHz below the test frequency, to determine the lower 3^{rd} adjacent channel power.

Step 10 Verify compliance of the upper and lower adjacent channel power with the third adjacent channel power requirement.

Step 11 Repeat Steps 1 through 10 for the other two test frequencies (Section 2.4.4).

Step 12 Repeat Steps 1 through 11 with the spectrum analyzer set to peak hold and verify that the adjacent channel power measurements satisfy the requirements of Section 2.2.1.3.7 when compensating for the increased power measurement due to peak measurement versus average measurement. (See Note 1 under the first adjacent channel power measurement.)

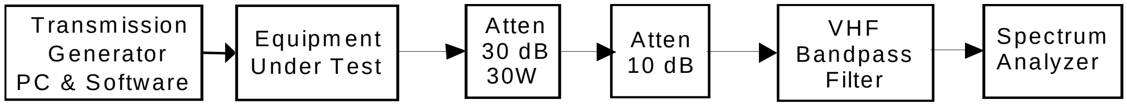


Figure 2-17: Second, Third, and Fourth Adjacent Channel Power Measurement

Method of Measurement for the Fourth Adjacent Channel

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)
VHF Bandpass Filters (each with a 3 dB bandwidth of 25 kHz and attenuation in excess of 50 dB at ±50 kHz), each with a center frequency at one of the 4th adjacent channels of the test frequencies (Section 2.4.4)
Spectrum Analyzer (with power band marker function)

Procedure

Step 1 Connect the equipment as shown in Figure 2-17 using a VHF bandpass filter with a center frequency that is 100 kHz above one of the test frequencies (Section 2.4.4).

Step 2 Tune the transmitter to the test frequency in Step 1.

Step 3 Start the transmission generator that produces test payload in burst form, and key the transmitter under test “on”.

Step 4 Set the analyzer span to 50 kHz and tune the analyzer to the center frequency of the VHF bandpass filter. Decrease the analyzer input attenuator to the minimum level at which the attenuated RF signal from the transmitter under test does not overload the analyzer. Use the analyzer IF signal as the trigger source for the display and set averaging to 10.

Step 5 Set the analyzer’s power band marker function to 40 kHz and determine the fourth upper adjacent channel power. Notice that the measurement bandwidth is defined by the VHF bandpass filter; setting the power band marker to the same bandwidth will give erroneous results.

Step 6 Repeat Steps 1 to 5, except replace the VHF bandpass filter with one whose center frequency is 100 kHz below the test frequency, to determine the fourth lower adjacent channel power.

Step 7 Verify compliance of the measured upper and lower fourth adjacent channel power with the fourth adjacent channel power requirement (Section 2.2.1.3.7).

Step 8 Repeat Steps 1 to 7 for the other two test frequencies (Section 2.4.4).

Step 9 Repeat Steps 1 through 8 with the spectrum analyzer set to peak hold and verify that the adjacent channel measurements satisfy the requirements of

Section 2.2.1.3.7 when compensating for the increased power measurement due to peak measurement versus average measurement. (See Note 1 under the first adjacent channel power measurement.)

Alternative Measurement Procedure for Adjacent Channel Power

Equipment Required

Transmission Generator (PC with suitable software)
Attenuator (30 dB/30 W)
Notch Filters at the test frequencies (capable of suppressing the on-channel signal by at least 60 dB)
Spectrum Analyzer (with power band marker function)

Procedure

Step 1 Connect the equipment as shown in Figure 2-18.

Step 2 Tune the transmitter to one of the test frequencies (Section 2.4.4).

Step 3 Start the transmission generator that produces test payload in burst form, and key the transmitter under test "on".

Step 4 Use an attenuator to protect the measurement equipment and a notch filter centered on the carrier frequency, if the dynamic range of the spectrum analyzer is not sufficient. Set the spectrum analyzer resolution bandwidth (Br) much narrower than the channel bandwidth and the video bandwidth (Bv) equal to ten times Br in order to avoid errors due to video averaging of noise.

Step 5 Measure and store the RF signal spectrum centered on the carrier frequency with a frequency span wide enough to display the entire modulation spectrum between the -80 dB points, referred to the peak value.

Step 6 Convert the logarithmic trace values from the spectrum analyzer to linear spectral power densities by the relation:

$$P_i = \frac{10^{\frac{PidBm}{10}}}{B_n}$$

where: P_{idBm} = Trace values (dBm)
B_n = Effective noise bandwidth of the spectrum analyzer (Hz)
P_i = Spectral power densities (mW/Hz)

Note: B_n = k * Br, *where* k *is a constant specified for each spectrum analyzer.*

Step 7 Perform integration of the linear spectral power densities. For computation of the linear spectral power values in the first, second, third, and fourth adjacent channels, use the formula:

$$P_{ch} = B_{ch} \times \frac{1}{N} \times \sum_{i=1}^{N} P_i$$

where: P_{ch} = power in the considered channel

B_{ch} = bandwidth of the 1st, 2nd, 3rd, or 4th adjacent channel, within which adjacent channel power is defined (16 kHz and 25 kHz bandwidths for the 1st adjacent channels, 25 kHz for the 2nd, 3rd, and 4th adjacent channels)

N = Number of power samples within the limits of the considered channel (assigned bandwidth B_{ch})

Step 8 Perform the adjacent channel power measurement for the first, second, third, and fourth adjacent channels on both sides of the carrier frequency (lower and upper adjacent channels).

Step 9 Verify that the adjacent channel power levels on either side of the carrier for the first, second, third, and fourth adjacent channels are lower than the respective adjacent channel power requirements.

Step 10 Repeat Steps 2 to 9 for the other two test frequencies (Section 2.4.4).

Step 11 Repeat Steps 2 through 10 with the spectrum analyzer set to peak hold and verify that the adjacent channel power measurements satisfy the requirements of Section 2.2.1.3.7 when compensating for the increased power measurement due to peak measurement versus average measurement. (See Note 1 under the first adjacent channel power measurement.)

Method of Measurement Beyond the Fourth Adjacent Channel

Step 1 Connect the equipment as shown in Figure 2-18.

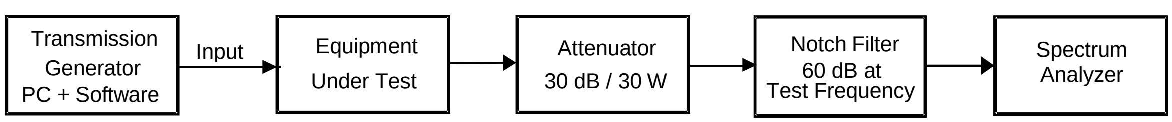


Figure 2-18: Power Measurement Beyond the Fourth Adjacent Channel

Step 2 Use a notch filter centered at one of the test frequencies (Section 2.4.4) to attenuate the on-channel signal in order to increase the dynamic range of the measurement without overloading the spectrum analyzer. Measure the frequency response of the filter and take this into account when presenting noise measurement results.

Step 3 Use the transmission generator and key the transmitter under test with repetitive test payload in burst form.

Step 4 Tune the transmitter to the test frequency selected in Step 2.

Step 5 Adjust the spectrum analyzer reference level to provide the maximum dynamic range for display and set the input attenuator to minimum. Ensure that no signal at the analyzer input exceeds the maximum allowable level.

Step 6 Record the adjacent channel power level measured in each 25 kHz channel bandwidth in the 4^{th} adjacent channel through the 32^{nd} adjacent channel using the power band marker function of the analyzer.

Step 7 Plot each measured adjacent channel power in dBm versus its adjacent channel number in linear/linear scale. Also plot the maximum level spectrum mask on the same graph by interconnecting the points (4, -38 dBm) and (32, -53 dBm) with a straight line.

Note 2: *The two points (4, -38 dBm) and (32, -53 dBm) in Step 7 define the 5 dB per octave slope that limits the adjacent channel power between the 4^{th} and 32^{nd} adjacent channels as defined in Section 2.2.1.3.7.*

Step 8 Verify that the measured adjacent channel power levels between the 4^{th} and 32^{nd} adjacent channels are below the maximum level spectrum mask plotted in Step 7.

Step 9 Mark on the spectrum analyzer the spectrum level at the 32^{nd} adjacent channel corresponding to a power level of –53 dBm in a 25 kHz band.

Step 10 Observe the power spectrum on the spectrum analyzer display to verify that the RF spectrum beyond the 32^{nd} adjacent channel is no more than the level established in Step 9 above.

Step 11 Repeat Steps 2 to 10 for the other test frequencies (Section 2.4.4).

Step 12 Repeat Steps 2 through 11 with the spectrum analyzer set to peak hold and verify that the adjacent channel power measurements satisfy the requirements of Section 2.2.1.3.7 when compensating for the increased power measurement due to peak measurement versus average measurement. (See Note 1 under the first adjacent channel power measurement.)

2.4.4.2.8 RESERVED

2.4.4.2.9 Load VSWR Capability – RF Output Power (Section 2.2.1.3.9)

Equipment Required

Transmission Generator (PC with suitable software)
30 dB Directional Coupler
Adjustable Delay Line
2:1 VSWR Resistive Load
Vector Signal Analyzer (with power band marker function)

Procedure

Step 1 Connect the equipment as shown in Figure 2-19.

Step 2 Tune the transmitter to one of the test frequencies (Section 2.4.4).

Step 3 Key the transmitter under test with the transmission generator with repetitive test payload in continuous form.

Step 4 Vary the VSWR phase angle of the load with the delay line and measure the minimum average forward RF output power from the transmitter using the power band marker function of the vector signal analyzer.

Step 5 Verify compliance of the measured minimum average forward RF output power with the load VSWR requirement (Section 2.2.1.3.9).

Step 6 Repeat Steps 2 to 5 for the other two test frequencies (Section 2.4.4).

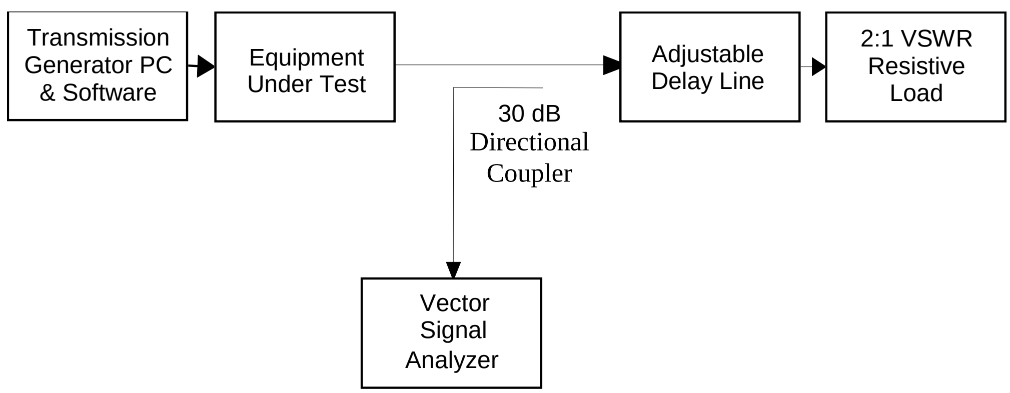


Figure 2-19: Load VSWR Capability

2.4.4.2.10 Frequency Tolerance (Section 2.2.1.3.10)

Equipment Required

30 dB Directional Coupler
High Power Load, 50 ohms
Precision Calibrated Attenuator, 20 dB (NARDA 757C-20 or equivalent)
Pulsed Microwave Frequency Counter, better than 1 x 10^{-8} measurement accuracy
(HP 5361A, option 010 or equivalent)

Procedure

Step 1 Connect the equipment as shown in Figure 2-20.

Step 2 Command the transceiver to transmit an unmodulated carrier on the lowest test frequency defined in Section 2.4.4.

Step 3 Measure the frequency of the carrier and verify compliance with the frequency tolerance requirement (Section 2.2.1.3.10).

Step 4 Repeat Steps 2 and 3 for the other two test frequencies (Section 2.4.4).

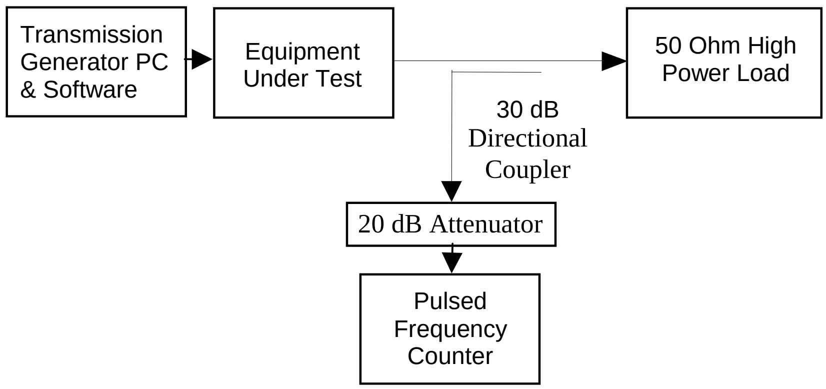


Figure 2-20: Frequency Tolerance Test Setup

Note: *The EUT crystal stability, aging, and temperature coefficients shall demonstrate that consideration has been given to the temperature variation to which the equipment will be subjected (See Section 2.3, "Environmental Test Conditions") and the frequency range for which the equipment is designed to operate.*

2.4.4.3 Physical Layer System Level Test Procedures

2.4.4.3.1 Receive to Transmit Turnaround Time (Section 2.2.1.1.4)

Equipment Required

VDL Mode 3 Test Set (Section 2.4.3)

Procedure

Step 1 Connect the equipment as shown in Standard Test Configurations 1, 2, or 3 shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test, and configure the Test Set with GS1 in GSE and AC1 in ASE active.

Step 2 Configure GS1 in system configuration 2V2D with squelch window setting of 6.

Step 3 Initialize the EUT and AC1 with the designated channel identifier for Net ID A and place the EUT in BER mode.

Step 4 Verify completion of net entry by the EUT and AC1.

Step 5 Activate the PTT of the EUT to initiate voice transmission.

Step 6 Command GS1 to poll AC1 in successive MAC cycles to force AC1 to transmit poll response in each of the successive MAC cycles. Set the ground radio polling reply counter, NL2, to 255. Set the EUT TL4 timer to 300, the maximum value (300 = 72 seconds), so that it does not time-out its connection due to loss of polling.

Step 7 To simulate the minimum spacing between an uplink beacon message and transmissions from an aircraft radio whose timing error is -1 symbol period, introduce an offset of +17 symbol periods in the timing of the Poll Response transmitted by AC1.

Note: *For EUT not intended to support discrete addressing the offset may be increased to 33 symbol periods.*

Step 8 Verify at the EUT that no bit errors are received from the AC1 transmitted poll response M burst to determine whether or not the EUT received all of the D8PSK symbols appropriate for that message burst. Verify at GS1 that the voice transmission from the EUT is received within 1 D8PSK symbol of its scheduled time and that the header and V/D (voice) bursts contain 8 and 192 D8PSK symbols respectively.

Step 9 Repeat Steps 2 to 8 for system configuration 2V1D.

2.4.4.3.2 Transmit to Receive Turnaround Time (Section 2.2.1.1.5)

Equipment Required

VDL Mode 3 Test Set (Section 2.4.3)

Procedure

Step 1 Connect the equipment as shown in Standard Test Configuration 1, 2, or 3 shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test, and configure the Test Set with GS1 and AC1 active.

Step 2 Configure GS1 in system configuration 2V2D.

Step 3 Initialize the EUT and AC1 with the designated channel identifier for Net A.

Step 4 Verify completion of net entry by the EUT and AC1.

Step 5 Command GS1 to poll the EUT in successive MAC cycles to force the EUT to transmit poll response in each of the successive MAC cycles.

Step 6 Activate the PTT of AC1 and initiate voice transmission.

Step 7 Introduce a timing offset in AC1 which is offset from its nominal TRP by -2 symbol periods to simulate the maximum timing error between two aircraft radios.

Step 8 Verify at the EUT that the voice transmission by AC1 is received with no loss of voice frames and the poll response M bursts of the EUT occur with less than or equal to 1 D8PSK symbol offset.

Step 9 Repeat Steps 2 to 8 for system configuration 2V1D.

2.4.4.3.3 Tuning Time (Section 2.2.1.1.3)

Note: *The manufacturer may submit written evidence to demonstrate compliance with this requirement. The 100 ms applies to tuning in Basic Voice mode (no discrete-addressed services), as the wait to send the Leaving Net message would otherwise prevent the compliance with 100ms to tune to the new channel.*

2.4.4.3.4 Notification Services

Note: *The manufacturer may verify compliance with the requirement by demonstration.*

2.4.5 Test for Protocols above Physical Layer

For testing avionics EUT for compliance with the requirements for protocol layers above the Physical layer and system level performance requirements, the VDL Mode 3 Test Set defined in Section 2.4.3 is used. Three standard test configurations are defined in Figures 2-7, 2-8, and 2-9, respectively, to facilitate testing the appropriate classes of equipment defined. The Test Set should be configured with specific ground stations, aircraft stations, and system configurations to support specific tests and will be specified separately for each test.

Unless otherwise stated:

a. There is no external noise nor interference injected.

b. All system parameters will be set at the default values.

c. The subnetwork interface is set for the Raw Interface as defined in the Network Initialization Exchange Identifier (XID) parameter and in the payload identification octet of the VDL Mode 3 MASPS in RTCA DO-224B, Section 3.3.2.3.3.3.4.1.3, except for specific ISO 8208 and CLNP subnetwork layer tests.

d. Injection of errors into the data messages implies that sufficient errors are introduced to exceed the error correction capability of the system.

2.4.5.1 Test Set Configuration

The Test Set is configured to emulate specific operational scenarios required for verification of the functions and performance of the avionics EUT in accordance with a set of test procedures associated with a given test case. The configuration of the Test Set required to support each test is described in a configuration table at the beginning of each test prior to the presentation of the detailed test procedures. The Test Set configuration table is oriented to user groups and provides information on the Net ID, ground station emulator, channel frequency, system configuration, aircraft station, squelch window setting, and the message generator/processor associated with each net. A sample configuration table structure is given in Table 2-4.

Table 2-4: Example of Test Set Configuration Table

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	2	Voice/Data
B	GS2	f_2	1. 2V1D 2. 2V2D	AC1	2	Voice/Data

In Table 2-4, the Test Set is configured with two VDL Mode 3 nets designated as Net IDs A and B. GS1 initially operates at channel frequency f_1, in Net A of system configuration 2V2D, with the EUT as the aircraft station, with the squelch window parameter set to 2, and requires voice and data transmission support from the Message Generator/Processor. Net B is configured similarly except that GS2 is the ground station, frequency is f_2, system configuration is initially 2V1D, and AC1 is the aircraft station in the Net. In Table 2-4, note that two system configurations are shown, in reverse order, for each net. For Net A on f1, 2V2D and 2V1D are designated as configurations 1 and 2 for GS1; and for Net B on f2, 2V1D and 2V2D are designated as configurations 1 and 2 for GS2. This means that the test will be initially run with the first system configuration for each ground station, i.e., 2V2D for GS1 and 2V1D for GS2. The test will then be repeated for the second system configurations identified, i.e., 2V1D for GS1 and 2V2D for GS2. Note that the test procedures are written for the first set of system configurations. Depending upon the tests, some adaptation of the test procedures may be required for the second set of system configurations.

2.4.5.2 Test Case Definition and Organization

Test cases are defined based on the functionality of the VDL Mode 3 radio that the test is intended to verify. Functionally related test cases are grouped into separate test groups. An identification scheme is used to uniquely identify each test case with its associated test group. The identification consists of a numeric field for the test group followed by a "-" and a second numeric field for the test within the test group. For example, Test Case 2-3 designates test 3 in test group 2. This nomenclature for the test group and test case does not apply to the Physical layer and environmental tests. Table 2-5 defines the 13 test groups for the MOPS testing. Table B-1 provides the traceability between environmental tests and the applicable equipment classes. Table B-2 provides the traceability for tests in the standard test conditions and the applicable equipment classes.

Table 2-5: Test Group Definition

Test Group	Test Group Description
1	Link Management Functionality Test
2	Voice Operation - Normal Conditions
3	Voice Operation - Special Timing Conditions
4	Data Operation
5	System Configuration - 3T (Optional)
6	System Configuration - 3S
7	System Configurations – 1V3D/1V2D
8	CLNP Subnetwork Interface
9	8208 Subnetwork Interface
10	Make-before-Break Operation
11	RESERVED
12	User Notification
13	Basic Voice Radio Tests

Each test case contains the following information:

Objective – defines the purpose of the test.

Test Set-up – defines the test set configuration required to support the test.

Procedure – specifies the detailed step-by-step test procedures to be followed.

2.4.5.3 Test Group 1 -- Link Management Functionality Test

Objective

Verify compliance of the EUT with RTCA DO-224B requirements associated with link management functions, including link establishment (net initialization, net entry, and link negotiation), link parameter modification, link recovery, release, and handoff.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3, shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test defined in Table 2-5.

2.4.5.3.1 Test 1-1 -- Net Initialization and Dummy Poll Response

Objective

a. Verify proper net initialization.

b. Verify that voice access is supported after net initialization.

c. Verify that the EUT transmits Dummy Poll Responses when the ground station does not support discrete-addressing.

d. Verify that the EUT does not complete net initialization if the information in the System Configuration, Ground Station Code, and Squelch Window fields of any two consecutive uplink M bursts is not identical.

e. Verify that the EUT requires receipt of two identical uplink M bursts in two consecutive MAC cycles to achieve net initialization.

f. Verify that the EUT does initialize when tuned to a data slot.

Table 2-6: Test 1-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 4V 2. 3V (A/C ID=61)	EUT	*	downlink voice
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	*Any*	downlink voice

* *Squelch Window parameter is fixed at any allowable value for all except Step 4, where the Squelch Window parameter varies every MAC cycle.*

Procedure

Step 1 Configure GS1 for system configuration 4V with discrete addressing not supported and select the designated channel identifier of Net ID A for the EUT.

Step 2 Key the PTT of the EUT, and verify successful voice access by the EUT. (This verifies that the EUT completes net initialization and transitions to TS1 timing state without prior ground station code information of GS1.)

Step 3 Verify with the Test Set that the EUT transmits Dummy Poll Responses autonomously and randomly once every 25 MAC cycles (6 seconds) in the downlink M slots normally reserved for poll responses (LBAC 1).

Step 4 Suppress uplink beacon transmissions for slots B, C and, if applicable, D. Vary the squelch window setting in the uplink M bursts for slot A so no two consecutive uplink M bursts have the same squelch window field. Re-initialize the EUT and verify that the EUT does not complete net initialization and remains in TS0 timing state.

Step 5 Stop varying the squelch window parameter and verify that the EUT completes net initialization and transitions to TS1 timing state.

Step 6 Repeat Steps 1-2, except that GS1 is configured to support discrete addressing.

Step 7 Verify with the Test Set that the EUT does not transmit Dummy Poll Responses.

Step 8 Repeat Steps 1 through 7 with GS1 in system configuration 3V.

Step 9 Reconfigure GS1 for system configuration 2V2D and select the designated channel identifier to slot C (data slot) for the EUT.

Step 10 Wait for 15 seconds or longer and verify that the EUT remains in TS0 timing state.

Step 11 Repeat Step 10 with GS1 in system configuration 2V1D and select the designated channel identifier of slot C (data slot) for the EUT.

Step 12 Select the designated channel identifier of slot D (Invalid Channel Suffix) for the EUT.

Step 13 Wait for 15 seconds or longer and verify that the EUT remains in TS0 timing state.

2.4.5.3.2 Link Establishment

2.4.5.3.2.1 Test 1-2a -- Net Entry

Table 2-7a: Test 1-2a Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT (IV0)	any	downlink voice downlink data

Objective

a. Verify net entry when discrete addressing is supported.

b. Verify voice accesses after net entry.

c. Verify that the EUT transmits a Poll Response message when polled by the ground station after completion of Net Entry.

Procedure

Step 1 Configure GS1 for system configuration 2V2D and command GS1 to ignore Net Entry requests.

Step 2 Select the designated channel identifier of Net ID A for the EUT.

Step 3 Wait for 820 ms and verify completion of Net Initialization by activating the PTT of the EUT and verify voice access by the EUT.

Step 4 Verify at GS1 that the EUT initiates Net Entry procedures automatically after Net Initialization with Net Entry request transmission.

Step 5 Repeat Steps 1 and 2, but command GS1 to respond to Net Entry requests.

Step 6 Verify the Net Entry procedure by the EUT that follows automatically after the completion of Net Initialization by monitoring the timing of the bursts with the Test Set for the following message exchanges between the EUT and GS1:

a. Verify Net Entry Request message in the downlink M burst
b. Observe Net Entry Response (no previous link) message in the uplink M burst
c. Verify Poll Response message in the downlink M burst in the next MAC cycle following the Net Entry Response message
d. Observe Supported Options message in the uplink M burst in the following MAC cycle

Step 7 Verify Voice access after completion of Net Entry by demonstrating successful voice access by the EUT.

Step 8 Verify completion of Net Entry by demonstrating that the EUT responds to a poll request from GS1 with a Poll Response message using LBAC 1 in the MAC cycle immediately following the poll.

Sep 9 Monitor at GS1 the format of the received Net Entry Request and Poll Response and verify compliance with the respective message format and the M downlink burst training sequence requirements.

Step 10 Repeat the test for system configuration 2V1D.

2.4.5.3.2.2 Test 1-2b -- Initial Link Negotiation

Table 2-7b: Test 1-2b Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT (ID1, ID2, or SL0)	any	downlink voice downlink data

Objective

a. Verify proper link establishment (net initialization, net entry, initial link negotiation, and join event) when discrete addressing is supported.

b. Verify voice and data accesses after link establishment.

c. Verify that the EUT transmits a Poll Response message when polled by the ground station.

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Command GS1 to ignore Net Entry requests.

Step 3 Wait for 820 ms and verify completion of Net Initialization by activating the PTT of the EUT and verify voice access by the EUT.

Step 4 Verify at GS1 that the EUT initiates Net Entry procedures automatically after Net Initialization with Net Entry request transmission.

Step 5 Repeat Steps 1 and 2, but command GS1 to respond to Net Entry requests.

Step 6 Reinitialize the EUT and verify that after completion of net initialization and timing state transition from TS0 to TS1, the EUT automatically starts net entry procedures. Monitor the timing of the bursts with the Test Set for the following message exchanges between the EUT and GS1:

a. Verify Net Entry Request message in the downlink M burst
b. Observe Net Entry Response (no previous link) message in the uplink M burst
c. Verify Poll Response message in the downlink M burst in the next MAC cycle following the Net Entry Response message
d. Observe Supported Options message in the uplink M burst in the following MAC cycle

<u>Note</u>: *The initial Poll Response may or may not include a Reservation Request for XID frame transmission. Supported Option message may include a Reservation Response or a RACK if a Reservation Request is included in the initial Poll Response. Since there are no other activities going on in the net during the test, a Reservation Request will be granted a Reservation Response.*

e. Verify CTRL_CMD_LE in the downlink V/D (data) channel

<u>Note</u>: *If the initial Poll Response is used to request for XID frame transmission, the CTRL_CMD_LE frame transmission will occur in the next MAC cycle. If the initial Poll Response is not used to request data slot for XID, Reservation Request will use random access M bursts, resulting in delay in transmission of CTRL_CMD_LE.*

f. Observe CTRL_RSP_LE in the uplink V/D (data) channel

Step 7 Verify completion of link establishment by demonstrating successful voice and data accesses by the EUT.

Step 8 Verify that the EUT responds to a poll request from GS1 with a Poll Response message using LBAC 1 in the MAC cycle immediately following the poll.

Step 9 Monitor at GS1 the format of the received Net Entry Request, Poll Response, and CTRL_CMD_LE and verify compliance with the respective message format and the M downlink burst training sequence requirements.

Step 10 Repeat the test for system configuration 2V1D.

2.4.5.3.2.3 Test 1-2c -- Poll/Poll Response and Implicit Link Release

Table 2-7c: Test 1-2c Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink voice downlink data

Objective

a. Observe that GS1 polls the EUT regularly and verify that the EUT responds each valid poll with a Poll Response.

b. Verify that upon expiration of the TL4 Timer, the EUT attempts to reestablish the link by sending a Net Entry Request message (Implicit Link Release).

c. Verify that the aircraft is capable of correcting 3 bit errors in the uplink M burst.

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Verify completion of Net Entry by polling the EUT and demonstrating that the EUT responds with a Poll Response message.

Step 3 Observe that GS1 polls the EUT regularly and the EUT responds to each Poll with a Poll Response message.

Step 4 Inject sufficient bit errors in the Poll Request portion of the uplink M message at GS1 to exceed the error correction capability of the Golay code prior to transmission and verify that the EUT does not respond to the poll request.

Step 5 Continue to poll the EUT with the same corrupted Poll Request message as in Step 4. Verify that the EUT does not respond to the poll request. Observe that GS1 stops polling the EUT and declares the link lost after receiving no responses from the EUT for NL2 successive poll requests.

Step 6 Wait for a time period at least equal to TL4 MAC cycles from the last Poll Request since the initial error injection in Step 4. Verify at GS1 that the EUT transmits a Net Entry Request message.

Step 7 Repeat Steps 1 to 4, but inject exactly 3 bit errors in the Poll Request portion of the uplink M message at GS1 prior to transmission and verify that the EUT responds to the poll request.

Step 8 Repeat the test for system configuration 2V1D.

2.4.5.3.2.4 Test 1-2d -- Radio Identifier Unavailable Test

Objective

a. Verify that the EUT properly processes the Supported Options message when it indicates Radio Identifier Unavailable.

Table 2-7d: Test 1-2d Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
B	GS1	f_1	2V2D	EUT	any	None

Procedure

Step 1 Configure GS1 for system configuration 2V2D and command GS1 to indicate 'Radio Identifier Unavailable' in the Supported Options Message.

Step 2 Select the designated channel identifier of Net ID B for the EUT.

Step 3 After transmission of the Supported Options message from GS1, verify that the EUT does not attempt Initial Link Negotiation (e.g., no reservation requests sent).

2.4.5.3.3 Test 1-3 -- Net Entry Request Retransmission and Delayed Net Entry

Objective

Verify proper Net Entry Request retransmission procedures, the maximum number of net entry retransmission is NL1, and the delayed net entry procedures. Verify that net entry retransmission will occur due to each of the following anomalies:

a. Non-receipt of net entry request by the ground station

b. Non-receipt of net entry response by the aircraft station

c. Non-receipt of net entry poll response by the ground station

d. Non-receipt of reservation response message by the aircraft station

Table 2-8: Test 1-3 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Command GS1 to ignore the Net Entry Request message.

Step 3 Verify that the EUT retransmits the Net Entry Request message.

Step 4 Activate the PTT at the EUT to initiate voice access.

Step 5 Verify that voice access is supported after net initialization and while net entry procedures are ongoing.

Step 6 Verify that retransmission of Net Entry Request is random and retransmission stops after NL1 retries.

Step 7 Reinitialize the EUT and command GS1 to stop ignoring the received Net Entry Request message, but inject four bit errors on the Net Entry Response message to exceed the error correction capability of the Golay code prior to transmission at GS1 instead.

Step 8 Verify that the EUT retransmits the Net Entry Request message.

Step 9 Reinitialize the EUT and command GS1 to stop injecting errors on the Net Entry Response message prior to transmission, but inject four bit errors on the received net entry Poll Response message to exceed the error correction capability of the Golay code at GS1.

Step 10 Verify that the EUT retransmits the Net Entry Request message.

Step 11 Reinitialize the EUT and command GS1 to stop injecting errors on the received net entry Poll Response messages, but inject four bit errors on the ensuing Reservation Response message to exceed the error correction capability of the Golay code prior to transmission.

Step 12 Verify that the EUT retransmits the Net Entry Request message.

Step 13 Reset GS1 and reinitialize the EUT.

Step 14 Command GS1 to send a Net Entry Response message in response to the Net Entry Request message from the EUT with the local identifier field set to 0, indicating that the net is currently full.

Step 15 Verify for the next 50 MAC cycles at GS1 that the EUT does not retransmit the Net Entry Request message.

Step 16 Activate the PTT at the EUT to initiate downlink voice transmission.

Step 17 Verify at GS1 use of Local ID 61 by the EUT in the voice header of the downlink V/D (voice) burst.

Step 18 Send a test message of 64 octets to the EUT for transmission down to GS1.

Step 19 Verify at GS1 that no reservation request is received.

Step 20 Command GS1 to send a Net Entry Response message addressed to the EUT via its aircraft ICAO address with an assigned Local ID other than 61.

Step 21 Activate the PTT at the EUT to initiate a downlink voice transmission.

Step 22 Verify at GS1 the voice header of the downlink V/D (voice) burst the use of the assigned Local ID by the EUT.

Step 23 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.3.4 Test 1-4 -- Initial Link Negotiation - Exceptional Cases

Objective

a. Verify that the EUT retransmits the CTRL_CMD_LE frame when a CTRL_RSP_LE response is not received in T3 MAC cycles.

b. Verify that the EUT retransmits the CTRL_CMD_LE frame when a unicast frame is received while waiting for a CTRL_RSP_LE response.

c. Observe that the ground station can negotiate the link parameters in the CTRL_RSP_LE response.

d. Verify that the EUT can reject the parameters transmitted by the ground station in the CTRL_RSP_LE frame by terminating the data link connection.

e. Observe that the ground station can reject the parameter setting in the CTRL_CMD_LE frame by transmitting a CTRL_RSP_LCR.

Table 2-9: Test 1-4 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Command GS1 to ignore the CTRL_CMD_LE message from the EUT.

Step 3 Verify that the EUT retransmits CTRL_CMD_LE after a time period equal to the T3 Timer (Link Initialization Time) parameter since the initial transmission of the CTRL_CMD_LE frame.

Step 4 Command GS1 to negotiate the parameter value of the subnetwork interface to a type supported by the EUT in the CTRL_RSP_LE frame.

Step 5 Verify that the EUT accepts the negotiated value and completes link establishment.

Step 6 Repeat Step 4 except the parameter value of the subnetwork interface as proposed by GS1 is undefined and is unacceptable to the EUT.

Step 7 Verify at GS1 that the EUT transmits a CTRL_RSP_LCR frame to clear the data link connection.

Step 8 Command GS1 to send an uplink data message to the EUT. Verify at GS1 that no ACK is received from the EUT.

Step 9 Command GS1 to poll the EUT and verify that the EUT responds with a poll response.

Step 10 Repeat Step 4, but command GS1 to reject the parameter values identified in the received CTRL_CMD_LE. Observe that GS1 transmits a CTRL_RSP_LCR frame.

Step 11 Send an uplink data message to the EUT. Verify at GS1 that no ACK is received from the EUT.

Step 12 Command GS1 to poll the EUT and verify that the EUT responds with a poll response.

Step 13 Reestablish net entry with GS1. Send a CTRL_CMD_LE frame setting RE to 1, WE to 1, and N1 to 32.

Step 14 Retune the EUT to another frequency, wait TL3 sec and then retune back to f_1. Verify that the EUT waits only 1 MAC cycle before sending the Net Entry Request.

Step 15 Once the data connection is established, verify that the N1 parameter has been returned to the default value by downlinking a data frame larger than 32 bytes.

Step 16 Retune the EUT to another frequency and retune back to f_1. Send a CTRL_CMD_LE frame with N1 set to 32.

Step 17 Retune the EUT to another frequency and retune back to f_1 in less than TL3 sec.

Step 18 After connection establishment is complete, attempt to downlink a data frame larger than 32 bytes and verify it is not transmitted.

Step 19 Send a data frame less than 32 bytes long and verify it is received.

Step 20 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.3.5 Test 1-5 -- Ground Initiated Addressed Link Parameter Modification

Objective

Verify proper aircraft radio response to:

a. A ground-initiated addressed link parameter modification

b. A ground-initiated broadcast link parameter modification

Table 2-10: Test 1-5 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 After the EUT completes link establishment, command GS1 to transmit a CTRL_CMD_LPM frame to the EUT in the V/D (data) slot for an addressed link parameter modification to modify the N1 parameter from the default value of 930 octets to 32 octets.

Step 3 Verify that the EUT responds to the ground command with a Reservation Request message.

Step 4 Upon receiving a Reservation Response message in the uplink M burst from GS1, verify that the EUT transmits a CTRL_RSP_LPM frame in the assigned V/D (data) slot(s).

Step 5 Submit a 930-octet downlink message to the EUT and verify at GS1 that no reservation request is initiated for the 930-octet message. (This verifies that link parameter N1 has been modified.)

Step 6 Command GS1 to transmit a CTRL_CMD_LPM frame for a broadcast link parameter modification to change parameter N1 from 32 back to the default value of 930 octets.

Step 7 Verify that the EUT does not respond to GS1's CTRL_CMD_LPM broadcast message with ACK frame by observing that no ACK frame from the EUT is received at GS1.

Step 8 Submit a downlink message of less than 930 octets to the EUT for delivery to GS1.

Step 9 Verify at GS1 that the message is received in a single media access event.

Step 10 Send a CTRL_CMD_LPM frame from the EUT including a parameter modification to change parameter N1 to 32.

Step 11 Verify the receipt of the ACK M-burst in response to the CTRL_RSP_LPM frame uplinked by GS1.

Step 12 Submit a 930-octet downlink message to the EUT and verify at GS1 that no reservation request is initiated for the 930-octet message. (This verifies that link parameter N1 has been modified.)

Step 13 Command GS1 to transmit a CTRL_CMD_LPM frame for a broadcast link parameter modification to change parameter N1 to 64 octets, RE to 1 and WE to 1.

Step 14 Retune the EUT to another frequency, wait TL3 sec and then retune back to f_1. Verify that the EUT waits only 1 MAC cycle before sending the Net Entry Request.

Step 15 Once the data connection is established, verify that the N1 parameter has been returned to the default value by downlinking a data frame larger than 64 bytes.

Step 16 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.3.6 Test 1-6 -- Aircraft Recovery

Objective

Verify proper aircraft radio recovery from a power down and power up cycle.

Table 2-11: Test 1-6 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 After completion of link establishment by the EUT, power down the EUT momentarily and power the EUT back up. Verify that the EUT reinitializes and completes link establishment.

Step 3 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.3.7 Test 1-7 -- Recovery for System Configurations that Support Data Link

Objective

Use a data-capable system configuration to verify proper recovery in the event of a loss of state information in the ground station protocol stack.

Table 2-12: Test 1-7 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 After the EUT completes net entry, command GS1 to lose protocol state information.

Step 3 Command GS1 to transmit a broadcast Recovery message.

Step 4 Wait and observe that GS1 transmits a Recovery message that includes a reservation response granting a data slot access to the EUT.

Step 5 Verify at GS1 that the EUT responds to the Recovery message, which is addressed to the EUT's local ID, with a CTRL_CMD frame containing an Expedited Recovery XID and a Network Initialization XID.

Step 6 Verify at GS1 the format of the received CTRL_CMD frame and that of the Expedited Recovery XID and the Network Initialization XID.

Step 7 Command GS1 to broadcast a Connection Check XID within a CTRL_CMD_LPM message with the correct local identifier and the ICAO aircraft address associated with the EUT.

Step 8 Initiate a data access at the EUT to transmit a test message to GS1.

Step 9 Verify successful receipt of the test message at GS1.

Step 10 Repeat Steps 1-9 but inject an incorrect ICAO aircraft address in the (Connection Check) CTRL_CMD_LPM message.

Step 11 Verify at GS1 that the EUT initiates the normal link establishment procedures.

Step 12 Repeat the test procedure with GS1 in system configuration 1V2D.

Step 13 Repeat Steps 2-9 with GS1 in system configuration 1V2D with the EUT local ID 1 higher than in Step 12. Verify the implied data access from the M uplink Recovery message by successful completion of expedited recovery.

2.4.5.3.8 Test 1-8 -- Recovery for Voice-Only Nets that Support Discrete Addressing

Objective

Verify proper recovery for voice-only system configurations that support discrete addressing in the event of a loss of state information in the ground station protocol stack.

Table 2-13: Test 1-8 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 4V 2. 3V (A/C ID≠61)	EUT	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 4V and select the designated channel identifier of Net ID A for the EUT.

Step 2 Wait for the EUT to complete link establishment.

Step 3 Command GS1 to lose protocol state information.

Step 4 Command GS1 to transmit a broadcast Recovery message.

Step 5 Observe at GS1 that a Poll Request is sent to the EUT with its local ID.

Step 6 Verify at GS1 that the EUT responds with a Net Entry Request message.

Step 7 Command GS1 to ignore the received Net Entry Request.

Step 8 Verify at GS1 that the EUT does not initiate a retransmission until polled as long as GS1 remains in the Recovery mode.

Step 9 Repeat Steps 4-7 and command GS1 to process the Net Entry Request.

Step 10 Verify recovery of the net by demonstrating voice access by the EUT.

Step 11 Repeat Step 5, but command GS1 not to poll the EUT after the initial transmission of the broadcast Recovery message.

Step 12 Verify that the EUT does not initiate net entry procedures.

Step 13 Command GS1 to stop the Recovery procedures.

Step 14 Verify that the EUT initiates net entry.

Step 15 Repeat the test procedure with GS1 in system configuration 3V.

2.4.5.3.9 Test 1-9 -- Link Release and Handoff

Objective

a. Verify proper explicit link release procedures by the EUT.

b. Verify proper handoff procedure.

c. Verify proper actions from the EUT on implicit link release conditions.

d. Verify the proper setting of the default parameter RL (Leaving Net Randomizer).

e. Verify retuning to the new net after Leaving Net timer times out

Table 2-14: Test 1-9 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1*	f_1	1. 2V2D 2. 2V1D	EUT	Any	downlink data
A	GS2*	f_2	1. 2V1D 2. 2V2D	EUT	Any	downlink data

*In this test GS1 will hand off the aircraft station to GS2.

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT. Configure GS2 for system configuration 2V1D, and select Net ID A on f_2.

Step 2 Wait for the EUT to complete net entry.

Step 3 Command GS1 to send two Next Net messages, one with f_2/2V1D/Net ID A as the next net and the other with f_2/2V1D/Net ID B as the next net, to the EUT in successive MAC cycles.

Step 4 Verify at GS1 that the EUT does not respond with a Next Net ACK message in the next Poll Response message.

Step 5 Observe that GS1 initiates Next Net message retransmission after the EUT transmits the Poll Response message and command GS1 to transmit only a single Next Net message with f_2/2V1D/Net ID A as the next net.

Step 6 Verify at GS1 that the EUT does not respond with a Next Net ACK message in the next Poll Response message.

Step 7 Observe that GS1 initiates Next Net message retransmission after the EUT transmits the Poll Response message and command GS1 to resume transmission of two identical Next Net messages in two consecutive MAC cycles with f_2/2V1D/Net ID A as the next net.

Step 8 Verify at GS1 that a Next Net ACK message is transmitted by the EUT as a Poll Response message the next time GS1 polls the EUT.

Step 9 Monitor at GS1 the received Next Net ACK message and verify its format.

Step 10 Command GS1 to send a poll request every MAC cycle and a series of short uplink messages, each requiring a single V/D (data) burst to ensure that all subsequent downlink M burst opportunities are not available for random access.

Step 11 Command the EUT to retune to the next net.

Step 12 Verify at GS1 that no Leaving Net message is received and the EUT retunes to the new net in 2 MAC cycles (480 ms).

Step 13 Command GS1 to stop polling and stop data transmission to ensure that subsequent downlink M burst opportunities are available for random access.

Step 14 Command the EUT to tune to the f1/Net ID A.

Step 15 Verify that the EUT sends a Leaving Net message to GS2 no more than 310 milliseconds after the EUT is commanded to retune.

Note: *For the 2V1D configuration the maximum delay is increased from 310 ms to 330 ms.*

Step 16 Verify the proper format of the Leaving Net message.

Step 17 Verify that the EUT retunes and automatically sends a Net Entry Request message to GS1 as part of the link establishment procedure with GS1.

Step 18 Repeat the test procedure with GS1 in system configuration 2V1D and GS2 in system configuration 2V2D.

2.4.5.3.10 Test 1-10 -- System Configuration Mismatch

Objective

a. Verify that the EUT stays in TS0 if it receives a System Configuration it cannot process from the M uplink beacon.

Table 2-14a: Test 1-10 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	binary 1110	EUT	Any	N/A

Procedure

Step 1 Configure GS1 to indicate a binary 1110 in the system configuration field of the M uplink normal message and select the designated channel identifier of Net ID A for the EUT.

Step 2 Verify that the EUT remains in TS0 after tuning to f_1 by demonstrating that the assertion of PTT does not result in voice access.

Step 3 Deactivate the PTT.

Step 4 Wait 65 sec and verify that the EUT still remains in TS0 by demonstrating that the assertion of PTT does not result in voice access.

2.4.5.3.11 Test 1-11 -- Addressing in 2V2D and 2V1D

Objective

a. For System Configurations 2V2D and 2V1D, verify that aircraft radio treats Local IDs with Group ID A (00_b) and C (10_b) as user Group A and Group IDs B (01_b) and D (11_b) as User Group B.

Table 2-14b: Test 1-11 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A/B	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	

Procedure

Step 1 Configure GS1 for configuration 2V2D with nets A and B and select the designated channel identifier of Net ID A for the EUT.

Step 2 Command GS1 to assign Local ID 1 to the EUT upon receiving the Net Entry Request.

Step 3 Poll the EUT with Local ID 1.

Step 4 Verify that the EUT responds with a Poll Response.

Step 5 Key the PTT of the EUT.

Step 6 Verify at GS1 that the voice bursts occur in time slot A.

Step 7 Repeat Steps 2 through 5 three times, but change the Local ID assigned to the EUT to 60 (A60), 129 (C01) and 188 (C60), respectively.

Step 8 Verify at GS1 that the EUT responds with a poll response and the voice bursts occur in time slot A for each assigned Local ID.

Step 9 Repeat the test for system configuration 2V1D.

2.4.5.3.12 Test 1-12 -- Link Handoff

Objective

a. Verify proper handoff procedures using Previous Link Preserved and No Previous Link.

Table 2-14c: Test 1-12 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A, B	GS1	f_1	1. 2V2D 2. 2V1D	EUT	Any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Wait for the EUT to complete link establishment with Net A

Step 3 Retune the EUT to Net B.

Step 4 Upon receiving the Net Entry Request message, command GS1/Net B to send a Net Entry Response of Type 2 – "Previous Link Preserved".

Step 5 Verify that no join or leave event occurs over the data interface to the message generator/processor.

Step 6 Verify downlink data operation is still available by downlinking a data frame.

Step 7 Retune the EUT back to Net A, but command GS1/Net A to send a Net Entry Response of Type 1- "No Previous Link."

Step 8 Verify that the EUT generates a Leave event, specifying the previous ground station, for transfer over the data interface to the message generator/processor.

Step 9 Repeat the test with GS1 in system configuration 2V1D.

2.4.5.3.13 Test 1-13 -- Link Authentication

Objective

a. Verify authentication procedures for Control messaging

Table 2-14d: Test 1-13 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	Any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Wait for the EUT to complete net entry with Net A. Configure the EUT to include an Authentication XID with non-zero authentication type in the CTRL_CMD_LE frame.

Step 3 Verify completion of Link Establishment by downlinking a data frame.

Step 4 Uplink a CTRL_CMD_LPM frame including an Authentication XID with an invalid Authentication Type of FFh.

Step 5 Verify CTRL_RSP_LPM frame from EUT includes Authentication XID indicating an Authentication Type of 0.

Step 6 Tune EUT off channel and back on. Configure the EUT to include an Authentication XID in the CTRL_CMD_LE frame with a non-zero authentication type.

Step 7 Command GS1 to send a different authentication type in the CTRL_RSP_LE frame.

Step 8 Command the EUT to send a CTRL_CMD_LPM frame and verify it includes an Authentication XID with authentication type of zero.

Step 9 Tune EUT off channel and back on. Configure the EUT to include an Authentication XID in the CTRL_CMD_LE frame with a non-zero authentication type.

Step 10 After Link Establishment, command GS1 to send a CTRL_CMD_LPM frame including an Authentication XID including a bad signature, along with a change of parameter N1downlink to 32 bytes.

Step 11 Downlink a data frame greater than 32 bytes in length (and less than 923 bytes) and verify it is received by GS1 (thereby illustrating the CTRL_CMD_LPM frame is rejected).

Step 12 Repeat the test for system configuration 2V1D.

2.4.5.4 Test Group 2 -- Voice Operation - Normal Conditions

Objective

Verify for compliance with RTCA DO-224B the voice operations associated with the aircraft radio under normal timing conditions.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3, shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

2.4.5.4.1 Test 2-1 -- Receiver Operating Logic

Objective

Verify that the EUT operates normally in receive mode.

Table 2-15: Test 2-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A, B	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	uplink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Command GS1 to ignore Net Entry Requests from the EUT. Wait for the EUT to complete net initialization.

Step 3 Activate the GS1 PTT of Net A and initiate voice transmission.

Step 4 Verify at the EUT that the EUT receives the voice transmission of GS1.

Step 5 Deactivate the GS1 PTT (Net A) and activate the GS1 PTT for Net B.

Step 6 Verify that the EUT does not receive Net B voice transmission.

Step 7 Advance GS1's V/D (voice) bursts associated with Net A with respect to the uplink M bursts to outside the squelch window setting of the EUT.

Step 8 Verify that uplink V/D (voice) bursts from Net A of GS1 are rejected by the EUT by observing no audio output from the EUT.

Step 9 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.4.2 Test 2-2 -- Transmitter PTT Operating Logic

Objective

Verify proper aircraft PTT operations.

Table 2-16: Test 2-2 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT AC1	any	downlink voice uplink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT and AC1.

Step 2 Upon detecting the voice channel being idle, activate the PTT of the EUT and begin voice transmission.

Step 3 Verify that the EUT has access to the voice channel of Net A by observing that the EUT's voice transmission is received at both GS1 and AC1.

Step 4 With the EUT's PTT continuously activated, verify that the EUT loses access to the voice channel after 35 seconds.

Step 5 Verify that the EUT can regain voice access only after resetting its PTT.

Step 6 While the EUT's PTT is re-engaged and the EUT has access to the voice channel, activate the GS1 PTT of Net A with preemption activated.

Step 7 Verify that the EUT's access to the voice channel is preempted by GS1 by observing that the EUT receives the voice transmission of GS1.

Step 8 Activate the EUT's PTT and verify that the EUT cannot preempt GS1's voice access.

Step 9 Continue to hold the PTT of the EUT while releasing the GS1 PTT and verify that the EUT does not gain access to the voice channel.

Step 10 Reset the PTT and reactivate the PTT of the EUT and verify that the EUT gains access to the voice channel.

Step 11 Release the PTT of the EUT and activate AC1's PTT to access the voice channel.

Step 12 Activate the PTT of the EUT and verify that the EUT cannot pre-empt AC1's voice access.

Step 13 Continue to hold the PTT of the EUT while releasing AC1's PTT and verify that the EUT does not gain access to the voice channel.

Step 14 Reset and reactivate the PTT of the EUT and verify that the EUT gains access to the voice channel.

Step 15 Activate the PTT of AC1 and verify that AC1 does not preempt EUT's voice access. Release EUT's PTT.

Step 16 Activate and do not release EUT's PTT. Activate GS1's PTT while the ground preemption feature is deactivated. Verify that GS1 does not preempt EUT's voice access. Release EUT's PTT.

Step 17 Activate and do not release EUT's PTT. Retune EUT to a new channel different from GS1. Verify that the EUT's voice transmission ceases on the old channel within 2 MAC cycles (480 ms) after the retuning command and that the EUT does not transmit on the new channel.

Step 18 Release and reactivate EUT's PTT before EUT transitions to TS3. Verify that the EUT does not transmit.

Step 19 With EUT's PTT still activated, tune EUT back to f_1/Net A and verify that the EUT does not transmit after radio retunes to f_1/Net A for as long as the PTT is asserted. For those EUT supporting the optional handoff requirement (RTCA DO-224B, 3.3.5.4.5), verify that the audio terminates upon the radio receipt of the tuning command.

Step 20 Release and reactivate EUT's PTT. Verify the EUT does transmit.

Step 21 Retune EUT to f_1/Net C and verify the EUT does not transition out of TS0 by activating the EUT's PTT and verifying there is no transmission.

Step 22 Retune EUT to f_1/Net D and verify the EUT does not transition out of TS0 by activating the EUT's PTT and verifying there is no transmission.

Step 21 Repeat the test for system configuration 2V1D.

2.4.5.4.3 Test 2-3 -- Step-on

Objective

a. Verify that simultaneous activation of PTT by two aircraft stations will result in step-on conditions.

b. Verify proper procedures for clearing the interference condition.

Table 2-17: Test 2-3 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink voice uplink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Activate the PTT of the EUT.

Step 3 Command GS1 to send an uplink M burst in the next MAC cycle with the voice field encoded as 10_b to indicate that the channel is unoccupied.

Step 4 Verify at GS1 that the EUT ceases voice transmission within two MAC cycles (one MAC cycle is 240 ms) of the first transmitted voice burst.

Step 5 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.4.4 Test 2-4 -- RESERVED

Table 2-18: RESERVED

2.4.5.4.5 Test 2-5 -- Communications Relay by a Second Aircraft Station

Objective

Verify Air-Ground voice communications via relay of a second aircraft.

Table 2-19: Test 2-5 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT AC1	any	downlink voice uplink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT and AC1.

Step 2 Wait for both the EUT and AC1 to complete link initialization. Sever the link between GS1 and the EUT. (Note that AC1 remains connected with both GS1 and the EUT).

Step 3 Wait 12 seconds for the EUT to transition to TS2 timing state.

Step 4 Activate the PTT of the EUT to initiate voice access to request voice relay via the operator of AC1 to link with GS1.

Step 5 Verify voice connectivity between the EUT and GS1 via voice relay by the AC1 operator.

Step 6 Repeat Steps 1 to 5, except interchange the roles between the EUT and AC1 and verify voice connectivity between the AC1 and GS1 via voice relay by the EUT operator.

Step 7 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.4.6 Test 2-6 -- Burst Timing

Objective

a. Verify timing of TDMA frame, slot, and MAC cycle.

b. Verify that all the EUT's V/D bursts obey the slot boundaries and that the training sequences associated with the V/D (voice) bursts meet the ramp up and ramp down requirements.

Table 2-20: Test 2-6 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Activate the EUT's PTT and initiate downlink voice transmission.

Step 3 Verify with the Test Set that the timing of the middle of the first symbol of the synchronization sequence of every V/D (voice) burst is within ±1 symbol period of an ideal periodicity of exactly 120 ms.

Step 4 Verify that the transmission of the training sequence associated with the V/D (voice) bursts meets the ramp up and ramp down requirements in Sections 2.2.1.3.3 and 2.2.1.3.4.

Step 5 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.4.7 Test 2-7 -- Voice Delay

Objective

a. Verify compliance of the transmit delay between the speech input and the associated V/D (voice) burst output at RF of the EUT with DO-224B, Section 3.3.5.4.2.1.

b. Verify compliance of the receive delay between the reception of the V/D (voice) burst at the receiver RF input and the speech output of the EUT with DO-224B, Section 3.3.5.4.2.2.

c. Verify compliance with the end-to-end audio delay of DO-224B, Section 2.6.2.2 with the EUT and GS1 connected back to back.

Table 2-21: Test 2-7 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink voice uplink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Activate the PTT of the EUT and apply a 1 kHz continuous tone to the microphone input.

Step 3 Measure the time from the beginning of the 1 kHz tone to the beginning of the first V/D (voice) burst at RF.

Step 4 Add the time occupied by the synchronization sequence, voice header, and vocoder silence frame(s) (2.29 + 3.05*n ms, where n is the number of vocoder silence frames) from the measurement.

Step 5 Repeat Steps 1-4 25 times by activating the PTT in random.

Step 6 Verify that each measured time is less than 175 ms.

Note: *GS1 must be able to recognise silence frames from the EUT vocoder, or there will be a 15.25 ms uncertainty in the measurements.*

Step 7 Repeat Steps 2 and 3, but measure the time from the beginning of the 1 kHz tone input to the EUT to the beginning of the corresponding 1 kHz tone received at the voice output of GS1.

Step 8 Repeat Step 7 25 times by activating the PTT in random.

Step 9 Verify that each measured time is less than 236 ms.

Step 10 Command GS1 to generate a vocoded 1 kHz continuous tone that originates at the start of the first vocoder frame in the slot transmission.

Step 11 Measure at the EUT the time elapsed from the beginning of the first received RF burst at the RF interface to the beginning of the reconstructed 1 kHz tone output at the audio interface.

Step 12 Repeat the measurements 25 times by activating the PTT in random.

Step 13 Verify that each measured time is less than 40 ms.

Step 14 Repeat Steps 10-12, but activate the GS1 PTT and apply a 1 kHz continuous tone to the microphone input and measure the time from the beginning of the 1 kHz tone input to GS1 to the beginning of the corresponding 1 kHz tone received at the EUT voice output.

Step 15 Verify that each measured time is less than 236 ms.

Step 16 Repeat the test procedure with GS1 in system configuration 2V1D.

Alternate Procedure:

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT. Connect a second EUT to the system

Step 2 Command GS1 to generate a vocoded 1 kHz continuous tone that originates at the start of the first vocoder frame in the slot transmission.

Step 3 Measure at both EUTs the time elapsed from the beginning of the first received RF burst at the RF interface to the beginning of the reconstructed 1 kHz tone output at the audio interface.

Step 4 Repeat the measurements 25 times by activating the PTT in random.

Step 5 Verify that each measured time is less than 40 ms.

Step 6 Activate the PTT of the EUT and apply a 1 kHz continuous tone to the microphone input.

Step 7 Measure the time from the beginning of the 1 kHz tone input to the EUT to the beginning of the corresponding 1 kHz tone received at the voice output of GS1.

Step 8 Repeat Step 7 25 times by activating the PTT in random.

Step 9 Verify that each measured time is less than 236 ms.

Step 10 Repeat Steps 6-8, but measure the time from the beginning of the 1 kHz tone input to the EUT#1 to the beginning of the corresponding 1 kHz tone received at the voice output of EUT#2.

Step 11 Subtract the average receive delay of EUT#2 measured in Step 5 from the measured end-to-end time of Step 10.

Step 12 Verify that each measured time is less than 175 ms.

Step 13 Repeat Steps 6-8, but activate the GS1 PTT and apply a 1 kHz continuous tone to the microphone input and measure the time from the beginning of the 1 kHz tone input to GS1 to the beginning of the corresponding 1 kHz tone received at the EUT voice output.

Step 14 Verify that each measured time is less than 236 ms.

Step 15 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.4.8 Avionics Radio Voice Quality Tests

Equipment Required

VDL Mode 3 Test Set
Voice Quality Measurement System (Malden Electronics DSLA or equivalent)

2.4.5.4.8.1 Test 2-8 -- Voice Quality Test of the Ground-to-Air Link

Procedure

Step 1 Connect the equipment as in Figure 2-1.

Step 2 Configure GS1 in f1/4V/Net A, where f1 is one of the test frequencies (Section 2.4.4).

Step 3 Select the designated channel identifier of Net A for the AC1 radio.

Step 4 Ensure that AC1 transitions to the TS1 timing state.

Step 5 Adjust the output attenuator to the GS1 transmitter to ensure that the signal level at the RF input of the AC1 radio is about –50 dBm.

Step 6 Activate the PTT of GS1 and initiate the Voice Quality Measurement System to output voice-band test messages with appropriate speech level for the GS1 transmitter for transmission through the ground-to-air reference link for MOS measurement.

Step 7 Record the measured MOS as $MOS_{ref\_up.}$

Step 8 Replace the AC1 radio in Figure 2-1 with the EUT and initialize the EUT.

Step 9 Activate the PTT of GS1 and initiate the Voice Quality Measurement System to output the same voice-band test messages with appropriate speech level to GS1 for transmission through the ground-to-air test link for MOS measurement.

Step 10 Record the MOS as MOS_{up}.

Step 11 Compare the MOS_{up} measurement of Step 9 with that of MOS_{ref_up} and verify that MOS_{up} is no less than MOS_{ref_up} - 0.2.

Step 12 Repeat Steps 1 to 11 for the other test frequencies (Section 2.4.4).

2.4.5.4.8.2 Test 2-9 -- Voice Quality Test of the Air-to-Ground Link

Procedure

Step 1 Connect the equipment as in Figure 2-2.

Step 2 Configure GS1 in f1/4V/Net A, where f1 is one of the test frequencies (Section 2.4.4).

Step 3 Select the designated channel identifier of Net A for AC1.

Step 4 Wait for AC1 to transition to the TS1 timing state.

Step 5 Adjust the output attenuator to the AC1 transmitter to ensure that the signal level at the RF input of GS1 is about –50 dBm.

Step 6 Activate the PTT of AC1 and initiate the Voice Quality Measurement System to output voice-band test messages with appropriate speech level for the AC1 transmitter for transmission through the air-to-ground reference link for MOS measurement.

Step 7 Record the MOS value as MOS_{ref_down}.

Step 8 Replace the AC1 reference radio in Figure 2-2 with the EUT and initialize the EUT.

Step 9 Activate the PTT of the EUT and initiate the Voice Quality Measurement System to output the same voice-band test messages with appropriate speech level for the EUT transmitter for transmission through the air-to-ground test link for MOS measurement.

Step 10 Record the MOS value as MOS_{down}.

Step 11 Compare MOS_{down} to MOS_{ref_down} and verify that MOS_{down} is no less than MOS_{ref_down}.- 0.2.

Step 12 Repeat Steps 1 to 11 for the other test frequencies (Section 2.4.4).

2.4.5.4.9 Test 2-10 -- Urgent Downlink Request (UDR)

Objective

a. Verify that the aircraft radio transmits a Reservation Request M burst message (or Poll Response M burst message, as appropriate) setting the Voice Request field to 'Request Priority Access' and transmits at the next available opportunity to signal a UDR.

b. Verify that the aircraft radio does not signal a UDR to the ground station when the ground station does not support UDR.

c. Verify that an indication is provided that UDR is unavailable when UDR is activated and the ground station does not support the UDR option.

Table 2-22: Test 2-10 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 1V3D 2. 1V2D	EUT	any	-

Procedure

Step 1 Configure GS1 for system configuration 1V3D, which supports UDR, and select the designated channel identifier of Net ID A for the EUT.

Step 2 Wait for the EUT to complete net entry.

Step 3 Command GS1 to poll the EUT once every MAC cycle and command GS1 to ignore random access Reservation Request messages from the EUT.

Step 4 Activate the PTT of GS1 to occupy the voice channel.

Step 5 Command the EUT to send an Urgent Downlink Request message.

Step 6 Verify at GS1 that a Poll Response message is received from the EUT with the Voice Request field set to 'Request Priority Access'.

Step 7 Verify at GS1 that the EUT stops transmitting Reservation Request messages after the initial transmission of Poll Response message with the Voice Request field set to 'Request Priority Access'. Verify that the EUT continues to respond to Poll Requests with the Voice Request field set to 'Request Priority Access' in all subsequent Poll Response messages.

Step 8 Release the GS1 PTT and activate the PTT of the EUT.

Step 9 Verify that subsequent to the PTT action of the EUT the Voice Request field of the Poll Responses is reset to ‘No Request'.

Step 10 Repeat Steps 1-5, but command GS1 to stop polling the EUT and command GS1 to process random access Reservation Request messages in Step 3.

Step 11 Verify at GS1 that a random access Reservation Request message is received with the Voice Request field set to 'Request Priority Access'.

Step 12 Verify that the EUT stops transmitting random access Reservation Request after GS1’s transmission of a RACK message.

Step 13 Repeat Steps 10-11 but command GS1 not to send RACK messages to the EUT.

Step 14 Verify at GS1 that the EUT continues to retransmit random access Reservation Request messages with the Voice Request field set to 'Request Priority Access'.

Step 15 Resume Poll Request transmission at GS1.

Step 16 Verify at GS1 the receipt of a Poll Response message from the EUT with the Voice Request field set to 'Request Priority Access'.

Step 17 Verify that the EUT stops transmitting random access Reservation Request messages after transmitting the Poll Response.

Step 18 Reconfigure GS1 such that UDR is not supported.

Step 19 Command the EUT to re-enter the net.

Step 20 Initiate a UDR at the EUT.

Step 21 Verify at the EUT that an indication is provided that UDR is not available.

Step 22 Verify at GS1 that no reservation request is transmitted by the EUT.

Step 23 Repeat the test procedure for system configuration 1V2D.

2.4.5.4.10 Test 2-11 -- Vocoder Output

Objective

a. Verify that the EUT outputs the desired bit sequence output given the appropriate input test vectors

Procedure

This is verified by applying the vocoder test vectors to the vocoder subassembly of the EUT and relying on DO-178B documentation to prove applicability to the EUT system.

2.4.5.4.11 Test 2-12 -- Voice Synthesis

Objective

a. Verify that the vocoder operates regardless of the varying propagation delay and relative clock timing drifts between transmitter and receiver.

b. Verify that the voice output is reduced slowly to silence when bursts are missing and resumes normal voice output when receipt of V/D (voice) bursts continues.

Table 2-22a: Test 2-12 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	2V2D	EUT	Any	downlink voice uplink voice
A	GS1	f_1	2V1D	EUT	Any	downlink voice uplink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Activate the PTT of GS1, while adjusting the burst timing of each voice burst such that each burst is offset from the nominal time of burst by +1/2 symbol period followed by an offset of -1/2 symbol period alternately.

Step 3 Verify that the voice output at the EUT is without audible dropouts.

Step 4 Deactivate the PTT of GS1 and remove the GS1 voice burst timing offsets of ±1/2 symbol period introduced in Step 2.

Step 5 Activate the PTT of GS1, while varying the ground station timing continuously such that the ground station timing advances by ¼-symbol period every TDMA frame for a period that corresponds to the maximum PTT event of 35 seconds.

Step 6 Verify that the voice output at the EUT is without audible dropouts.

Step 7 Deactivate the PTT of GS1 and return GS1 normal.

Step 8 Activate the PTT of GS1 for 5 seconds with voice bursts, then drop the next 16 voice bursts, followed by resumption of voice bursts, while maintaining voice signal field encoding of 01_b in the uplink M bursts throughout the ground PTT event.

Step 9 Verify that there is a 1.5 to 2.5 second silence (or pseudo-noise) in the voice output at the EUT, approximately 5 seconds after the activation of the PTT.

Step 10 Verify also that there is no perceptible pops or clicks in the transition to and out of silence.

Step 11 Repeat the test for system configuration 2V1D.

2.4.5.5 Test Group 3 -- Voice Operation - Special Timing Conditions

Objective

To test for compliance with the RTCA DO-224B requirements associated with voice operations under special timing conditions.

Test Setup

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3, shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

2.4.5.5.1 Test 3-1 -- Aircraft VDL Mode 3 Timing Maintenance

Objective

Verify that the EUT maintains system timing based on the timing of ground beacons.

Table 2-23: Test 3-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Verify completion of net initialization by demonstrating successful voice access.

Step 3 Activate the PTT of the EUT for voice transmission.

Step 4 Verify with the Test Set that all V/D (voice) bursts occur in LBACs 2 and 6 in time slot A.

Step 5 Measure the time offset between the GS1 Timing Reference and the V/D (voice) bursts in LBAC 6.

Step 6 Verify that the measured offset is 65±1 symbol periods.

Step 7 Introduce a timing offset of up to 1 ms in the GS1 reference time.

Step 8 Measure the time offset at GS1 between the ground timing reference and the LBAC 6 transmission from the EUT.

Step 9 Verify that the timing offset between the ground reference and LBAC 6 remains at 65±1 symbol periods.

Note: *This demonstrates that the ground station timing offset has been incorporated by the EUT to update its timing reference in determining its downlink burst timing.*

Step 10 Repeat the test for system configuration 2V1D. The expected offsets in steps 6 and 9 for system configuration 2V1D should be 118±1 symbol periods.

2.4.5.5.2 Test 3-2 -- Aircraft Validity Window Test

Objective

a. Verify that the EUT does not use the current beacon for timing update if the current beacon is offset outside the range of –K(n+1)+1 to +1 symbol periods from the previous beacon. (K=4 for 4-slot configurations and 8 for 3-slot configurations, n = squelch window parameter)

b. Verify that the EUT opens up the validity window to accept all timing updates when CTC1 exceeds 24.

Table 2-24: Test 3-2 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	1	downlink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Wait for the EUT to transition to TS1 timing state.

Step 3 Introduce an offset to the ground station timing such that the beacons are transmitted with the beacon timing advanced from the initial beacon timing by approximately 5 symbol periods.

Step 4 Monitor the timing of the received poll responses from the EUT at GS1 for approximately 30 seconds.

Step 5 Verify that the received poll response timing tracks the GS1 timing by observing that the ground station timing offset introduced in Step 3 is accepted for timing update by the EUT.

Step 6 Introduce an additional timing offset of 9 symbol periods to the GS1 system timing.

Step 7 Repetitively key the PTT on the EUT for about 10 seconds.

Step 8 Monitor the timing of the received RF V/D (voice) bursts from the EUT at GS1 for approximately 10 seconds.

Step 9 Verify that the received voice burst timing remains offset by approximately 9 symbol periods from the GS1 timing and a single 9-symbol period timing adjustment to the voice burst occurs after about 6 seconds. (This verifies that beacon timing offsets greater than the validity windows are ignored by the aircraft radio for about 25 MAC cycles and the aircraft radio validity window is changed to "wide open" after about 25 MAC cycles to accept the next beacon for its timing update.)

Step 10 Retard the timing of the beacons by 3 symbol periods.

Step 11 Repeat steps 7-9 and verify that the EUT does not accept timing updates for approximately the first 25 MAC cycles and accepts the ground timing update introduced in Step 10 after approximately 25 MAC cycles.

Step 12 Repeat the test for system configuration 2V1D. The offsets in Step 6 and 9 should use 18 symbols instead of 9 symbols due to the larger validity window of the 3-slot system configurations.

2.4.5.5.3 Test 3-3 -- Receipt/Process of Beacon Information From a Distant Station

Objective

Verify that the EUT uses the information field in a beacon with valid Slot ID and Ground Station Code even though the timing of the beacon is outside the validity window.

Table 2-25: Test 3-3 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	1	downlink voice
A	GS2	f_1	1. 2V2D 2. 2V1D	EUT	1	downlink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Configure GS2 with the same system configuration, Slot ID, and GSC as GS1, but retard the timing of GS2 from that of GS1 by 5 symbol periods and maintain this offset throughout the test. Command GS2 not to transmit beacons.

Step 3 Wait for the EUT to complete net initialization.

Step 4 Activate the PTT of the EUT to initiate downlink voice transmission.

Step 5 Command GS1 to stop transmitting beacons and poll requests after the EUT has seized the voice channel.

Note: Steps 6-11 should be performed within 6 seconds of Step 4.

Step 6 Activate the PTT of GS2 to initiate uplink voice transmission with voice preemption.

Step 7 Command GS2 to transmit beacons and poll requests.

Step 8 Verify that EUT's downlink transmission is preempted. (This verifies that the voice field of GS2's beacon transmission was processed and was used by the EUT to terminate the downlink voice transmission.)

Step 9 Deactivate the PTT of GS2.

Step 10 Activate the PTT of the EUT to initiate downlink voice transmission.

Note: Due to the timing offset of GS2, it will not likely change the voice signalling field to indicate the channel is 'Occupied'; hence, the aircraft radio will cease transmitting after only a few bursts. This should still be sufficient for Step 11.

Step 11 Verify at GS2 that the timing of the downlink voice header is 5 symbols (± 1 symbol) advanced relative to the GS2 timing. (This verifies that the EUT does not accept the timing updates from GS2, but decodes and processes the beacon information.)

Step 12 Repeat the test for system configuration 2V1D.

2.4.5.5.4 Test 3-4 -- Timing State Transition and Air-to-Air Communications

Objective

a. Verify Primary and Alternate Timing References.

b. Verify aircraft VDL timing state transitions.

c. Verify truncated voice mode and burst timing.

d. Verify free running voice mode and burst timing.

e. Verify Squelch Window settings for truncated voice mode.

f. Verify air-to-air voice communications in TS2 and TS3 timing states.

Verify that an aircraft radio in TS1 timing state cannot transmit voice bursts in a voice channel already occupied by another aircraft radio in TS2 timing state, unless its optional TX inhibit for voice due to a cleared CTS indication was disabled.

Verify that an aircraft radio in TS2 timing state cannot transmit voice bursts in a voice channel already occupied by another aircraft radio in TS2 timing state, unless its optional TX inhibit for voice due to a cleared CTS indication was disabled.

Verify that an aircraft radio in TS3 timing state cannot transmit voice bursts in a voice channel already occupied by another aircraft radio in TS3 timing state, unless its optional TX inhibit for voice due to a cleared CTS indication was disabled.

Verify that the aircraft radio's slot timing drifts at a rate no greater than ±5ppm with respect to UTC, while the radio is in TS3 timing state.

Table 2-26: Test 3-4 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT, AC1	any	uplink/downlink voice
B	GS2	f_1	1. 2V2D 2. 2V1D	AC2	any	

Procedure

Subtest 1: TS2 Transition and Truncated Voice Operation

Step 1 Configure GS1 for system configuration 2V2D Net ID A and select the designated channel identifier of Net ID A for the EUT and AC1. Configure GS2 for system configuration 2V2D Net ID B and select the designated channel identifier of Net ID B for AC2.

Step 2 Wait for the EUT and AC1 to complete link establishment procedures.

Step 3 Sever the link from GS1 to the EUT to emulate loss of ground station beacon at the EUT. Note that the link between GS1 and AC1 and the link between AC1 and the EUT remain connected.

Note 1: *Severing one RF link between two stations without affecting all other RF connections in the net can be accomplished by inserting appropriate RF attenuation between the RF ports of the stations, whose connections are to be severed, and the RF Bridge. The following is an example of setting the attenuators. The tester should adjust the attenuators based on the RF output of the transmitters involved.*

Example: With an RF output of 15W (42 dBm) a total attenuation of 160 dB will reduce the signal level to –118 dBm, which is 18 dB below the receiver threshold and will have an equivalent effect of a broken RF connection. A pad of 50 dB is placed in each RF path to prevent overloading the receiver. To sever the link between GS1 and the EUT without affecting all other links, a 30-dB attenuator is inserted between GS1 and the RF Bridge and the same attenuation is placed between the EUT and the RF Bridge. Signals between GS1 and the EUT are attenuated by a total of 160 dB to about –18 dB below receiver threshold to emulate a broken RF link. Signal for all other RF links are attenuated by 130 dB to about –88 dBm, which is 12 dB above receiver threshold to ensure nearly error-free reception.

Step 4 Immediately after the uplink from GS1 to the EUT is severed, activate the PTT of the EUT for approximately 1 second and release for approximately 1 second repetitively to initiate voice access for direct air-to-air communications with AC1.

Step 5 At the Test Set, monitor the Message ID field of the EUT voice bursts for 60 consecutive MAC cycles.

Step 6 Verify that transition from TS1 voice to TS2 voice occurs. Specifically, verify that TS1 voice continues during the coasting period and that transition to TS2 voice occurs approximately 50 MAC cycles after loss of Beacon. Also verify direct air-to-air voice communications with AC1 during the coasting period, during transition to TS2, and after transition to TS2.

Step 7 Repeat Steps 4-5, but key the PTT continuously for 60 MAC cycles and observe the message ID field of the voice bursts that the EUT stays in TS1.

Step 8 Release the PTT and reactivate the PTT and verify that the EUT has transitioned to TS2. (This verifies that transition to TS2 is delayed until the PTT is released.)

Step 9 Verify that there is no discontinuity in speech or breakup in voice prior to transition, during transition, and after transition to TS2.

Step 10 Measure the truncated voice bursts of the EUT, and verify that the duration of each burst is about 85% of a normal full voice burst and the bursts are all confined in slot A.

Step 11 Advance or retard the V/D (voice) bursts of AC1 relative to the GS1 timing to verify the actual squelch window setting of the EUT in TS2 is in compliance with RTCA DO-224B.

Step 12 Verify that the EUT stays in TS2 indefinitely as long as AC1 is connected to GS1 and the EUT and that the link between GS1 and the EUT remains severed.

Subtest 2: TS2 Unblocking Own RF Transmission over another TS1 Voice Access [OPTIONAL]

Step 13 Activate the PTT of AC1 (in TS1) to access the voice channel.

Step 14 Activate the PTT of the EUT (in TS2) with TX inhibit for voice disabled.

Step 15 Verify that the EUT cannot unblock its TX inhibit for voice when the voice channel is occupied by another aircraft radio in TS1 timing state by observing that no RF transmissions of voice bursts are emanating from the EUT.

Subtest 3: TS1 Unblocking Own RF Transmission over another TS2 Voice Access [OPTIONAL]

Step 16 Clear the PTTs of both the EUT and AC1.

Step 17 Repeat Steps 1-11, but interchange the roles of AC1 and the EUT.

Step 18 Activate the PTT of AC1 (in TS2) to access the voice channel.

Step 19 Activate the PTT of the EUT (in TS1) with TX inhibit for voice disabled.

Step 20 Verify that the EUT (in TS1), with TX inhibit for voice disabled, can gain access to the voice channel already occupied by another aircraft radio transmitting truncated voice by observing RF transmissions of voice bursts from both aircraft radios.

Step 21 Release and reactivate the PTT of the EUT with TX inhibit for voice enabled.

Step 22 Verify that the EUT (in TS1), with TX inhibit for voice enabled, cannot gain access to the voice channel already occupied by an aircraft radio transmitting truncated voice by observing that AC1 continues to have sole access to the voice channel.

Subtest 4: Air-to-Air Communications between TS2 Users

Step 23 While AC1 is in timing state TS2, sever the link from GS1 to the EUT to force the EUT to transition to TS2.

<u>Note 2:</u> *The sole purpose of GS2 is to provide Alternate Timing Signals to keep the EUT and AC1 in TS2 timing state indefinitely.*

Step 24 While both the EUT and AC1 are in TS2, verify direct air-to-air communications between the two aircraft.

Subtest 5: TS2 Unblocking Own RF Transmission over another TS2 Voice Access [OPTIONAL]

Step 25 Activate the PTT of AC1.

Step 26 Activate the PTT of the EUT with TX inhibit for voice disabled.

Step 27 Verify that the EUT (in TS2), with TX inhibit for voice disabled, can gain access to the voice channel already occupied by another aircraft radio also in TS2 timing state by observing RF transmissions of voice bursts from both aircraft radios.

Step 28 Reset the PTT of the EUT and reactivate the PTT of the EUT with TX inhibit for voice enabled.

Step 29 Verify that the EUT (in TS2), with TX inhibit for voice enabled, cannot gain access to the voice channel already occupied by another aircraft radio also in TS2 timing state by observing that AC1 continues to have sole access to the voice channel.

Step 30 Clear the PTTs of both the EUT and AC1.

Subtest 6: TS3Transition and Air-to-air Communications between TS3 Users

Step 31 Command GS2 to stop transmitting beacons and verify that the EUT transitions from TS2 to TS3 in f (free running parameter) MAC cycles after the link termination. (AC1 and AC2 should also transition to TS3.)

Step 32 While in TS3, initiate voice access at the EUT following the LBPTT protocol, and verify that air-to-air voice communications is supported in TS3.

Step 33 Verify at RF that the V/D (voice) bursts in TS3 are not truncated.

Step 34 Activate the PTT of AC1 for six (eight for 2V1D) times and initiate a short voice transmission each time such that the timing of the RF bursts associated with the current PTT event is offset from that of the previous PTT event by 5 ms. Verify at the EUT that all voice transmissions are received.

Step 35 Sever the link between AC1 and AC2 while maintain the links between AC1 and the EUT and between AC2 and the EUT. (See Note 1.)

Step 36 Activate AC2's PTT and initiate voice transmission for 15 seconds. Activate AC1's PTT for 30 seconds. Adjust the burst timing of AC1 and AC2, if necessary, such that the RF bursts of AC1 and AC2 are not overlapping. Observe at GS2 that the RF bursts from both AC1 and AC2 are present for the respective duration of the PTTs and verify at the EUT that the voice received is the juxtaposition of the entire 15 seconds from AC2 followed by the last 15 seconds from AC1.

Step 37 Verify that the EUT remains in TS3.

Subtest 7: Unblocking Own RF Transmission of one TS3 Radio over another TS3 Voice Access [OPTIONAL]

Step 38 Activate the PTT of AC1.

Step 39 Activate the PTT of the EUT with TX inhibit for voice disabled.

Step 40 Verify that the EUT (in TS3), with TX inhibit for voice disabled, can gain access to the voice channel already occupied by another aircraft radio also in TS3 timing state by observing RF transmissions of voice bursts from both aircraft radios.

Step 41 Release and reactivate the PTT of the EUT with TX inhibit for voice enabled.

Step 42 Verify that the EUT (in TS3), with TX inhibit for voice enabled, cannot gain access to the voice channel already occupied by another aircraft radio also in TS3 timing state by observing that AC1 continues to have sole access to the voice channel.

Step 43 Clear the PTTs of both the EUT and AC1.

Subtest 8: Transition from TS3 to TS2 and TS1 Upon Restoration of Ground Station

Step 44 Restore the link between GS1 and AC1 only.

Step 45 Observe that AC1 transitions from TS3 to TS1 and verify that the EUT transitions from TS3 to TS2.

Step 46 Restore the link from GS1 to the EUT and verify that the EUT transitions from TS2 to TS1.

Step 47 Repeat Step 44, but Restore the link between GS1 and the EUT only.

Step 48 Verify that the EUT transitions from TS3 to TS1.

Subtest 9: Timing Accuracy in Timing State TS3

Step 49 While EUT is in TS1 timing state, command GS1 to stop transmitting beacons.

Step 50 Wait 60 seconds to ensure that the EUT transitions to timing state TS3.

Step 51 Activate the PTT of the EUT to initiate voice transmission.

Step 52 Measure the relative timing of the V/D (voice) burst with respect to the GS1 timing.

Step 53 Wait for another 60 seconds and Repeat Steps 51 and 52.

Step 54 Verify that the difference between the relative timing measured in Step 52 and Step 53 is within ±3 symbol periods.

Note 3: *This verifies that the EUT's slot timing drifts with respect to UTC at a rate no greater than ±5ppm.*

Step 55 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.5.5 Test 3-5 -- Abnormal Link Initialization

Objective

a. Verify aircraft radio link initialization under abnormal timing conditions.

b. Verify that aircraft radio is unable to transition out of TS0 if the aircraft radio is tuned to a data slot.

Table 2-27: Test 3-5 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT, AC1	any	uplink/downlink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT and AC1.

Step 2 Sever the link between GS1 and the EUT to emulate the condition that no GS1 beacon is available at the EUT. Ensure that AC1 remains connected to both GS1 and the EUT. (See Note 1 of Section 2.4.5.5.4.)

Step 3 Reinitialize the EUT.

Step 4 Verify that the EUT completes net initialization and transitions from timing state TS0 to TS2 directly.

Step 5 Verify that the EUT is unable to have voice access prior to attaining TS2 timing state.

Note 1: Since it would take approximately 12 seconds to transition from TS0 to TS2, one way to verify Step 5 is to key the PTT repeatedly over the 12 second period after reinitialization in Step 3 and verify that the PTTs result in no voice access.

Step 6 Sever the link between GS1 and AC1.

Step 7 Reinitialize the EUT and AC1.

Step 8 Verify that both the EUT and AC1 transition from timing state TS0 to TS3 directly in about 12 seconds in an assumed voice-only mode.

Note 2: One way to verify Step 8 is to key the PTT of the EUT repeatedly over the 12 seconds period after reinitialization in Step 7 and verify that the PTTs result in no voice access.

Step 9 Verify that the EUT is unable to have voice access prior to attaining TS3 timing state.

Step 10 Repeat Step 1, but tune the EUT to the data slot of Net ID A, i.e., slot C.

Step 11 Wait for 65 seconds and verify that the EUT remains in timing state TS0 by demonstrating that PTT does not result in voice access.

Step 12 Repeat the test for system configuration 2V1D.

2.4.5.5.6 Test 3-6 -- Invalid Alternate Timing

Objective

a. Verify that an aircraft radio will not transition out of TS0 if the received alternate timing does not contain enough information to positively identify the appropriate voice slot.

Table 2-27a: Test 3-6 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	4V	EUT	any	uplink/downlink voice

Procedure

Step 1 Configure GS1 for system configuration 4V Net ID A only and tune the EUT to f_1/Net D.

Step 2 Verify that the EUT is receiving the M Uplink messages in slot A from GS1.

Step 3 Activate the PTT of the EUT and verify it does not transmit, indicating it is still in TS0.

2.4.5.6 Test Group 4 -- Data Operation

Objective

To test for compliance with RTCA DO-224B requirements associated with data operations.

Test Setup

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3, shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

2.4.5.6.1 Test 4-1 -- Simultaneous Voice and Data Accesses

Table 2-28: Test 4-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data/voice

Objective

Verify that the aircraft radio supports independent voice and data access.

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Wait for EUT to complete net establishment. Submit a continuous string of messages of 930 octets (including DLS frame headers) or less each to the EUT for delivery to GS1 to block the data channel.

Step 3 Activate the PTT of the EUT and verify at GS1 simultaneous and independent reception of voice and data messages.

Step 4 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.6.2 Test 4-2 -- Burst Timing

Objective

Verify that the aircraft radio V/D (data) bursts are within the time slots assigned.

Table 2-29: Test 4-2 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A B	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data downlink voice

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Submit downlink data messages of 930 octets (including DLS frame headers) to block the data channel. Verify with the Test Set that all V/D (data) bursts are in time slot C.

Step 3 Activate the PTT of the EUT.

Step 4 Verify with the Test Set that all received V/D (voice) bursts are in time slot A.

Step 5 Select Net ID of B for the EUT and repeat steps 2-4 ensuring voice in slot B and data in slot D. (Slot C for system configuration 2V1D)

Step 6 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.6.3 Test 4-3 -- Reservation Request Via Random Access

Table 2-30: Test 4-3 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	Downlink/uplink data

Objective

a. Verify that the aircraft radio uses the downlink random access M burst channel for reservation request.

b. Verify that the maximum number of random access reservation request retransmissions is NM1.

c. Verify that the aircraft radio continues to send a data reservation request in poll responses after NM1 random access reservation request retransmissions.

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Set the TL4 polling timeout parameter to 300 MAC cycles (72 seconds) in the EUT.

Note: *Test 4-3 must be completed within 72 seconds to ensure that the EUT TL4 timer does not time-out (and re-attempt net entry) due to lack of ground polling requests.*

Step 3 Suppress GS1 from polling the EUT.

Step 4 Submit to GS1 for delivery to the EUT a series of priority 3 messages (3 = top priority encoded as binary 11 in the 2-bit priority field) to block the data channel temporarily.

Step 5 Submit a priority 2 (2-bit priority field encoded as 10) message of length 128 octets (including DLS frame header) followed by a second priority 2 message of length 64 octets to the EUT for delivery to GS1.

Step 6 Verify at GS1 that a Reservation Request message associated with the 128-octet priority 2 message is transmitted in the random access downlink M burst.

Step 7 Observe that a Reservation Request Acknowledgment (RACK) message is sent by GS1 to the EUT in an uplink M burst.

Step 8 Verify at GS1 that there is no Reservation Request retransmission from the EUT.

Step 9 Stop sending uplink messages to GS1 to unblock the data channel.

Step 10 Verify that a Reservation Response message is transmitted from GS1 to the EUT to grant the data channel access for the outstanding request and that data transmission by the EUT starts in the next MAC cycle in slot C after receiving the Reservation Response message.

Step 11 Verify that transmission of a Reservation Request message associated with the second priority 2 message is not initiated until the data transmission for the previous message is completed and the corresponding uplink ACK message has been received at the EUT.

Step 12 Repeat Steps 1-5, but suppress GS1 from transmitting RACK and Reservation Responses. Verify that the EUT retransmits the Reservation Request until after the total number of retransmissions reaches NM1.

Step 13 Monitor at GS1 to verify that the Reservation Request transmission satisfies the requirements of timing and format for the downlink M bursts.

Step 14 Immediately after NM1 retransmissions of the reservation request in Step 12, reset GS1 to resume RACK and Reservation Response processing and command GS1 to poll the EUT.

Step 15 Verify at GS1 that the EUT transmits a poll response with the outstanding data reservation request.

Step 16 Repeat the test for system configuration 2V1D.

2.4.5.6.4 Test 4-4 -- Reservation Request Via Poll Response

Objective

Verify that aircraft radios can use poll response opportunities to transmit reservation requests.

Table 2-31: Test 4-4 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data uplink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Submit to GS1 for delivery to the EUT a series of priority 3 messages to block the data channel temporarily.

Step 3 Verify that the EUT sends a Poll Response with no slots requested to GS1 when polled by GS1 and GS1 does not respond to the Poll Response without reservation request.

Step 4 Command GS1 to ignore random access Reservation Request messages, so that polling is the only means for requesting downlink reservations.

Step 5 Submit a single message of priority 2 to the EUT for delivery to GS1. Verify that the EUT sends a Poll Response with reservation request for the priority 2 message when polled by GS1.

Step 6 Observe that GS1, with no time slots available to assign for this request, sends neither a Reservation Response nor a RACK in responding to the Poll Response.

Step 7 Verify that use of the Random Access downlink M burst for re-transmitting the reservation request has been stopped at the EUT upon receiving the poll request.

Step 8 Verify that the EUT continues to respond to poll requests with poll responses containing the same reservation request.

Step 9 Stop submitting messages to GS1 to unblock the data channel.

Step 10 Observe that a Reservation Response message is transmitted by GS1 and is received by the EUT by verifying that the EUT initiates data transmission in the assigned time slots beginning in the following MAC cycle.

Step 11 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.6.5 Test 4-5 -- Downlink Data Transmission

Objective

a. Verify operations associated with downlink data transmissions.

b. Verify multiple access for downlink data operation

Table 2-32: Test 4-5 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT, AC1	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 With no message pending on the network, submit a single message of priority 2 (2-bit priority field encoded as 10) and length 930 octets (including DLS frame header) to the EUT for delivery to GS1.

Step 3 After receiving a reservation response associated with the outstanding message, and prior to T1 timer expiration at the EUT, submit a sequence of five priority 1 (2-bit priority field encoded as binary 01) messages of 84 octets each (including DLS frame headers) to the EUT for delivery to GS1.

Step 4 Verify with the Test Set that the data transmission of the single 930-octet message begins in the next MAC cycle after the Reservation Response and consists of exactly 15 V/D (data) bursts.

Step 5 Observe that an uplink ACK message is transmitted in one of the V/D (data) slots by GS1 in the uplink within T_ack MAC cycles after the last downlink V/D (data) burst (with EOM flag) is received.

Step 6 Verify that the uplink ACK frame is properly extracted from the uplink V/D (data) transmission by observing that no retransmission of the downlink message occurs.

Step 7 Verify at GS1 that upon completion of the single 930-octet message transmission, a reservation request for the five 84 octet messages (See Step 3) is initiated in the form of a single media access event.

Step 8 Verify at GS1 that the EUT downlinks the frame grouped five priority 1 messages by observing that, upon transmitting the reservation response by GS1, the downlink data transmission begins and takes 7 V/D (data) bursts.

Step 9 Upon completion of the downlink V/D (data) bursts, observe that a single ACK frame is generated by GS1 and is transmitted in an uplink V/D (data) burst within T_ack MAC cycles from the time the last downlink V/D (data) burst is received.

Step 10 Verify that there are no further downlink transmissions in the V/D (data) slots.

Step 11 Command GS1 to send neither ACK nor XID_RSP_LE frames and repeat Steps 2-8.

Step 12 Verify at GS1 that retransmission of the 930-octet frame occurs after expiration of T1 timer at the EUT.

Step 13 Verify that duplicate frames are received at GS1, as a result of suppressing the uplink ACK frame transmission.

Step 14 Verify that retransmission of the outstanding message stops when the number of successive T1 timer expirations exceeds N2.

Step 15 Command GS1 to send a V/D (data) message to the EUT and verify at GS1 that the associated downlink ACK message is not received in the next MAC cycle after GS1 transmits the last V/D (data) burst. (This Step verifies that the EUT has terminated the data link.)

Step 16 Repeat the test procedure for system configuration 2V1D.

2.4.5.6.6 Test 4-6 -- Uplink Data Reception

Objective

a. Verify the generation and transmission of a downlink ACK M burst upon accepting an uplink data transmission at the aircraft radio.

b. Verify that the address used in data transmission is unique.

c. Verify multiple access between ground and aircraft users in data operation.

Table 2-33: Test 4-6 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data uplink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 With no messages outstanding in the network, submit a single message of length less than 930 octets (including DLS frame header) to GS1 for transmission to the EUT.

Step 3 Verify with the Message Generator/Processor that the EUT receives the uplink data message. Also verify at GS1 that a downlink ACK associated with the outstanding uplink data transmission is generated and transmitted by the EUT in the downlink Random Access M slot, which is exactly one MAC cycle from the beginning of the last V/D (data) burst received with an EOM indication.

Step 4 Submit a single message of length less than 930 octets (including DLS frame header) to GS1 with message addressee different from the user ID assigned to the EUT.

Step 5 Verify at GS1 that no downlink ACK is received from the EUT in the next MAC cycle after the last uplink V/D (data) burst transmission.

Step 6 Submit separate 930-octet messages to GS1 and the EUT for transmission to the EUT and GS1, respectively.

Step 7 Verify that both messages are received at the respective destinations.

Step 8 Repeat the test for system configuration 2V1D.

2.4.5.6.7 Test 4-7 -- Priority Processing (1)

Objective

Verify that higher priority messages are transmitted ahead of lower priority messages.

Table 2-34: Test 4-7 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Submit a single (463-930 octet) message of priority 2 (2-bit priority field encoded as 10) to the EUT for transmission to GS1.

Step 3 Upon receiving the reservation response for the priority 2 message, submit 3 new messages of priorities 0, 1, and 2 in increasing order of priorities to the EUT for delivery to GS1, i.e., lower priority ahead of higher priority. Each of the three messages is between 463 and 930 octets in length (including DLS frame headers) to prevent messages from being grouped.

Step 4 Verify that the three new messages are transmitted in separate media access events after the outstanding priority 2 message has been transmitted and acknowledged and that the three messages are transmitted in decreasing order of priorities, i.e., higher priority messages are transmitted ahead of lower priority messages.

Step 5 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.6.8 Test 4-8 -- Priority Processing (2)

Objective

Verify that a higher priority message can replace an outstanding lower priority message using the Random Access M downlink, only if the higher priority message is of equal or less length than the outstanding lower priority message.

Table 2-35: Test 4-8 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data uplink data

Procedure (Continued from Test 4-7)

Step 1 Set the TL4 polling timeout parameter to 300 (72 seconds) in the EUT.

Note: Test 4-8 must be completed within 72 seconds to ensure that the EUT TL4 timer does not time-out (and re-attempt net entry) due to lack of ground polling requests.

Step 2 Submit to GS1 for delivery to the EUT a series of priority 2 messages to block the data channel temporarily.

Step 3 Suppress GS1 from polling the EUT temporarily.

Step 4 Send a priority 0 message of length less than 930 octets (including DLS frame header) to the EUT for transmission to GS1.

Step 5 After the EUT initiates a reservation request and receives a RACK response from GS1 for the priority 0 message, submit a new priority 1 message, which is equal to or less than the length of the outstanding message, to the EUT for delivery to GS1.

Step 6 Verify that a new reservation request is initiated and a new RACK response is received at the EUT.

Step 7 Stop submitting messages to GS1 and verify that the new priority 1 message has replaced the priority 0 message in the downlink transmission.

Step 8 Repeat Steps 1-4.

Step 9 After the EUT initiates reservation request and receives a RACK response from GS1, submit a new priority 1 message, which is longer in length than the outstanding message, to the EUT for delivery to GS1.

Step 10 Verify that no new reservation request is initiated at the EUT.

Step 11 Stop submitting messages to unblock the data channel.

Step 12 Verify that the original priority 0 message is transmitted prior to the new priority 1 message in the downlink.

Step 13 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.6.9 Test 4-9 -- Priority Processing (3)

Objective

Verify that a higher priority message can replace an outstanding lower priority message using a Poll Response opportunity.

Table 2-36: Test 4-9 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data uplink data

Procedure (Continued from Test 4-8)

Step 1 Verify that GS1 is configured to poll aircraft.

Step 2 Submit to GS1 for transmission to the EUT a series of priority 2 messages to block the data channel temporarily.

Step 3 Send a single message (less than 930 octets in length) of priority 0 to the EUT for transmission to GS1.

Step 4 After the EUT initiates a reservation request for the priority 0 message, submit a new priority 1 message, which is longer in length than the outstanding priority 0 message, to the EUT for delivery to GS1.

Step 5 Wait for at least one poll response opportunity before stopping submitting messages to GS1 to clear the data channel.

Step 6 Verify that the priority 1 message has replaced the priority 0 message and is transmitted first.

Step 7 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.6.10 Test 4-10 -- Broadcast Message Reception

Objective

Verify the aircraft radio's capability to receive uplink data broadcast.

Table 2-37: Test 4-10 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	uplink broadcast

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Command GS1 to uplink a broadcast message.

Step 3 Verify that the EUT receives the broadcast message.

Step 4 Verify that the EUT does not respond to broadcast message with ACK by observing that no ACK is received at GS1.

Step 5 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.6.11 Test 4-11 -- Data Access and Timing States

Objective

Verify that no data access is permitted for TS2 and TS3 timing states.

Table 2-38: Test 4-11 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A B	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Suppress the beacon transmission of Net A to force the EUT to transition to TS2 timing state, but continue to transmit beacons for Net B.

Step 3 Send a data packet to the EUT for transmission to GS1 and verify that data access is not supported in TS2 timing state.

Step 4 Suppress GS1 from transmitting beacons for Net B. Verify that the EUT eventually transitions to timing state TS3.

Step 5 Send a data packet to the EUT for transmission to GS1 and verify that no data access is supported in TS3 timing state.

Step 6 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.6.12 Test 4-12 -- Preservation of Acknowledged Frames in Downlink Data Retransmission (for radios implementing frame grouping only)

Objective

a. Verify that upon T1 expiration, downlink data retransmission will not add new acknowledged frames to the frame group.

Table 2-38a: Test 4-12 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Send a series of priority 2 messages to GS1 to block the data channel.

Step 3 Submit three priority 1 messages of length 128 octets each to the EUT for delivery to GS1.

Step 4 Stop sending messages to GS1 to unblock the data channel.

Step 5 After receiving a reservation request at GS1 and prior to T1 timer expiration at the EUT, submit a single priority-2 message of 84 octets (including DLS frame headers) to the EUT for delivery to GS1.

Step 6 Verify with the Test Set that the reservation request takes the form of a single data access event and the transmission of the downlink data bursts after reservation is granted by GS1.

Step 7 Verify that the downlink data transmission is associated with the three priority 1 messages.

Step 8 Suppress GS1 from transmitting an uplink ACK message for the downlink data transmission.

Step 9 Wait for the T1 timer associated with the downlink data access to expire.

Step 10 Verify at GS1 that a new Reservation Request message is received at GS1.

Step 11 Verify at GS1 that the ensuing downlink V/D (data) bursts is associated with the retransmission of the three original priority 1 messages. (This demonstrates that no new ACK frames have been added to the frame group during retransmission, even though a new message is in a higher priority queue.)

Step 12 Repeat the test for system configuration 2V1D.

2.4.5.6.13 Test 4-13 -- Radio Identifier Test

Objective

a. Verify that the EUT proper processes the Supported Options message.

b. Verify that the EUT properly processes the Address Type field for acknowledgement of data transmission.

Table 2-38b: Test 4-13 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V1D	EUT, AC1	any	Uplink data, downlink data
B, A	GS1	f_1	2. 3V1D	EUT, AC1	any	Uplink data, downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V1D and select the designated channel identifier of Net ID A for AC1.

Step 2 Configure the EUT with the same ICAO address as AC1 and select the designated channel identifier of Net ID A for the EUT and log into the net.

Step 3 Command GS1 to corrupt ACK frames by indicating the wrong Radio Identifier (and not adjust the Toggle bit).

Step 4 Send a downlink data transmission via the EUT.

Step 5 Verify the Address Type field of the downlink data frame indicates the correct Radio Identifier as assigned in the Supported Options message sent to the EUT during net entry.

Step 6 Verify the EUT retransmits the data frame after receiving the ACK burst with a different Radio Identifier.

Step 7 Command GS1 to perform normal ACK processing.

Step 8 Verify the EUT stops retransmission upon receiving the ACK frame with the correct Radio Identifier.

Step 9 Repeat the test for System Configuration 3V1D, but put the EUT in Net ID B while AC1 stays in Net ID A.

2.4.5.6.14 Test 4-14 -- Net Termination

Objective

a. Verify voice operation with aircraft ID of 61 after receiving Terminate Net message from the ground station.

Table 2-38c: Test 4-14 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 2V2D 2. 2V1D	EUT	any	downlink data

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Verify completion of Net Establishment by initiating and verifying completion of data access at the EUT.

Step 3 Command GS1 to send a Terminate Net message to the EUT.

Step 4 Command GS1 to poll the EUT with the aircraft ID previously assigned.

Step 5 Verify that no Poll Response is received at GS1.

Step 6 Activate the PTT of the EUT and initiate voice transmission.

Step 7 Verify at GS1, in the voice header of the downlink voice transmission, that aircraft ID 61 is used.

Step 8 Repeat the test procedure with GS1 in system configuration 2V1D.

2.4.5.7 Test Group 5 -- System Configuration - 3T (If applicable)

Objective

Verify compliance with RTCA DO-224B requirements associated with the 3T configuration for the aircraft radio.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3, shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

2.4.5.7.1 Test 5-1 -- Voice and Data Accesses

Objective

Verify compliance of the aircraft radio voice access by reservation and dependency between voice access and data access in 3T configuration.

Table 2-39: Test 5-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	3T	EUT	any	downlink voice downlink data

Procedure

Step 1 Configure GS1 for system configuration 3T and select the designated channel identifier for the EUT.

Step 2 Wait for the EUT to complete net entry procedures.

Step 3 With the voice channel idle and no pending data messages, activate the EUT's PTT.

Step 4 Verify with the Test Set that a downlink M burst is transmitted requesting a voice reservation.

Step 5 Observe that GS1 grants the EUT's request by sending a reservation response in the M uplink.

Step 6 Verify that all subsequent V/D (voice) bursts occur only in time slot D.

Step 7 Submit a 930-octet message to the EUT for delivery to GS1 in the absence of voice access.

Step 8 Verify that 15 consecutive B, C, and D time slots are used for the required 15 V/D (data) bursts.

Step 9 Repeat Step 7, but activate the EUT's PTT right after the data message is sent to the EUT for delivery to GS1.

Step 10 Verify that voice access request by the EUT is denied until the ongoing data transmission is completed.

Step 11 Submit a 930-octet message to the EUT for delivery to GS 1 while the voice channel is busy. Verify that data transmission occurs in consecutive B and C time slots only.

2.4.5.7.2 Test 5-2 -- Automated Ground Station Handoff

Objective

Verify automated handoff of ground stations for the aircraft EUT based on the received signal strength of the ground stations.

RTCA DO-224B does not currently specify 3T handoff criteria. Such handoff criteria are left to the avionics manufacturers to determine. Therefore, sample criteria for automated ground station handoff in 3T are proposed to develop the associated sample MOPS test procedures. Depending upon the specific implementation of the avionics manufacturers, the test procedures may have to be modified.

Sample Handoff Criteria: Handoff from the current ground station to the new ground station shall be based on the following conditions.

a) The signal quality used for determining handoff is based on the median signal level of the received signal over the last 20 measurements of each candidate ground station, assuming one measurement per MAC cycle.

b) The current ground station signal level is below –70 dBm (±1.5 dB).

c) The new ground station signal is at least 6 dB (±1.5 dB) stronger than that of the current ground station if the current ground station signal level is below –80 dBm. The new ground station signal is at least 10 dB (±1.5 dB) stronger than that of the current ground station if the current ground station signal level is above –80 dBm.

Table 2-40: Test 5-2 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	3T	EUT	any	downlink data
A	GS2	f_2	3T	EUT	any	downlink data

Procedure

Step 1 Configure GS1 and GS2 for system configuration 3T with frequency f1 and f2, respectively, and select f1 and the designated channel identifier for the EUT.

Step 2 Adjust the output power levels of GS1 and GS2 such that the levels measured at the RF port of the EUT are -75 dBm for GS1 and -85 dBm for GS2.

Step 3 Increase the GS2 output power in steps of 3 dB until the level reaches -61 dBm.

Step 4 Verify that ground station handoff from GS1 to GS2 occurs automatically when the median of the received signal level of GS2 over the last 20 MAC cycles reaches –66.5 dBm or above.

Step 5 Verify handoff of ground stations by observing that the EUT has switched its channel frequency from f_1 to f_2 and performed net entry with GS2. Verify that the EUT completes link establishment with GS2 by initiating a downlink data access.

Step 6 Repeat Step 2, but adjust GS1 and GS2 output power such that the resulting signal levels at the RF port of the EUT are –85 dBm and –96 dBm, respectively.

Step 7 Increase the GS2 output power in steps of 3 dB.

Step 8 Verify that no ground station handoff occurs when the median received GS2 signal level over the last 20 MAC cycle is –81 dBm or below and that handoff from GS1 to GS2 occurs automatically when the median signal level of GS2 over the last 20 MAC cycles reaches -80.5 dBm or above at the input of the EUT.

Step 9 Verify handoff of ground stations by observing that the EUT has switched its channel frequency from f_1 to f_2 and performed net entry with GS2. Verify that the EUT completes link establishment with GS2 by initiating a downlink data access.

Step 10 Repeat Step 2, but adjust GS1 and GS2 output power such that the resulting signal levels at the RF port of the EUT are –68 dBm and –80 dBm, respectively.

Step 11 Increase the GS2 output power in steps of 3 dB from –80 dBm to –20 dBm and verify that handoff of ground stations does not occur.

2.4.5.7.3 Test 5-3 -- Voice Operation Under Abnormal Timing Conditions

Objective

Verify that truncated voice mode is not supported in 3T.

Table 2-41: Test 5-3 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	3T	EUT AC1	any	downlink voice/data

Procedure

Step 1 Configure GS1 for system configuration 3T and select the designated channel identifier for the EUT and AC1.

Step 2 Suppress the beacon transmission of both GS1 and GS2 to emulate loss of both ground stations.

Step 3 Verify that the EUT transitions from timing state TS1 through TS2.

Step 4 Verify that truncated voice is not supported at the EUT during the transitional TS2 period with AC1 by observing that any attempt of PTT by the EUT will not result in voice access.

Step 5 Verify that data is not supported while the EUT is in TS2 by attempting to send downlink data through the EUT.

Step 6 Verify that the EUT transitions from timing state TS2 to TS3.

Step 7 Verify that free-running voice is supported at the EUT in timing state TS3 with AC1.

Step 8 Verify that data is not supported while the EUT is in either TS2 or TS3.

2.4.5.7.4 Test 5-4 -- Timing of 3T System Configuration

Objective

a. Verify the TDMA frame structure for 3T configuration.

b. Verify M downlink burst structure and format.

Table 2-42: Test 5-4 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	3T	EUT	any	downlink voice downlink data

Procedure

Step 1 Configure GS1 for system configuration 3T and select the designated channel identifier for the EUT.

Step 2 Activate the PTT of the EUT for about one second prior to releasing the PTT. Repeat this action for a minimum of 50 times asynchronous to TDMA frame timing.

Step 3 Verify that M downlink bursts for the voice reservation request occur in LBACs 1, 2, 3, 4, 5, 7, 9, 13, 15, or 17.

Step 4 Verify at GS1 that the timing of the LBACs in Step 3 is within ±1 symbol period relative to Table 3-55 of RTCA DO-224B and that the M burst format meets the requirements.

Note: *For the test setup the transmission delay between the EUT and GS1 is assumed to be negligible. The EUT's TRP should be within ±1 symbol period relative to* Table 3-55 of RTCA DO-224B, *when the EUT is in timing state TS1.*

2.4.5.8 Test Group 6 -- System Configuration - 3S

Objective

Verify compliance with the RTCA DO-224B requirements for aircraft radios in 3S configuration.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3, shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

2.4.5.8.1 Test 6-1 -- Automatic Selection of Master Ground Stations

Objective

Verify that the aircraft station automatically selects the master ground station in 3S configuration.

Table 2-43: Test 6-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 3S 2. 2S1X	EUT	any	uplink and downlink voice
B	GS2	f_1	1. 3S 2. 2S1X		any	uplink and downlink voice

Procedure

Step 1 Configure GS1 and GS2 for system configuration 3S with Net ID A and B, respectively, and select the designated channel identifier Net ID A for the EUT.

Step 2 Set the GS1 and GS2 RF output such that the signal levels at the input to the EUT are –50 dBm for GS1 and –75 dBm for GS2.

Step 3 Provide different audio streams for GS1 and GS2.

<u>Note:</u> *Having two different audio streams is for the purpose of facilitating the test and would not happen in the real world.*

Step 4 Select the designated channel identifier of Net A for the EUT.

Step 5 Verify that the EUT selects GS1 as its master ground station by verifying that the EUT is receiving GS1 audio.

Step 6 Adjust GS1 output power in 10 dB steps to –90 dBm. Dwell at each power setting for about 10 seconds.

Step 7 Verify change of master ground station by the EUT from GS1 to GS2 by verifying that the EUT is receiving the GS2 audio stream when the GS1 level is reduced to –80 dBm.

Step 8 Repeat the test procedure with GS1 in system configuration 2S1X.

2.4.5.8.2 Test 6-2 -- Timing of 3S System Configuration

<u>Objective</u>

a. Verify the TDMA frame structure for 3S configuration.

b. Verify M downlink burst structure and format.

c. Verify that downlink V/D (voice) bursts occur only in time slot A.

<u>Table 2-44</u>: Test 6-2 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 3S 2. 2S1X	EUT	any	downlink voice

<u>Procedure</u>

Step 1 Configure GS1 for system configuration 3S Net ID A and select the designated channel identifier of Net ID A for the EUT.

Step 2 Monitor the poll request and poll response at GS1 and verify that the poll response from the EUT occurs in the even TDMA frames and that both the timing of the M burst and the M burst format meet the requirements.

Step 3 Activate the PTT of GS1 to initiate voice transmission in time slot B.

<u>Note:</u> *This is not the normal mode of operation to facilitate the testing.*

Step 4 Deactivate the PTT of GS1 after 10 seconds.

Step 5 Activate the PTT of the EUT and initiate a short voice transmission. Repeat the voice access for about 10 times.

Step 6 Verify at GS1 that all the downlink V/D (voice) bursts occur in slot A.

Step 7 Repeat the test procedure with GS1 in system configuration 2S1X.

2.4.5.9 Test Group 7 -- System Configurations 1V3D and 1V2D

Objective

Verify compliance of the EUT with RTCA DO-224B requirements associated with configurations 1V3D and 1V2D.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3 shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

2.4.5.9.1 Test 7-1 -- Access of Downlink M Bursts

Objective

Verify that aircraft radios in 1V3D can access all 7 (5 for 1V2D) available downlink M-bursts in accordance with DO-224B. Verify specifically that a Poll Response always uses the downlink M burst in time slot A of even TDMA frame and that a UDR can use any of the remaining 6 (4 for 1V2D) downlink M burst opportunities.

Table 2-45: Test 7-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 1V3D 2. 1V2D	EUT	any	downlink voice

Procedure

Step 1 Configure GS1 for configuration 1V3D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Wait for the EUT to complete net entry.

Step 3 Command GS1 to poll the EUT.

Step 4 Verify at GS1 that the Poll Response message from the EUT was transmitted in time slot A of the even TDMA frame in the next MAC cycle after the poll.

Step 5 Repeat Steps 3 and 4 five times.

Step 6 Command GS1 to stop polling the EUT and activate the PTT at GS1 to occupy the voice channel.

Step 7 Activate the UDR at the EUT.

Step 8 Monitor the Reservation Request messages at GS1 and verify that the Reservation Request message is transmitted in one of the 6 available downlink M burst opportunities (one each in time slots B, C, and D for the even and odd MAC cycles).

Step 9 Release the GS1 PTT and activate the PTT at the EUT to verify channel access by the EUT and the clearing of the UDR at the EUT.

Step 10 Release the PTT of the EUT and command GS1 to poll the EUT once.

Step 11 Repeat Steps 6 through 10 repeatedly until the condition that at least one Reservation Request message is transmitted in each of the 6 available downlink M burst opportunities (one each in time slots B, C, and D for the even and odd MAC cycles) is met.

Step 12 Repeat the test for system configuration 1V2D.

2.4.5.9.2 Test 7-2a -- Local IDs and Use of Proper Time Slots for Voice Bursts

Objective

a. Verify that 1V3D and 1V2D support up to 240 users by demonstrating that the aircraft radio can be addressed with at least one ID in each of the four groups of 60 addresses (ID 1-60 (A01-A60), 65-124 (B01-B60), 129-188 (C01-C60), 193-252 (D01-D60)).

b. Verify that voice transmission uses time slot A.

Table 2-46a: Test 7-2a Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 1V3D 2. 1V2D	EUT	any	downlink voice/data

Procedure

Step 1 Configure GS1 for configuration 1V3D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Command GS1 to assign Local ID 1 (A01) to the EUT upon receiving the Net Entry Request.

Step 3 Wait for Net Entry to be completed.

Step 4 Command GS1 to poll Local ID 1 (A01).

Step 5 Verify at GS1 that a Poll Response message is received from the EUT.

Step 6 Repeat Steps 1 through 5 seven times, but in each repeat of Step 2, change the Local ID assigned to the EUT to 60 (A60), 65 (B01), 124 (B60), 129 (C01), 188 (C60), 193 (D01), and 252 (D60), respectively.

Step 7 Reintialize the EUT.

Step 8 Command GS1 to send a Net Entry Response message in response to the Net Entry Request message from the EUT with the local identifier field set to 0, indicating that the net is full.

Step 9 Activate the PTT of the EUT and begin voice transmission.

Step 10 Verify at GS1 reception of voice bursts in time slot A from the EUT.

Step 11 Repeat the test for System Configuration 1V2D.

2.4.5.9.3 Test 7-2b -- Use of Proper Time Slots for Data Bursts

Objective

a. Verify that data transmission uses consecutive B, C, and D slots.

Table 2-46b: Test 7-2b Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 1V3D 2. 1V2D	EUT	any	downlink voice/data

Procedure

Step 1 Configure GS1 for configuration 1V3D and select the designated channel identifier of Net ID A for the EUT.

Step 2 Wait for EUT to complete link establishment.

Step 3 Send a test message to the EUT for transmission to GS1 with message length equal to the default value of N1, i.e., 930 octets.

Step 4 Verify at GS1 that the EUT sends a reservation request and the subsequent data transmission occurs with 15 V/D (data) bursts in 15 consecutive B, C, and D, slots (B and C slots for 1V2D).

Step 5 Repeat the test for System Configuration 1V2D.

2.4.5.10 Test Group 8 -- CLNP Subnetwork Interface Test Procedures

Objective

Verify compliance with RTCA DO-224B requirements associated with the CLNP subnetwork interface.

Test Set-up

a. Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1 or 3, shown in Figure 2-7 or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

b. The tests are divided into two groups: point-to-point compression tests and multicast tests. For the point-to-point tests, the EUT is configured with a point-to-point network service access point (NSAP) address as is the message generator.

c. For the multicast tests, two NSAP addresses are defined: one representing a predefined multicast address; the other representing a dynamically defined multicast address. The message generator/processor is configured to recognize these addresses as multicast. The ground compressor and the avionics decompressor are initialized for the predefined multicast address, using an index number of one (1). In this case, the predefined multicast address and the point-to-point NSAP of the message generator represent the NSAP pair.

d. The ground station emulator uses a broadcast link address for any frames containing a CLNP packet with a multicast address.

2.4.5.10.1 Point-to-Point Compression Subnetwork Tests

2.4.5.10.1.1 Test 8-1 -- Subnetwork Initialization

Objective

Verify Correct Coding of network XID parameters.

Table 2-47: Test 8-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	2V2D	EUT	any	

Procedure

Step 1 Configure GS1 for configuration 2V2D and select the designated channel identifier of Net ID A for the EUT. Set the Network Type Value (NTV) to Hex 01, set CT1 to 5, CT2 to 60 seconds, and CT3 to 1 minute.

Step 2 Initialize the EUT to establish a link with GS1 in Net A.

Step 3 Verify that the NTV parameter is correctly set within the downlinked XID parameters.

Step 4 Verify that the CT1, CT2, and CT3 parameters are correctly defined in the EUT.

2.4.5.10.1.2 Test 8-2 -- ATN Packet Compression

Objective

Verify that ATN packets are sent compressed.

Procedure (continued from previous test)

Step 1 Using the aircraft ATN capable device, open a TP4 connection with the ground ATN device, specifying a connection with ATN quality of service (QOS)/Priority/Security values of your choice.

Step 2 Send a series of data from the EUT to GS1, making sure that the data unit size is much smaller than the maximum transmission unit (MTU) of the VDL Mode 3 connectionless subnetwork interface, i.e., smaller than 923 bytes.

Step 3 Verify at GS1 that the first packet (the connection request) is uncompressed and subsequent information (data packet and acknowledgment packet transport protocol data units [TPDUs]) is compressed.

Step 4 Verify that the TP4 connection is functioning normally by observing that no retransmission occurs, i.e., the EUT decompresses TP4 acknowledgements from the ground and the TP4 acknowledgements are accepted by the TP4 process.

2.4.5.10.1.3 Test 8-3 -- CLNP Packet Compression

Objective

Verify that CLNP packets are sent compressed.

Procedure (continued from previous test)

Step 1 Using the aircraft ATN capable device, open a new TP4 connection with the ground ATN device, specifying no ATN options.

Step 2 Send data with a data unit larger than 923 bytes from the EUT to GS1.

Step 3 Verify at GS1 that the subsequent CLNP packets, which contain the TPDU, are received as long compressed packets.

Step 4 Repeat Steps 1-3 but vary the optional header fields in the CLNP protocol data unit (PDU) to exercise the entire compressor formatting. Include packets with and without additional options.

Step 5 Verify that the TP4 connection is functioning normally by observing that no retransmission occurs, i.e., the EUT decompresses TP4 acknowledgements from the ground and the TP4 acknowledgements are accepted by the TP4 process.

2.4.5.10.1.4 Test 8-4 -- CLNP Packet Decompressing

Objective

Verify that long compressed CLNP packets are correctly processed.

Note: Decompression of short CLNP compressed packets is verified during the application of Tests 7-2 and 7-3.

Procedure (continued from previous test)

Step 1 Using an existing TP4 connection, send from GS1 to the EUT a TPDU with over 923 octets of user data.

Step 2 Verify with the Test Set that the data is acknowledged by the avionics TP4 process by observing that an ACK is received at GS1.

2.4.5.10.1.5 Test 8-5 -- Compression Bypass

Objective

Verify that CLNP packets which are not of type Data or Error are correctly forwarded and transferred uncompressed.

Procedure (continued from previous test)

Step 1 Using the ground ATN capability generate a CLNP Echo Request packet to be sent from GS1 to the EUT with destination NSAP set to that of the aircraft ATN capability.

Step 2 Verify with the Test Set that a CLNP Echo Response from the EUT is received at GS1 and that no compression occurs when transmitting the CLNP Echo Request and Response.

2.4.5.10.1.6 Test 8-6 -- Index Idle

Objective

Verify that idle index numbers are reused.

Procedure (continued from previous test)

Step 1 Using the aircraft ATN capable device, open 140 new TP4 connections with a different NSAP, every second. Note that it is not necessary that the connection succeed, i.e., the NSAPs can represent no responding ground entity. The TP4 retransmission timer, T1, must be set to a value larger than 140 seconds.

Step 2 Verify that the 127^{th} through 140^{th} connections reuse the first 14 index numbers. That is, index numbers 2 through 15 are reused, the index number 1 being permanently reserved for multicast purposes.

2.4.5.10.1.7 Test 8-7 -- Compression Initialization

Objective

Verify that index information is deleted whenever system initialization occurs.

Procedure (continued from previous test)

Step 1 Use the aircraft ATN capable device to open multiple TP4 connections with the ground.

Step 2 Use the ground ATN capable device to open multiple TP4 connections with the EUT.

Step 3 Send enough downlink messages to start the compression of headers on all of the TP4 connections.

Step 4 Command the ground CLNP compressor to send a restart packet.

Step 5 Verify that all index information associated with the TP4 connections opened by the aircraft ATN device is deleted.

Step 6 Send a new downlink message for each TP4 connection.

Step 7 Verify with the Test Set that the message received is uncompressed.

Step 8 Verify that the index number associated with the predefined multicast NSAP is unchanged.

Step 9 Force the system to generate a Leave Event.

Step 10 Verify that all index information is deleted, except for the index associated with the predefined multicast NSAP.

Step 11 Reopen a previous NSAP pair connection.

Step 12 Verify that the first packet is sent uncompressed.

2.4.5.10.2 Multicast Compression Subnetwork Tests

2.4.5.10.2.1 Test 8-8 -- Predefined Multicast Decompression

Objective

Verify that compressed multicast subnetwork data packets that use predefined and dynamic NSAPs are correctly processed.

Procedure (continued from previous test)

Step 1 Use the ground ATN capable device to generate one hundred 50-byte messages using the Connectionless Transport Protocol (CLTP) with checksum option, specifying the predefined multicast NSAP as the destination address. Each message must contain a unique sequence number and a unique test pattern. Each message is to be injected into GS1 at the rate of one per second.

Step 2 Verify that all of the data is received by the EUT, decompressed correctly, in order, with no gaps.

Step 3 Use the ground ATN capable device to generate one hundred 50-byte messages using CLTP with checksum option, specifying the dynamic multicast NSAP as the destination address. Each message must contain a unique sequence number and a unique test pattern. Each message is to be injected into the VDL Mode 3 test suite at the rate of one per second.

Step 4 Verify that all the data is received by the EUT, decompressed correctly, in order, and with no gaps.

Step 5 Continue to generate and transmit the data defined in Steps 1 and 3.

Step 6 Power down the EUT and re-enter the net, performing all initializations as required, using the subnetwork parameters as defined in Test 8-1.

Step 7 Wait for the EUT to complete link establishment procedure.

Step 8 Verify that decompression of the multicast data resumes in order and that the delay for the resumption of decompression is no more than 5 seconds. (The CT1 parameter guarantees that an uncompressed packet is sent every 5th packet, by default).

2.4.5.11 Test Group 9 -- ISO 8208 Subnetwork Interface Test Procedures

Objective

Verify compliance with RTCA DO-224B requirements associated with the ISO 8208 subnetwork interface.

Test Set-up

a. Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1 or 3, shown in Figure 2-7 or 2-9, as appropriate for the class of equipment under test identified in Table 2-5. Some additional terms are used in this Test Group to provide further definition of where the test point is to be located.

b. The VDL Mode 3 Ground Network Simulator is a portion of the Data Message Generator/Processor that simulates the ground SNDCF and the Ground ATN element.

c. The High Layer Entity (HLE) is a portion of the Data Message Generator/Processor that simulates the aircraft DTE and SNDCF and the aircraft ATN element.

d. For the purposes of this Test Group, the Aircraft Network Interface (ANI) is a portion of the EUT that performs the subnetwork sublayer functions. Actual implementations may also include some link layer functions within the ANI.

e. The Ground Network Interface (GNI) is a portion of GS1 and GS2 that performs the subnetwork sublayer functions.

Test Group 9 tests are divided into functional areas, 8208 Compressor Initialization, Virtual Call Setup, Data Transfer and Flow Control, Call Termination, and State Error Recovery procedures, as shown in Table 2-48.

Table 2-48: 8208 Compressor Subnetwork Test Summary

Functional Area	Test Procedure
8208 Compressor Initialization	**Test 9-1** 8208 Compressor Initialization
8208 Compressor Virtual Call Setup	**Test 9-2** 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority
	Test 9-3 8208 Compressor Virtual Call Setup, Aircraft-Initiated, Low-Priority
8208 Compressor Data Transfer and Flow Control	**Test 9-4** 8208 Compressor Data Transfer Bi-directional Transfer
	Test 9-5 8208 Compressor Data Transfer Unidirectional Transfer with Window Rotation
	Test 9-6 8208 Compressor Data Transfer Duplicate Suppression
	Test 9-7 8208 Compressor Data Transfer Reject Procedure
	Test 9-8 8208 Compressor Data Transfer Mbit Segmentation
	Test 9-9 8208 Compressor Data Transfer Mbit Reassembly
	Test 9-10 8208 Compressor Data Transfer Reset Initiation Procedure
	Test 9-11 8208 Compressor Data Transfer Reset Responder Procedure
	Test 9-12 8208 Compressor Data Transfer –Generating a Multiplexed Packet
	Test 9-13 8208 Compressor Data Transfer – De-Multiplexing
	Test 9-14 8208 Compressor Flow Control Receipt of RECEIVE NOT READY
	Test 9-15 RESERVED
8208 Compressor Virtual Circuit Termination Procedures	**Test 9-16** 8208 Compressor Ground-Initiated CLEAR Procedure
Channel State Test Procedures – Error Recovery Procedures	**Test 9-17** DCE Call Setup and Clearing States
	Test 9-18 ADCE Call Setup and Clearing States
	Test 9-19 DCE Restart States
	Test 9-20 DCE Reset States
	Test 9-21 ADCE Reset States
	Test 9-22 ADCE Flow Control Transfer States
	Test 9-23 DCE Flow Control Transfer States
	Test 9-24 RESERVED

Functional Area	Test Procedure
	Test 9-25 RESERVED
	Test 9-26 VDL Mode 3 Subnetwork Error Processing for ISO 8208 Packets

2.4.5.11.1 8208 Compressor Initialization

The 8208 Compressor Initialization Test verifies that the XID exchange performs successful initialization of the 8208 compressor.

2.4.5.11.1.1 Test 9-1 -- 8208 Compressor Initialization

Objective

Verify correct coding of network XID parameters.

Table 2-49: Test 9-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	2V2D	EUT	any	downlink data uplink data

Procedure

Step 1 Configure GS1 for configuration 2V2D and select the designated channel identifier of Net ID A for the EUT. Set the Network Initialization XID parameter with Network Type Value (NTV) to Hex 00, and set subparameters VER to 1, Ground DTE (GDTE) address to 155, and Aircraft DTE Subaddress (ADSA) to 0.

Step 2 Initialize the EUT to establish a link with GS1 in Net A.

Step 3 Verify that the NTV, ADSA and 8208 compression Version (VER) parameters are correctly set within the downlinked XID parameters.

Step 4 In the XID response; verify that the NTV, GDTE, and VER parameters are correctly set.

2.4.5.11.2 8208 Compressor Virtual Call Setup

The 8208 Compressor Virtual Call Setup consists of a set of tests used to verify the connection establishment of a virtual circuit. These tests examine both air-initiated and ground-initiated connection establishment as well as connection establishment based on priority.

2.4.5.11.2.1 Test 9-2 -- 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority

Objective

Verify that a connection (virtual circuit) is established. This connection is a ground-initiated high-priority virtual circuit.

Procedure

Step 1 Perform Test 9-1, 8208 compressor Initialization

Step 2 Verify upon XID exchange that a join event is sent to the ANI.

Step 3 Verify that the ANI receives an ES/IS packet and forwards it to the aircraft ATN router.

Note: *The ISH packet can be sent in a Subnetwork Data XID parameter from Step 1 or included in the Fast Select data of Step 4. If sent in the Fast Select data, Step 3 will follow Step 4.*

Step 4 Use the VDL Mode 3 Ground Network Simulator to generate a CALL Request by the GNI with Priority set to 1; Sequence Number set to 0; Temporary Channel set in range of 1 to 3; Address Mobile (AM) set to the ADSA value in Test 9-1; Address, Ground (AG) set to the GDTE value set in Test 9-1; Fast Select field set to 1; and fast select data containing a local reference (LREF) negotiation request.

Step 5 Verify that the aircraft unit translates the Incoming Call to an ISO 8208 CALL Request.

Step 6 Verify that the aircraft unit generates a CALL ACCEPT by the ANI with:

Octet 1 -- Set to Hex 54

Octet 2 -- Temporary Channel Number (TC) set to the TC value generated in the CALL REQUEST by the GNI and a Sequence number set to 0

Octet 3 -- Permanent Channel Number (CH) set in the range of 0 to 15, and an AM field set to the ADSA value in Test 9-1

Octet 4 -- AG field set to the value of the GDTE determined in Test 9-1

Octets 5 to 5+n -- Containing Fast Select data in response to the LREF negotiation request

Upon successful verification, the aircraft channel is now considered in the Data Transfer (p4) State.

2.4.5.11.2.2 Test 9-3 -- 8208 Compressor Virtual Call Setup, Aircraft-Initiated, Low-Priority

Objective

Verify that a connection (virtual circuit) is established. This connection is an aircraft-initiated low-priority virtual circuit.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Use the aircraft ATN capable device to open a new low-priority TP4 connection with the ground ATN device.

Step 3 Verify that the ISO 8208 CALL REQUEST is translated into a CALL REQUEST by the ANI.

Step 4 Verify the format of the CALL REQUEST by the ANI.

Octet 1 -- Set to Hex 50.

Octet 2 -- Priority (P) field set to 0 and the Sequence number set to 0.

Octet 3 -- CH set in range of 0 to 15 and an AM field set to the ADSA value in Test 9-1.

Octet 4 -- AG field set to the value of the GDTE determined in Test 9-1.

Octet 5 -- FS field set to zero indicating no Fast Select data.

Step 5 Observe that the VDL Mode 3 Ground Network Simulator generates a CALL ACCEPT by the GNI.

Step 6 Verify that the CALL ACCEPT by the GNI is translated by the ANI into an ISO 8208 CALL ACCEPT. The channel is now in the Data Transfer (p4) state.

2.4.5.11.3 8208 Compressor Data Transfer and Flow Control

The 8208 Compressor Data Transfer and Flow Control section consists of a set of tests used to verify activity of the aircraft system in the Data Transfer State and Flow Control States. This section tests Mbit segmentation and reassembly, multiplexing and de-multiplexing of packets, duplicate suppression, resequencing, REJECT procedure, RESET procedure, and interrupt processing.

2.4.5.11.3.1 Test 9-4 -- 8208 Compressor Data Transfer Bi-Directional Transfer

Objective

Verify that once a connection is established, data may be transferred downlink by the aircraft or uplink by the ground system over the same channel.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Using the aircraft ATN capable device, open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 3 Send a series of 128 octet data, initiated by both the aircraft High Layer Entity (HLE) and VDL Mode 3 Ground Network Simulator.

Step 4 Verify that the ISO 8208 DATA packets are translated into VDL Mode 3 DATA Packets.

Step 5 Verify that the EUT generates VDL Mode 3 DATA Packets that contain the Sequence Number (SN) and Packet Sent (PS) field values incremented by ONE for each ISO 8208 DATA Packet received from the aircraft HLE.

Step 6 Verify that the Packet Received (PR) field in the VDL Mode 3 DATA Packets generated by the EUT is correctly incremented based upon the VDL Mode 3 DATA Packets received from the VDL Mode 3 Ground Network Simulator.

Step 7 Verify that the Sequence Number field is updated in accordance with modulo 64 arithmetic and the PS and PR fields in accordance with modulo 16 arithmetic.

2.4.5.11.3.2 Test 9-5 -- 8208 Compressor Unidirectional Data Transfer with Window Rotation

Objective

Verify that once a connection is established, data can be sent continuously by the ground unit unidirectionally and window rotation occurs.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Using the ground ATN capability, generate 10 CLNP ECHO REQUEST Packets, with destination NSAP set to that of the aircraft ATN, at one-second intervals.

Step 3 The aircraft ATN system will not respond to the ECHO REQUEST Packets.

Step 4 Verify that the ADCE generates a RECEIVE READY packet after the receipt of 8 unsolicited VDL Mode 3 Ground DATA Packets.

2.4.5.11.3.3 Test 9-6 -- 8208 Compressor Data Transfer Duplicate Suppression

Objective

Verify that when a VDL Mode 3 duplicate packet (packet with the same sequence number) is received by the aircraft unit, the aircraft unit performs duplicate suppression.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Using the aircraft ATN capable device, open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 3 Send a series of data from the ground ATN device.

Step 4 Allow the VDL Mode 3 Ground Network Simulator to duplicate an 8208 data packet (same sequence number). This duplicate packet shall be transmitted following the original 8208 data packet.

Step 5 Verify that all packets delivered to the TP4 process by the ANI are in correct sequential order with no packets missing and no duplicate packets.

2.4.5.11.3.4 Test 9-7 -- 8208 Compressor Data Transfer Reject Procedure

Objective

Verify that a VDL Mode 3 Data packet lost in transmission between the ground system and aircraft Packet Level Protocol (PLP) evokes the REJECT procedure by the aircraft.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Using the aircraft ATN capable device, open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 3 Send a series of data from the ground ATN device.

Step 4 Allow the VDL Mode 3 Ground Network Simulator to discard a VDL Mode 3 DATA packet for transmission.

Step 5 Verify that the aircraft EUT generates a REJECT packet as a result of receiving a Data packet with a valid PR field, but an invalid PS field.

Step 6 Resend the Data packets starting with the PS value determined by the aircraft REJECT packet. Verify that all packets delivered to the TP4 process by the ANI are in correct sequential order with no packets missing and no duplicate packets.

2.4.5.11.3.5 Test 9-8 -- 8208 Compressor Data Transfer Mbits Segmentation

Objective

Verify that ISO 8208 data received by the ANI can be segmented across the VDL Mode 3 interface.

Procedure

Step 1 Configure GS1 for configuration 2V2D and select the designated channel identifier of Net ID A for the EUT. Set the Network Initialization XID parameter with Network Type Value (NTV) to Hex 00; set subparameters VER to 1; GDTE address to 155; ADSA to 0; and set Mbits to 176 octets.

Step 2 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority (Steps 2-6)

Step 3 Use the aircraft ATN capable device to open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 4 Using the aircraft ATN capable device, generate data at the transport of 512 bytes (allow the local ISO 8208 DTE/DCE interface the ability to transmit data packets of 1024 octets).

Step 5 Verify that the EUT segments the ISO 8208 data packets received into 176 octet packets.

2.4.5.11.3.6 Test 9-9 -- 8208 Compressor Data Transfer Mbits Reassembly

Objective

Verify that segmented VDL Mode 3 Data Packets received from the ground can be reassembled by the ANI.

Procedure

Step 1 Configure GS1 for configuration 2V2D and select the designated channel identifier of Net ID A for the EUT. Set the Network Initialization XID parameter with NTV to Hex 00; set subparameters VER to 1; GDTE address to 155; and ADSA to 0; and set Mbits to 176 octets.

Step 2 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority (Steps 2-6)

Step 3 Use the ground ATN capable device to open a TP4 connection with the aircraft ATN device, specifying a priority to map to the high-priority circuit.

Step 4 Use the ground ATN capable device to generate data at the transport of 512 bytes, allowing the ground VDL Mode 3 to segment down to 176 octets.

Step 5 Verify that all packets delivered to the TP4 process by the ANI are in correct sequential order with no packets missing and no duplicate packets.

2.4.5.11.3.7 Test 9-10 -- 8208 Compressor Data Transfer Reset Initiation Procedure

Objective

Verify the reset procedure when initiated by the aircraft unit.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Use the aircraft ATN capable device to open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 3 Send a series of data from the ground ATN device and aircraft ATN device.

Step 4 From the aircraft 8208 interface send an ISO 8208 RESET REQUEST Packet to the ANI prior to completion of the 8208 data exchange.

Step 5 Verify that an ISO 8208 RESET CONFIRMATION was received by the ANI.

Step 6 Verify that a RESET REQUEST by the ANI is generated and transmitted to the VDL Mode 3 Ground Network Simulator.

Step 7 The VDL Mode 3 Ground Network Simulator generates a RESET CONFIRMATION by the GNI.

Step 8 Verify that recovery occurs at the TP4 layer as a result of transport retransmission.

2.4.5.11.3.8 Test 9-11 -- 8208 Compressor Data Transfer Reset Responder Procedure

Objective

Verify the reset procedure by aircraft receipt of a RESET REQUEST packet.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Use the aircraft ATN capable device to open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 3 Send a series of data from the ground ATN device and aircraft ATN device.

Step 4 From the VDL Mode 3 Ground Network Simulator, issue a RESET REQUEST Packet to the ANI.

Step 5 Verify that upon receipt of the RESET REQUEST packet, an ISO 8208 RESET REQUEST is sent across the 8208 interface.

Step 6 Verify that an ISO 8028 RESET CONFIRMATION is received by the ANI across the 8208 interface and an ANI generated RESET CONFIRMATION is transmitted to the ground.

Step 7 Verify that recovery occurs at the TP4 layer as a result of transport retransmission.

2.4.5.11.3.9 Test 9-12 -- 8208 Compressor Data Transfer – Generating a Multiplexed Packet

Objective

Verify the aircraft unit's ability to multiplex packets.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Use the aircraft ATN capable device to open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 3 Using the aircraft ATN capable device, generate a message of length 512 octets at the transport layer.

Step 4 Verify data segmentation by the EUT into 176-octet packets within the VDL Mode 3 subnetwork, allowing data to be queued and subsequently to be multiplexed over the channel.

2.4.5.11.3.10 Test 9-13 -- 8208 Compressor Data Transfer–De-Multiplexing

Objective

Verify the ability of the aircraft EUT to de-multiplex VDL Mode 3 packets.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Use the ground ATN capable device to open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 3 From the ground ATN capable device, generate data consisting of 512 octets at the transport layer. This will force data segmentation into 176 octet packets within the VDL Mode 3 subnetwork.

Step 4 The ground will perform multiplexing of the VDL Mode 3 DATA packets based upon the segmentation.

Step 5 Verify that upon receipt of a multiplexed packet, the EUT performs de-multiplexing of the VDL Mode 3 DATA packets.

Step 6 Verify that all packets delivered to the TP4 process by the ANI are in correct sequential order with no packets missing and no duplicate packets.

2.4.5.11.3.11 Test 9-14 -- 8208 Compressor Flow Control Receipt of RECEIVE NOT READY

Objective

Verify that the aircraft unit ceases the flow of VDL Mode 3 data upon receipt of a RECEIVE NOT READY from the VDL Mode 3 Ground Network Simulator.

Procedure

Step 1 Perform Test 9-2, 8208 Compressor Virtual Call Setup, Ground-Initiated, High-Priority.

Step 2 Use the ground ATN capable device to open a TP4 connection with the ground device, specifying a priority to map to the high-priority circuit.

Step 3 Send a series of data from both the ground ATN device and the aircraft ATN device at one-second intervals for 30 seconds.

Step 4 After 10 seconds, have the VDL Mode 3 Ground Network Simulator send a RECEIVE NOT READY packet to the ANI. If a RECEIVE NOT READY condition cannot be forced, the tests within this step need not be performed.

Step 5 Verify that upon receipt of the RECEIVE NOT READY, the ANI ceases the flow of data.

Step 6 After 10 seconds, the VDL Mode 3 Ground Network Simulator issues a RECEIVE READY.

Step 7 Verify that the flow of data continues from the ANI to the VDL Mode 3 Ground Network Simulator.

2.4.5.11.3.12 Test 9-15 -- RESERVED

2.4.5.11.4 8208 Compressor Virtual Circuit Termination Procedures

The 8208 Compressor Virtual Circuit Termination section tests the EUT's ability to clear an established channel.

2.4.5.11.4.1 Test 9-16 -- 8208 Compressor Ground-Initiated CLEAR Procedure

Objective

Verify that the correctly clears a channel when a VDL Mode 3 CLEAR REQUEST is generated by the VDL Mode 3 Ground Network Simulator.

Procedure

Step 1 Perform Test 9-3, 8208 Compressor Virtual Call Setup, Aircraft-Initiated, Low-Priority.

Step 2 Verify that both the high and low-priority channels are opened.

Step 3 Use the ground ATN capable device to open a TP4 connection with the aircraft ATN capable device, specifying a priority to map to the low-priority circuit.

Step 4 From the 8208 interface, generate an ISO 8208 CLEAR REQUEST with Cause Code set to 141 and Diagnostic Code set to 162 (DTE Not Operational) on the low-priority channel.

Step 5 Verify that that this packet is translated into a VDL Mode 3 CLEAR REQUEST by the GNI and then is translated by the EUT into an ISO 8208 CLEAR REQUEST.

Step 6 Verify that the EUT issues a CLEAR CONFIRMATION to the GNI and that the EUT issues an ISO 8208 CLEAR CONFIRMATION to its DTE.

Step 7 Wait 10 seconds upon receipt of the VDL Mode 3 CLEAR CONFIRMATION.

Step 8 Use the ground ATN capable device to open a TP4 connection with the aircraft ATN capable device, specifying a priority to map to the low-priority circuit.

Step 9 Verify that a low-priority channel is re-opened, demonstrating the aircraft EUT’s ability to reuse the low-priority channel.

2.4.5.11.5 Channel State Test Procedures–Error Recovery Procedures

The Channel State Test Procedures are designed to test the Restart, Call Setup and Clearing, Reset, Flow Control and Data Transfer State tables of the aircraft EUT. While the Nominal State Test Procedures were captured in the earlier sections of this document, this section focuses on the Error Recovery State Test Procedures.

The Error Recovery State Test Procedures are designed to test the capability of the Aircraft EUT to recover from erroneous packets received over the ISO 8208 or VDL Mode 3 interface. A series of ISO 8208 and VDL Mode 3 packets will be transferred across the ANI boundaries to stimulate the logical states. Table 2-50 shows the required input and output for this test. Entries in the table are denoted either "ISO 8208" or "VDL Mode 3". ISO 8208 refers to transactions at the HLE interface, and VDL Mode 3 refers to transactions at the GNI-ANI interface. Unless otherwise noted, all tests occur on a single logical channel.

Use the ISO 8208 test set to perform the HLE functions, and use the VDL Mode 3 Ground Network simulator to perform GNI functions.

The packet transactions in Table 2-50 are required for the Error Recovery Test Procedures.

2.4.5.11.5.1 Test 9-17 -- DCE Call Setup and Clearing States

Objective

Verify the Call Setup and Clearing States.

Procedure

Step 1 Ready State (p1)

This test uses Transactions 1 and 2 to verify the DCE (p1) State.

a. Send an ISO 8208 CALL ACCEPT to the ANI. At the HLE, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 41. Return an ISO 8208 CLEAR CONFIRMATION to the ANI. Verify that there is no corresponding output on the VDL Mode 3 interface.

b. Perform the procedures in Step 1a replacing the ISO 8208 CALL ACCEPT sent to the ANI with each of the following ISO 8208 packets: RESET REQUEST, CLEAR CONFIRMATION, RESET CONFIRMATION, DATA, RECEIVE READY and RECEIVE NOT READY. Verify the results as in Step 1a.

c. Send an ISO 8208 RESTART REQUEST to the ANI with channel number not equal to zero. At the HLE, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 20. Return an ISO 8208 CLEAR CONFIRMATION to the ANI. Verify that there is no corresponding output on the VDL Mode 3 interface.

Table 2-50: ISO 8208 and VDL Mode 3 ANI Packet Transactions for Error Recovery Testing

Trans-action #	ANI Input	ANI Output
1	Invalid ISO 8208 Packet	ISO 8208 CLEAR REQUEST
2	ISO 8208 CLEAR CONFIRMATION	VDL Mode 3 CLEAR CONFIRMATION
3	ISO 8208 CALL REQUEST	VDL Mode 3 CALL REQUEST
4	Invalid ISO 8208 Packet	ISO 8208 CLEAR REQUEST VDL Mode 3 CLEAR REQUEST
5	Any ISO 8208 Packet except CLEAR REQUEST or CLEAR CONFIRMATION	None
6	VDL Mode 3 CLEAR CONFIRMATION	None
7	VDL Mode 3 CALL REQUEST	ISO 8208 CALL REQUEST
8	Invalid VDL Mode 3 Packet	VDL Mode 3 CLEAR REQUEST ISO 8208

Trans-action #	ANI Input	ANI Output
		CLEAR REQUEST
9	VDL Mode 3 CLEAR REQUEST	ISO 8208 CLEAR REQUEST
10	VDL Mode 3 CLEAR REQUEST	VDL Mode 3 CLEAR CONFIRMATION
11	Invalid VDL Mode 3 Packet	VDL Mode 3 CLEAR REQUEST
12	VDL Mode 3 CALL ACCEPT	ISO 8208 CALL ACCEPT
13	VDL Mode 3 CLEAR CONFIRMATION	VDL Mode 3 CLEAR REQUEST ISO 8208 CLEAR REQUEST
14	Invalid ISO 8208 Packet	ISO 8208 DIAGNOSTIC
15	ISO 8208 DIAGNOSTIC	None
16	ISO 8208 RESTART CONFIRMATION	None
17	ISO 8208 RESTART CONFIRMATION	ISO 8208 RESTART REQUEST
18	Invalid ISO 8208 Packets	None
19	VDL Mode 3 RESET CONFIRMATION	None
20	ISO 8208 RESET CONFIRMATION	None
21	Invalid Mode 3 Packet	None
22	ISO 8208 RESET CONFIRMATION	VDL Mode 3 RESET REQUEST ISO 8208 RESET REQUEST
23	Invalid ISO 8208 Packets	ISO 8208 RESET REQUEST VDL Mode 3 RESET REQUEST
24	VDL Mode 3 RESET CONFIRMATION	VDL Mode 3 RESET REQUEST ISO 8208 RESET REQUEST
25	Not used	
26	VDL Mode 3 RNR	None
27	Invalid VDL Mode 3 RR	VDL Mode 3 RESET REQUEST ISO 8208 RESET REQUEST
28	Invalid VDL Mode 3 DATA	VDL Mode 3 RESET REQUEST ISO 8208 RESET REQUEST
29	Invalid VDL Mode 3 DATA	VDL Mode 3 REJECT
30	Invalid PS in ISO 8208 DATA	None
31	Invalid ISO 8208 RR	ISO 8208 RESET REQUEST VDL Mode 3 RESET REQUEST
32	ISO 8208 RNR	None
33	Not used	
34	Not used	
35	Not used	
36	Not used	
37	ISO 8208 CALL REQUEST	ISO 8208 RESET REQUEST
38	Not used	
39	VDL Mode 3 CALL REQUEST	None
40	Not used	
41	VDL Mode 3 DATA	VDL Mode 3 RNR
42	Invalid VDL Mode 3 Packet	VDL Mode 3 RESET REQUEST ISO 8208 RESET REQUEST
43	Invalid VDL Mode 3 DATA	None

Trans- action #	ANI Input	ANI Output
44	ISO 8208 RECEIVE READY	ISO 8208 DATA VDL Mode 3 REJECT
45	VDL Mode 3 DATA	None
46	ISO 8208 DATA	None
47	Invalid ISO 8208 DATA	None
48	ISO 8208 CLEAR REQUEST	ISO 8208 CLEAR CONFIRMATION VDL Mode 3 CLEAR REQUEST
49	Invalid VDL Mode 3 RNR	VDL Mode 3 RESET REQUEST ISO 8208 RESET REQUEST
50	Invalid VDL Mode 3 REJECT	VDL Mode 3 RESET REQUEST ISO 8208 RESET REQUEST
51	Invalid ISO 8208 DATA	ISO 8208 RESET REQUEST VDL Mode 3 RESET REQUEST
52	Invalid ISO 8208 RNR	ISO 8208 RESET REQUEST VDL Mode 3 RESET REQUEST
53	Not used	

d. Perform the procedures in Step la, replacing the ISO 8208 CALL ACCEPT sent to the ANI with an ISO 8208 packet having a packet type identifier shorter than one byte. Verify that the diagnostic code is set to 38 in the ISO 8208 CLEAR REQUEST.

e. Perform the procedures in Step la, replacing the ISO 8208 CALL ACCEPT sent to the ANI with an ISO 8208 packet having a packet type identifier which is undefined or not supported. Verify that the ANI returns an ISO 8208 CLEAR REQUEST with diagnostic code set to 33.

Step 2 DTE Call Request State (p2)

This test uses Transactions 2, 3, 4, and 6 to verify the DCE (p2) State.

a. Send an ISO 8208 CALL REQUEST to the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CALL REQUEST packet from the ANI is received.

b. Send an ISO 8208 RESET REQUEST on the same switched virtual circuit (SVC) to the ANI. At the HLE, verify than an ISO 8208 CLEAR REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 21. Return an ISO 8208 CLEAR CONFIRMATION and use the VDL Mode 3 Ground Network Simulator to return a VDL Mode 3 CLEAR CONFIRMATION to the ANI.

c. Perform the procedures in Steps 2a and 2b, replacing the ISO 8208 RESET REQUEST sent to the ANI in procedure 2b with each of the following ISO 8208 packets: CALL REQUEST, CALL ACCEPT, CLEAR CONFIRMATION, DATA, RECEIVE READY and RECEIVE NOT READY. Verify the results as in Step 2b.

d. Perform the procedures in Steps 2a and 2b, replacing the ISO 8208 RESET REQUEST sent to the ANI in procedure 2b with an ISO 8208 packet having a packet type identifier shorter than one byte. Verify that the diagnostic code is set to 38 in the CLEAR REQUESTs.

e. Perform the procedures Steps 2a and 2b, replacing the ISO 8208 RESET REQUEST sent to the ANI in procedure 2b with an ISO 8208 packet having a packet type identifier which is undefined or not supported. Verify that the diagnostic code is set to 33 in the CLEAR REQUESTs.

f. Perform the procedures in Steps 2a and 2b, replacing the ISO 8208 RESET REQUEST sent to the ANI in procedure 2b with an ISO 8208 RESTART REQUEST or a RESTART CONFIRMATION with a logical channel number not equal to zero. Verify that the diagnostic code is set to 41 in the CLEAR REQUESTs.

Step 3 DCE Call Request State (p3)

This test uses Transactions 2, 4, 6, and 7 to verify the DCE (p3) State.

a. Send a VDL Mode 3 CALL REQUEST to the ANI. Verify that the ISO 8208 CALL REQUEST packet is forwarded to the HLE.

b. Send an ISO 8208 RESET REQUEST on the same SVC to the ANI. At the HLE, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 22. Send an ISO 8208 CLEAR CONFIRMATION to the ANI, and use the data generator to send a VDL Mode 3 CLEAR CONFIRMATION to the ANI. Verify that there is no corresponding output at the ISO 8208 and VDL Mode 3 interfaces.

c. Perform the procedures in Steps 3a and 3b five times. For each iteration replace the ISO 8208 RESET REQUEST sent to the ANI in Step 3b with one of the following ISO 8208 packets: CLEAR CONFIRMATION, DATA, RECEIVE READY, and RECEIVE NOT READY. Verify the results as in Step 3b.

d. Perform the procedures in Steps 3a and 3b, replacing the ISO 8208 RESET REQUEST sent to the ANI in Step 3b with an ISO 8208 packet having a Packet Type Identifier shorter than one byte. Verify that the diagnostic code is set to 38.

e. Perform the procedures in Steps 3a and 3b, replacing the ISO 8208 RESET REQUEST sent to the ANI in Step 3b with an ISO 8208 packet having a Packet Type Identifier which is undefined or not supported. Verify that the diagnostic code is set to 33.

f. Perform the procedures in Steps 3a and 3b, replacing the ISO 8208 RESET REQUEST sent to the ANI in Step 3b with an ISO 8208 RESTART

REQUEST Packet with the logical channel identifier not equal to zero. Verify that the diagnostic code is set to 41.

Step 4 Data Transfer State (p4)

This test uses Transactions 2, 3, 4, 6, and 12 to verify the ADCE and DCE (p4) States.

a. Perform call setup procedures, in Test 9-2.

b. Send an ISO 8208 CALL REQUEST on the open SVC to the ANI. At the HLE, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 23. Bit eight of the Clearing Cause Field should be set to zero because the error originated at the DTE/DCE interface. Return an ISO 8208 CLEAR CONFIRMATION, and use the data generator to send a VDL Mode 3 CLEAR CONFIRMATION to the ANI. Verify that the ANI does not forward either of the received CLEAR CONFIRMATION packets (ground or air originated).

c. Perform the procedures in Step 4a and Step 4b two times. For the first iteration replace the ISO 8208 CALL REQUEST sent to the ANI with an ISO 8208 CALL ACCEPT. For the second iteration, replace the ISO 8208 CALL REQUEST sent to the ANI with an ISO 8208 CLEAR CONFIRMATION. Verify the results as in Step 4b.

Step 5 Call Collision State (p5)

The error recovery procedures for the Call Collision (p5) State will not be tested.

Step 6 Clear Request by DTE State (p6)

The error recovery procedures for the Clear Request by DTE (p6) State will not be tested.

Step 7 DCE Clear to DTE State (p7)

a. Send an ISO 8208 Call Request to the ANI. At the VDL Mode 3 Ground Network Simulator, verify the receipt of a VDL Mode 3 CALL REQUEST packet from the ANI.

b. Send an ISO 8208 Restart Request to stimulate the ANI into the DCE (p7) State. Send the following ISO 8208 packets and verify that there is no output at the VDL Mode 3 interface.

ISO 8208 CALL REQUEST.
ISO 8208 CALL ACCEPT.
ISO 8208 RESET REQUEST.
ISO 8208 RESET CONFIRMATION.
ISO 8208 DATA.

ISO 8208 RR.
ISO 8208 RNR.
ISO 8208 PACKET TYPE ID SHORTER THAN 1 BYTE.
ISO 8208 PACKET WHICH IS UNDEFINED.

c. From the HLE test set, generate an ISO 8208 CLEAR CONFIRMATION packet to the ANI. From the VDL Mode 3 Ground Network Simulator test set, generate a VDL Mode 3 CLEAR CONFIRMATION packet back to the ANI. These events will allow the ANI's state machines to return in the Ready (p1) State.

2.4.5.11.5.2 Test 9-18 -- ADCE Call Setup and Clearing States

Objective

This test uses Transactions 6, 10, and 11 to verify the ADCE (p1) State.

Procedure

Step 1 ADCE Ready State (p1)

a. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 CLEAR REQUEST Packet to the ANI. At the VDL Mode 3 Ground Network Simulator, verify the receipt of a VDL Mode 3 CLEAR CONFIRMATION packet from the ANI.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 CALL ACCEPT Packet to the ANI. At the VDL Mode 3 Ground Network Simulator, verify the receipt of a VDL Mode 3 CLEAR REQUEST packet from the ANI with diagnostic code set to 20. From the VDL Mode 3 Ground Network Simulator, return a VDL Mode 3 CLEAR CONFIRMATION to the ANI. Verify that there is no corresponding output at the ANI/HLE interface.

c. Perform the procedures in Steps 1a and 1b six times. For each iteration replace the VDL Mode 3 CALL ACCEPT packet sent to the ANI in Step 1b with one of the following VDL Mode 3 Packets: CLEAR CONFIRMATION, DATA, RESET REQUEST, RECEIVE NOT READY, and RECEIVE READY. Verify the results as in Step 1b.

Step 2 GNI Call Request State (p2)

This test uses Transactions 2, 6, 7, and 8 to verify the ADCE (p2) State.

a. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 CALL REQUEST to the ANI. Verify the corresponding ISO 8208 Call Request.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 CLEAR CONFIRMATION on the same SVC to the ANI. At the HLE, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL

Mode 3 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 21. Bit eight of the Clearing Cause Fields should be set to one, because the error was detected at the VDL Mode 3 interface. Send an ISO 8208 CLEAR CONFIRMATION and use the data generator to return a VDL Mode 3 CLEAR CONFIRMATION to the ANI.

c. Perform the procedures in Steps 2a and 2b two times. For the first iteration, replace the VDL Mode 3 CLEAR CONFIRMATION Packet sent to the ANI in Step 2 with a VDL Mode 3 CALL REQUEST. For the second iteration, replace the CLEAR CONFIRMATION with a VDL Mode 3 CALL ACCEPT Packet. Verify the results as in Step 2b.

d. Perform the procedures in Steps 2a and 2b six times. For each iteration replace the VDL Mode 3 CLEAR CONFIRMATION sent to the ANI in Step 2b with one of the following VDL Mode 3 Packets: DATA, RESET REQUEST, RECEIVE NOT READY, RECEIVE READY. Verify the results as in Step 2b.

Step 3 ADCE Call Request State (p3)

This test uses Transactions 2, 3, 6, and 8 to verify the ADCE (p3) State.

a. Send an ISO 8208 CALL REQUEST to the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CALL REQUEST packet is received from the ANI.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 CLEAR CONFIRMATION to the ANI with TC set to 0. At the HLE, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 22. Bit eight of the Clearing Cause Fields should be set to one, because the error was detected at the VDL Mode 3 interface. Return an ISO 8208 CLEAR CONFIRMATION, and then return a VDL Mode 3 CLEAR CONFIRMATION to the ANI.

c. Perform the procedures in Steps 3a and 3b, replacing the VDL Mode 3 CLEAR CONFIRMATION sent to the ANI in Step 3b with each of the following VDL Mode 3 packets: RECEIVE READY, RECEIVE NOT READY, DATA, and RESET REQUEST. Verify the results as in Step 3b.

Step 4 ADCE Data Transfer State (p4)

This test uses Transactions 2, 3, 6, 8, and 12 to verify the ADCE (p4) State.

a. Perform call setup procedures, Test 9-2.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 frame containing a VDL Mode 3 CALL ACCEPT Packet to the ANI. At the HLE, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CLEAR REQUEST packet is received for the ANI with diagnostic code set to 23. The Clearing Cause Fields will have bit 8 set to 1 because the error originated within the VDL Mode 3 subnetwork. Return an ISO 8208 CLEAR CONFIRMATION, and then return a VDL Mode 3 CLEAR CONFIRMATION to the ANI.

c. Perform the procedures in Steps 4a and 4b. Replace the VDL Mode 3 CALL ACCEPT sent to the ANI in Step 4b with a VDL Mode 3 CLEAR CONFIRMATION. Verify the results as in Step 4b.

Step 5 Clear Request by VDL Mode 3 GNI State (p6)

The error recovery procedures for the Clear Request by GNI (p6) State will not be tested.

Step 6 Clear Request by ADCE to GNI (p7)

This test uses Transactions 2, 3, 6, 12, 13, and 21 to verify the actions of the ANI while the SVC is in the ADCE (p7) State.

a. Perform virtual call setup procedures, Test 9-2.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 CLEAR CONFIRMATION to the ANI. At the HLE, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 23. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CLEAR REQUEST packet is received from the ANI. Send a VDL Mode 3 frame containing a VDL Mode 3 CALL ACCEPT Packet to the ANI. Verify that there is no corresponding output from this action.

c. Send the following VDL Mode 3 packets to the ANI: DATA, RESET, RECEIVE NOT READY, and RECEIVE READY. Verify that there is no corresponding output from this action.

d. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 CLEAR REQUEST to the ANI. Send an ISO 8208 CLEAR CONFIRMATION to the ANI.

2.4.5.11.5.3 Test 9-19 -- DCE Restart States

Objective

Verify the Restart States

Procedure

Step 1 Packet Level Ready State (r1)

This test uses Transactions 14, 15, 16, and 17 to verify the DCE (r1) State.

a. From the HLE, send an ISO 8208 CALL REQUEST packet to the ANI with SVC number 0. At the HLE, verify that the ANI has generated an ISO 8208 DIAGNOSTIC packet back to the HLE with the diagnostic code set to 36 and the diagnostic cause field containing the first three bytes of the ISO 8208 CALL REQUEST.

b. From the HLE, send an ISO 8208 RESTART REQUEST packet to the ANI with a format error. At the HLE, verify that the ANI has returned an ISO 8208 DIAGNOSTIC packet with diagnostic code set to either 38, 39, 81 or 82 and the diagnostic cause field contains the first three bytes of the ISO 8208 RESTART REQUEST.

c. From the HLE, send an ISO 8208 RESTART CONFIRMATION packet to the ANI. At the HLE, verify that the ANI has returned an ISO 8208 RESTART REQUEST packet back to the HLE with diagnostic code set to 17.

d. Send an ISO 8208 RESTART CONFIRMATION to the ANI. The ANI enters the DCE (r1) State.

Step 2 DTE Restart Request State (r2)

The DTE Restart Request (r2) State error recovery procedures will not be tested.

Step 3 DCE Restart Request State (r3)

This test uses Transactions 14, 15, 16, 17 and 18 to verify the DCE (r3) State.

a. Perform the procedures in Step 1d, DCE enters the (r3) State.

b. Perform the procedures in Step lb.

c. Perform the procedures in Step 1a.

d. Perform the procedures in Step 1d.

Step 4 DCE Special Cases

This test uses Transaction 14.

a. From the HLE, send an ISO 8208 packet to the ANI that is less than two bytes in length. At the HLE, verify that the ANI returns an ISO 8208 DIAGNOSTIC packet with diagnostic code set to 38.

b. From the HLE, send an ISO 8208 CALL REQUEST packet to the ANI with an invalid General Format Identifier (GFI). At the HLE, verify that the ANI returns an ISO 8208 DIAGNOSTIC packet with diagnostic code set to 40.

2.4.5.11.5.4 Test 9-20 -- DCE Reset States

<u>Objective</u>

Verify the DCE Reset States.

Procedure

Step 1 Erroneous ISO 8208 Packets for the Flow Control Ready State (d1)

This test uses Transactions 3, 6, 12, 19, 20, 23, and 48 to verify the DCE (d1) State.

a. Perform the call setup procedures in Test 9-2.

b. From the HLE, send an ISO 8208 RESTART REQUEST packet to the ANI with a logical channel identifier unequal to zero on the open SVC. At the HLE, verify that the ANI sends an ISO 8208 RESET REQUEST packet to the HLE. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 RESET REQUEST is received from the ANI on the related SVC with diagnostic code set to 41.

c. . From the HLE, send an ISO 8208 RESET CONFIRMATION packet to the ANI on the open SVC. At the HLE, verify that an ISO 8208 RESET REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 RESET REQUEST packet is received from the ANI with diagnostic code set to 27.

d. Perform the procedures in Steps lb and 1c. For this iteration, replace the ISO 8208 RESTART REQUEST sent to the ANI in Step lb with a packet having an invalid Packet Type Identifier shorter than one byte. Verify that the diagnostic codes are set to 38 in the corresponding RESET REQUESTs.

e. Perform the procedures in Step lb and Step 1c. For this iteration, replace the ISO 8208 RESTART REQUEST with a packet having a Packet Type Identifier, which is undefined. Verify that the diagnostic codes are set to 33 in the corresponding RESET REQUESTs.

Step 2 Reset Request by DTE (d2)

The DTE Reset Request (d2) State error recovery procedures will not be tested.

Step 3 Reset Request by DCE to DTE (d3)

This test uses Transactions 3, 6, 12, 18, 19, 20, 22, and 48 to verify the DCE (d3) State.

a. Perform the call setup procedures in Test 9-2.

b. From the HLE, send a DATA packet to the ANI. Verify that there is no related output at the ANI/GNI interface.

c. Perform the procedures in Step 3c, replacing the DATA packet sent to the ANI in Step 3c with each of the following ISO 8208 packets: RESTART REQUEST with channel number unequal to zero, RECEIVE READY, RECEIVE NOT READY, REJECT, a packet having a Packet Type Identifier shorter than one byte, and a Packet having a Packet Type Identifier which is undefined. Send an ISO 8208 RESET CONFIRMATION and use the data generator to send a VDL Mode 3 RESET CONFIRMATION to the ANI. Verify the results as in 3c.

2.4.5.11.5.5 Test 9-21 -- ADCE Reset States

Objective

Verify the ADCE Reset States

Procedure

Step 1 ADCE Flow Control Ready State (d1)

This test uses Transactions 3, 6, 12, 19, 20, 24, and 48 to verify the ADCE (d1) State.

a. Perform the call setup procedures in Test 9-2.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 RESET CONFIRMATION packet to the ANI. At the HLE, verify that an ISO 8208 RESET REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 RESET REQUEST packet is received from the ANI with diagnostic code set to 27.

c. Return an ISO 8208 RESET CONFIRMATION, and then from the VDL Mode 3 Ground Network Simulator, return a VDL Mode 3 RESET CONFIRMATION to the ANI.

Step 2 Reset Request by GNI State (d2)

The Reset Request by GNI (d2) State error recovery procedures will not be tested.

Step 3 Reset Request by ADCE to GNI State (d3)

This test uses Transactions 3, 6, 12, 19, 20, 21, 24, and 48 to verify the ADCE (d3) State.

a. Perform the call setup procedures in Test 9-2.

b. Send a VDL Mode 3 RESET CONFIRMATION packet to the ANI on the open SVC. At the HLE, verify that an ISO 8208 RESET REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 RESET REQUEST packet is received from the ANI with diagnostic code set to 27.

c. From the VDL Mode 3 Ground Network Simulator, send a DATA packet to the ANI. Verify that there is no related output at the ANI/HLE interface.

d. Perform the procedure in Step 3c five times. For each iteration, replace the DATA packet sent to the ANI with one of the following VDL Mode 3 packets: RECEIVE READY and RECEIVE NOT READY.

e. Perform the procedures in Step 1c.

2.4.5.11.5.6 Test 9-22 -- ADCE Flow Control Transfer States

Objective

Verify the ADCE Flow Control Transfer State.

Procedure

Step 1 GNI Receive Not Ready State (g2)

This test uses Transactions 3, 6, 12, 19, 20, 26, 27, 48, 49, and 50 to verify the ADCE (g2) State.

a. Perform the virtual call setup procedures in Test 9-2.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 RECEIVE NOT READY Packet to the ANI.

c. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 RECEIVE READY packet to the ANI with an invalid PR field. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 RESET REQUEST packet is received from the ANI, and at the HLE, verify that an ISO 8208 RESET REQUEST packet is received from the ANI with diagnostic code set to 2.

d. Return an ISO 8208 RESET CONFIRMAT1ON and use the data generator to return a VDL Mode 3 RESET CONFIRMAT1ON to the ANI.

e. Perform the procedures in Steps lb, 1c, and 1d two times. For the first iteration replace the VDL Mode 3 RECEIVE READY Packet with an invalid PR field sent to the ANI in Step 1c with a VDL Mode 3 RECEIVE NOT READY Packet with an invalid PR field. For the second iteration replace the VDL Mode 3 RECEIVE READY Packet with a VDL Mode 3 REJECT Packet with an invalid PR field. Verify the results as in Step 1c.

Step 2 GNI Receive Ready State (g1)

This test uses Transaction 3, 6, 12, 19, 20, 27, 48, 49, and 50 to verify the ADCE (g1) State.

Perform the procedures in Steps la, 1c, 1d, 1e, and 1f; but when performing the procedures in Step le, do not send the RNR that is called for in Step 1b.

Step 3 ADCE Receive Not Ready State (f2)

This test uses Transactions 3, 12, 19, 20, 32, 41, and 42 to verify the ADCE (f2) State.

a. Perform the call setup procedures as specified in Test 9-2 to open an SVC.

b. Send an ISO 8208 RECEIVE NOT READY packet to the ANI via the DTE/DCE interface on the open SVC.

c. Send multiple VDL Mode 3 DATA packets from the VDL Mode 3 Ground Network Simulator to the ANI until the ANI sends a VDL Mode 3 RECEIVE NOT READY packet back to the VDL Mode 3 Ground Network Simulator. If a RECEIVE NOT READY condition cannot be forced, the tests within this step need not be performed.

d. From the VDL Mode 3 Ground Network Simulator test set, generate a VDL Mode 3 DATA packet to the ANI with an invalid PR field. At the HLE, verify that an ISO 8208 RESET REQUEST packet is received from the ANI, and at the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 2.

e. Verify that the VDL Mode 3 Ground Network Simulator sends a VDL Mode 3 RESET CONFIRMATION back to the ANI and that the aircraft DTE returns back an ISO 8208 RESET CONFIRMATION to the ANI's DTE/DCE interface.

Step 4 ADCE Receive Not Ready State (f2). Reject condition

This test uses Transactions 32, 41, 43 and 44 to verify the ADCE (f2) State.

a. Perform the call setup procedures as specified in Test 9-2, Compressor Virtual Call Setup, Ground-Initiated, High-Priority, to open an SVC.

b. Send an ISO 8208 RECEIVE NOT READY packet to the ANI via the DTE/DCE interface on the open SVC.

c. Send multiple VDL Mode 3 DATA packets from the VDL Mode 3 Ground Network Simulator to the ANI until the ANI sends a VDL Mode 3 RECEIVE NOT READY packet back to the VDL Mode Ground Network Simulator.

d. Generate a VDL Mode 3 DATA packet from the VDL Mode 3 Ground Network Simulator with an invalid PS field to the ANI.

e. From the HLE test set, generate an ISO 8208 RECEIVE READY packet to the ANI. At the HLE, verify the receipt of all the ISO 8208 DATA packets previously stored by the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 REJECT packet is received from the ANI with the expected PS value.

f. Generate a VDL Mode 3 DATA packet from the VDL Mode 3 Ground Network Simulator with the new PS value to the ANI.

g. At the HLE test set, verify the receipt of the ISO 8208 DATA packet sent from the ANI for correctness.

Step 5 ADCE Receive Not Ready State (f2). Valid DATA Packet received

This test uses Transactions 6, 32, 41, 44, 45, and 48 to verify the ADCE (f2) State.

a. Perform the procedures in Steps 3b and 3c.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 DATA packet to the ANI. Verify that there is no related output at the ANI/HLE.

c. Perform the procedures in Step 4c.

Step 6 ADCE Receive Ready State (f1)

This test uses Transactions 3, 6, 12, 19, 20, 28, 29, and 48 to verify the ADCE (f1) State.

a. Perform the call setup procedures as specified in Test 9-2 to open an SVC.

b. From the VDL Mode 3 Ground Network Simulator test set, generate a VDL Mode 3 DATA packet to the ANI with an invalid PR field. At the HLE, verify that an ISO 8208 RESET REQUEST packet is received from the ANI, and at the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 CLEAR REQUEST packet is received from the ANI with diagnostic code set to 2.

c. Verify that the VDL Mode 3 Ground Network Simulator sends a VDL Mode 3 RESET CONFIRMATION back to the ANI and that the aircraft DTE returns back an ISO 8208 RESET CONFIRMATION to the ANI's DTE/DCE interface.

Step 7 ADCE Receive Ready State (f1), Reject Condition

With a channel open still from the previous test:

a. Generate within the VDL Mode 3 Ground Network Simulator a VDL Mode 3 DATA packet with an invalid PS field and send the packet to the ANI.

b. At the HLE, verify that no related output is received. At the VDL Mode 3 Ground Network Simulator, verify that the ANI has generated a VDL Mode 3 REJECT packet with the expected PS value.

c. Generate a VDL Mode 3 DATA packet from the VDL Mode 3 Ground Network Simulator with the new PS value to the ANI.

d. At the HLE test set, verify the receipt of the ISO 8208 DATA packet sent from the ANI for correctness.

2.4.5.11.5.7 Test 9-23 -- DCE Flow Control Transfer States

Objective

Verify the DCE Flow Control Transfer States

Procedure

Step 1 DCE Receive Ready State (f1)

This test uses Transactions 3, 6, 12, 19, 20, 30, 48 and 51 to verify the DCE (f1) State.

a. Perform the call setup procedures in Test 9-2.

b. From the HLE, send an ISO 8208 DATA packet to the ANI with an invalid PS field. At the HLE, verify the receipt of an ISO 8208 RESET REQUEST packet from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 RESET REQUEST packet is received from the ANI with diagnostic code set to 1. From the HLE, return an ISO 8208 RESET CONFIRMATION packet to the ANI, and from the VDL Mode 3 Ground Network Simulator, return a VDL Mode 3 RESET CONFIRMATION packet back to the ANI.

c. From the HLE, send an ISO 8208 DATA packet to the ANI with an invalid PR field. At the HLE, verify the receipt of an ISO 8208 RESET REQUEST packet from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 RESET REQUEST packet is received from the ANI with diagnostic code set to 2.

d. Perform the reset confirmation procedures in Test 9-22 Step 1d.

e. Perform the procedures in Steps 1c and 1d. Replace the ISO 8208 DATA Packet sent to the ANI in Step 1c with an ISO 8208 DATA Packet less than four bytes in length. Verify that the diagnostic codes are equal to 38.

f. Generate an ISO 8208 CALL REQUEST packet from the aircraft DTE with the user data size negotiation facility set to 128 octets. Generate a CALL ACCEPT packet from the VDL Mode 3 Ground Network Simulator to open an SVC and forward the related ISO 8208 CALL ACCEPT packet to the aircraft DTE with the acceptance of the negotiated user data size.

g. From the HLE test set, generate an ISO 8208 DATA packet to the ANI with a user data size greater than the maximum negotiated data size at call setup time. At the HLE, verify that the ANI has sent an ISO 8208 RESET REQUEST packet, and at the VDL Mode 3 Ground Network Simulator test set, verify that a VDL Mode 3 RESET REQUEST packet is received from the ANI with diagnostic code set to 39. Return an ISO 8208 RESET CONFIRMATION packet from the HLE test set back to the ANI.

Likewise, return a VDL Mode 3 RESET CONFIRMATION from the VDL Mode 3 Ground Network Simulator test set back to the ANI.

Step 2 DCE Receive Not Ready (f2)

This test uses Transactions 3, 6, 12, 19, 20, 23, 26, 46, 47, and 48 to verify the DCE (f2) State.

a. Perform the call setup procedures in Test 9-2.

b. From the VDL Mode 3 Ground Network Simulator, send a VDL Mode 3 RECEIVE NOT READY Packet.

c. Send an ISO 8208 DATA Packet to the ANI until the ANI returns an ISO 8208 RECEIVE NOT READY Packet to the HLE. If a Receive Not Ready condition cannot be forced, the tests within this step need not be performed.

d. At the VDL Mode 3 Ground Network Simulator, verify that no VDL Mode 3 DATA packets are received.

e. Perform the procedures in Step 1c. Verify the results.

f. Perform the reset confirmation procedures in Test 9-22 Step 1d.

Step 3 DTE Receive Ready (g1)

This test uses Transactions 3, 6, 12, 19, 20, 31, 48 and 52 to verify the DTE (g1) State.

a. Perform the call setup procedures in Test 9-2.

b. At the HLE, generate an ISO 8208 RECEIVE READY packet to the ANI with an invalid PR field. At the HLE, verify that an ISO 8208 RESET REQUEST packet is received from the ANI. At the VDL Mode 3 Ground Network Simulator, verify that a VDL Mode 3 RESET REQUEST packet is received from the ANI with diagnostic code set to 2.

c. Perform the reset confirmation procedures in Test 9-22 Step 1d.

d. Perform the procedures in Step 3b and Step 3c two times. For the first iteration, replace the ISO 8208 RECEIVE READY sent to the ANI in Step 3b with an ISO 8208 RECEIVE NOT READY. For the second iteration, replace the ISO 8208 RECEIVE READY Packet sent to the ANI in Step 3b with an ISO 8208 REJECT Packet. Verify the results as in 3b.

e. At the HLE, generate an ISO 8208 flow control (RECEIVE READY, RECEIVE NOT READY or REJECT) packet to the ANI that is less than 3 bytes in length. Verify that there is no related output at the ANI/GNI interface.

Step 4 DTE Receive Not Ready (g2)

This test uses Transactions 3, 6, 12, 31, 32, and 48 to verify the DTE (g2) State.

a. Perform the call setup procedures in Test 9-2.

b. Send an ISO 8208 RECEIVE NOT READY to the ANI.

c. Perform the procedures in Steps 3b, 3c, 4b and 3d.

2.4.5.11.5.8 Test 9-24 -- RESERVED

2.4.5.11.5.9 Test 9-25 -- RESERVED

2.4.5.11.5.10 Test 9-26 -- VDL Mode 3 Subnetwork Error Processing for ISO 8208 Packets

Objective

These tests are designed to verify the ANI's ability to perform error processing functions due to erroneous ISO 8208 packet contents. They include tests for D-bit in packet, Q-bit in packet, Invalid Priorities, Unsupported Facilities, Illegal Calling Address and Illegal Called Address.

Procedure

Step 1 D-bit in packet.

a. Perform the Call Setup procedures as specified in Test 9-2 to open an SVC.

b. From the HLE test set, generate an ISO 8208 DATA packet with D-bit set to 1. At the HLE test set, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with cause code set to 133, and diagnostic code set to 166. Respond with an ISO 8208 CLEAR CONFIRMATION to the ANI. Verify that there is no related output to the VDL Mode 3 Ground Network Simulator test set.

Step 2 Q-bit in packet

With the SVC still open from the previous test, generate an ISO 8208 DATA packet (from the HLE test set), with Q-bit set to 1, to the ANI. At the HLE test set, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with cause code set to 133, and diagnostic code set to 83. Respond with an ISO 8208 CLEAR CONFIRMATION to the ANI. Verify that there is no related output to the VDL Mode 3 Ground Network Simulator test set.

Step 3 Invalid Priorities

From the HLE test set, generate an ISO 8208 CALL REQUEST packet to the ANI with the priority facility present. Set the priority value to be between 2 and 254 inclusive. At the HLE test set, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with cause code set to 131, and diagnostic code set to 66. Respond with an ISO 8208 CLEAR CONFIRMATION to the ANI. Verify that there is no related output to the VDL Mode 3 Ground Network Simulator test set.

Step 4 Unsupported Facility

From the HLE test set, generate an ISO 8208 CALL REQUEST packet with a facility which is not supported by the ANI. At the HLE test set, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with cause code set to 131, and diagnostic code set to 65. Respond with an ISO 8208 CLEAR CONFIRMATION to the ANI. Verify that there is no related output to the VDL Mode 3 Ground Network Simulator test set.

Step 5 Illegal Calling DTE Address

From the HLE test set, generate an ISO 8208 CALL REQUEST packet using an invalid calling DTE address to the ANI. At the HLE test set, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with cause code set to 141, and diagnostic code set to 68. Respond with an ISO 8208 CLEAR CONFIRMATION to the ANI. Verify that there is no related output to the VDL Mode 3 Ground Network Simulator test set.

Step 6 Illegal Called DTE Address

From the HLE test set, generate an ISO 8208 CALL REQUEST packet using an invalid called DTE address to the ANI. At the HLE test set, verify that an ISO 8208 CLEAR REQUEST packet is received from the ANI with cause code set to 141, and diagnostic code set to 67. Respond with an ISO 8208 CLEAR CONFIRMATION to the ANI. Verify that there is no related output to the VDL Mode 3 Ground Network Simulator test set.

2.4.5.12 Test Group 10 -- Make-before-Break (MbB) Operation

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3, shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

2.4.5.12.1 Test 10-1 -- MbB Initialization

Objective

Verify that the MbB parameters are initialized correctly within the radio.

Initialization and Setup

The test set shall be initialized such that a Network Type of 0000 0001 is in effect (No Subnetwork Compression). The two Ground Stations need to be connected to the equivalent of separate GNIs.

Table 2-51: Test 10-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	2V2D	EUT	any	downlink data
A	GS2	f_2	2V2D	EUT	any	downlink data

Procedure

Step 1 Have the EUT perform link establishment with GS1, while configured for MbB operation for the CLNP (No Compression) subnetwork interface.

Step 2 Verify that the parameter former_GNIp in the downlinked CTRL_CMD_LE frame has a value of zero.

Step 3 Have GS1 include a GNIp-Group parameter set (DO-224B, Section 3.3.3.3.1.2) with valid parameters in the CTRL_RSP_LE frame. In particular, the MbB_Operations_Permitted parameter shall be set to FALSE. (This parameter must be false at this time, as the aircraft has downlinked a zero value for the former_GNIp parameter.)

Step 4 Retune the EUT to a clear frequency and then back to f_1 and repeat Steps 1 and 3 within TL3 seconds. This time uplink a valid set of GNIp-Group parameters with the MbB_Operations_Permitted parameter set to TRUE and the Operative_GNIp parameter set to a different value than that used in Step 3. Verify that the downlinked XID parameter, former_GNIp, has the value transmitted in Step 3.

Step 5 Wait TL3 seconds. Perform Steps 1 and 2 again. Verify that the former_GNIp parameter is set to zero.

2.4.5.12.2 Test 10-2 -- Leave Event Processing

Objective

Verify that a Leave Event message is sent at the appropriate times.

Initialization and Setup

The test set shall be initialized such that a Network Type of 0000 0011 is in effect (No Subnetwork Compression).

Table 2-52: Test 10-2 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	2V2D	EUT	any	data

Procedure

Step 1 Perform Steps 1, 3, and 4 of Test 10-1. The EUT should now be in a MbB-capable mode.

Step 2 Wait Aircraft_TMbB seconds. Verify that the airborne ATN router receives its first Leave Event Message at this time and that the message refers to the former_GNIp, i.e., the GNIp referenced in the GNIp-Group parameter set transmitted in Step 3 of Test 10-1.

Step 3 Perform Step 1 again. Then repeat Step 4 of Test 10-1 within Aircraft_TMbB seconds sending an unused operative_GNIp parameter value. (At this point three different values have been sent to the aircraft). Verify that the only Leave Event Message sent to the airborne ATN machine is upon reception of the last transmittal (i.e., during the repeat of Step 4 of Test 10-1) and that the Leave Event Message references the first operative_GNIp value transmitted.

Step 4 Perform Steps 1, 3 and 4 of Test 10-1 with the following modification. The value of the MbB_Operations_Permitted parameter is set to FALSE in all transmittals. Verify that a Leave Event Message is sent to the airborne ATN machine upon completion of the net entry procedures of Step 4 of Test 10-1. Verify that the message references the first operative_GNIp transmitted (i.e. that of Step 3 of Test 10-1)

Step 5 Perform Step 1 again. Then repeat Step 4 of Test 10-1 within Aircraft_TMbB seconds sending an operative_GNIp parameter value that is the same as the last sent and an MbM_Operations_Permitted value set to FALSE. Verify that two Leave Event Messages are sent to the airborne ATN machine upon reception of the last transmittal (i.e., during the repeat of Step 4) and that the Leave Event Messages reference the operative_GNIp values transmitted.

2.4.5.12.3 Test 10-3 -- Subnetwork Packet Processing Using MbB

Objective

Verify that in MbB operation, the EUT differentiates packets from the ATN router destined for different GNIs.

Initialization and Setup

The test set shall be initialized such that a Network Type of 0000 0011 (No Subnetwork Compression) is in effect for Steps 1 through 4. Step 5 requires a Network Type of 0000 0001 (Subnetwork Compression operative). The ground and airborne ATN machines are required for this test. The ground ATN machine must be capable of supporting two logical IDRP state machines to emulate two separate ATN domains (or there can be two separate ground ATN machines).

Table 2-53: Test 10-3 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	2V2D	EUT	Any	data
A	GS2	f_2	2V1D	EUT	Any	data

Procedure

Step 1 Perform Steps 1 and 3 of Test 10-1. Verify that an IDRP connection between aircraft and ground ATN routers is started (starting this connection is the responsibility of the ground ATN machine).

Step 2 Start a CLNP echo request originating in the aircraft ATN router with destination address of the ground ATN router. Verify that the Ground Subnetwork Address field in the DLS sublayer frame header (DO-224B, Section 3.3.2.2.2.1) is set to the Operative_GNIp value established in Step 1.

Step 3 Continue the echo request operation in Step 2, sending a new request every second. Perform Step 4 of Test 10-1. Verify that an IDRP connection between aircraft and ground ATN routers is started. (Note the ground ATN capability will have to have two logical ATN state machines so that the IDRP connections are viewed as existing in two separate network domains.)

Step 4 Start a second CLNP echo request originating in the aircraft ATN router with a destination address of the ground ATN router used to establish the IDRP connection in Step 4 of Test 10-1. Verify that the Ground Subnetwork Address field in the DLS sublayer frame header (DO-224B, Section 3.3.2.2.2.1) is set to the Operative_GNIp value established in Step 3 for this echo request. Verify that echo requests started in Steps 2 and 3 have the Operative_GNIp value in the frame header established in Step 1.

Step 5 Repeat Steps 1 through 4 with CLNP compression in operation.

2.4.5.13 Test Group 11 -- RESERVED

Table 2-54 RESERVED

Table 2-55 RESERVED

2.4.5.14 Test Group 12 -- User Notification

Objective

Verify compliance with RTCA DO-224B requirements associated with User Notification.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, 2, or 3, shown in Figure 2-7, 2-8, or 2-9, as appropriate for the class of equipment under test identified in Table 2-5.

2.4.5.14.1 Test 12-1 -- User Notification

Objective

a. Verify that an indication is provided to the aircraft user if any of the following events occurs:

   1) Voice transmission (including unintentional transmission) is stopped when received uplink M burst voice signal code is other than 01_b
   2) PTT event exceeds the 35-second limit
   3) PTT is asserted while access is not allowed

b. Verify that the source of voice access (uplink or downlink) is provided to the aircraft user.

Table 2-56: Test 12-1 Test Set Configuration

Net ID	Ground Station	Channel Frequency	System Configuration	Aircraft Station	Squelch Window	Message Generator/Processor
A	GS1	f_1	1. 4V 2. 3V	EUT, AC1	Any	Uplink/downlink voice

Procedure

Step 1 Configure GS1 for system configuration 4V and select the designated channel identifier of Net ID A for the EUT and AC1.

Step 2 Wait for the EUT and AC1 to complete link initialization.

Step 3 Key the PTT of the EUT. While the EUT has access to the voice channel, command GS1 to transmit an uplink M burst with the 2-bit voice field coded as 00_b (ground access).

Step 4 Verify that an indication is provided by the EUT that the voice access by the EUT has been pre-empted.

Step 5 Configure GS1 to transmit all uplink M bursts with the 2-bit voice field coded as 10_b as (channel idle). Key the PTT of the EUT.

Step 6 Verify after 2 MAC cycles that an indication is provided by the EUT that the voice access is terminated.

Step 7 Configure GS1 to encode voice signal field normally. Key the EUT's PTT while the voice channel is idle and hold the PTT down to emulate a stuck-microphone condition.

Step 8 Verify that an indication is provided by the EUT that voice access has been terminated since the 35 second time out has been reached.

Step 9 Release the PTT of the EUT.

Step 10 Repeat Steps 1 and 2.

Step 11 Key the PTT at AC1 and verify that an indication of downlink voice is provided by the EUT.

Step 12 Release AC1's PTT. Repeat Step 10, but key the PTT at GS1 instead. Verify that an indication is provided by the EUT indicating uplink voice.

Step 13 Command EUT to tune to a frequency, f2, not occupied by GS1, then power GS1 down and reinitialize the EUT with channel identifier of Net ID A of channel frequency f_1.

Step 14 While in TS0, key the PTT at the EUT and verify that an indication is provided by the EUT that voice access is inhibited.

Note: *Step 14 should be performed within 12 seconds of Step 13, prior to the EUT transitioning to TS3.*

Step 15 Repeat the test for System Configuration 3V.

2.4.5.15 Test Group 13 -- Basic Voice-only Radio Tests

Objective

Verify compliance with RTCA DO-224B requirements associated with basic voice operations for IB0 avionics radios.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1, shown in Figure 2-7 for the IB0- class of equipment under test.

2.4.5.15.1 Test 13-1 – Link Management Functionality Test

2.4.5.15.1.1 Test 13-1a -- Net Initialization and Dummy Poll Response

Same as Test 1-1

2.4.5.15.1.2 Test 13-1b Aircraft Recovery -- Aircraft Recovery

Same Test Objective and Test Set Configuration as in Test 1-6

Procedure

Step 1 Configure GS1 for system configuration 2V2D and select the designated channel identifier of Net ID A for the EUT.

Step 2 After completion of net initialization by the EUT, power down the EUT momentarily and power the EUT back up. Verify that the EUT reinitializes and completes net initialization automatically.

Step 3 Reinitialize GS1 to the same channel and system configuration. Verify that EUT reinitializes and completes net initialization automatically.

Step 4 Repeat the test for system configuration 2V1D.

2.4.5.15.1.3 Test 13-1c -- System Configuration Mismatch

Same as Test 1-10

2.4.5.15.2 Test 13-2 Voice Operation -- Normal Conditions

Objective

Verify for compliance with RTCA DO-224B the voice operations associated with the basic voice-only aircraft radio under normal timing conditions.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1 in Figure 2-7.

2.4.5.15.2.1 Test 13-2a -- Receiver Operating Logic

Same as Test 2-1, except delete the first sentence in Step 2.

2.4.5.15.2.2 Test 13-2b -- Transmitter PTT Operating Logic

Same as Test 2-2, except that in Step 17 the EUT does not transmit Leaving Net message verify that the voice access is lost as soon as the EUT receives the command to retune.

2.4.5.15.2.3 Test 13-2c -- Step-on

Same as Test 2-3.

2.4.5.15.2.4 Test 13-2d -- RESERVED

2.4.5.15.2.5 Test 13-2e -- Communications Relay by a Second Aircraft Station

Same as Test 2-5.

2.4.5.15.2.6 Test 13-2f -- Burst Timing

Same as Test 2-6.

2.4.5.15.2.7 Test 13-2g -- Voice Delay

Same as Test 2-7.

2.4.5.15.2.8 Test 13-2h -- Voice Quality Test of the Ground-to-Air Link

Same as Test 2-8.

2.4.5.15.2.9 Test 13-2i -- Voice Quality Test of the Air-to-Ground Link

Same as Test 2-9.

2.4.5.15.2.10 Test 13-2j – Vocoder Output

Same as Test 2-11.

2.4.5.15.2.11 Test 13-2k -- Voice Synthesis

Same as Test 2-12.

2.4.5.15.3 Test 13-3 Voice Operation -- Special Timing Conditions

Objective

Verify for compliance with RTCA DO-224B the voice operations associated with the basic voice-only aircraft radio under special timing conditions.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1 in Figure 2-7.

2.4.5.15.3.1 Test 13-3a -- Aircraft VDL Mode 3 Timing Maintenance

Same as Test 3-1, except in Step 2 verify completion of net initialization by demonstrating successful voice access and in Step 4 verify that all V/D (voice) bursts occur in LBACs 2 and 6 in time slot A.

2.4.5.15.3.2 Test 13-3b -- Aircraft Validity Window Test

Same as Test 3-2, except that in steps 4 and 5 replace poll response with V/D (voice) bursts by activating the PTT of the EUT.

2.4.5.15.3.3 Test 13-3c -- Receipt/Process of Beacon Information From a Distant Station

Same as Test 3-3, except that in Step 3 wait for the EUT to complete Net Initialization.

2.4.5.15.3.4 Test 13-3d -- Timing State Transition and Air-to-Air Communications

Same as Test 3-4, except that the EUT, being a basic voice-only radio, will complete only net initialization, and does not initiate nor complete net entry.

2.4.5.15.3.5 Test 13-3e -- Abnormal Link Initialization

Same as Test 3-5.

2.4.5.15.3.6 Test 13-3f -- Invalid Alternate Timing

Same as Test 3-6.

2.4.5.15.4 Test 13-4 System Configuration -- 3S for Basic Voice-only Avionics Radio

Objective

Verify compliance with the RTCA DO-224B requirements for aircraft radios in 3S configuration.

Test Set-up

Connect the Test Set and the EUT in accordance with the Standard Test Configuration 1 shown in Figure 2-7.

2.4.5.15.4.1 Test 13-4a -- Automatic Selection of Master Ground Stations

Same as Test 6-1.

2.4.5.15.4.2 Test 13-4b -- Timing of 3S System Configuration

Same as Test 6-2, except replacing Step 2 of Test 6-2 with the following:

Step 2 Monitor the Dummy Poll Response transmission from the EUT at GS1 and verify that the Dummy Poll Response from the EUT occurs in the even TDMA frames and that both of the timing of the M burst and the M burst format meet the requirements.

2.4.5.15.5 Test 13-5 – User Notification

Same as Test 12-1

3.0 INSTALLED EQUIPMENT PERFORMANCE

3.1 Equipment Installation

The equipment shall be installed in accordance with the manufacturer's installation instructions.

3.1.1 Accessibility

Equipment controls and displays installed for in-flight use shall be readily accessible from the pilot's normal seated position. The appropriate operator/crew member(s) shall have an unobstructed view of displayed data when in the normal seated position.

3.1.2 Aircraft Environment

The equipment performance shall be compatible with the environmental conditions present in the specific location in the aircraft where the equipment is installed.

3.1.3 Display Visibility

Display intensity shall be adjustable to levels suitable for data interpretation under all cockpit ambient light conditions ranging from total darkness to reflected sunlight.

Note: *Visors, glare shields, or filters may be used to achieve an acceptable level of display visibility.*

3.1.4 Dynamic response

Operation of the equipment shall not be adversely affected by aircraft maneuvering or changes in attitude encountered in normal flight operations.

3.1.5 Failure Protection

Any probable failure of the equipment shall not degrade the normal operation of equipment or systems connected to it. Likewise, the failure of interfaced equipment or systems shall not degrade normal operation of the equipment.

3.1.6 Inadvertent Turnoff

Appropriate controls shall be provided to prevent the inadvertent turnoff of the equipment.

3.1.7 Aircraft Power Source

The voltage and voltage tolerance characteristics of the equipment shall be compatible with the aircraft power source.

3.2 Installed Equipment Performance Requirements

The installed equipment shall meet the requirements stated in Sections 2.1 and 2.2 in addition to, or as modified by, the requirements stated below.

3.2.1 Dynamic Response

Operation of the equipment shall not be adversely affected by aircraft ground operations, maneuvering, or changes in attitude encountered in normal flight operations.

3.2.2 Interference Effects

The equipment shall not be the source of harmful conducted or radiated interference and shall not be adversely affected by conducted or radiated interference from other equipment or systems installed in the aircraft.

<u>*Notes:*</u>

1. *Electromagnetic compatibility (EMC) problems noted after installation of this equipment may result from such factors as design characteristics of previously installed systems or equipment and the physical installation itself. It is not intended that the equipment manufacturer necessarily design for all installation environments. The installing facility will be responsible for resolving any incompatibility between this equipment and previously installed equipment in the aircraft. The various factors contributing to the incompatibility must be considered.*

2. *The FCC requirement in CFR 47, of –40 dBc for aircraft spurious emissions, may not protect GNSS (including GPS) navigation receivers nor Aeronautical Mobile Satellite Service (AMSS) communication receivers from harmful interference because additional attenuation is required. Of particular concern to GNSS are VHF 12th and 13th harmonics (especially at 121.150, 121.175, 121.2, 131.2, 131.25, and 131.3 MHz). Of particular concern to AMS(R)S are the VHF 12th and 13th harmonics (for AMS(R)S systems operating in the band 1525 - 1559 MHz, especially at 118.0 - 119.9 MHz and at 127.1 - 129.9 MHz; and for AMS(R)S systems operating in the band 1610 - 1626.5 MHz, especially at 121.1 - 123.85 MHz and 134.15 - 135.55 MHz).*

3. *Spurious emissions from the VHF antenna or a VHF box can be a problem. Additional filtering and shielding may be required to protect navigation receivers on an aircraft. Intersystem EMC issues are beyond the scope of this document. However, if simultaneous operation is required, the methodology stated in the following equation, if applicable, may be used to determine the harmonic levels that would be acceptable for a given set of conditions. The conditions that correlate with a particular manufacturer's transmitter design should be specified in the installation information for the transmitter if the manufacturer intends for the transmitter to be used on aircraft that would include such receiving systems.*

   Transmitter Harmonic Level = Sensitivity of Receiving System
   + Receiver Interference to Desired Signal Level
   - Safety Margin
   - Aggregate Effect Margin
   + Antenna Isolation
   + Harmonic Filter Attenuation (if used)

Examples for GNSS and AMSS: *The levels listed in* *Table 3-1* *are not specifications but are simply the result of the listed receiver and installation parameters, which vary with specific receivers and installations.*

Table 3-1: Example of Interference Protection for GNSS and AMSS

Item		GNSS		AMSS	
1	Victim operating frequency.	1575.4	MHz	1530.0	MHz
2	Receiver Susceptibility Mask	-120.5	dBm	-163.2	dBm
3	Aeronautical Safety Margin	6.0	dB	0.0	dB
4	Total Allowed RFI at receiver input	-126.5	dBm	-163.2	dBm
5	Worst VDL noise equivalent factor	0.0	dB	0.0	dB
6	Multiple System Allotment	6.0	dB	0.0	dB
7	Single Emitter Allotment	0.0	dB	0.0	dB
8	Allowable VDL-induced RFI at Victim	-132.5	dBm	-163.2	dBm
9	Antenna Gain toward RFI source	0.0	dBi	0.0	dBi
10	VDL-Antenna-Port-to-Victim-Antenna-Port Isolation	36.4	dB	36.1	dB
11	RFI Emission Limit	-96.1	dBm	-127.1	dBm
12	Max VDL Transmit Power	41.8	dBm	41.8	dBm
13	Maximum Permissible VDR Harmonic Power Level	-60.0	dBm	-60.0	dBm
14	Example Required External Filter Rejection	36.1	dB	67.1	dB
15	Example Total Harmonic Control (VDR design + external filter)	-137.9	dBc	-168.9	dBc

Item Notes: Items 2, 6, 9, 10, 14 and 15 are installation dependent.

1. GNSS (1559-1610 MHz); AMSS (1525-1559 MHz).
2. Susceptibility = Sensitivity (dBm) + Interference to Signal ratio (I/S) (dB). As of 2001, most G/A GPS receivers permit I/S of +20 dB. GPS Sensitivity from RTCA DO-208, Section 2.2.3.1; GPS I/S from RTCA DO-208, Section 2.2.3.2, Continuous Wave. SATCOM susceptibility from RTCA DO-210D, Change 1, Section 2.1.9.
3. Safety Margin per RTCA DO-235.
4. Calculated as Item 2 (dBm) - Item 3 (dB).
5. Item maintained for compatibility with other analyses, no effect on VDL.
6. Assume that there are multiple systems contributing GPS interference. This value may be 0 or 3 to 10 dB depending on installation.
7. Item maintained for compatibility with other analyses, assume only single VDR transmitting on the same aircraft.
8. Calculated as Item 4 (dBm) + Item 5 (dB) - Item 6 (dB) + Item 7 (dB)
9. Item maintained for compatibility with other analyses. For this analysis, the antenna gain is assumed to be included in Item 10.
10. Isolation from TX antenna port to RX antenna port, taken as free-space loss at a distance of 1 meter, with no consideration of antenna gain, antenna pattern or cable loss.
11. Calculated as Item 8 (dBm) + Item 10 (dB).
12. Assume 15 W (41.8 dBm) VDL transmitter with no cable loss.
13. VDL harmonic output level per Section 2.2.1.3.6. For AMSS, it is assumed that the steps taken to reduce 12^{th} and 13^{th} order harmonic levels for GNSS result in the same reduction for adjacent AMSS frequencies.
14. Better VDL Harmonic performance will result in lower necessary filter rejection. Calculated as Item 13 (dBm) – Item 11 (dBm).
15. Total Harmonic Level allowed at input to transmit antenna, relative to carrier power. Calculated as Item 11 (dBm) – Item 12 (dBm).

Other References: RTCA DO-229B, GPS/WAAS Airborne Equipment
RTCA DO-262 MOPS for Next-Generation AMS(R)S Airborne Equipment

3.3 Conditions of Test

Conditions stated in the following sections are applicable to the equipment tests specified in Section 3.4.

3.3.1 Power Input

Unless otherwise specified, tests shall be conducted with the equipment powered by the aircraft's electrical power generating system.

3.3.2 Associated Equipment or Systems

Unless otherwise specified, all electrically operated equipment and systems on the aircraft shall be operational before conducting interference tests.

3.3.3 Environment

During the tests, the equipment shall not be subjected to environmental conditions that exceed those specified by the manufacturer.

3.4 Test Procedures for Installed Equipment Performance

The following test procedures are considered satisfactory for determining required equipment performance when the equipment is installed in an aircraft. Although specific test procedures are cited, it is recognized that other methods may be preferred by the installing activity. These alternate procedures may be used if the installing activity can show that they provide at least equivalent information. In such cases, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternate procedures. The equipment shall be tested to demonstrate compliance with the minimum requirements stated in Section 2.2. In order to meet this requirement, test results provided by the equipment manufacturer as proof of conformity may be accepted in lieu of bench tests performed by the installing activity.

3.4.1 Procedures

3.4.1.1 Conformity Inspection

Visually inspect the installed equipment to determine the use of acceptable workmanship and engineering practices. Verify that all mechanical and electrical connections have been made properly and the equipment has been located and installed in accordance with the manufacturer's recommendations.

3.4.1.2 Equipment Function

Vary all controls of the equipment through each function to determine that the equipment is operating according to the manufacturer's instructions and that each control performs its intended function.

3.4.1.3 Equipment Accessibility

Determine that all equipment controls are readily accessible and that displayed data is easily interpreted.

3.4.1.4 Interference Effects

With the equipment energized, individually operate each other electrically operated equipment and system on the aircraft to determine that no significant conducted or radiated interference exists. Evaluate all reasonable combinations of control settings and operating modes. Operate communications and navigation equipment on at least the low, high, and one mid-band frequency. Make note of systems or modes of operation that should also be evaluated during flight. If appropriate, repeat tests using emergency power with the aircraft's batteries alone and the inverters operating.

Note: *The procedure may be adequate in consideration of the note in Section 3.2.2.*

3.4.1.5 Power Supply Fluctuations

Under normal aircraft conditions, cycle the aircraft engine(s) through all normal power settings and verify proper operation of the equipment as specified by the equipment manufacturer.

3.4.1.6 Reception

The reception of VHF communications signals shall be confirmed by monitoring a local communication frequency to verify that the receiver produces a clearly audible and understandable output.

3.4.1.7 Transmission

The transmission of VHF communications signals shall be verified by establishing contact with another VHF communication station and receiving a report of reliable communications.

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4 EQUIPMENT OPERATIONAL PERFORMANCE CHARACTERISTICS

4.1 Operational Performance Requirements

To ensure for the operator that operations can be conducted safely and reliably in the expected operational environment, there are specific minimum acceptable VDL Mode 3 equipment performance requirements that shall be met. The following paragraphs identify these requirements.

4.1.1 Power Input

Prior to flight, the power necessary for proper operation must be available to the equipment.

4.1.2 Equipment Operating Functions

The equipment shall operate in each of its installed operating modes, voice and data, as appropriate to the installed equipment.

4.1.3 Communication Controls

Cockpit control(s) required for proper operation of the equipment shall be available for use.

4.1.4 Communications Displays

The required displays for the selection, control, and annunciation of the various communication functions and modes of operation shall be available for use.

4.1.5 System Operational Indication

Communication failure or degradation below minimum acceptable performance shall be readily discernible.

4.1.6 Equipment Operating Limitations

Equipment operating limitations of the aircraft station should be contained in the aircraft flight manual. System operational readiness shall be monitored either by means of Built In Test Equipment (BITE) and/or by suitable tests contained in a check list or flight manual.

4.2 Test Procedures for Operational Performance Requirements

Operational equipment tests may be conducted as part of normal pre-flight tests. For those tests that can be run only in flight, procedures should be developed to perform these tests as early during the flight as possible to verify that the equipment is performing its intended function(s).

4.2.1 Power Input

With the aircraft's electrical power generating system operating, energize the equipment and verify that electrical power is available to the equipment.

4.2.2 Equipment Functional Tests

Verify that the equipment performs its intended function(s) for each of the operating modes available to the operator and from available ground facilities.

4.2.2.1 Voice Test

This operational test is applicable if the installed equipment supports voice communications. Select an available ground-facility voice-channel; press the microphone key and, using proper microphone techniques, request a radio check. Release the key and listen for the reply from the ground facility. Check for the intelligibility of the received message and the report of your transmission.

4.2.2.2 Data Link Test

This operational test is applicable if the installed equipment supports data link communications. Select an available ground facility data channel, and using the associated data link message entry and retrieval equipment, send a test message that will elicit a response. Check for the timeliness of the reply message, that the reply-message is appropriate to the transmitted test message, and that the reply-message has no apparent errors.

4.2.3 Communications Controls

The communications controls shall be operated, as required, to verify satisfactory equipment response.

4.2.4 Communications Displays

With the equipment operating, verify that the required display(s) are operational.

4.2.5 System Operational Indication

All equipment failure annunciators shall be tested during preflight tests to verify proper operation.

4.2.6 Equipment Operating Limitations

Verify that any equipment operating limitations of the aircraft station, and necessary operational tests, if any, are contained in the aircraft flight manual.

Membership

Special Committee 172, Working Group 3

Minimum Operational Performance Standards for Aircraft VDL Mode 3 Transceiver Operating in the Frequency Range 117.975-137.000 MHz

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Moody, John	MITRE/CAASD
Mottola, John	Raytheon Systems Company
Muraca, Peter	Federal Aviation Administration
Murray, Dave	ITT Industries
Mustach, Thomas	Federal Aviation Administration
Nagowski, Victor	ARINC Incorporated
Nair, K.	Project Management Enterprises Inc.
Nelsen, Robert	OPTIMUS Corporation
Newitt, J.	JWN Consulting
Nguyen, Vincent	Federal Aviation Administration
Oishi, Roy	ARINC Incorporated
Olson, Richard	Federal Aviation Administration
Orlando, Vincent	MIT Lincoln Laboratory
Pannucci, John	Rohde & Schwarz, Inc.
Pavan, Reddy	Raytheon Systems Company
Pawlowitz, Timothy	Federal Aviation Administration
Peak, Cindy	Air Traffic Control Association
Pede, Mark	TRW, Inc.
Perry, Geoff	SITA
Phillips, Brent	Federal Aviation Administration
Phillips, Wayne	Veridian
Pichavant, Claude	Airbus France
Pickens, Andrew	AvCom, Inc.
Platt, Philip	Qinetiq, ATC Research Group
Prill, Robert	BAE Systems Technology Services Sector/FAA Division
Pye, John	Veridian
Ruana, Rudy	RTCA
Russell, William	Russell Systems

Sayadian, Albert	Trios Associates, Inc.
Sayadian, Edward	ITT Industries
Scardina, John	Federal Aviation Administration
Schirm, Lothar	Rohde & Schwarz, Inc.
Schlickenmaier, Herbert	National Aeronautics & Space Administration
Signore, Ted	MITRE/CAASD
Smith, Larry	General Dynamics Decision Systems
Smith, Munro	SITA
Snively, Austin	American Airlines
Speltens, Marc	EUROCONTROL
Spring, Rick	Rockwell Collins, Inc.
Stapleton, Brian	The Boeing Company
Stayton, Greg	L-3 Communications
Stroop, David	CIE Engineering, Inc
Studenberg, Fred	Rockwell Collins, Inc.
Tahmisian, Ted	Raytheon Systems Company
Thornton, Gayle	Federal Aviation Administration
Thusius, Patrick	U. S. Air Force
Van Trees, Stephen	Federal Aviation Administration
Wade, Matthew	Federal Aviation Administration
Walen, David	Federal Aviation Administration
Wendel, Terence	Federal Aviation Administration
White, Ben	Consultant
White, Brian	MITRE Corporation
Wilson, Warren	MITRE Corporation
Winick, Alexander	1 Grp of Consultants & Independents
Wolf, Marcus	Federal Communications Commission
Yagodich, Milan	MYCOMM, Inc.
Zhou, Janet	Honeywell ASTG

APPENDIX A

ACRONYMS

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Acronyms

A/C	Aircraft
AC1	Aircraft Station 1
AC2	Aircraft Station 2
ACK	Acknowledgment
A-CLDL	Acknowledged-Connectionless Data Link
ACR	Adjacent Channel Rejection
ADCE	Aircraft Data Circuit-terminating Equipment
ADSA	Aircraft DTE Subaddress
AG	Address, Ground
A/G	Air-Ground
AGC	Automatic Gain Control
AM	Address, Mobile
AMBE	Advanced Multi-Band Excitation
AMCP	Aeronautical Mobile Communications Panel
AM(R)S	Aeronautical Mobile (Route) Service
AMSS	Aeronautical Mobile Satellite Service
ANI	Aircraft Network Interface
AOC	Aeronautical Operational Control
ASE	Aircraft Station Emulator
ATC	Air Traffic Control
ATN	Aeronautical Telecommunications Network
ATS	Alternate Timing Source
BER	Bit Error Rate
BITE	Built In Test Equipment
bps	bits per second
CCI	Co-Channel Interference
CLNP	Connectionless Network Protocol
CLTP	Connectionless Transport Protocol
CMD	Command
CMU	Communication Management Unit
CRC	Cyclic Redundancy Check
CTC	Coast Timing Counter
CTRL	Control
CW	Continuous Wave
D8PSK	Differential Eight Phase Shift Keying
dB	decibel
dBc	decibels relative to the carrier
dBm	decibels relative to 1 milliwatt
DCE	Data Circuit-terminating Equipment
D/L	Downlink
DLS	Data Link Services
DSB-AM	Double Sideband-Amplitude Modulation
DTE	Data Terminating Equipment
DVSI	Digital Voice Systems, Incorporated
EMC	Electromagnetic Compatibility

EMI	Electromagnetic Interference
EOM	End-of-Message
ES	End system
ES-IS	End System-Intermediate System
EUT	Equipment Under Test
EVM	Error Vector Magnitude
FAR	Federal Aviation Regulations
FCC	Federal Communications Commission
FEC	Forward Error Correction
FIS	Flight Information Services
FS	Fast Select
GDTE	Ground Data Terminating Equipment
GFI	General Format Identifier
GHz	gigahertz
GNI	Ground Network Interface
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GS	Ground Station
GSE	Ground Station Emulator
GS1	Ground Station 1
GS2	Ground Station 2
GSx	Ground Station x
HLE	Higher Layer Entity
Hz	Hertz
Hz/s	Hertz per Second
ICAO	International Civil Aviation Organization
ID	Identification
IP3	3rd order Intercept point
IS	Intermediate System
I/S	Interference to Signal ratio
ISO	International Standards Organization
ITU	International Telecommunications Union
kHz	kilohertz
LBAC	Logical Burst Access Channel
LBPTT	Listen-Before-Push-To-Talk
LCR	Link Connection Refused
LDMITT	Lower Data/Management Interface Test Tool
LME	Link Management Entity
LPM	Link Parameter Modification
LREF	Local Reference
LT	Lower Tester
M burst	Management burst
MAC	Media Access Control
MASPS	Minimum Aviation System Performance Standards

MbB	Make-before-Break
MHz	megahertz
MOPS	Minimum Operational Performance Standards
MOS	Mean Opinion Score
μsec	microsecond
μWatt	microwatt
ms	millisecond
MTU	Maximum Transmission Unit
NIST	National Institute of Standards and Technology
nmi	nautical miles
NSAP	Network Service Access Point
NTV	Network Type Value
nW	nanowatt
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
PLP	Packet Level Protocol
ppm	parts per million
PR	Packet Received
PS	Packet Sent
PTT	Push-To-Talk
QOS	Quality of Service
RACK	Reservation Request Acknowledgment
RF	Radio Frequency
RFI	Radio Frequency Interference
rms	root mean square
RSP	Response
RTCA	RTCA, Inc.
SARPs	Standards and Recommended Practices (ICAO)
SN	Sequence Number
SNAcP	Subnetwork Access Protocol
SNDCF	Subnetwork Dependent Convergence Function
SUT	System Under Test
SVC	Switched Virtual Circuit
TC	Temporary Channel number
TDMA	Time Division Multiple Access
TP4	Transport Protocol Class 4
TPDU	Transport Protocol Data Unit
TRP	Timing Reference Point
TS	Timing State
UDMITT	Upper Data/Management Interface Test Tool
UDR	Urgent Downlink Request
UL	Uplink
UT	Upper Tester

V/D	Voice or Data
VDL	VHF Digital Link
VDR	VHF Digital Radio (VDL Mode 3 capable)
VER	Version number of 8208 compression
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
XID	Exchange Identifier

APPENDIX B

REQUIREMENT CROSS REFERENCE MATRICES: VERIFICATION TESTING AND EQUIPMENT CLASSES

Normative Appendix

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Table B-1 contains the MOPS environmental condition requirements cross reference to verification testing and equipment classes. Table B-2 contains the MOPS standard condition requirements cross reference to verification testing and equipment classes. For the purpose of traceability, these tables assume that the division between architecture SL and SU equipment is as defined in Appendix C. In the Table, X indicates that this requirement is applicable and the specified test should be performed to qualify the indicated class of equipment as MOPS-compliant. A blank entry indicates that the tests of the indicated paragraph need not be performed to qualify the indicated class of equipment as MOPS-compliant. An entry of O indicates that the requirement is associated with the optional 3T configuration and needs to be performed only if the manufacturers choose to qualify the equipment for the option.

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Table B-1: Traceability Matrix For Environmental Conditions

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)	MOPS (DO-271C)	Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
PHYSICAL LAYER											
Physical Layer System Level Attributes											
Magnetic Effect - XCVR in Receive Mode	2.3.1	N/A	N/A	15.0	X	X	X	X	X		
Magnetic Effect - XCVR in Transmit Mode	2.3.1	N/A	N/A	15.0	X	X	X	X	X		
Emission of Radio Frequency - XCVR in Receive Mode	2.3.1	N/A	N/A	21.0	X	X	X	X	X		
Emission of Radio Frequency - XCVR in Transmit Mode	2.3.1	N/A	N/A	21.0	X	X	X	X	X		
Receive to Transmit Turnaround Time during:											
• Low and High Temperature	2.2.1.1.4 and 2.3.1	3.3.1.6.1	2.4.4.3.1	4.5.1 and 4.5.3	X	X	X	X	X		
Transmit to Receive Turnaround Time during:											
• Low and High Temperature	2.2.1.1.5 and 2.3.1	3.3.1.6.2	2.4.4.3.2	4.5.1 through 4.5.4	X	X	X	X	X		
Receiver Attributes											
Sensitivity during											
• Low and High Temperature	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	4.5.1 through 4.5.4	X	X	X	X	X		
• Altitude	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	5.0	X	X	X	X	X		
• Humidity	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	6.0	X	X	X	X	X		
• Shock	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	7.0	X	X	X	X	X		
• Vibration	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	14.0	X	X	X	X	X		
• Power Input (Normal and Abnormal)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	16.5.1 through 16.5.4	X	X	X	X	X		
• Voltage Spike	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	18.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)	MOPS (DO-271C)	Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
• Induced Signal Susceptibility	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	19.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	25.0	X	X	X	X	X		
Adjacent Channel Rejection during:											
• Low and High Temperature	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	4.5.1 and 4.5.3	X	X	X	X	X		
• Altitude	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	5.0	X	X	X	X	X		
• Humidity	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	6.0	X	X	X	X	X		
• Shock	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	7.0	X	X	X	X	X		
• Vibration	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	14.0	X	X	X	X	X		
• Power Input (Normal)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	16.5.1 and 16.5.2	X	X	X	X	X		
• Voltage Spike	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	18.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	25.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	**MASPS (DO-224B)**	**MOPS (DO-271C)**	**Enviro Cond (DO-160D)**	**IB0**	**IV0**	**ID1**	**ID2**	**SL0**	**SU1**	**SU2**
Receiver Performance in the Presence of Strong Signals Within the VHF Aeronautical Band during:											
• Low and High Temperature	2.2.1.2.3 and 2.3.1	N/A	2.4.4.1.3	4.5.1 and 4.5.3	X	X	X	X	X		
Receiver Performance in the Presence of Strong Signals Outside the VHF Aeronautical Band during:											
• Low and High Temperature	2.2.1.2.4 and 2.3.1	N/A	2.4.4.1.4	4.5.1 and 4.5.3	X	X	X	X	X		
Desired Signal Dynamic Range during:											
• Low Temperature	2.2.1.2.5 and 2.3.1	N/A	2.4.4.1.5	4.5.1	X	X	X	X	X		
Symbol Rate Capture Range during:											
• Low and High Temperature	2.2.1.2.6 and 2.3.1	N/A	2.4.4.1.6	4.5.1 and 4.5.3	X	X	X	X	X		
Frequency Capture Range during:											
• Temperature Variation	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	5.0	X	X	X	X	X		
• Vibration	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	8.0	X	X	X	X	X		
• Power Input (Normal)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	16.5.1 and 16.5.2	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	18.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	25.0	X	X	X	X	X		
Transmitter Attributes											
Bit Rate during:											
• Low and High Temperature	2.2.1.3.1 and 2.3.1	N/A	2.4.4.2.1	4.5.1 and 4.5.3	X	X	X	X	X		
• Temperature Variation	2.2.1.3.1 and 2.3.1	N/A	2.4.4.2.1	5.0	X	X	X	X	X		
RF Output Power during:											
• Low and High Temperature	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	4.5.1 through 4.5.4	X	X	X	X	X		
• Altitude	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	5.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)	MOPS (DO-271C)	Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
• Humidity	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	6.0	X	X	X	X	X		
• Shock	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	7.0	X	X	X	X	X		
• Vibration	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	14.0	X	X	X	X	X		
• Power Input (Normal and Abnormal)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	16.5.1 through 16.5.4	X	X	X	X	X		
• Voltage Spike	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	19.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	25.0	X	X	X	X	X		
RF Power Rise Time during:											
• Low and High Temperature	2.2.1.3.3 and 2.3.1	N/A	2.4.4.2.3	4.5.1 and 4.5.3	X	X	X	X	X		
Symbol Constellation Error during:											
• Low and High Temperature	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	4.5.1 through 4.5.4	X	X	X	X	X		
• Altitude	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	5.0	X	X	X	X	X		
• Humidity	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	6.0	X	X	X	X	X		
• Shock	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	7.0	X	X	X	X	X		
• Vibration	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	10.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)	MOPS (DO-271C)	Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
• Fluids Susceptibility (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	14.0	X	X	X	X	X		
• Power Input (Normal and Abnormal)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	16.5.1 through 16.5.4	X	X	X	X	X		
• Voltage Spike	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	19.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	25.0	X	X	X	X	X		
Spurious Emissions during:											
• Low and High Temperature	2.2.1.3.6 and 2.3.1	N/A	2.4.4.2.6	4.5.1 and 4.5.3	X	X	X	X	X		
Adjacent Channel Power during:											
• Low and High Temperature	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	4.5.1 through 4.5.4	X	X	X	X	X		
• Altitude	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	5.0	X	X	X	X	X		
• Humidity	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	6.0	X	X	X	X	X		
• Shock	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	7.0	X	X	X	X	X		
• Vibration	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	14.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	**MASPS (DO-224B)**	**MOPS (DO-271C)**	**Enviro Cond (DO-160D)**	**IB0**	**IV0**	**ID1**	**ID2**	**SL0**	**SU1**	**SU2**
• Power Input (Normal)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	16.5.1 and 16.5.2	X	X	X	X	X		
• Voltage Spike	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	19.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	25.0	X	X	X	X	X		
Frequency Tolerance during:											
• Low and High Temperature	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	4.5.1 and 4.5.3	X	X	X	X	X		
•											
• Vibration	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	8.0	X	X	X	X	X		
• Power Input (Normal)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	16.5.1 and 16.5.2	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	19.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	25.0	X	X	X	X	X		
Layers above the Physical Layer											
• End-to-end Voice	2.3.1	3.3.5	2.4.5.4.1	See Tables 2-2 and 2-3	X	X	X	X	X		
• End-to-end Data (ISO 8208)	2.3.1	3.3.2, 3.3.4, Appendix J	2.4.5.10.1.2	See Tables 2-2 and 2-3			X			X	

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement MOPS (DO-271C)	Requirement MASPS (DO-224B)	Verification Test MOPS (DO-271C)	Verification Test Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
• End-to-end Data (CLNP)	2.3.1	3.3.2, 3.3.4, Appendix K	2.4.5.11.2.1	See Tables 2-2 and 2-3				X			X

Requirement Description	Requirement MOPS (DO-271C)	Requirement MASPS (DO-224B)	Verification Test MOPS (DO-271C)	Verification Test Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
PHYSICAL LAYER											
Physical Layer System Level Attributes											
Magnetic Effect - XCVR in Receive Mode	2.3.1	N/A	N/A	15.0	X	X	X	X	X		
Magnetic Effect - XCVR in Transmit Mode	2.3.1	N/A	N/A	15.0	X	X	X	X	X		
Emission of Radio Frequency - XCVR in Receive Mode	2.3.1	N/A	N/A	21.0	X	X	X	X	X		
Emission of Radio Frequency - XCVR in Transmit Mode	2.3.1	N/A	N/A	21.0	X	X	X	X	X		
Receive to Transmit Turnaround Time during:											
• Low and High Temperature	2.2.1.1.4 and 2.3.1	3.3.1.6.1	2.4.4.3.1	4.5.1 and 4.5.3	X	X	X	X	X		
Transmit to Receive Turnaround Time during:											
• Low and High Temperature	2.2.1.1.5 and 2.3.1	3.3.1.6.2	2.4.4.3.2	4.5.1 through 4.5.4	X	X	X	X	X		
Receiver Attributes											
Sensitivity during											
• Low and High Temperature	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	4.5.1 through 4.5.4	X	X	X	X	X		
• Altitude	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	5.0	X	X	X	X	X		
• Humidity	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	6.0	X	X	X	X	X		
• Shock	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	7.0	X	X	X	X	X		
• Vibration	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	14.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	**MASPS (DO-224B)**	**MOPS (DO-271C)**	**Enviro Cond (DO-160D)**	**IB0**	**IV0**	**ID1**	**ID2**	**SL0**	**SU1**	**SU2**
• Power Input (Normal and Abnormal)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	16.5.1 through 16.5.4	X	X	X	X	X		
• Voltage Spike	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	19.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.2.1 and 2.3.1	N/A	2.4.4.1.1	25.0	X	X	X	X	X		
Adjacent Channel Rejection during:											
• Low and High Temperature	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	4.5.1 and 4.5.3	X	X	X	X	X		
• Altitude	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	5.0	X	X	X	X	X		
• Humidity	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	6.0	X	X	X	X	X		
• Shock	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	7.0	X	X	X	X	X		
• Vibration	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	14.0	X	X	X	X	X		
• Power Input (Normal)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	16.5.1 and 16.5.2	X	X	X	X	X		
• Voltage Spike	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	18.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	22.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)	MOPS (DO-271C)	Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
• Lightning Direct Effects (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.2.2 and 2.3.1	N/A	2.4.4.1.2	25.0	X	X	X	X	X		
Receiver Performance in the Presence of Strong Signals Within the VHF Aeronautical Band during:											
• Low and High Temperature	2.2.1.2.3 and 2.3.1	N/A	2.4.4.1.3	4.5.1 and 4.5.3	X	X	X	X	X		
Receiver Performance in the Presence of Strong Signals Outside the VHF Aeronautical Band during:											
• Low and High Temperature	2.2.1.2.4 and 2.3.1	N/A	2.4.4.1.4	4.5.1 and 4.5.3	X	X	X	X	X		
Desired Signal Dynamic Range during:											
• Low Temperature	2.2.1.2.5 and 2.3.1	N/A	2.4.4.1.5	4.5.1	X	X	X	X	X		
Symbol Rate Capture Range during:											
• Low and High Temperature	2.2.1.2.6 and 2.3.1	N/A	2.4.4.1.6	4.5.1 and 4.5.3	X	X	X	X	X		
Frequency Capture Range during:											
• Temperature Variation	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	5.0	X	X	X	X	X		
• Vibration	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	8.0	X	X	X	X	X		
• Power Input (Normal)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	16.5.1 and 16.5.2	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	18.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.2.7 and 2.3.1	N/A	2.4.4.1.7	25.0	X	X	X	X	X		
Transmitter Attributes											
Bit Rate during:											
• Low and High Temperature	2.2.1.3.1 and 2.3.1	N/A	2.4.4.2.1	4.5.1 and 4.5.3	X	X	X	X	X		
• Temperature Variation	2.2.1.3.1 and 2.3.1	N/A	2.4.4.2.1	5.0	X	X	X	X	X		
RF Output Power during:											
• Low and High Temperature	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	4.5.1 through 4.5.4	X	X	X	X	X		
• Altitude	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	4.6.1	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)	MOPS (DO-271C)	Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
• Decompression (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	5.0	X	X	X	X	X		
• Humidity	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	6.0	X	X	X	X	X		
• Shock	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	7.0	X	X	X	X	X		
• Vibration	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	14.0	X	X	X	X	X		
• Power Input (Normal and Abnormal)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	16.5.1 through 16.5.4	X	X	X	X	X		
• Voltage Spike	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	19.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.3.2 and 2.3.1	N/A	2.4.4.2.2	25.0	X	X	X	X	X		
RF Power Rise Time during:											
• Low and High Temperature	2.2.1.3.3 and 2.3.1	N/A	2.4.4.2.3	4.5.1 and 4.5.3	X	X	X	X	X		
Symbol Constellation Error during:											
• Low and High Temperature	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	4.5.1 through 4.5.4	X	X	X	X	X		
• Altitude	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	5.0	X	X	X	X	X		
• Humidity	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	6.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)	MOPS (DO-271C)	Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
• Shock	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	7.0	X	X	X	X	X		
• Vibration	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	11.0	X	X	X	X	X		
• Sand and Dust (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	14.0	X	X	X	X	X		
• Power Input (Normal and Abnormal)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	16.5.1 through 16.5.4	X	X	X	X	X		
• Voltage Spike	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	19.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.3.5 and 2.3.1	N/A	2.4.4.2.5	25.0	X	X	X	X	X		
Spurious Emissions during:											
• Low and High Temperature	2.2.1.3.6 and 2.3.1	N/A	2.4.4.2.6	4.5.1 and 4.5.3	X	X	X	X	X		
Adjacent Channel Power during:											
• Low and High Temperature	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	4.5.1 through 4.5.4	X	X	X	X	X		
• Altitude	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	4.6.1	X	X	X	X	X		
• Decompression (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	4.6.2	X	X	X	X	X		
• Overpressure (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	4.6.3	X	X	X	X	X		
• Temperature Variation	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	5.0	X	X	X	X	X		
• Humidity	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	6.0	X	X	X	X	X		
• Shock	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	7.0	X	X	X	X	X		
• Vibration	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	8.0	X	X	X	X	X		
• Waterproof (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	10.0	X	X	X	X	X		
• Fluids Susceptibility (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	11.0	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	**MASPS (DO-224B)**	**MOPS (DO-271C)**	**Enviro Cond (DO-160D)**	**IB0**	**IV0**	**ID1**	**ID2**	**SL0**	**SU1**	**SU2**
• Sand and Dust (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	12.0	X	X	X	X	X		
• Fungus Resistance (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	13.0	X	X	X	X	X		
• Salt Spray (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	14.0	X	X	X	X	X		
• Power Input (Normal)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	16.5.1 and 16.5.2	X	X	X	X	X		
• Voltage Spike	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	17.0	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	19.0	X	X	X	X	X		
• Radio Frequency Susceptibility (Radiated and Conducted)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	20.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.3.7 and 2.3.1	N/A	2.4.4.2.7	25.0	X	X	X	X	X		
Frequency Tolerance during:											
• Low and High Temperature	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	4.5.1 and 4.5.3	X	X	X	X	X		
• Vibration	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	8.0	X	X	X	X	X		
• Power Input (Normal)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	16.5.1 and 16.5.2	X	X	X	X	X		
• Audio Frequency Conducted Susceptibility - Power Inputs	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	18.0	X	X	X	X	X		
• Induced Signal Susceptibility	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	19.0	X	X	X	X	X		
• Lightning Induced Transient Susceptibility (if required)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	22.0	X	X	X	X	X		
• Lightning Direct Effects (if required)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	23.0	X	X	X	X	X		
• Icing (if required)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	24.0	X	X	X	X	X		
• Electrostatic Discharge (ESD) (if required)	2.2.1.3.10 and 2.3.1	N/A	2.4.4.2.10	25.0	X	X	X	X	X		
Layers above the Physical Layer											
• End-to-end Voice	2.3.1	3.3.5	2.4.5.4.1	See Tables 2-2 and 2-	X	X	X	X	X		

Table B-1: Traceability Matrix For Environmental Conditions (Continued)

Requirement Description	Requirement		Verification Test		Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)	MOPS (DO-271C)	Enviro Cond (DO-160D)	IB0	IV0	ID1	ID2	SL0	SU1	SU2
				3							
• End-to-end Data (ISO 8208)	2.3.1	3.3.2, 3.3.4, Appendix J	2.4.5.10.1.2	See Tables 2-2 and 2-3			X			X	
• End-to-end Data (CLNP)	2.3.1	3.3.2, 3.3.4, Appendix K	2.4.5.11.2.1	See Tables 2-2 and 2-3				X			X

Table B-2: Traceability Matrix For Standard Conditions

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
PHYSICAL LAYER FUNCTIONS										
Sensitivity	2.2.1.2.1	3.5.2, 3.6.1	2.4.4.1.1	X	X	X	X	X		
Adjacent Channel Rejection	2.2.1.2.2	N/A	2.4.4.1.2	X	X	X	X	X		
Receiver Performance in the Presence of Strong Signals Within the VHF Aeronautical Communications Band	2.2.1.2.3	N/A	2.4.4.1.3	X	X	X	X	X		
Receiver Performance in the Presence of Strong Signals Outside the VHF Aeronautical Communications Band	2.2.1.2.4	N/A	2.4.4.1.4	X	X	X	X	X		
Desired Signal Dynamic Range	2.2.1.2.5	N/A	2.4.4.1.5	X	X	X	X	X		
Symbol Rate Capture Range	2.2.1.2.6	N/A	2.4.4.1.6	X	X	X	X	X		
Frequency Capture Range	2.2.1.2.7	N/A	2.4.4.1.7	X	X	X	X	X		
Phase Acceleration	2.2.1.2.8	N/A	2.4.4.1.8	X	X	X	X	X		
Conducted Spurious Emission	2.2.1.2.10	N/A	2.4.4.1.10	X	X	X	X	X		
FM Broadcast Intermodulation	2.2.1.2.11	N/A	2.4.4.1.11	X	X	X	X	X		
In-Band Intermodulation	2.2.1.2.12	N/A	2.4.4.1.12	X	X	X	X	X		
Functions	2.2.1	3.3.1.1	Summary							
Transceiver Frequency Control	2.2.1.1.1	3.3.1.1.1	Test 1-9		X	X	X	X		
Data Reception by the Transceiver or Receiver	2.2.1	3.3.1.1.2	Test 4-6			X	X	X		
Data Transmission by the Transceiver or Transmitter	2.2.1	3.3.1.1.3	Test 4-5			X	X	X		
Notification Services	N/A	3.3.1.1.4	2.4.4.3.4	X	X	X	X	X		
Modulation Scheme	2.2.1.1.2	3.3.1.2	2.4.4.1.1	X	X	X	X	X		
Data Encoding	2.2.1	3.3.1.2.1	Test 13-2b	X						
			Test 2-2		X	X	X	X		
Transmitted Signal Form	2.2.1	3.3.1.2.2	2.4.4.2.5	X	X	X	X	X		
Modulation Rate (Channel Bit Rate)	2.2.1.3.1	3.3.1.2.3	2.4.4.2.1	X	X	X	X	X		
Emission Designator	N/A	3.3.1.2.4	Not a Requirement							
Pulse Shaping Filters	2.2.1	3.3.1.2.5	2.4.4.2.5, 2.4.4.2.7	X	X	X	X	X		
Time Division Multiple Access (TDMA) Time Slot Bursts	N/A	3.3.1.3	Not a Requirement							
Management (M) Burst and Handoff Check Message (H) Uplink	2.2.1	3.3.1.3.1	Test 1-2a		X	X	X	X		
			Test 13-1a	X						
			Test 5-1		O	O	O	O		
Training Sequence	2.2.1	3.3.1.3.1.1	Test 1-2a		X	X	X	X		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
			Test 13-1a	X						
			Test 5-1		O	O	O	O		
Transmitter Ramp-Up and Power Stabilization	2.2.1.3.3	3.3.1.3.1.1.1	Test 1-2a		X	X	X	X		
			Test 13-1a	X						
			Test 5-1		O	O	O	O		
Synchronization and Ambiguity Resolution	2.2.1	3.3.1.3.1.1.2	Tests 1-2a, 1-9		X	X	X	X		
			Test 13-1a	X						
			Test 5-1		O	O	O	O		
System Data and Handoff Check Message	2.2.1	3.3.1.3.1.2	Test 1-2a		X	X	X	X		
			Test 13-1a	X						
			Test 5-1		O	O	O	O		
Transmitter Ramp-Down	2.2.1.3.4	3.3.1.3.1.3	Test 1-2a		X	X	X	X		
			Test 13-1a	X						
			Test 5-1		O	O	O	O		
Management (M) Burst Downlink	2.2.1	3.3.1.3.2	Test 13-1a	X						
			Test 1-2a		X	X	X	X		
Training Sequence	2.2.1	3.3.1.3.2.1	Test 13-1a	X						
			Test 1-2a		X	X	X	X		
Transmitter Ramp-Up and Power Stabilization	2.2.1.3.3	3.3.1.3.2.1.1	2.4.4.2.3	X	X	X	X	X		
Synchronization and Ambiguity Resolution	2.2.1	3.3.1.3.2.1.2	Test 13-1a	X						
			Tests 2-10, 1-2a, 1-2c		X	X	X	X		
System Data	2.2.1	3.3.1.3.2.2	Test 13-1a	X						
			Test 1-2a		X	X	X	X		
Transmitter Ramp-Down	2.2.1.3.4	3.3.1.3.2.3	2.4.4.2.4	X	X	X	X	X		
Voice or Data (V/D) Burst	2.2.1	3.3.1.3.3	Test 13-2b	X						
			Test 2-2		X	X	X	X		
			Test 4-5			X	X	X		
Training Sequence	2.2.1	3.3.1.3.3.1	Test 13-2b	X						
			Test 2-2		X	X	X	X		
Transmitter Ramp-Up and Power Stabilization	2.2.1.3.3	3.3.1.3.3.1.1	2.4.4.2.3	X	X	X	X	X		
Synchronization and Ambiguity Resolution	2.2.1	3.3.1.3.3.1.2	Tests 13-2a, 13-2b	X						
			Tests 2-1, 2-2		X	X	X	X		
Header	2.2.1	3.3.1.3.3.2	13-2b	X						
			Test 2-2		X	X	X	X		
			Test 4-5			X	X	X		
User Information	2.2.1	3.3.1.3.3.3	Test 13-2b	X						
			Test 2-2		X	X	X	X		
			Test 4-5			X	X	X		
Transmit Ramp-Down	2.2.1.3.4	3.3.1.3.3.4	2.4.4.2.4	X	X	X	X	X		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	**MASPS (DO-224B)**		**IB0**	**IV0**	**ID1**	**ID2**	**SL0**	**SU1**	**SU2**
Interleaving	2.2.1	3.3.1.4	Not implemented in VDL3							
Bit Scrambling	2.2.1	3.3.1.5	Tests 13-2a, 13-2b	X						
			Tests 2-1, 2-2		X	X	X	X		
			Tests 4-5, 4-6			X	X	X		
Transmit/Receive Turnaround Time	N/A	3.3.1.6	Header							
Receive to Transmit Turnaround Time	2.2.1.1.4	3.3.1.6.1	2.4.4.3.1	X	X	X	X	X		
Transmit to Receive Turnaround Time	2.2.1.1.5	3.3.1.6.2	2.4.4.3.2	X	X	X	X	X		
Transmission Characteristics	N/A	3.3.1.7	Header							
Carrier Frequencies	2.2.1.1.1	3.3.1.7.1	2.4.4.2.10	X	X	X	X	X		
Spurious Emissions	2.2.1.3.6	3.3.1.7.2	2.4.4.2.6	X	X	X	X	X		
Adjacent Channel Emissions	2.2.1.3.7	3.3.1.7.3	2.4.4.2.7	X	X	X	X	X		
(Reserved)	2.2.1.3.8	N/A	2.4.4.2.8							
Load VSWR Capability	2.2.1.3.9	N/A	2.4.4.2.6, 2.4.4.2.9	X	X	X	X	X		
Fringe Coverage	N/A	3.3.1.8	Header							
Recommendation	N/A	3.3.1.8.1	Not a Requirement							
Revised Physical Layer Requirements	2.2.1.4	N/A	Not a Requirement							
DATA LINK LAYER										
MAC Sublayer	2.2.2	3.3.2.1	Test 13-2b	X						
			Test 2-2		X	X	X	X		
			Test 4-1			X	X	X		
MAC Services		3.3.2.1.1	Header							
Multiple Access	2.2.2	3.3.2.1.1.1	Test 13-2b	X						
			Tests 2-2		X	X	X	X		
			Tests 4-1, 4-5, 4-6, 5-1 (O)			X	X	X		
Recommendation	N/A	3.3.2.1.1.1.1	Not a Requirement							
Channel Occupancy	2.2.2	3.3.2.1.1.2	Test 13-2b	X						
			Test 2-2		X	X	X	X		
			Test 4-5		X	X	X	X		
MAC Protocol Framework	N/A	3.3.2.1.2	Header							
Timing Structure	2.2.2	3.3.2.1.2.1	Test 13-2f	X						
			Test 2-6		X	X	X	X		
			Test 4-2			X	X	X		
TDMA Frame	2.2.2	3.3.2.1.2.1.1	Test 13-2f	X						
			Test 2-6		X	X	X	X		
			Test 4-2			X	X	X		
Time Slot	2.2.2	3.3.2.1.2.1.2	Test 13-2f	X						
			Test 2-6		X	X	X	X		
			Test 4-2			X	X	X		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
Timing Accuracy (Timing State 1)	2.2.1	3.3.2.1.2.1.2.1	Test 13-3a	X						
			Test 3-1		X	X	X	X		
Timing Accuracy (Timing State 2 or 3)	2.2.1	3.3.2.1.2.1.2.2	Test 3-4		X	X	X	X		
			Test 13-3d	X						
Bursts	2.2.2	3.3.2.1.2.1.3	Test 13-2f	X						
			Tests 2-6		X	X	X	X		
			Tests 4-2			X	X	X		
Epoch	N/A	3.3.2.1.2.1.4	GS requirement							
External Time Reference Interface	N/A	3.3.2.1.2.1.5	GS requirement							
System Data and Header Field Formats	2.2.2	3.3.2.1.2.2	Tests 13-2a, 13-2b	X						
			Tests 2-1, 2-2, 1-2a, 2-10		X	X	X	X		
			Tests 4-5, 4-6			X	X	X		
User Groups	2.2.2	3.3.2.1.2.3	Tests 13-1a, 13-2a	X						
			Tests 1-1, 2-1		X	X	X	X		
System Configurations	2.2.2	3.3.2.1.2.4	Tests 13-1a, 13-2a, 13-4a	X						
			Tests 1-1, 2-1, 5-1 (O), 6-1, 7-1		X	X	X	X		
Media Access Control Cycle	2.2.2	3.3.2.1.2.5	Test 13-2f	X						
			Tests 2-6		X	X	X	X		
			Test 4-2			X	X	X		
Logical Burst Access Channels	2.2.2	3.3.2.1.2.5.1	Test 13-3a	X						
			Tests 3-1, 7-1		X	X	X	X		
			Test 4-2			X	X	X		
Burst Access Timing	2.2.2	3.3.2.1.2.5.2	Tests 13-2f, 13-3a, 13-3d, 13-4b	X						
			Tests 2-6, 3-1, 3-4, 4-2, 5-4 (O), 6-2		X	X	X	X		
			Test 4-2			X	X	X		
Access Rules for M Downlink	2.2.2	3.3.2.1.2.5.3	Test 13-1a	X						
			Tests 1-2, 1-9, 2-6, 4-3, 4-4, 4-6, 5-4 (O), 6-2, 7-1		X	X	X	X		
			Tests 4-3, 4-4, 4-6			X	X	X		
Aircraft MAC Service System Parameters	2.2.2	3.3.2.1.3	Summary Requirement							
Parameter t (Truncation)	2.2.2	3.3.2.1.3.1	Tests 13-3d, 13-3e	X						
			Tests 3-4, 3-5		X	X	X	X		
Validity Window	2.2.2	3.3.2.1.3.1.1	Test 13-3b	X						
			Test 3-2		X	X	X	X		
Receipt of Beacon Information	2.2.2	3.3.2.1.3.1.2	Test 13-3c	X						
			Test 3-3		X	X	X	X		
Parameter f (Free Running)	2.2.2	3.3.2.1.3.2	Test 13-3d, 13-3e	X						
			Test 3-4, 3-5		X	X	X	X		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	**MASPS (DO-224B)**		**IB0**	**IV0**	**ID1**	**ID2**	**SL0**	**SU1**	**SU2**
Parameter NM1 (Maximum Retry)	2.2.2	3.3.2.1.3.3	Test 4-3			X	X	X		
Parameter RR (Reservation Request Randomizer)	2.2.2	3.3.2.1.3.4	Test 4-3			X	X	X		
Parameter RE (Net Entry Request Randomizer)	2.2.2	3.3.2.1.3.5	Test 1-3		X	X	X	X		
Parameter RL (Leaving Net Randomizer)	2.2.2	3.3.2.1.3.6	Test 1-9		X	X	X	X		
Parameter WR (Reservation Request Retransmission Delay)	2.2.2	3.3.2.1.3.7	Test 4-3			X	X	X		
Description of Procedures	2.2.2	3.3.2.1.4	Summary Requirement							
Timing Acquisition and Maintenance	N/A	3.3.2.1.4.1	Header							
Primary Timing Reference	2.2.2	3.3.2.1.4.1.1	Test 13-3a	X						
			Test 3-1		X	X	X	X		
Alternate Timing Reference	2.2.2	3.3.2.1.4.1.2	Test 13-3d	X						
			Test 3-4		X	X	X	X		
Coast Timing Counters	2.2.2	3.3.2.1.4.1.3	Tests 13-3a, 13-3d	X						
			Tests 3-1, 3-4		X	X	X	X		
Timing States	2.2.2	3.3.2.1.4.1.4	Tests 13-3d	X						
			Tests 3-4		X	X	X	X		
Recommendation	2.2.2	3.3.2.1.4.1.4.1	Not a Requirement							
Timing State Transitions	2.2.2	3.3.2.1.4.1.5	Test 13-2b, 13-3d	X						
			Test 2-2, 3-4, 3-5		X	X	X	X		
Tuning to Invalid Channel – TS1	2.2.2	3.3.2.1.4.1.5.1	Test 13-2b, 13-3e	X						
			Test 2-2, 3-5		X	X	X	X		
Tuning to Invalid Channel – TS2/TS3	2.2.2	3.3.2.1.4.1.5.2	Test 13-2b, 13-3f	X						
			Test 2-2, 3-6		X	X	X	X		
Dummy Poll Responses	2.2.2	3.3.2.1.4.1.6	Test 13-1a	X						
			Test 1-1		X	X	X	X		
Voice Operation Support	2.2.2	3.3.2.1.4.2	Tests 13-2, 13-3d, 13-4a	X						
			Tests 2-1, 2-2, 2-3, 2-5, 3-4, 5-1 (O), 5-3 (O), 6-1		X	X	X	X		
Voice Access Channel Contention	2.2.2	3.3.2.1.4.2.1	Tests 13-2b, 13-2c	X						
			Tests 2-2, 2-3		X	X	X	X		
User Notification	2.2.2	3.3.2.1.4.2.2	Test 13-5	X						
			Test 12-1		X	X	X	X		
Free Running Voice Operation	2.2.2	3.3.2.1.4.2.3	Test 13-3d	X						
			Test 3-4		X	X	X	X		
Link Management Support	N/A	3.3.2.1.4.3	Header							
Polling	2.2.2	3.3.2.1.4.3.1	Test 1-2		X	X	X	X		
Net Entry Request Message	2.2.2	3.3.2.1.4.3.2	Test 1-2		X	X	X	X		
Next Net Message	2.2.2	3.3.2.1.4.3.3	Test 1-9		X	X	X	X		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
Leaving Net Message	2.2.2	3.3.2.1.4.3.4	Test 1-9		X	X	X	X		
Tuning to Next Net	2.2.2	3.3.2.1.4.3.4.1	Test 1-9		X	X	X	X		
Maximum Leaving Net Delay	2.2.2	3.3.2.1.4.3.4.2	Test 1-9		X	X	X	X		
Terminate Net Message	2.2.2	3.3.2.1.4.3.5	Test 4-14		X	X	X	X		
Supported Options Message	2.2.2	3.3.2.1.4.3.6	Tests 2-10		X	X	X	X		
RESERVED (Formerly Multiple Radio Operation)	N/A	3.3.2.1.4.3.7	N/A							
Data Operation Support	N/A	3.3.2.1.4.4	Header							
Segmentation Function	2.2.2	3.3.2.1.4.4.1	Tests 4-5, 4-6			X	X	X		
Uplink Data Transfer	N/A	3.3.2.1.4.4.2	GS requirement							
Acknowledgement Protocol	2.2.2	3.3.2.1.4.4.2.1	Tests 4-6			X	X	X		
Downlink Data Transfer	N/A	3.3.2.1.4.4.3	Header							
Data Transfer	2.2.2	3.3.2.1.4.4.3.1	Test 4-11			X	X	X		
Assemble Message for MAC Data Transfer	2.2.2	3.3.2.1.4.4.3.2	Tests 4-3, 4-4, 4-5			X	X	X		
Request a Reservation	N/A	3.3.2.1.4.4.3.3	Header							
Reservation via Slotted Aloha Random Access	2.2.2	3.3.2.1.4.4.3.3 .1	Tests 4-3			X	X	X		
Reservation Request Acknowledgement	2.2.2	3.3.2.1.4.4.3.3 .2	Tests 4-3, 4-4			X	X	X		
Reservation via Poll Response	2.2.2	3.3.2.1.4.4.3.3 .3	Test 4-4			X	X	X		
Reservation Request Retransmission	2.2.2	3.3.2.1.4.4.3.4	Tests 4-3, 4-4			X	X	X		
Reservation Confirmation Indication	2.2.2	3.3.2.1.4.4.3.5	Test 4-5			X	X	X		
Acknowledgement Protocol	2.2.2	3.3.2.1.4.4.3.6	Test 4-5			X	X	X	X	X
MAC Data Frame Transmission	2.2.2	3.3.2.1.4.5	Test 4-5			X	X	X		
Automated Handoff for 3T Configuration	2.2.2	3.3.2.1.4.6	Test 5-2		O	O	O	O		
Data Link Services (DLS) (VDL Mode 3)										
Services	2.2.2	3.3.2.2.1	Tests 4-5, 4-6			X	X	X	X	X
Error Detection	2.2.2	3.3.2.2.1.1	Tests 4-5, 4-6			X	X	X		
Address Identification	2.2.2	3.3.2.2.1.2	Tests 4-5, 4-6			X	X	X		
Address Uniqueness	2.2.2	3.3.2.2.1.2.1	Tests 4-5, 4-6			X	X	X		
Broadcast Addressing	2.2.2	3.3.2.2.1.2.2	Test 4-10			X	X	X		
Data Transfer	2.2.2	3.3.2.2.1.3	Tests 4-5, 4-6			X	X		X	X
VDL Mode 3 Data Link Service Protocol Specification		3.3.2.2.2	Not a Requirement							
Frame Format	2.2.2	3.3.2.2.2.1	Tests 4-5, 4-6			X	X		X	X
FCS/Aircraft Address Field	2.2.2	3.3.2.2.2.2	Tests 4-5, 4-6			X	X	X		
FCS/Aircraft Station Address	2.2.2	3.3.2.2.2.2.1	Tests 4-5, 4-6			X	X	X		
Address Type	2.2.2	3.3.2.2.2.2.2	Tests 4-5, 4-6			X	X	X		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
Link Control Field	2.2.2	3.3.2.2.2.3	Tests 4-5, 4-6			X	X		X	X
Frame Type	2.2.2	3.3.2.2.2.3.1	Tests 4-5, 4-6			X	X		X	X
Priority	2.2.2	3.3.2.2.2.3.2	Tests 4-7, 4-8, 4-9			X	X		X	X
More Frame	2.2.2	3.3.2.2.2.3.3	Tests 4-5, 4-6			X	X		X	X
Toggle	2.2.2	3.3.2.2.2.3.4	Test 4-5, 4-6			X	X		X	X
Data Control Field	2.2.2	3.3.2.2.2.4	Tests 4-5, 4-6			X	X		X	X
Ground Subnetwork Address Subfield	2.2.2	3.3.2.2.2.4.1	Tests 4-5, 4-6			X	X		X	X
Data Length Subfield	2.2.2	3.3.2.2.2.4.2	Tests 4-5, 4-6			X	X		X	X
Information Field	2.2.2	3.3.2.2.2.5	Tests 4-5, 4-6			X	X		X	X
Data Link Service System Parameters	2.2.2	3.3.2.2.3	Summary Requirement							
Timer T3 (Link Initialization Time)	2.2.2	3.3.2.2.3.1	Test 1-4			X	X		X	X
Parameter N1 (Maximum Frame Group Size)	2.2.2	3.3.2.2.3.2	Test 4-5			X	X		X	X
Description of Procedures	2.2.2	3.3.2.2.4	Summary Requirement							
Mode of Operation	N/A	3.3.2.2.4.1	Header							
Operational Mode	2.2.2	3.3.2.2.4.1.1	Tests 4-5, 4-6			X	X		X	X
Broadcast	2.2.2	3.3.2.2.4.2	Test 4-10			X	X		X	X
Information Transfer	N/A	3.3.2.2.4.3	Header							
Transmission Queue Management	2.2.2	3.3.2.2.4.3.1	Tests 4-7, 4-8, 4-9			X	X		X	X
Priority Processing	2.2.2	3.3.2.2.4.3.1.1	Tests 4-7, 4-8, 4-9			X	X		X	X
Recommendation for Frame Grouping	N/A	3.3.2.2.4.3.1.2	Not a requirement							
Frame Grouping	2.2.2	3.3.2.2.4.3.1.2.1	Test 4-5			X	X		X	X
Reception Acknowledgment	N/A	3.3.2.2.4.3.2	Header							
Acknowledged Frames	2.2.2	3.3.2.2.4.3.2.1	Test 4-5			X	X		X	X
Unacknowledged Frames	2.2.2	3.3.2.2.4.3.2.2	Test 4-10			X	X		X	X
Transmission Acknowledgment/Retransmission	2.2.2	3.3.2.2.4.3.3	Tests 4-5			X	X		X	X
Control Frame	2.2.2	3.3.2.2.4.4	Tests 1-2b, 1-4, 1-5			X	X		X	X
Control Command Frame	2.2.2	3.3.2.2.4.4.1	Tests 1-2b, 1-4, 1-5			X	X		X	X
Control Response Frame	2.2.2	3.3.2.2.4.4.2	Tests 1-2b, 1-4, 1-5			X	X		X	X
Mac-DLS Processing Delay	N/A	3.3.2.2.5	Header							
Aircraft MAC-DLS Processing Delays	2.2.2	3.3.2.2.5.1	Test 4-6			X	X	X	X	X
Downlink ACK Transmission Delay	2.2.2	3.3.2.2.5.2	Test 4-6			X	X	X	X	X
Uplink ACK Transmission Delay	N/A	3.3.2.2.5.3	GS requirement							
Downlink Data Transmission Delay	2.2.2	3.3.2.2.5.4	Test 4-5			X	X	X		
Link Management Entity (LME) Sublayer (VDL Mode 3)										
Services	2.2.2	3.3.2.3.1	Summary Requirement							
Operation Procedures	2.2.2	3.3.2.3.2	Summary Requirement							
Link Establishment	2.2.2	3.3.2.3.2.1	Summary Requirement							

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
Net Initialization	2.2.2	3.3.2.3.2.1.1	Tests 13-1a, 13-3e	X						
			Tests 1-1, 3-5		X	X	X	X		
Net Entry	2.2.2	3.3.2.3.2.1.2a	Tests 1-2a, 1-3, 7-2		X	X	X	X		
		3.3.2.3.2.1.2b	Tests 1-2b			X	X		X	X
Supported Options	2.2.2	3.3.2.3.2.1.2.1	Test 2-10		X	X	X	X		
Initial Link Negotiation	2.2.2	3.3.2.3.2.1.3	Tests 1-2b, 1-4			X	X		X	X
Air Initiation	2.2.2	3.3.2.3.2.1.3.1	Test 1-2b			X	X		X	X
General Ground Response	2.2.2	3.3.2.3.2.1.3.2	GS requirement							
Air Response	2.2.2	3.3.2.3.2.1.3.3	Test 1-2b			X	X		X	X
Exceptional Cases	N/A	3.3.2.3.2.1.3.4	Header							
Parameter Negotiation	2.2.2	3.3.2.3.2.1.3.4.1	Test 1-4			X	X		X	X
Unacceptable Parameters	2.2.2	3.3.2.3.2.1.3.4.2	Test 1-4			X	X		X	X
Incorrect Response	2.2.2	3.3.2.3.2.1.3.4.3	Test 1-4			X	X		X	X
Command Retransmission	2.2.2	3.3.2.3.2.1.3.4.4	Test 1-4			X	X		X	X
Response Retransmission	N/A	3.3.2.3.2.1.3.4.5	GS requirement							
Parameter Longevity	2.2.2	3.3.2.3.2.1.3.5	Test 1-4			X	X		X	X
Net Entry Parameter Applicability	2.2.2	3.3.2.3.2.1.3.5.1	Test 1-4			X	X		X	X
Previous Link Preserved	2.2.2	3.3.2.3.2.1.3.5.2	Test 1-4			X	X		X	X
Slot Selection (Configurations 3S and 2S1X)	2.2.2	3.3.2.3.2.2	Tests 13-4a, 13-4b	X						
			Tests 6-1, 6-2		X	X	X	X		
Link Modification	N/A	3.3.2.3.2.3	Header							
Description of LME Procedures	2.2.2	3.3.2.3.2.3.1	Test 1-5			X	X		X	X
Link Maintenance Procedures	2.2.2	3.3.2.3.2.3.2	Test 1-5			X	X		X	X
Addressed Link Parameter Modification	N/A	3.3.2.3.2.3.2.1	Header							
Ground Initiation	2.2.2	3.3.2.3.2.3.2.1.1	GS requirement							
General Aircraft Response	2.2.2	3.3.2.3.2.3.2.1.2	Test 1-5			X	X		X	X
Ground Acknowledgment	2.2.2	3.3.2.3.2.3.2.1.3	GS requirement							
Aircraft Initiation	2.2.2	3.3.2.3.2.3.2.1.4	Test 1-5			X	X		X	X

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	**MASPS (DO-224B)**		**IB0**	**IV0**	**ID1**	**ID2**	**SL0**	**SU1**	**SU2**
General Ground Response	2.2.2	3.3.2.3.2.3.2.1.5	Test 1-5			X	X		X	X
Air Response	2.2.2	3.3.2.3.2.3.2.1.6	Test 1-5			X	X		X	X
Broadcast Link Parameter Modification	N/A	3.3.2.3.2.3.2.2	Header							
Ground Initiation	2.2.2	3.3.2.3.2.3.2.2.1	GS requirement							
General Aircraft Response	2.2.2	3.3.2.3.2.3.2.2.2	Test 1-5			X	X		X	X
Parameter Longevity	2.2.2	3.3.2.3.2.3.2.3	Test 1-5			X	X		X	X
Net Entry Parameter Applicability	2.2.2	3.3.2.3.2.3.2.3.1	Test 1-5			X	X		X	X
Link Maintenance	2.2.2	3.3.2.3.2.4	Test 1-2c		X	X	X	X		
Recovery	2.2.2	3.3.2.3.2.5	Tests 1-6, 1-7, 1-8		X	X	X	X		
Polling System Configurations	2.2.2	3.3.2.3.2.5.1	Test 1-8		X	X	X	X		
Data-Capable System Configurations	2.2.2	3.3.2.3.2.5.2	Test 1-7			X	X		X	X
Missed Poll	2.2.2	3.3.2.3.2.5.3	Test 1-8		X	X	X	X		
Retransmission	2.2.2	3.3.2.3.2.5.4	Test 1-8		X	X	X	X		
Verification	2.2.2	3.3.2.3.2.5.5	Test 1-7			X	X		X	X
1V3D/1V2D System Configurations	2.2.2	3.3.2.3.2.5.6	Test 1-7			X	X		X	X
Link Release	N/A	3.3.2.3.2.6	Header							
Explicit Link Release	2.2.2	3.3.2.3.2.6.1	Test 1-9		X	X	X	X		
Implicit Link Release	2.2.2	3.3.2.3.2.6.2	Test 1-2c			X	X	X		
Handoff	N/A	3.3.2.3.2.7	Header							
Air-initiated Link Handoff	2.2.2	3.3.2.3.2.7.1	Tests1-9, 5-2 (O)		X	X	X	X		
Ground-initiated Link Handoff	2.2.2	3.3.2.3.2.7.2	Test 1-9		X	X	X	X		
Same GNI	2.2.2	3.3.2.3.2.7.3	Test 1-12			X	X	X	X	X
Different GNI	2.2.2	3.3.2.3.2.7.4	Test 1-12			X	X	X	X	X
Authentication	2.2.2	3.3.2.3.2.8	Header							
Signature Verification	2.2.2	3.3.2.3.2.8.1	Test 1-13			O	O		O	O
Unknown Authentication Type	2.2.2	3.3.2.3.2.8.2	Test 1-13			O	O		O	O
Authentication Type Mismatch	2.2.2	3.3.2.3.2.8.3	Test 1-13			O	O		O	O
Invalid Signature	2.2.2	3.3.2.3.2.8.4	Test 1-13			O	O		O	O
Link Management Frames	2.2.2	3.3.2.3.3	Tests 1-2a, 1-2c, 1-8, 1-9		X	X	X	X		
			Test 1-7			X	X	X	X	X
			Test 1-2b			X	X		X	X
M Burst Message Format	2.2.2	3.3.2.3.3.1	Tests 1-2a, 1-2c, 1-8, 1-9		X	X	X	X		
			Test 1-7			X	X	X	X	X
			Test 1-2b			X	X		X	X

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
LME Service System Parameters	2.2.2	3.3.2.3.3.2	Tests 1-2a, 1-2c, 1-3		X	X	X	X		
			Test 1-2b			X	X		X	X
RESERVED	2.2.2	3.3.2.3.3.2.1	N/A							
Counter NL2 (Polling Reply Counter)	2.2.2	3.3.2.3.3.2.2	Test 1-2c		X	X	X	X		
Timer TL3 (Disconnect Delay Timer)	N/A	3.3.2.3.3.2.3	GS requirement							
Timer TL4 (Polling Interval)	2.2.2	3.3.2.3.3.2.4	Test 1-2c		X	X	X	X		
Parameter WE (Net Entry Retransmission Delay)	2.2.2	3.3.2.3.3.2.5	Test 1-3		X	X	X	X		
Parameter NL5 (Multiple Radio Local Identifier Buffer)	2.2.2	3.3.2.3.3.2.6	GS requirement							
Parameter NL6 (Free Address Recovery)	2.2.2	3.3.2.3.3.2.7	GS requirement							
Exchange Identity (XID) Parameter Format	2.2.2	3.3.2.3.3.3	Tests 1-2b, 1-4, 1-5, 1-7			X	X		X	X
Public Parameters	N/A	3.3.2.3.3.3.1	Header							
General Public Parameters	2.2.2	3.3.2.3.3.3.1.1	Tests 1-4, 1-5			X	X		X	X
VDL Mode 3 Public Parameters	N/A	3.3.2.3.3.3.1.2	Header							
VDL Mode 3 Public Parameter Set Identifier	2.2.2	3.3.2.3.3.3.1.2.1	Tests 1-4, 1-5			X	X		X	X
Timer T1 (Delay Before Retransmission)	2.2.2	3.3.2.3.3.3.1.2.2	Tests 1-4, 1-5			X	X		X	X
Timer T_Ack (Maximum Delay Allowable for Acknowledgement)	N/A	3.3.2.3.3.3.1.2.3	GS requirement							
Private Parameters	2.2.2	3.3.2.3.3.3.2	Tests 1-4, 1-5			X	X		X	X
General Private Parameters	2.2.2	3.3.2.3.3.3.3	Tests 1-4, 1-5			X	X		X	X
General Purpose Information Private Parameters	2.2.2	3.3.2.3.3.3.3.1	Tests 1-4, 1-5			X	X		X	X
Aircraft-initiated Information Private Parameters	2.2.2	3.3.2.3.3.3.3.2	Tests 1-4, 1-5			X	X		X	X
VDL Mode 3 Private Parameters	N/A	3.3.2.3.3.3.4	Header							
General Purpose Information Private Parameters	2.2.2	3.3.2.3.3.3.4.1	Tests 1-4, 1-5			X	X		X	X
Private Parameter Set Identifier	2.2.2	3.3.2.3.3.3.4.1.1	Tests 1-4, 1-5			X	X		X	X
Algorithm Version Number Parameter	2.2.2	3.3.2.3.3.3.4.1.2	Tests 1-4, 1-5			X	X		X	X
Network Initialization Parameter	2.2.2	3.3.2.3.3.3.4.1.3	Tests 1-4, 1-5			X	X		X	X
Connection Check Parameter	2.2.2	3.3.2.3.3.3.4.1.4	Tests 1-4, 1-5			X	X		X	X
Version Parameter	2.2.2	3.3.2.3.3.3.4.1	Tests 1-4, 1-5			X	X		X	X

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
		.5								
Authentication Parameter	2.2.2	3.3.2.3.3.3.4.1.6	Tests 1-4, 1-5			X	X		X	X
Subnetwork User Data Parameter	2.2.2	3.3.2.3.3.3.4.1.7	Tests 1-4, 1-5			X	X		X	X
Assigned Altitude Parameter	2.2.2	3.3.2.3.3.3.4.1.8	Tests 1-4, 1-5,			X	X		X	X
Air-initiated Information Private Parameters	2.2.2	3.3.2.3.3.3.4.2	Tests 1-4, 1-5			X	X		X	X
Expedited Recovery Parameter	2.2.2	3.3.2.3.3.3.4.2.1	Tests 1-4, 1-5			X	X		X	X
t (Truncation) Parameter	2.2.2	3.3.2.3.3.3.4.2.2	Tests 1-4, 1-5			X	X		X	X
f (Free Running) Parameter	2.2.2	3.3.2.3.3.3.4.2.3	Tests 1-4, 1-5			X	X		X	X
Former-GNIp Parameter	2.2.3	3.3.2.3.3.3.4.2.4	Tests 1-4, 1-5			X	X		X	X
Ground-initiated Modification Private Parameters	N/A	3.3.2.3.3.3.4.3	GS requirement							
NM1 (Maximum Retry) Parameter	2.2.2	3.3.2.3.3.3.4.3.1	Tests 1-4, 1-5			X	X		X	X
RR (Reservation Request Randomizer) Parameter	2.2.2	3.3.2.3.3.3.4.3.2	Tests 1-4, 1-5			X	X		X	X
WR (Reservation Request Delay) Parameter	2.2.2	3.3.2.3.3.3.4.3.3	Tests 1-4, 1-5			X	X		X	X
RE (Net Entry Randomizer) Parameter	2.2.2	3.3.2.3.3.3.4.3.4	Tests 1-4, 1-5			X	X		X	X
RL (Leaving Net Randomizer) Parameter	2.2.2	3.3.2.3.3.3.4.3.5	Tests 1-4, 1-5			X	X		X	X
Timer T3 (Link Initialization Time) Parameter	2.2.2	3.3.2.3.3.3.4.3.6	Tests 1-4, 1-5			X	X		X	X
RESERVED	2.2.2	3.3.2.3.3.3.4.3.7	N/A							
Timer TL3 (Disconnect Delay Timer)	N/A	3.3.2.3.3.3.4.3.8	GS requirement							
Timer TL4 (Polling Interval)	2.2.2	3.3.2.3.3.3.4.3.9	Tests 1-4, 1-5			X	X		X	X
WE (Net Entry Request Delay) Parameter	2.2.2	3.3.2.3.3.3.4.3.10	Tests 1-4, 1-5			X	X		X	X
Operative_GNIp Parameter	2.2.2	3.3.2.3.3.3.4.3.11	Tests 1-4, 1-5			X	X		X	X

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
Aircraft_TMbB Parameter	2.2.2	3.3.2.3.3.3.4.3.12	Tests 1-4, 1-5			X	X		X	X
MbB_Operations-Permitted	2.2.2	3.3.2.3.3.3.4.3.13	Tests 1-4, 1-5			X	X		X	X
Ground-initiated Information Private Parameters	N/A	3.3.2.3.3.3.4.4	GS requirement							
Counter NL2 (Polling Reply) Parameter	2.2.2	3.3.2.3.3.3.4.4.1	GS requirement							
NL5 (Multiple Radio Local Identifier Buffer) Parameter	2.2.2	3.3.2.3.3.3.4.4.2	GS requirement							
NL6 (Free Address Recovery) Parameter	2.2.2	3.3.2.3.3.3.4.4.3	GS requirement							
SUBNETWORK LAYER PROTOCOL AND SERVICES (VDL MODE 3)										
Payload Identification	2.2.3	3.3.3.1	Test Group 9			X			X	
			Tests 8-2 to 8-8				X			X
Compression Signaling	2.2.3	3.3.3.2	Test Group 9			X			X	
			Tests 8-2 to 8-5				X			X
ISO 8208 Compression	2.2.3	3.3.3.2.1	Test Group 9			X			X	
CLNP Compression	2.2.3	3.3.3.2.2	Tests 8-1 to 8-8				X			X
Raw Payload Type	2.2.3	3.3.3.2.3	Tests 4-5, 4-6			X	X		X	X
ATN Frame Mode Payload Type	N/A	3.3.3.2.4	N/A							
Make_before_Break (MbB) Operation										
General Requirements	2.2.3	3.3.3.3.1	Tests 10-1, 10-2, 10-3			X	X		X	X
GNIp-Group Addressing	2.2.3	3.3.3.3.1.1	Tests 10-1, 10-2, 10-3			X	X		X	X
GNIp-Group Parameter Set	2.2.3	3.3.3.3.1.2	Tests 10-1, 10-2, 10-3			X	X		X	X
MbB Avionics Requirements	2.2.3	3.3.3.3.2	Tests 10-1, 10-2, 10-3			X	X		X	X
Initialization	2.2.3	3.3.3.3.2.1	Tests 10-1, 10-2, 10-3			X	X		X	X
Determining MbB Applicability in the Aircraft	2.2.3	3.3.3.3.2.2	Tests 10-1, 10-2, 10-3			X	X		X	X
Aircraft MbB Operation	2.2.3	3.3.3.3.2.3	Tests 10-1, 10-2, 10-3			X	X		X	X
GNIp Requirements	2.2.3	3.3.3.3.3	Tests 10-1, 10-2, 10-3			X	X		X	X
Determining MbB Applicability on the Ground	2.2.3	3.3.3.3.3.1	Tests 10-1, 10-2, 10-3			X	X		X	X
Compatibility with Aircraft not Requesting MbB Capability	2.2.3	3.3.3.3.3.2	Tests 10-1, 10-2, 10-3			X	X		X	X
Operative_GNIp Requirements	2.2.3	3.3.3.3.3.3	Tests 10-1, 10-2, 10-3			X	X		X	X
Former_GNIp Requirements	2.2.3	3.3.3.3.3.4	Tests 10-1, 10-2, 10-3			X	X		X	X
Recommended MbB Parameter Values	2.2.3	3.3.3.3.4	Tests 10-1, 10-2, 10-3			X	X		X	X
Router Interface Recommendation	N/A	3.3.3.4	Not a Requirement							
Subnetwork Interface Support	N/A	3.3.3.5	Header							
Aircraft Subnetwork Interface Support	2.2.3	3.3.3.5.1	Tests 4-5, 4-6			X	X		X	X

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
Ground Station Subnetwork Interface Support	2.2.3	3.3.3.5.2	GS Requirement							
Raw Subnetwork Interface Operation	N/A	3.3.3.6	Header							
Protocol Identifier	2.2.3	3.3.3.6.1	Tests 4-5, 4-6			X	X		X	X
Supported Protocols	2.2.3	3.3.3.6.2	Header							
ACARS over VDL3	2.2.3	3.3.3.6.2.1	Not a Requirement			O	O		O	O
Flight Information Service – Broadcast	2.2.3	3.3.3.6.2.2	Not a Requirement			O	O		O	O
Reserved for Testing	2.2.3	3.3.3.6.2.3	Not a Requirement							
VDL MODE 3 SNDCF INTRODUCTION										
VDLMode 3 SNDCF Introduction	2.2.3	3.3.4	Summary Requirement							
The ISO 8208 SNDCF Interface	2.2.3	3.3.4.1	Test Groups 9			X			X	
The Frame-Based SNDCF Interface	2.2.3	3.3.4.2	Test Groups 8				X			X
Frame-Based SNDCF Support for Broadcast and Unicast Network Packets	2.2.3	3.3.4.2.1	Tests 8-2, 8-3, 8-4				X			X
ATN Router Support	N/A	3.3.4.2.2	Header							
Join/Leave Events	2.2.3	3.3.4.2.2.1	Tests 1-12, 8-1				X			X
Payload Identification	2.2.3	3.3.4.2.2.2	Test 8-2, 8-3, 8-4, 8-5				X			X
Disposition of CLNP and ISH Packets	2.2.3	3.3.4.2.2.3	Test 8-4				X			X
ISH Packets	2.2.3	3.3.4.2.2.4	Test 8-2				X			X
CLNP Compression	2.2.3	3.3.4.2.2.5	Tests 8-3, 8-8				X			X
The ATN Frame Mode SNDCF	N/A	3.3.4.3	N/A							
Subnetwork Interface Support	2.2.3.1	N/A	Header							
Aircraft Subnetwork Interface Support	2.2.3.1.1	N/A	Tests 8-2, 4-5, 4-6 for Frame-based interface				X			X
			Tests 9-2, 4-5, 4-6 for ISO 8208 interface			X			X	
Ground Station Subnetwork Interface Support	2.2.3.1.2	N/A	GS Requirement							
VOICE UNIT										
Services	2.2.4	3.3.5.1	Tests 13-2a, 13-2b	X						
			Tests 2-1, 2-2, 5-1 (O)		X	X	X	X		
Priority Access	2.2.4	3.3.5.1.1	Tests 13-2b	X						
			Tests 2-2		X	X	X	X		
Message Source Identification	2.2.4	3.3.5.1.2	Tests 13-5	X						
			Test 12-1		X	X	X	X		
Coded Squelch	2.2.4	3.3.5.1.3	Tests 13-2a	X						
			Tests 2-1		X	X	X	X		
Urgent Downlink Request Signaling	2.2.4	3.3.5.1.4	Test 2-10		X	X	X	X		
Speech Encoding	2.2.4	3.3.5.2	Test 13-2j	X						
			Test 2-11		X	X	X	X		
Speech Encoding Algorithm	2.2.4	3.3.5.2.1	Test 13-2j	X						

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
			Test 2-11		X	X	X	X		
Voice Burst Framing	2.2.4	3.3.5.2.2	Tests 2-6, 13-2f	X	X	X	X	X		
Vocoder Frame Bit Ordering	2.2.4	3.3.5.2.3	Test 13-2j	X						
			Test 2-11		X	X	X	X		
Parameters	2.2.4	3.3.5.3	Tests 13-2a	X						
			Tests 2-1		X	X	X	X		
Group ID	2.2.4	3.3.5.3.1	Tests 13-2a	X						
			Tests 2-1		X	X	X	X		
Squelch Window	2.2.4	3.3.5.3.2	Tests 13-2a	X						
			Tests 2-1		X	X	X	X		
Algorithm Version Number	2.2.4	3.3.5.3.3	Tests 1-4, 1-5, 1-7			X	X		X	X
Description of Procedures	N/A	3.3.5.4	Header							
Link Establishment	N/A	3.3.5.4.1	Header							
Link Initialization	2.2.4	3.3.5.4.1.1	Test 13-1a	X						
			Test 1-1		X	X	X	X		
Net Entry	2.2.4	3.3.5.4.1.2	Test 1-2a		X	X	X	X		
Timing	2.2.4	3.3.5.4.2	Test 13-2h	X						
			Test 2-6		X	X	X	X		
Transmit Delay	2.2.4	3.3.5.4.2.1	Test 13-2g	X						
			Test 2-7		X	X	X	X		
Receive Delay	2.2.4	3.3.5.4.2.2	Test 13-2g	X						
			Test 2-7		X	X	X	X		
Voice Transmit Function	2.2.4	3.3.5.4.3	Tests 13-2a, 13-2c, 13-5	X						
			Tests 2-1, 2-3, 12-1		X	X	X	X		
Demand-Assigned Circuits	2.2.4	3.3.5.4.3.1	Test 5-1		O	O	O	O		
Vocoder Processing	2.2.4	3.3.5.4.3.2	Test 13-3d	X						
			Test 3-4		X	X	X	X		
Truncated Mode Encoding	2.2.4	3.3.5.4.3.2.1	Test 13-3d	X						
			Test 3-4		X	X	X	X		
Truncated Mode Decoding	2.2.4	3.3.5.4.3.2.2	Test 13-3d	X						
			Test 3-4		X	X	X	X		
Truncated Mode Formatting	2.2.4	3.3.5.4.3.2.3	Test 13-3d	X						
			Test 3-4		X	X	X	X		
Access Pre-emption	2.2.4	3.3.5.4.3.3	Tests 13-3d	X						
			Tests 3-4		X	X	X	X		
Urgent Downlink Request	2.2.4	3.3.5.4.3.4	Test 2-10		X	X	X	X		
Urgent Downlink Request Not Supported	2.2.4	3.3.5.4.3.4.1	Test 2-10		X	X	X	X		
Anti-blocking	2.2.4	3.3.5.4.3.5	Test 13-3d	X						
			Test 3-4		X	X	X	X		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
Voice Receive Function	N/A	3.3.5.4.4	Header							
Preprocessing	N/A	3.3.5.4.4.1	Header							
Source Filtering	2.2.4	3.3.5.4.4.1.1	Tests 13-2a, 13-3d	X						
			Tests 2-1, 3-4		X	X	X	X		
Vocoder Processing	2.2.4	3.3.5.4.4.1.2	Test 13-3d	X						
			Test 3-4		X	X	X	X		
Source Identification	2.2.4	3.3.5.4.4.1.3	Test 13-5	X						
			Test 12-1		X	X	X	X		
Voice Synthesis	2.2.4	3.3.5.4.4.2	Test 13-2k	X						
			Test 2-12		X	X	X	X		
Handoff Recommendation	2.2.4	3.3.5.4.5	Test 13-2b	O						
			Test 2-2		O	O	O	O		
Ground-to-Air Voice Quality Requirement	2.2.4.1.1	3.3.5.2.1	Test 13-2h	X						
			Test 2-8		X	X	X	X		
Air-to-Ground Voice Quality Requirement	2.2.4.1.2	3.3.5.2.1	Test 13-2i	X						
			Test 2-9		X	X	X	X		
GROUND TRANSMITTER										
Ground Transmitter Power	N/A	3.4.1	GS Requirement							
Transmitter Duty Cycle	N/A	3.4.2	GS Requirement							
UPLINK										
Doppler Characteristics	N/A	3.5.1.1	Header							
Doppler Shift	2.2.1.2.7	3.5.1.1.1	2.4.4.1.7	X	X	X	X	X		
Doppler Rate	2.2.1.2.8	3.5.1.1.2	2.4.4.1.8	X	X	X	X	X		
Delay and Doppler Spread	N/A	3.5.1.1.3	Not a Requirement							
Signal Fading	N/A	3.5.1.2	Not a Requirement							
Fast Fading with Rotary Wing Aircraft	N/A	3.5.1.2.1	Not a Requirement							
Airborne Noise Environment	N/A	3.5.1.3	Not a Requirement							
Co-channel Interference	N/A	3.5.1.4	Header							
VDL Mode 3	2.2.1.2.9	3.5.1.4.2	2.4.4.1.9	X	X	X	X	X		
Typical Uplink Power Budget	N/A	3.5.2	Not a Requirement							
AIRBORNE RECEIVER										
Minimum Detectable Signal (Uplink)	N/A	3.6.1	Derived Requirement							
COMBINED AIRBORNE RECEIVE/TRANSMIT CHARACTERISTICS										
Frequency Stability	2.2.1.3.10	3.7.1	2.4.4.2.10	X	X	X	X	X		
Tuning Time	2.2.1.1.3	3.7.2	2.4.4.3.3	X	X	X	X	X		
Airborne Antenna Characteristics	N/A	3.7.3	Not a Radio Requirement							
Link Availability	N/A	3.7.4	System Requirement							
AIRBORNE TRANSMITTER										
Transmitter Power	2.2.1.3.2	3.8.1	2.4.4.2.2	X	X	X	X	X		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	MASPS (DO-224B)		IB0	IV0	ID1	ID2	SL0	SU1	SU2
DOWNLINK										
Downlink Channel Characteristics	N/A	3.9.1	Header							
Ground Noise Environment	N/A	3.9.1.1	Not a Requirement							
Typical Downlink Power Budget	N/A	3.9.2	Not a Requirement							
GROUND RECEIVER										
Minimum Detectable Signal (Downlink)	N/A	3.10.1	Derived Requirement							
COMBINED GROUND RECEIVE/TRANSMIT CHARACTERISTICS										
Frequency Stability	N/A	3.11.1	GS Requirement							
Ground Antenna Characteristics	N/A	3.11.2	GS Requirement							
FORMAT AND USAGE OF THE SYSTEM DATA AND HEADER SEGMENTS FOR VDL MODE 3 OPERATION										
General Formatting										
Unused Reserved (Spare) Bits	2.2.5	G.1.1	Test 1-1	X	X	X	X	X		
Bit Ordering	2.2.5	G.1.2	Test 1-1	X	X	X	X	X		
M Burst										
Non-3T Configuration M Uplink System Data Segment (Generic Elements)	2.2.5	G.2.1	Test 1-1	X	X	X	X	X		
Message ID	2.2.5	G.2.1.1	Test 1-1	X	X	X	X	X		
System Configuration	2.2.5	G.2.1.2	Test 1-1	X	X	X	X	X		
Voice Signal	2.2.5	G.2.1.3	Test 2-1	X	X	X	X	X		
Aircraft ID (Poll)	2.2.5	G.2.1.4	Test 1-1	X	X	X	X	X		
Beacon ID	2.2.5	G.2.1.5	Test 1-1	X	X	X	X	X		
Ground Station Code	2.2.5	G.2.1.6	Test 1-1	X	X	X	X	X		
Squelch Window	2.2.5	G.2.1.7	Test 13-2a	X						
			Test 2-1		X	X	X	X		
Normal Message	2.2.5	G.2.2	Test 13-1a	X						
			Test 1-1, 1-2		X	X	X	X		
Reservation Response	2.2.5	G.2.2.1	Test 2-10		X	X	X	X		
			Test 4-4			X	X	X		
Net Entry Response Message	2.2.5	G.2.3	Tests 1-2, 1-3		X	X	X	X		
Next Net Command Message	N/A	G.2.4	Introduction							
Next Net	2.2.5	G.2.4.1	Test 1-9		X	X	X	X		
Local User ID	2.2.5	G.2.4.2	Test 1-9		X	X	X	X		
Net Type	2.2.5	G.2.4.3	Test 1-9		X	X	X	X		
Recovery Message	2.2.5	G.2.5	Test 1-7		X	X	X	X		
Handoff Check Message	2.2.5	G.2.6	Test 5-2		O	O	O	O		
Ground Subnetwork Address	2.2.5	G.2.6.1	Test 5-2		O	O	O	O		
Adjacent Frequency <n>	2.2.5	G.2.6.2	Test 5-2		O	O	O	O		
3-T Configuration M Uplink System Data Segment (Generic Elements)	2.2.5	G.2.7	Test Group 5-1		O	O	O	O		

Table B-2. Traceability Matrix For Standard Conditions (Continued)

Requirement Description	Requirement		Verification Test (DO-271C)	Equipment Class						
	MOPS (DO-271C)	**MASPS (DO-224B)**		**IB0**	**IV0**	**ID1**	**ID2**	**SL0**	**SU1**	**SU2**
M Downlink System Data Segment (Generic Elements)	2.2.5	G.2.8	Test 13-1a	X						
			Tests 1-2a, 1-2c, 1-3		X	X	X	X		
			Test 4-3			X	X	X		
			Test 1-2b			X	X		X	X
Net Entry Request Message	2.2.5	G.2.9	Test 1-2a		X	X	X	X		
Poll Response and Reservation Request Message	2.2.5	G.2.10	Tests 1-2c, 2-10		X	X	X	X		
			Test 4-4			X	X	X		
Number of Slots Requested	2.2.5	G.2.10.1	Tests 1-2c, 4-4			X	X	X		
Data Priority	2.2.5	G.2.10.2	Tests 1-2c, 4-4			X	X	X		
Voice Request	2.2.5	G.2.10.3	Tests 1-2c, 2-10		X	X	X	X		
Acknowledgement Message	2.2.5	G.2.11	Test 4-6			X	X	X		
Leaving Net Message	2.2.5	G.2.12	Test 1-9		X	X	X	X		
Next Net ACK Message	2.2.5	G.2.13	Test 1-9		X	X	X	X		
Terminate Net Message	2.2.5	G.2.14	Test 4-14		X	X	X	X		
Supported Options Message	2.2.5	G.2.15	Test 1-2a		X	X	X	X		
V/D Burst	2.2.5	G.3	Header							
V/D (Voice) Burst Header Segment	2.2.5	G.3.1	Tests 13-2a, 13-2b, 13-3d	X						
			Tests 2-1,2-2,3-4		X	X	X	X		
Message ID	2.2.5	G.3.1.1	Tests 2-1, 2-2	X	X	X	X	X		
EOM	2.2.5	G.3.1.2	Tests 2-1, 2-2	X	X	X	X	X		
V/D (Data) Burst Header Segment	2.2.5	G.3.2	Tests 4-5, 4-6			X	X		X	X
Segment Number	2.2.5	G.3.2.1	Tests 4-5, 4-6			X	X		X	X
RANDOM NUMBER GENERATOR ALGORITHM	2.2.2	Appendix H	Tests 13-1a	X						
			Tests 1-1, 1-2, 1-3		X	X	X	X		
RANDOM ACCESS DOWNLINK M BURST SELECTION ALGORITHMS FOR AIRCRAFT RADIOS	2.2.2	Appendix I	Tests 13-1a	X						
			Test 1-3		X	X	X	X		
			Test 4-3			X	X	X		
ISO 8208 COMPRESSION DEFINITION	2.2.3	Appendix J	Test Group 9			X			X	
CLNP COMPRESSION DEFINITION	2.2.3	Appendix K	Header							
Compression Formatting	2.2.3	K.1	Test 8-2, 8-3				X			X
Compression Rules	2.2.3	K.2	Tests 8-2, 8-3, 8-5				X			X
Decompression Rules	2.2.3	K.3	Test 8-4				X			X
Compression System Parameters	2.2.3	K.4	Tests 8-6, 8-7, 8-8				X			X

APPENDIX C

FUNCTIONAL PARTITIONING FOR SEPARATED EQUIPMENT ARCHITECTURE

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C.1 Introduction

To support air carrier equipment configurations, the VDL Mode 3 MOPS includes a variety of equipment classes that define separated equipment architectures supporting the VDL Mode 3 subnetwork capabilities. This Appendix provides the partitioning of the VDL Mode 3 functionality between the VDR (Equipment Architecture SL) and CMU (Equipment Architecture SU).

C.2 Rationale

The deployment of VDL Mode 3 in the national airspace is projected to occur in phases. VDL Mode 3 deployment is expected to start initially with a VDL Mode 3 voice-only operational capability. It is anticipated that operational support of VDL Mode 3 data will be provided a few years after the introduction of the voice capability. Therefore, it is highly desirable to devise a plan for implementing VDL Mode 3 avionics equipment for air transport aircraft that:

a. supports the phased deployment of VDL Mode 3

b. minimizes the initial investment in avionics required to provide VDL Mode 3 voice capability

c. results in no modifications to previously installed VDL Mode 3 avionics when VDL Mode 3 data services become operational

To support these objectives, it is desirable to partition the VDL Mode 3 functions so that the VDR equipment alone is sufficient to support all VDL Mode 3 voice functions, including enhanced voice operations. The CMU should not be required for voice-only applications. This dictates that the VDR must include all functionality associated with the physical layer, the MAC sublayer, the part of the LME sublayer that supports voice operation, and the voice unit. Furthermore, the VDR should also include those DLS sublayer functions that need to be tightly coupled to the MAC and LME functions in order to perform certain time-critical functions.

The detailed functional partitioning between the VDR and CMU is given in Section C.3. Note that the recommended functional partitioning for VDL Mode 3 is consistent with the functional partitioning in aircraft within a VDL Mode 2 system.

C.3 Assumed VDL Mode 3 Functional Partitioning Between the VDR and CMU

The assumed VDL Mode 3 functional partitioning between VDR and CMU is shown in Table C-1.

Table C-1: VDL Mode 3 Functional Partitioning Between the VDR and CMU

VDL Mode3 Protocol Layer	Functionality Allocated to VDR	Functionality Allocated to CMU
Physical Layer	All functionality	None
MAC Sub-layer	All functionality	None
LME Sub-layer	a) Frequency tuning control b) Net Initialization c) Net Entry d) Link Maintenance e) Poll response f) Dummy poll response g) Recovery h) M- Recovery response Voice only and Voice/Data configurations i) Link Release & handoff Explicit & Implicit j) Urgent Downlink request k) 3T Net selection (If implemented)	a) DLS Connection Establishment (i.e. Link Initialization) b) Link (XID parameter) modification c) Authentication d) Recovery verification & XID processing e) Make-before-Break Operation f) Join/Leave Event Notification to upper layers
DLS Sub-layer	a) D/L Frame Group segmentation b) U/L Frame Group re-assembly c) U/L Frame ungrouping d) U/L Frame FCS/Address screening e) U/L Frame FCS removal f) D/L ACK processing (Acknowledgement of U/L Frames)	a) D/L Frame formatting b) D/L Frame re-transmission c) D/L Frame queuing & prioritization d) D/L Frame grouping e) U/L Frame duplicate detection & discard f) U/L ACK processing (Acknowledgement of D/L Frames)
Subnetwork Layer	None	All functionality
SNDCF	None	All functionality
Voice Codec	All functionality	None

APPENDIX D

FUNCTIONAL REQUIREMENTS FOR THE DATA/MANAGEMENT INTERFACE

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D.1 Data/Management Interface

Class SL0 equipment (designated as VDR in Table 2-1) and Class SU1/Class SU2 equipment (designated as CMU in Table 2-1) provide a Data/Management interface for the purpose of exchanging data and control information between the lower VDL Mode 3 protocol stack and the upper VDL Mode 3 protocol stack. An example of the Data/Management interface functionality is given in the following sections of this Appendix.

D.2 Data/Control Message Exchange

The Data/Management interface supports the data/control message exchanges as indicated in Table D-1.

Table D-1: Data/Control Messages

Primitive	Message Description	Signal Flow	
		From	**To**
PARAM.request	Message sent to provide MAC parameters/timers, other than default values, negotiated with the VDL Mode 3 GS, or to request MAC parameters/timers currently in use for debug purposes	CMU	VDR
UNITDATA.request	Message sent to deliver DLS Frame Group for downlink transmission	CMU	VDR
ADDR.request	Message sent to request Aircraft Address being used by VDR for U/L frame screening. To be used for debug/test purposes	CMU	VDR
CMU_ERROR.indication	Message sent in response to invalid or unrecognized message	CMU	VDR
RECOVERY.request	Message sent, in response to receipt of recovery indication, containing the D/L frame to be transmitted when the GS polls the VDR with a Recovery M burst with matching A/C ID	CMU	VDR
DLS_CONNECTED.ind	Message sent to indicate that a DLS connection has been established (initial link negotiated) with the VDL Mode 3 ground station. *Note: VDR uses this indication to report to Radio Tuning Panel that both enhanced voice and data services are now available via VDL Mode 3.*	CMU	VDR
DLS_ON.request	Message sent in response to the net entry indication to request that VDR enable processing of D/L and U/L V/D(data) bursts; Message also sent to enable processing when two VDRs were previously operating on the same data slot and the one that was active has left the net allowing the other to take its place	CMU	VDR

Primitive	Message Description	Signal Flow	
		From	To
DLS_OFF.request	Message sent in response to net entry indication to request that VDR not enable processing of D/L and U/L V/D(data) bursts and delivered frame groups because there is already another VDR operating on the same data slot	CMU	VDR
PURGE.request	Message sent to request discard of Frame Group whose transmission has not yet started	CMU	VDR
ENTER_NET.request	Message sent to request Net re-entry when the DLS function in the CMU has lost synchronization with the VDL Mode 3 ground station	CMU	VDR
DLS_DISCONNECTED.ind	Message sent to indicate that CMU and VDL Mode 3 ground station could not successfully complete the Initial Link Negotiation	CMU	VDR
LEAVE_NET.request	Message sent to request VDR to send a Leave Net message to the ground station	CMU	VDR
PARAM.confirm	Message sent to confirm acceptance of non-default parameters/timers or provide values in use	VDR	CMU
UNITDATA.indication	Message sent to deliver received U/L Frame Group addressed to CMU	VDR	CMU
ADDR.confirm	Message sent to provide Addresses being used for U/L Frame screening.	VDR	CMU
VDR_ERROR.indication	Message sent in response to invalid or unrecognized message	VDR	CMU
SQP.indication (reserved)	Signal quality indication	VDR	CMU
ENTERED_NET.indication	Message sent to indicate that Net Entry has been accomplished	VDR	CMU
UNITDATA.confirm	Message sent to confirm transmission or discard of Frame Group	VDR	CMU
RECOVERY.confirm	Message sent to confirm transmission of the CTRL_RSP frame when polled by GS	VDR	CMU
RECOVERY.indication	Message sent to indicate uplink M burst Recovery message has been received by VDR	VDR	CMU
LEFT_NET.indication	Message sent to indicate that VDR has sent a Leave Net message to the ground station	VDR	CMU
DLS_ON.confirm	Acknowledge receipt of the message DLS_ON.request	VDR	CMU
DLS_OFF.confirm	Acknowledge receipt of the message DLS_OFF.request	VDR	CMU

APPENDIX E

AUDIO TEST VECTORS

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E.1 Introduction

This appendix contains audio test vectors to assist manufacturers in the design and testing of their radio audio sections.

E.2 Test Vector for Setting Audio Levels

VDL Mode 3 radios use the DVSI 4.8 kbps AMBE+TM Vocoder for Air Traffic Communication to compress voice for digital transmission. Although the vocoder is designed to provide good quality voice transmission at low bit rates, it does not generally perform well with a single frequency tone. Such a tone would be useful in setting up receivers to provide an output audio level that is consistent among VDL Mode 3 radios and between VDL Mode 3 and DSB-AM radios.

This section presents a compressed test vector (CTV) that enables the decoder to generate a good quality sine wave which can be used for setting audio levels and characterizing harmonic distortion and noise performance.

E.2.1 Compressed Test Vector (CTV) Description

Figure E-1 provides a basic block diagram of the VDL Mode 3 receive signal flow highlighting the use of the CTV.

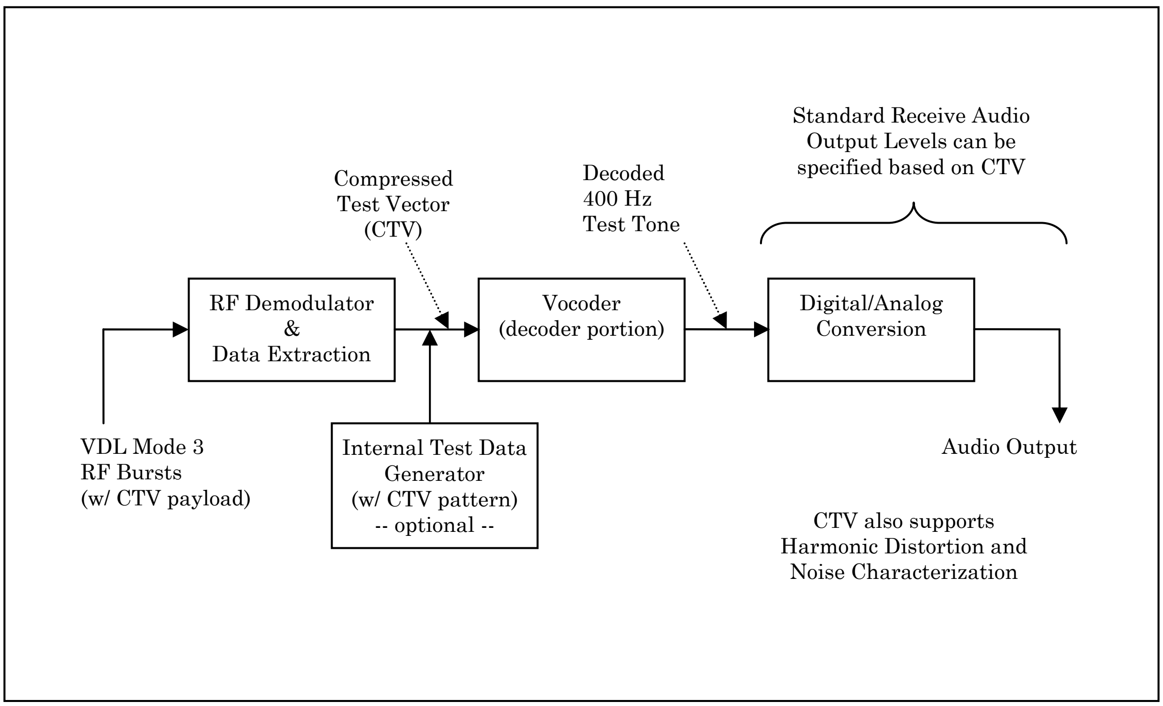

Figure E-1: VDL Mode 3 Receive Signal Flow with CTV

The compressed test vector generates a 400 Hz test tone with the following characteristics:

- Tone Frequency: 400 Hz
- Signal Power: -3 dBFS (RMS average power)
- Total Distortion: 0.0057% (band limited from 300 to 3700 Hz)

A 400 Hz tone was selected because this is the largest single frequency tone that the vocoder can generate. This frequency limit was discovered during empirical testing and validated by a review of the algorithm. Although a more common test tone frequency of 1004 Hz is desirable because it is located near the center of the passband, the 400 Hz tone is still within the passband and should not be significantly affected by band edge filter rolloff characteristics.

Figure E-2 provides an illustration of the decoded waveform. Figure E-3 and Figure E-4 provide frequency domain views.

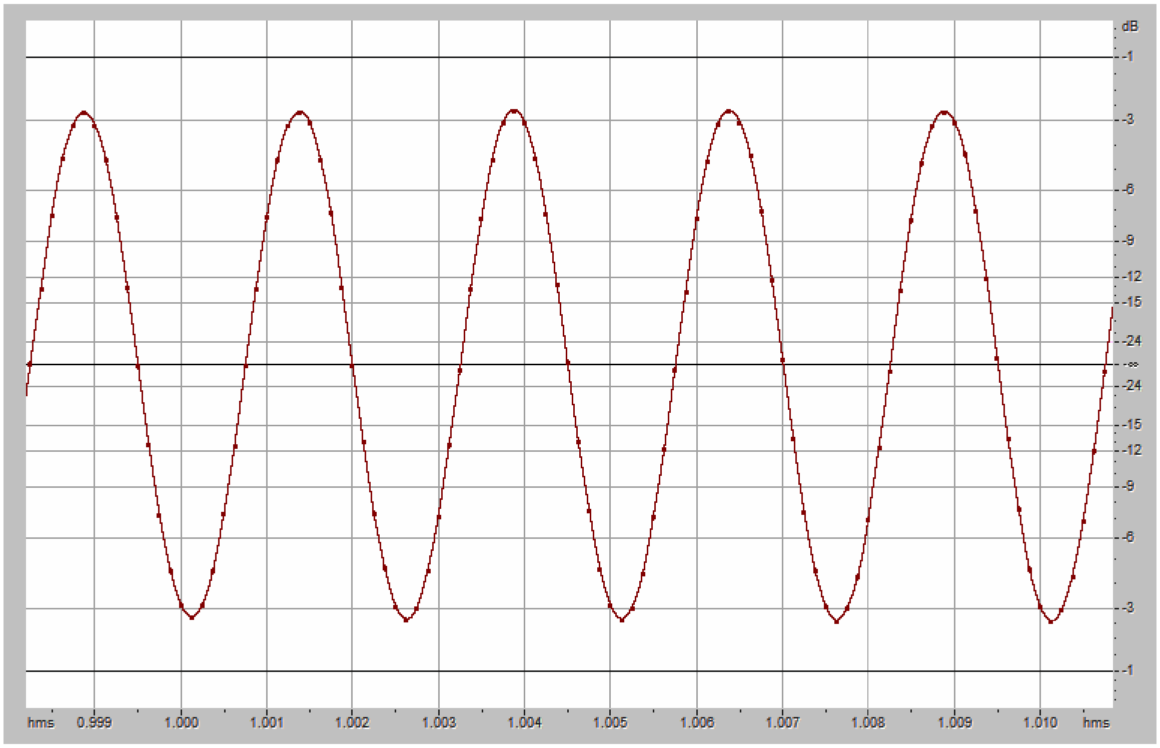

Figure E-2: CTV Waveform (400 Hz)

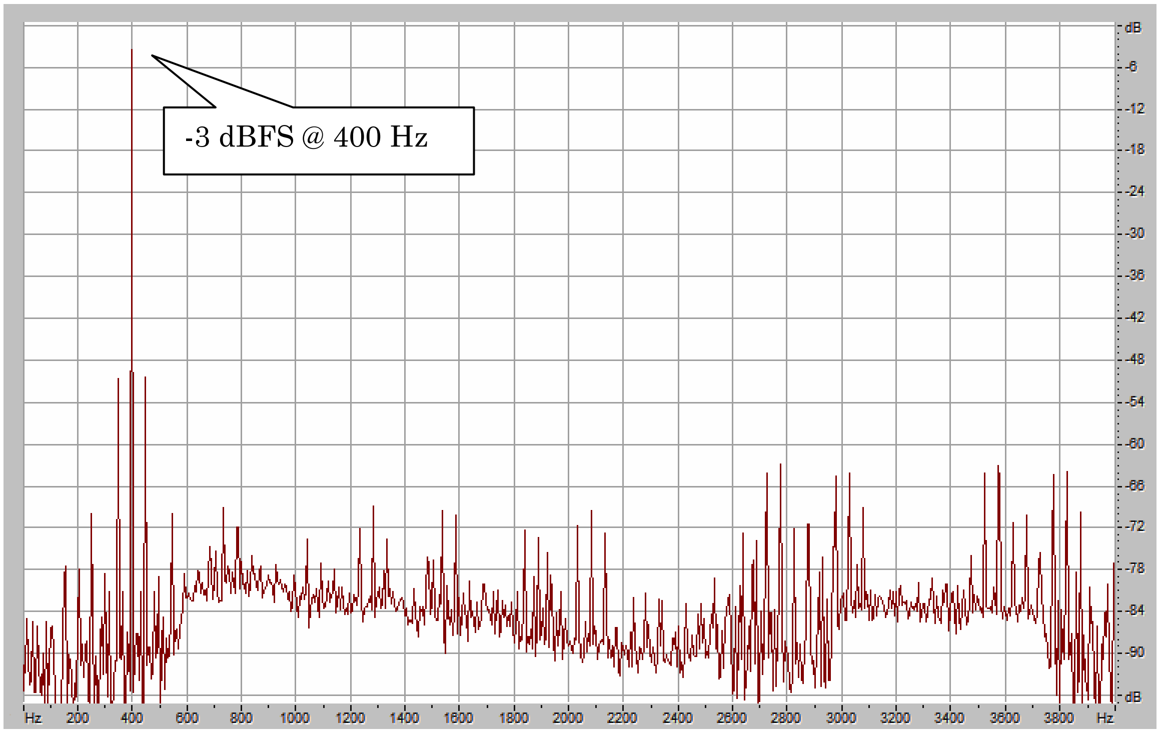

Figure E-3: CTV Frequency Domain View (FULL)

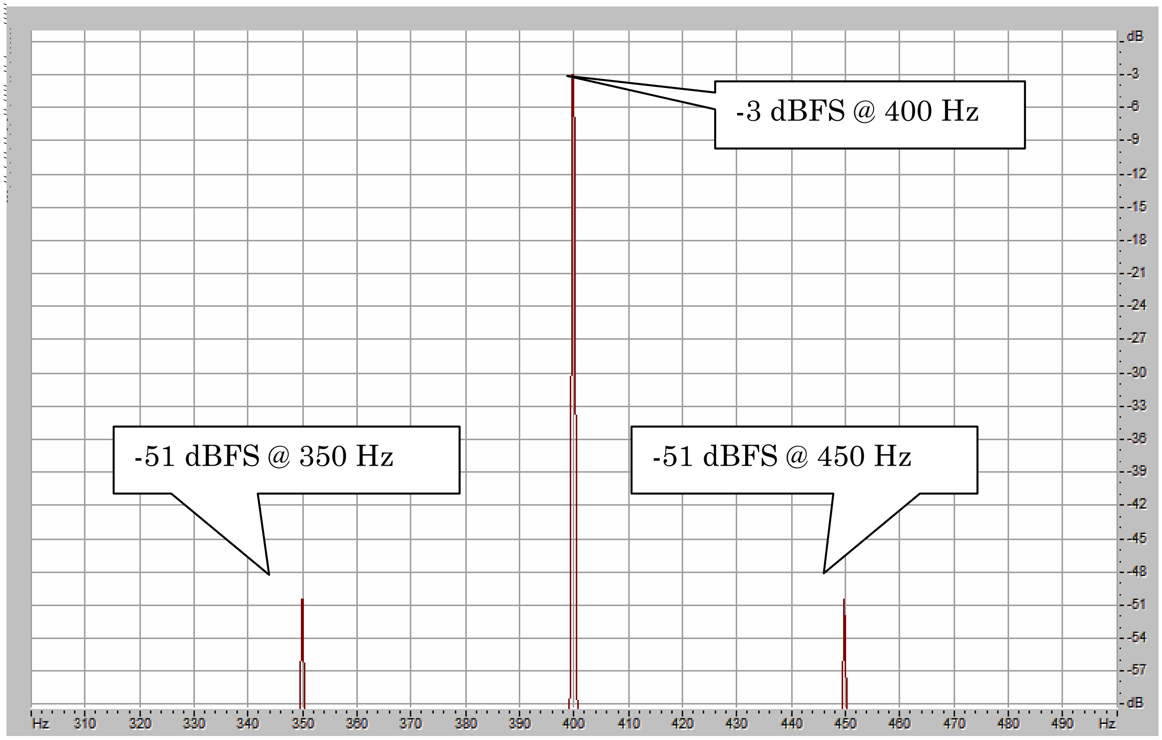

Figure E-4: CTV Frequency Domain View (ZOOM)

The CTV consists of a single frame of data that is repeated continuously and sent to the decoder. A single frame of compressed voice data is 96-bits long and represents 20 ms of voice when decoded. Six frames of data fill a voice burst slot for VDL Mode 3. The CTV data frame (in VDL Mode 3 bit order) is provided below:

CTV (Octal):	3464 0302 2044 3014 6114 4647 2423 3360
CTV (Hex):	7340 C242 460C C4C9 A751 36F0

The CTV was developed using the C-version of vocoder source code executing on a Windows PC. Use of the source code allowed direct editing of model parameters. Results were evaluated using Cool Edit Pro, a digital sound editing software package. Cool Edit Pro allows the display of signals in both time and frequency domains. The frequency domain plots provided in Figures 3 and 4 were generated using Cool Edit Pro's 65536-point Fast Fourier Transform (FFT) with Blackmann-Harris windowing.

E.2.2 Applications

The CTV has the following applications:

- Consistent system-wide audio levels,
- Characterization harmonic distortion and noise performance,
- Equipment standardization (if included in DO-271B MOPS),
- Level measurements using simple test equipment (RMS meter), and
- Equipment test purposes (factory & field).

E.2.3 Summary

The CTV can be used to setup proper VDL Mode 3 receiver audio levels from a digitally generated reference. It also can be used for characterizing radio harmonic distortion and noise performance.

E.3 Compressed Silence Test Vector

VDL Mode 3 radios use the DVSI 4.8 kbps AMBE+TM Vocoder for Air Traffic Communication vocoder to compress voice for digital transmission. At least one radio manufacturers has suggested that a compressed silence vector would be helpful in testing VDL Mode 3 radios. This vector could be applied at the RF input to a receiver and used to characterize the operation of the analog output circuitry (e.g., verify noise performance).

This paper presents two compressed silence vector (CSV) that will facilitate testing of analog audio circuitry in VDL Mode 3 radio receivers. The first is a single frame vector that produces a slightly colored noise spectrum with an average RMS energy of -87 dBFS. The second is a six-frame vocoder vector (one VDL Mode 3 burst) that produces a flat noise spectrum with an average RMS energy of -87.5 dBFS

E.3.1 Compressed Silence Test Vector (CSV) Description

Figure E-5 provides a basic block diagram of the VDL Mode 3 receive signal flow highlighting the use of the CSV. The next two subsections describe the single-frame and multi-frame versions of the CSV.

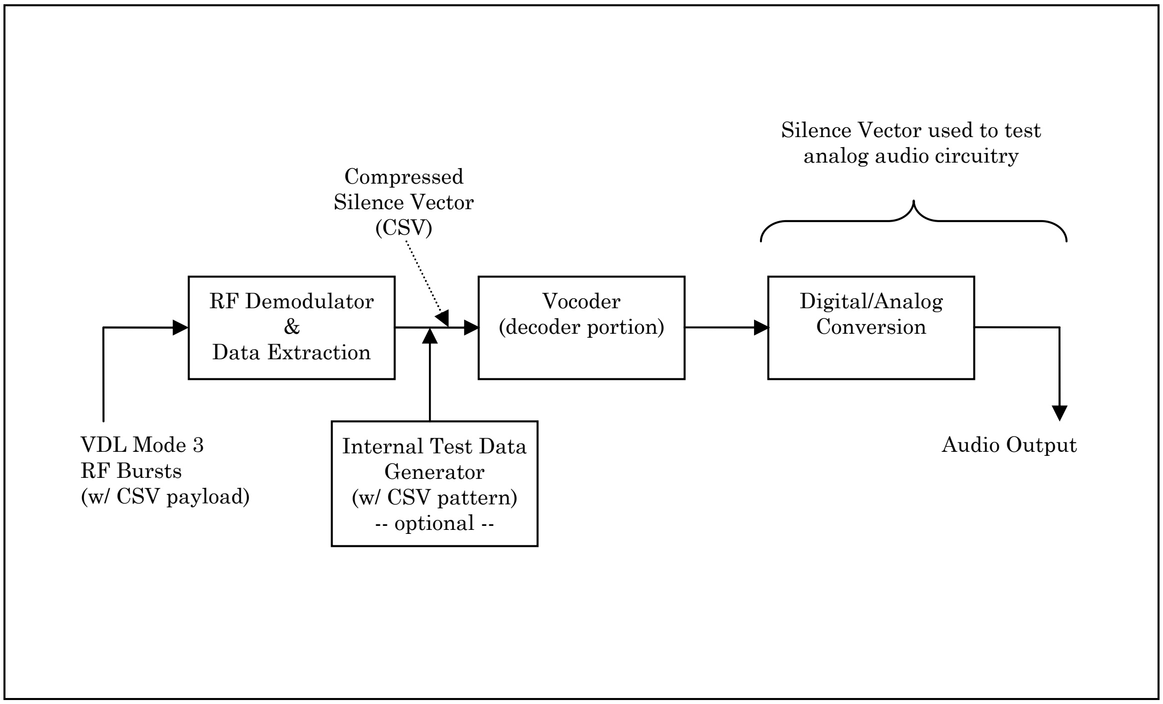

Figure E-5: VDL Mode 3 Receive Signal Flow using CSV

The compressed test vectors generate an output signal with the following characteristics:

	SF-CSV		MF-CSV
▪ Number of Vocoder Frames:	1		6
▪ Average RMS Energy:	-87.0 dBFS	-	87.6 dBFS
▪ Minimum Sample Value:	-3		-3
▪ Maximum Sample Value:	+3		+3

The vocoder is designed to work with 16-bit linear voice samples. The peak values of the output signal are +/- 3 or -80 dBFS. Figures E-6 and E-7 provide the output spectrum for the single and multiple frame CSVs, respectively.

A single vocoder frame of compressed voice data is 96-bits long and represents 20 ms of voice when decoded. Six vocoder frames of data fill a voice burst slot for VDL Mode 3.

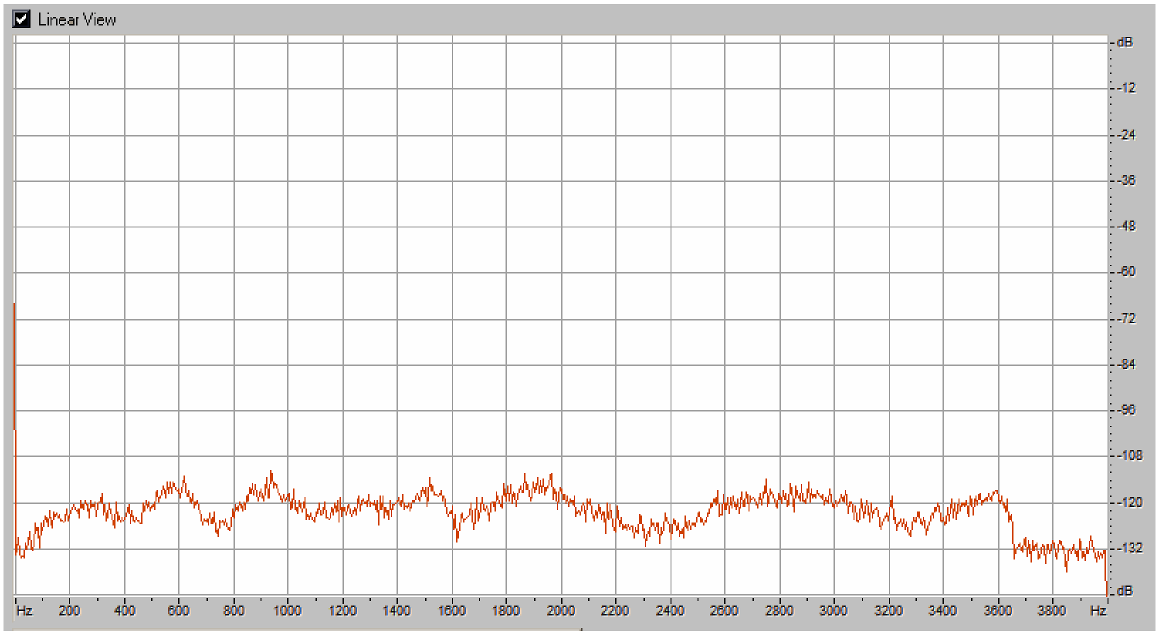

Figure E-6: Single Frame (SF-CSV) Frequency Domain View

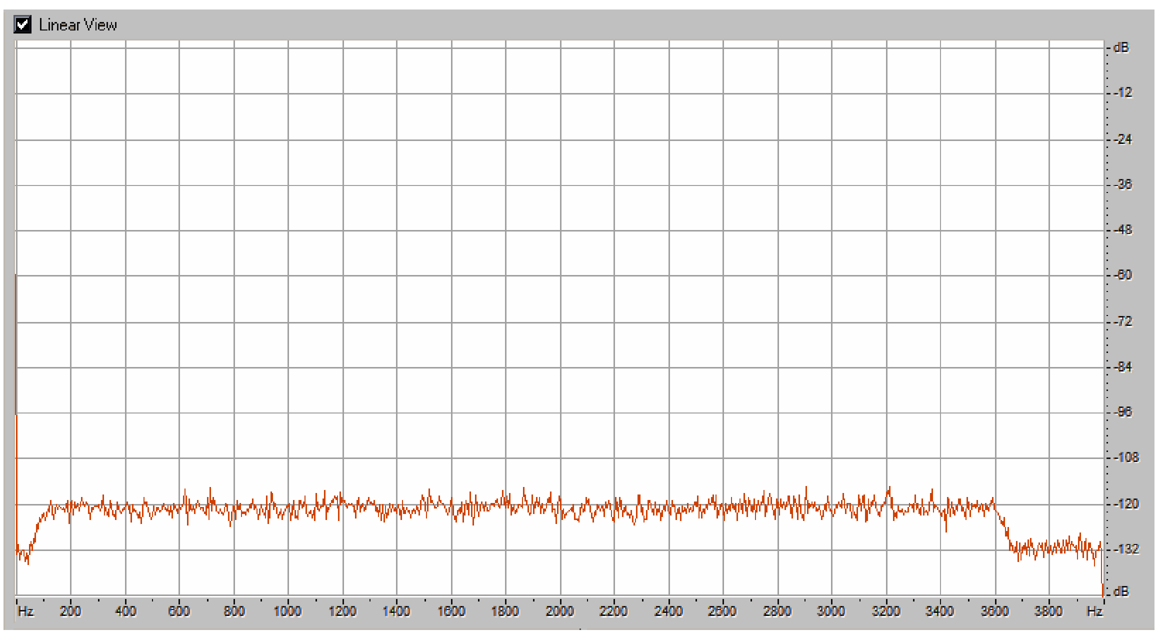

Figure E-7: Multiple Frame (MF-CSV) Frequency Domain View

The SF-CSV data frame (in octal and hex formats) is provided below:

CSV (Octal):	2420 2704 2020 0707 5715 6060 4237 3010
CSV (Hex):	5105 C441 01C7 BCDC 3089 F608

The MF-CSV data frame (in octal and hex formats) is provided below:

CSV (Octal):	2401 2210 4234 6513 3415 4060 4237 3010
	0420 2704 2020 1747 4755 6060 5233 3150
	2400 6230 4234 6513 1505 2374 4237 3010
	2730 4504 2124 3645 5711 7124 4237 1016
	0505 6310 6234 7541 3415 5060 5231 3050
	2721 2720 2120 1641 7605 1334 4237 1016
CSV (Hex):	5014 8889 CD4B 70D8 3089 F608
	1105 C441 03E7 9EDC 30A9 B668
	500C 9889 CD4B 3454 FC89 F608
	5D89 4445 47A5 BC9E 5489 F20E
	145C C8C9 CF61 70DA 30A9 9628
	5D15 D045 03A1 F852 DC89 F20E

The CSVs were developed using the C-version of vocoder source code executing on a Windows PC. Use of the source code allowed direct editing of model parameters. Results were evaluated using Cool Edit Pro, a digital sound editing software package. The frequency domain plots provided in Figures E-2 and E-3 were generated using Cool Edit Pro’s 32768-point Fast Fourier Transform (FFT) with Blackmann-Harris windowing.

E.3.2 Summary

Either or both of the CSVs can be used to test the analog audio circuits (e.g., verify noise performance) in VDL Mode 3 radio receivers.