PART III – SECTION J-3

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBSYSTEM SPECIFICATION

MULTIMODE DIGITAL RADIO (MDR)

Supporting Programmable VHF Multi-Mode Communication Equipment Operating within the Frequency Range of 112.000-137.000 MHz

Version 1.0

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 SCOPE

1.1 Identification

This document contains the subsystem specification for the NEXt generation air/ground (A/G) COMmunications (NEXCOM) System Very High Frequency (VHF) radio, to be used for A/G voice and data communications. It describes the features and performance required by the NEXCOM System radio equipment to satisfy Segment One of the NEXCOM Program. This document was prepared in accordance with the format requirements of FAA-STD-005e.

The physical/functional architecture of the NEXCOM equipment is judged by the Federal Aviation Administration (FAA) to be the most cost effective of various approaches for NEXCOM Segment One, and should provide the smoothest transition into the National Airspace System (NAS). This specification covers only the ground-based radio equipment, Multimode Digital Radio (MDR) to be purchased by the FAA. Since RTCA DO-224a, Minimum Aviation System Performance Standards (MASPS) applies to avionics, differences between the MASPS and specific needs of the ground station equipment are reflected in this specification. Initially the MDR radio is intended to operate as a 25 kHz Double Side Band-Amplitude Modulated (DSB-AM) radio. The radio will also operate at 8.33 kHz DSB-AM and VHF Digital Link (VDL) Mode 3. Most of the VDL Mode 3 timing, framing, vocoding, and link management described in the RTCA DO-224a (MASPS) will be demonstrated by the Radio Interface Unit (RIU) during initial digital deployment. The MDR/RIU will be tested and fielded as a VDL Mode 3 and DSB-AM compliant system.

1.2 System Overview

The primary objective of the NEXCOM Program is to provide Air Traffic Services the ability to accommodate the growing number of control sectors and communication needs using the available limited frequency spectrum. Principal goals of the system architecture include introduction of a new generation of VHF MDRs and RIUs into the ground facilities supporting air/ground communications, i.e., Remote Center Air/Ground (RCAG), Remote Communications Outlet (RCO) and Remote Transmitter and Receiver (RTR) facilities; support of existing legacy interfaces with Radio Control Equipment (RCE) and Voice Switching and Control Systems (VSCS); and transition to standardized, programmable digital operations for both ground sites and aircraft. The NEXCOM Segment One MDR will also be used to replace the current generation of DSB-AM mode radios to sustain DSB-AM operations at sites outside the NEXCOM Segment One Program.

The NEXCOM system provides voice and data communication exchanges between airborne and ground-based systems. It is an A/G subsystem of the Aeronautical Telecommunications Network (ATN) using the Aeronautical Mobile (Route) Services (AM(R)S) band and it is organized according to the Open System Interconnection (OSI) Model (defined by the International Standards Organization (ISO)). NEXCOM will provide reliable subnetwork services to the ATN systems. For services in addition to DSB-AM voice, the equipment incorporates the two lowest layers of the OSI Model. The

equipment specified here will replace existing DSB-AM transmitters and receivers, and provide Layer 1 and a portion of Layer 2 services of the OSI Model.

> Layer 1 (Physical Layer): Provides transmitter/receiver frequency control, bit exchanges over the radio medium, and notification functions. These functions are referred to as "radio" and "modulation/demodulation" functions. A Differential 8 Phase Shift Keying (D8PSK) modulation scheme provides a 31.5 kbps bit rate (at Layer 1) for digital voice and data.
>
> Layer 2 (Link Layer): The Link Layer is divided into a Media Access Control (MAC) sublayer, a Data Link Services (DLS) sublayer and a Link Management Entity (LME). The MAC sublayer provides access to the physical layer by a three-or-four slot Time Division Multiple Access (TDMA) algorithm controlling of channel access for VDL Mode 3.

The radio equipment will be compatible with the VDL Mode 3 specified in RTCA document DO-224a (MASPS), except as changed by this specification or the NEXCOM System Requirements Document (SRD). The DSB-AM sections in this document are taken from the existing purchase descriptions FAA-P-2883 and FAA-P-2884.

The 25 kHz DSB-AM mode is used for backward compatibility. The MDR needs to be physically compatible with existing equipment. It is meant to provide for digital voice, data, and analog voice communications while using the existing RCE. Technical parameters defining DSB-AM operation at 8.33 kHz channel spacing have been added in Section 3.2 in this document so that the MDR can operate in the 8.33 kHz International Civil Aviation Organization (ICAO) defined mode. This capability is included as a risk mitigator and there are no plans to use this operation in the NAS.

The equipment specified here is a subsystem of the NEXCOM System. Figure 1-1 identifies specifications currently under development. A Ground Network Interface (GNI) subsystem specification may contain requirements for equipment beyond Segment One, which will provide connectivity required for data link routers and their accompanying network services.

The NEXCOM System will be operated and maintained in the same facilities as the existing A/G communication system facilities i.e., RCAG, RCO, RTR and their control facilities. The NEXCOM equipment will be integrated into these existing facilities as smoothly as possible, replacing the current equipment.

NEXCOM Segment One will replace the current ground-based analog radios at High/Superhigh En Route facility locations with programmable MDRs and RIUs with an integrated voice encoder (vocoder).

During the initial transition phase of Segment One the MDRs will be operated in the 25 kHz DSB-AM mode used by the legacy radios. NEXCOM MDRs will be required to support A/G communications activities, which include the replacement and expansion of the existing A/G infrastructure using the legacy interface. Existing telecommunications, VSCS, and RCE will remain in operation on all voice channels for the foreseeable future.

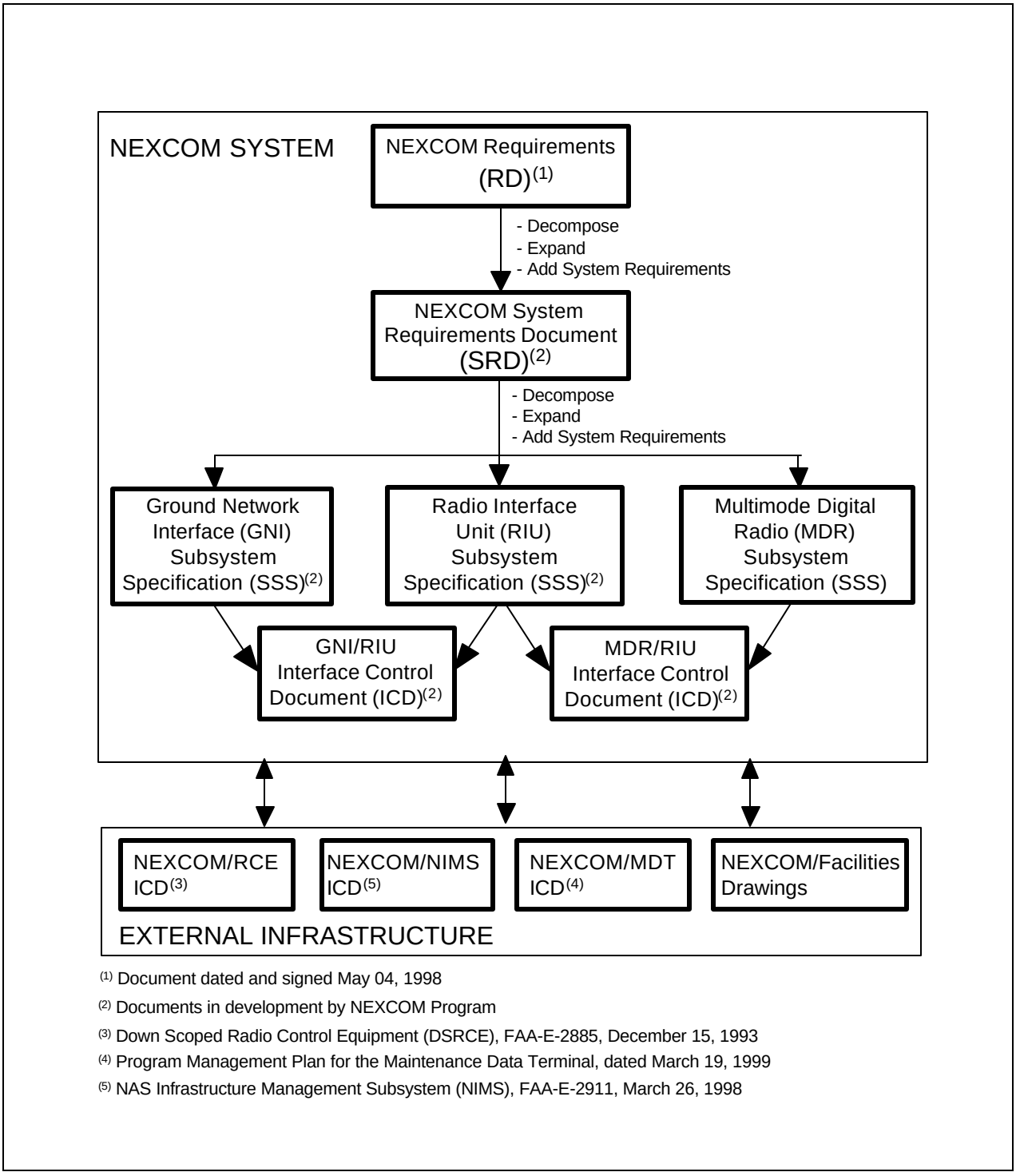


Figure 1-1: NEXCOM Document Tree

2.0 APPLICABLE DOCUMENTS

2.1 Government Documents

The following documents of the issues in effect on the date of the request for proposals (solicitation) form a part of this specification and are applicable to the extent specified here. In case of conflict between the documents referenced here and the contents of this specification, the contents of this specification **shall** take precedence.

2.1.1 Specifications

FAA:

FAA-E-2731G	Voice Switching and Control System (VSCS) Product Specification, 1996
FAA-E-2894A	Enhanced Terminal Voice Switch (ETVS) Specification, 1998
FAA-E-2911	NAS System Level Specification, NAS Infrastructure Management System (NIMS), Managed Subsystems, March 26, 1998
FAA-G-2100G	Electronic Equipment, General Requirements, September 28, 1999
FAA-P-2883	Purchase Description, VHF/UHF Air/Ground Radio Communications Receivers, April 14, 1994
FAA-P-2884	Purchase Description, VHF/UHF Air/Ground Radio Communications Transmitters, April 14, 1994

2.1.2 Standards

FAA:

FAA-STD-020B	Grounding, Bonding and Shielding, 1992

Military:

MIL-HDBK-454(1)	General Guidelines for Electronic Equipment, May 28, 1997
MIL-HDBK-470A	Designing and Developing Maintenance Products and Systems, Volume I and Volume II, August 4, 1997
MIL-STD-461E	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference, August 20, 1999

MIL-STD-810F	Environmental Test Methods and Engineering Guidelines, January 1, 2000
MIL-STD-889B	Dissimilar Metals, May 17, 1993

2.1.3 Other Government Documents

FAA:

NAS-IC-41024000	VSCS to the existing Radio Control Equipment Interface Control Document, October 10, 1997
NAS-IC-XXXX	Interface Control Document for Maintenance Data Terminal/Multimode Digital Radio, date XXXX
NAS-IC-41033502	Interface Control Document for Radio Interface Unit/Multimode Digital Radio, June 30, 2000, Version 1.2
NAS-IR-41024202	Interface Requirements Document for Tower Communication System (TCS)/Radio Control Equipment (RCE)
NAS-IR-51070000	Interface Requirements Document for NAS Infrastructure Management System Manager/Managed Subsystem, May 28, 1997
NEXCOM RD	Requirements Document for Next Generation Air/Ground Communications System (NEXCOM), Segment 1, May 4, 1998
DOT/FAA/CT-96/1	Human Factors Design Guide for Acquisition of Commercial Off-the-Shelf Subsystems, Non-Developmental Items, and Developmental Systems, January 15, 1999

FCC:

47 CFR Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations, October 1998
47 CFR Part 87	Aviation Services, October 1998

NIST:

FIPS PUB 140-1	Federal Information Processing Standards Publication, Security Requirements for Cryptographic Modules, National Institute of Standards and Technology, January 11, 1994

FIPS PUB 186-2	Federal Information Processing Standards Publication, Specifications for Digital Signature Standard (DSS), National Institute of Standards and Technology, January 27, 2000

NTIA:

National Telecommunications and Information Administration, Regulations and Procedures for Federal Radio Frequency Management, September 1995 Edition with Revisions for September 1996 and May 1997

2.2 Non-Government Documents

ICAO:

AMPC WG-D10/WP14	Proposed Material for Annex 10, Chapter 6, VHF Air/Ground Digital Link (VDL), January 1999
XXXX-XXXXX	Manual on VDL Mode 3 Technical Specifications
XXXX-XXXXX	Implementation Aspects for VDL Mode 3

RTCA:

DO-224a	Signal in Space Minimum Aviation System Performance Standards (MASPS) for Advanced VHF Digital Data Communications Including Capability with Digital Voice Technique Circuit Mode Minimum Aviation System Performance Standards (MASPS) Version 6, November 1999

EIA:

EIA-310-E	Cabinets, Racks, Panels, and Associated Equipment, March 17, 1999

ETSI:

ETSI Spec. EN-300-676	EMC and Radio Matters (ERM); Hand held, mobile and fixed radio transmitters, receivers and transceivers for VHF aeronautical mobile service using amplitude modulation Technical characteristics and methods for measurement.

IEEE/ANSI:

C62.31-1987	IEEE Standard Test Specifications for Gas-Tube Surge Protective Devices
C62.36-1994	IEEE Standard Test Method for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits
C62.41-1991	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
C62.47-1992	IEEE Guide on Electrostatic Discharge (ESD): Characterization of the ESD Environment

ISO/IEC:

ISO/IEC 7498	Information Technology-Open Systems Interconnection-Basic Reference Model, November 1994

2.3 Documentation Sources

2.3.1 FAA Documents

Copies of FAA specifications, standards, and publications may be obtained from the NEXCOM Contracting Officer, FAA, 800 Independence Avenue SW, Washington, DC 20591. Requests should clearly identify the desired material by number and state the intended use of the material. Revision FAA-G-2100G may be downloaded from the FAA at web site http://www.faa.gov/asd/standards/index.htm.

2.3.2 Military and Federal Documents

Single copies of unclassified military and federal specifications, standards, and publications may be obtained by writing the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120 or by calling (215) 697-3321 Monday through Friday, 8:00 a.m. to 4:30 p.m. (EST).

2.3.3 Federal Communications Commission Documents

Copies of 47 CFR, Part 2 and Part 87 may be obtained from the FCC, 445 12th Street, S.W., Washington D.C. or by downloading from the FCC web site at www.fcc.gov/oet/info/rules.

2.3.4 Electronic Industries Alliance Documents

Copies of Electronic Industries Alliance (EIA) standards may be obtained from the Electronic Industries Alliance, 2500 Wilson Boulevard, Arlington, VA 22201-3834, by calling (703) 907-7500, or through the web site http://www.eia.org.

2.3.5 National Telecommunications and Information Administration Documents

Copies of National Telecommunications and Information Administration (NTIA) materials may be obtained from NTIA, Department of Commerce, 14th Street and Constitution Avenue NW, Washington, DC, 20230, by calling (202) 377-1832, or through the web site http://www.ntia.doc.gov.

2.3.6 International Civil Aviation Organization Documents

Copies of International Civil Aviation Organization (ICAO) documents may be obtained from the ICAO Library, 999 University Street, Montreal, Quebec H3C 5H7, Canada. Note: For current working documents that are not final products, inquire at ICAO web site http://www.icao.org.

2.3.7 RTCA, Inc. Documents

Copies of RTCA, Inc. documents may be obtained from RTCA, Incorporated, 1140 Connecticut Avenue NW, Suite 1020, Washington, DC 20036, by calling (202) 833-9339, or through the web site http://www.rtca.org.

2.3.8 ASTM Documents

Copies of American Society for Testing and Materials (ASTM) materials may be obtained from the ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, by calling (610) 832-9585, or through the web site http://www.astm.org.

2.3.9 ETSI Documents

Copies of European Telecommunications Standards Institute documents may be obtained from the ETSI Secretariat at F-06921 Sophia Antipolis CEDEX – France by requesting a copy via the ETSI web site secretariat@etsi.fr.

2.3.10 ISO/IEC Documents

Copies of International Standards Organization documents may be obtained from American National Standards Institute, 11 West 42nd Street, 13th floor, US-New York, N.Y. 10036. Tele: 1 212 642 4900, Telefax: 1 212 398 0023, E-mail:info@ansi.org, Web: http://www.ansi.org/ or http://www.iso.ch/.

2.3.11 IEEE/ANSI Documents

Copies of IEEE/ANSI documents may be obtained from IEEE Customer Service, 445 Hoes Lane, P.O. Box 1331, Piscattaway, New Jersey 08855-1331. Phone (800) 701-4333 (in US and Canada), (732) 981-0060 (outside of US and Canada).

2.3.12 NIST Documents

Copies of National Institute of Standards and Technology may be obtained from NIST, 100 Bureau Drive, Gaithersburg, Maryland 20899-3460. Phone (301) 975-6478.

3.0 REQUIREMENTS

3.1 Definitions

3.1.1 "Shall"

When used in this specification, the word "**shall**" refers to an explicit requirement of a system component or the complete system. ([1]) ([2])

3.1.2 "Should"

When used in this specification, the word "*should*" refers to a desired characteristic of a system component or the complete system. ([1])

3.1.3 "Will"

When used in this specification, the word "will" provides information for a characteristic of a related system component or a complete related system.

3.2 MDR Requirements

The MDR is defined as one radio receiver and one radio transmitter. Unless otherwise stated, the MDR requirements apply to both MDR receiver and MDR transmitter for: 1) all operational modes of Section 3.2.1.1 and 2) the entire frequency range of Section 3.2.1.1.1, and 3) the operating conditions of Section 3.4.3.1. The system characteristics described here are for ground MDR equipment.

a) The MDR **shall$_1$** be implemented as a separate receiver and separate transmitter.
b) All MDR receiver and transmitter requirements **shall$_{(366)}$** be met under all operating conditions, with the Antenna Transfer Relay (ATR)(see section 3.2.2.2.14) in place.

3.2.1 MDR Functions and Software Requirements

3.2.1.1 Modes of Operation

a) The MDR receivers and transmitters **shall$_2$** operate in the ICAO DSB-AM Mode using 25 kHz channel separation.
b) The MDR receivers and transmitters **shall$_3$** operate in the ICAO VDL Mode 3 using 25 kHz channel separation.

---

[1]In this document, if the **shalls** and *shoulds* are seen as major cost drivers or are seen as unachievable by industry, the FAA is interested in having a dialogue concerning this matter.
[2]In this document the **shalls** have been numbered. Because of editorial rearrangements, additions and deletions of requirements in response to reviews and comments, the **shall** numbers are not consecutive and, if ordered starting with 1, there will be numbers missing.

c) The DSB-AM mode **shall$_4$** also operate using an 8.33 kHz channel separation in accordance with ETSI specification EN-300-676.

3.2.1.1.1 Tuning Range and Channel Increments

a) The MDR receivers and transmitters **shall$_5$** tune to any 25 kHz channel from 112.000 MHz to 136.975 MHz, the band from 118.000 MHz to 136.975 MHz in accordance with the ICAO Channelization Plan, and with the band 112.000 MHz to 118.000 MHz being a logical extension of the ICAO Channelization Plan.
b) The MDR receivers and transmitters **shall$_6$** have a user selectable minimum tunable frequency between 112.000 MHz and 118.000 MHz in 25 kHz steps.
c) Upon initialization (cold start as defined in Section 6.2.13), the start frequency **shall$_7$** default to 118.000 MHz and all control and monitor parameters assume their default values.
d) The equipment **shall$_8$** also tune in 8.33 kHz increments in accordance with the ICAO Channelization Plan.

Note: Allocation of all or part of the frequency band from 112.000 MHz up to 117.975 MHz is being considered for Aeronautical Mobile Communications.

3.2.1.2 VDL Mode 3 Protocol Services

For definitions of VDL Mode 3 Time Division Multiple Access (TDMA) see RTCA DO-224a (MASPS).

a) The MDR receiver and transmitter **shall$_9$** comply with RTCA DO-224a (MASPS).

3.2.1.2.1 VDL Mode 3 Physical Layer

a) VDL Mode 3 **shall$_{10}$** use the Differential 8 Phase Shift Keying (D8PSK) modulation scheme defined in the RTCA VDL Mode 3 MASPS.
b) The VDL Mode 3 symbol rate **shall$_{11}$** be 10,500 symbols/s with a tolerance of ±2 Parts Per Million (PPM), resulting in a nominal data rate of 31,500 bits per second (bps). Table 3-1 shows the RTCA DO-224a (MASPS) references:

Table 3-1: DO-224a (MASPS) References

Paragraph	Reference
3.3.1.2	Modulation scheme
3.3.1.2.1	Data encoding
3.3.1.2.2	Transmitted signal format

3.2.1.2.2 VDL Mode 3 Link Layer

a) The VDL Mode 3 Link Layer **shall$_{12}$** be in accordance with DO-224a (MASPS).

3.2.1.2.2.1 VDL Mode 3 MAC Sublayer

The following requirements apply to the MDR receiver and transmitter:

a) The MAC sublayer of the MDR receiver and transmitter **shall$_{13}$** be as defined in the RTCA DO-224a (MASPS).

Note: Appendix C contains a description of the MAC sublayer functionality.

3.2.1.2.2.2 External Time Reference

a) The MDR **shall$_{14}$** use the timing reference provided by the RIU as the basis for the frame timing for VDL Mode 3.

3.2.1.2.2.3 Logical Burst Access Channels (LBACs) for the Transmitter

a) The MDR transmitter **shall$_{15}$** transmit bursts received from the RIU based on the Time of Transmission (TOT) field of the RIU/MDR packet as defined in the MDR/RIU ICD.
b) The MDR transmitter **shall$_{16}$** use the TOT field as the time offset from the start of the MAC cycle (measured in 1/16th of a D8PSK symbol period, the symbol period being 95.24 μsec) to initiate the transmission of the burst. The TOT indicates where the center of the first symbol of the synchronization sequence is to be located in time relative to the start of the MAC cycle.
c) The MDR transmitter **shall$_{(396)}$** use the MAC_CYCLE field to determine for which MAC cycle in the epoch the burst applies.

3.2.1.2.2.4 LBACs for the Receiver

a) The MDR receiver **shall$_{(397)}$** use the TOT field to indicate the time offset from the beginning of the MAC cycle where the center of the first symbol of the synchronization sequence occurred for received bursts.
b) The MDR receiver **shall$_{(398)}$** use the MAC_CYCLE field to indicate which MAC cycle in the epoch the burst applies.
c) The MDR receiver **shall$_{(399)}$** use the Management Burst Receive Sync message to determine for which synchronization sequence is to be searched for a particular LBAC.

3.2.1.3 DSB-AM Protocol Services

3.2.1.3.1 Physical Layer

a) The modulation method **shall$_{17}$** be DSB-AM in accordance with the CFR 47, Part 2 and Part 87 and the NTIA, Regulations and Procedures for Federal Radio Frequency Management (Chapter 6, paragraph 6.3).

3.2.1.4 Software and Processor Requirements

a) The equipment **shall$_{18}$** be reconfigurable to allow the MDR receiver and transmitter to operate in the known approved ICAO standardized communication waveforms (i.e., 25 kHz DSB-AM, 8.33 kHz DSB-AM, and VDL Mode 3).
b) Protocols and user access/synchronization schemes in the equipment **shall$_{19}$** be programmable.
Note: The purpose of requiring programmability is to allow ease of changes as MASPS requirements are further refined/defined, and to allow implementation of future capabilities as the NEXCOM System evolves to meet NAS needs.

c) The MDR receiver and transmitter equipment, as separate entities, **shall$_{20}$** use no more than 50 percent of their non-volatile memory (as defined in Section 6.2.16) or storage, under worst-case conditions.
d) The MDR receiver and transmitter, as separate entities, **shall$_{21}$** use no more than 50 percent of their Random Access Memory (RAM), under worst-case conditions (e.g., when the MDR has both the software-in-use and a second software version loaded).
e) The processor utilization of the MDR receiver and transmitter, as separate entities, **shall$_{22}$** peak at 50 percent or less.
f) The equipment **shall$_{23}$** be able to accurately process dates in data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations.
g) The MDR receiver and transmitter **shall$_{24}$** revert to the previous version of software and restart, if the MDR does not successfully restart after receipt and execution of the Switch Software Version control parameter command.

3.2.1.5 MDR State and State Transition Requirements

a) The MDR **shall$_{(533)}$** have the following states: Off, Power Up, Offline, Online, Recovery, and Failed, as defined in Section 6.2.15.
b) The MDR **shall$_{(534)}$** provide visual indication of the MDR state on the MDR front panel.
c) The MDR **shall$_{(535)}$** not generate spurious alarms or alerts, read back monitored parameters inaccurately, or make erroneous log entries in any state or transition.

3.2.1.5.1 State Transition

a) The MDR **shall$_{(536)}$** transition from state to state in accordance with Section 6, Table 6-1, and Figure 6-1, as applicable.

3.2.1.5.2 Off State

a) When OFF, the MDR transmitter **shall$_{(537)}$** not transmit.
b) When OFF, the MDR receiver **shall$_{(538)}$** not generate any form of audio output.
c) When AC or DC power is present at the MDR power input, (i.e. not in the Off state) the MDR **shall$_{(539)}$** provide visual indication of Power.

3.2.1.5.3 Power Up State

a) When in the Power UP state,
   1) the MDR transmitter **shall$_{(540)}$** not transmit.
   2) the MDR receiver **shall$_{(541)}$** not generate any form of audio output.
b) The time between application/restoral of power to the MDR and the MDR's transition out of the Power Up state **shall$_{(542)}$** not exceed 30 seconds.
c) The MDR **shall$_{(543)}$** conduct and complete Power On Self Test functions in the Power Up state.
d) If the MDR was in Online state prior to the most recent Powerdown/Off state, upon completion of the Power Up sequence, the MDR **shall$_{(544)}$** transition from Power Up state to Online state.

d) If the MDR was in Offline state prior to the most recent Powerdown/Off state, upon completion of the Power Up sequence, the MDR **shall**$_{(545)}$ transition from Power Up state to Offline state.

3.2.1.5.4 Off Line State

a) When in Offline state, the remote analog audio and remote discrete PTT input of the MDR **shall**$_{(546)}$ be disabled.
b) When in Offline state, the digital, local analog audio and local PTT inputs of the MDR transmitter **shall**$_{(547)}$ be enabled.
c) The MDR **shall**$_{(548)}$ accept the Switch Software Version control parameter ID#15 only when in Offline state.
c) The MDR **shall**$_{(549)}$ conduct background built in test to detect and report equipment failures.

3.2.1.5.5 On Line State

a) When in Online state, the MDR **shall**$_{(550)}$ enable all functions except the local user (technician) analog audio input and local user PTT input are disabled when the remote user PTT (or audio equivalent) is active.
b) When in Online state, the MDR **shall**$_{(551)}$ reject all control parameter commands except the following:

ID	Parameter
1	Log In
5	MDR State
6	Alarm/Alert Threshold Setting
8	Squelch Setting
9	Squelch Window
11	Receiver Mute
14	ATR Switch Configuration
20	Transmission Timeout
21	Squelch On/Off
30	Request Read Back
34	MAC Timing Offset Correction
35	Suppress Alarm/Alert
37	Software Upload On/Off
38	Software Upload.

c) The MDR **shall**$_{(552)}$ conduct background built in test to detect and report equipment failures.

3.2.1.5.6 Recovery State

a) The MDR **shall**$_{(553)}$ enter the Recovery state when the MDR detects a potentially recoverable failure.
b) Potentially recoverable failures **shall**$_{(554)}$ include, but not be limited to, Over-Temperature conditions and RIU Timing Offset slip.

c) When in Recovery State, the MDR transmitter **shall**$_{(555)}$ not transmit.
d) When in Recovery state, the MDR receiver **shall**$_{(556)}$ not generate any form of audio output.
e) The MDR **shall**$_{(557)}$ transition from the Recovery state to the previous state if the recovery process has been successful (e.g. the recoverable fault was eliminated)
f) The MDR **shall**$_{(558)}$ transition from the Recovery state to the Failed state if the recovery process was not successful (e.g. the potentially recoverable fault could not be eliminated).

3.2.1.5.7 Failed State

a) When in Failed state,
   1) the MDR transmitter **shall**$_{(559)}$ not transmit.
   2) the MDR receiver **shall**$_{(560)}$ not generate any form of audio output
   3) the MDR **shall**$_{(561)}$ enable only those control commands that can be executed accurately.
b) The MDR **shall**$_{(562)}$ transition to the Failed state if the MDR detects an unrecoverable failure, defined as a failure that a local user (technician) cannot eliminate from outside the MDR.

3.2.1.5.8 Power Down State

a) If the MDR employs a Power Down state, when in Power Down state,
   1) the MDR transmitter **shall**$_{(563)}$ not transmit.
   2) the MDR receiver **shall**$_{(564)}$ not generate any form of audio output
   3) all MDR functions **shall**$_{(565)}$ be disabled, except logging/reporting and front panel indication.
   4) the MDR **shall**$_{(566)}$ provide visual indication on the front panel that the MDR is ready for transition to Off state.
b) Only Local Operator (technician) action **shall**$_{(567)}$ transition the MDR to Power Down state.

3.2.1.6 MDR/RIU Data Link Layer

3.2.1.6.1 HDLC Frame Structure

a) The MDR **shall**$_{(400)}$ support the HDLC Frame Structure as defined in NAS-IC-41033502.

3.2.1.6.2 Link Control

a) The MDR **shall**$_{(401)}$ support the link initialization procedures defined in NAS-IC-41033502.
b) The MDR **shall**$_{(402)}$ provide the means to clear the link at any time, in accordance to NAS-IC-41033502.

3.2.1.6.3 Link Level Parameters

a) The MDR **shall**$_{(403)}$ support the MDR/RIU Interface Link Level Parameters as defined in the Table below:

Link Level Parameters

Parameter	Description	Min	Max	Default
N1	Maximum number of information field bits	128	4096	512
N2	Link Status Counter	1	64	12
T1	Link response timer	100 ms	500 ms	200 ms
T2	Link retransmission timer	1 sec	10 sec	5 sec
T3	Reassembly Timer	50 ms	240 ms	100 ms

3.2.1.6.4 HDLC Frame Timing

a) The MDR **shall**$_{(404)}$ support the timing and size of HDLC frame transmissions between the MDR and RIU, in accordance to NAS-IC-41033502.

3.2.1.6.5 Link Level Message Description

a) The MDR **shall**$_{(405)}$ support the Link Level Message Structure between the MDR and RIU, in accordance to NAS-IC-41033502.

3.2.1.6.5.1 General Message Structure

a) The MDR **shall**$_{(406)}$ support the General Message Structure between the MDR and RIU, in accordance to NAS-IC-41033502.
b) The MDR **shall**$_{(407)}$ support the message types and message ID's, as defined in the Table below:

Message Identification

Message ID	Message Type
0	Voice-Burst
1	Data-Burst
2	Management-Burst
3	Sync Search Control
4	PCM Voice
5	Radio Control
6	Radio Monitoring
7	Link Status
8-255	Reserved

b) The MDR **shall**$_{(408)}$ support the field descriptions and message encoding, as defined in NAS-IC-41033502, for each of the message types identified in the Table above.

3.2.1.6.5.1.1 Voice-Burst Message

a) The MDR **shall**$_{(568)}$ support the capability to send/receive voice-burst messages to/from the RIU (Message ID = 0), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.2 Data-Burst Message

a) The MDR **shall**$_{(409)}$ support the capability to send/receive data-burst messages to/from the RIU (Message ID = 1), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.3 Management-Burst Message

a) The MDR **shall**$_{(410)}$ support the capability to send/receive management burst messages to/from the RIU (Message ID = 2), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.4 Sync Search Control Message

a) The MDR **shall**$_{(411)}$ support the capability to send/receive sync search control messages to/from the RIU (Message ID = 3), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.5 PCM-Voice Message

a) The MDR **shall**$_{(412)}$ support the capability to send/receive PCM-Voice messages to/from the RIU (Message ID = 4), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.6 Radio Control Message

a) The MDR **shall**$_{(413)}$ support the capability to send/receive radio control messages to/from the RIU (Message ID = 5), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.7 Radio Monitoring Message

a) The MDR **shall**$_{(414)}$ support the capability to send/receive radio monitoring messages to/from the RIU (Message ID = 6), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.8 Link Status Message

a) The MDR **shall**$_{(415)}$ support the capability to send/receive link status messages to/from the RIU (Message ID = 7), encoded as defined in NAS-IC-41033502.

b) The link status message **shall**$_{(416)}$ define the status of the MDR or be used by the RIU to complete the link initialization.

3.2.1.6.6 MDR Receiver HDLC Message Timing

a) For the first vocoder frame in a VDL Mode 3 received burst (VFSN=1), the Voice Burst HDLC message **shall**$_{(417)}$ have the LEN field set to 96.

c) For VFSN=1, the MDR Receiver **shall**$_{(418)}$ complete transmission of the Voice-Burst message HDLC end FLAG no later than time:

$$T_{RXV1} = \frac{\left(\frac{TOA}{16} + 55.5\right)}{10{,}500} + 0.0111 \text{ seconds,}$$

where T_{RXV1} is the time offset measured from the start of the 6-second VDL epoch in which the burst was received, and TOA is the Time of Arrival as specified in the Voice-Burst message header.

d) The MDR Receiver **shall(419)** send the vocoder frames to the RIU in the order in which they are demodulated.

e) The MDR Receiver **shall(420)** complete transmission of the HDLC end FLAG for the Voice-Burst message that contains vocoder frame 6 no later than time:

$$T_{RXV2\text{-}6} = \frac{\left(\frac{TOA}{16} + 55.5\right)}{10{,}500} + Tslot \text{ seconds,}$$

where $T_{RXV2\text{-}6}$ is the time offset measured from the start of the 6-second VDL epoch in which the burst was received, TOA is the Time of Arrival as specified in the Voice-Burst message header, and Tslot = 0.030 for 4-slot configurations and 0.040 for 3-slot configurations.

f) In VDL Mode 3 3-slot configurations, the MDR Receiver **shall(421)** complete transmission of the M-Burst message HDLC end FLAG no later than 40 milliseconds (one time slot) after the Time of Arrival (TOA) as specified in the Management-Burst message header.

g) In VDL Mode 3 4-slot configurations, the MDR Receiver **shall(422)** complete transmission of the M-Burst message HDLC end FLAG no later than 30 milliseconds (one time slot) after the Time of Arrival (TOA) as specified in the Management-Burst message header.

h) The MDR Receiver **shall(423)** send the data segments to the RIU in the order in which they are demodulated.

i) In VDL Mode 3 3-slot configurations, the MDR Receiver **shall(424)** complete transmission of the Data-Burst message HDLC end FLAG for the last Data-Burst message segment in a Data burst no later than 40 milliseconds (one time slot) after the Time of Arrival (TOA) as specified in the Data-Burst message header.

j) In VDL Mode 3 4-slot configurations, the MDR Receiver **shall(425)** complete transmission of the Data-Burst message HDLC end FLAG for the last Data-Burst message segment in a Data burst no later than 30 milliseconds (one time slot) after the Time of Arrival (TOA) as specified in the Data-Burst message header.

3.2.1.7 MDR/RIU Physical Layer

a) The MDR **shall(426)** support the fractional T1 protocol as defined in NAS-IC-41033502

3.2.1.7.1 T1 Time Slot Assignments

a) The MDR **shall(427)** be configurable to use any of one of the five data channels plus the timing channel (slots 1 and 2), in accordance with NAS-IC-41033502.

3.2.1.7.2 T1 Time Slots – Timing Channel

a) The MDR **shall**$_{(428)}$ support the characteristics of the T1 Timing Channel, in accordance with NAS-IC-41033502.
b) The MDR **shall**$_{(429)}$ loop-back to the RIU the information contained in the Timing Channel every T1 frame.
c) The looped back Timing Channel **shall**$_{(430)}$ be delayed in the MDR by one T1 frame.
d) The MDR Timing Channel loop-back **shall**$_{(431)}$ be required by the RIU when measuring the round trip time delay through an unknown path (e.g., Telco T1) between the RIU and the MDR.
e) The MDR **shall**$_{(432)}$ derive all necessary VDL Mode 3 TDMA timing information using the Timing Channel, T1 frame timing, and the MAC Timing Offset Correction messages provided by the RIU.
f) The MDR **shall**$_{(433)}$ incorporate the necessary corrections to compensate for internal delays within the radio (e.g., processing delays, FIR filter delays, modulation delays, demodulation delays).
g) In remote connections using asynchronous clocks, there exists the possibility that the elastic stores will repeat, or skip a frame, to accommodate clock slippage. Each MDR **shall**$_{(434)}$ be responsible for detecting this error condition and reporting it to the RIU.

3.2.2 Performance Requirements

3.2.2.1 MDR Receiver Requirements

3.2.2.1.1 Receiver Digital and Audio Interfaces

a) The main audio level **shall**$_{26}$ be controllable both locally from the MDT and remotely via the RIU.

3.2.2.1.1.1 VDL Mode 3

a) The digital interface **shall**$_{27}$ carry digitized voice with time-multiplexed user data, control signals, and timing signals, and RMMC information between the receiver and the RIU.
b) Voice **shall**$_{28}$ have priority over monitoring data (See section 3.2.3.3).
Note: There is no provision for local audio in VDL Mode 3.

3.2.2.1.1.2 DSB-AM

a) The MDR receiver **shall**$_{29}$ provide a main audio output on the rear of the receiver (See section 3.3.1.3).
b) There **shall**$_{31}$ be a local audio output terminated in a headset/headphone jack located on the front panel of the receiver. (See section 3.3.1.5.)
c) The main and local audio outputs **shall**$_{30}$ have a balanced 600 ohms (± 10 percent) output impedance.
d) The output level of the local headset/headphone **shall**$_{32}$ be independently controllable from the front panel.

3.2.2.1.1.2.1 DSB-AM PCM Voice Reception

a) The receive MDR **shall**$_{(435)}$ convert demodulated DSB-AM audio to linear Pulse Code Modulation (PCM) at a sampling rate of 8,000 16-bit PCM samples per second and send PCM messages to the RIU over the T1 link. The format of the PCM messages sent to the RIU **shall**$_{(436)}$ be as specified in NAS-IC-41033502.

b) PCM voice messages sent from the receive MDR to the RIU **shall**$_{(437)}$ have highest priority.

c) With the exception of the last PCM voice packet in a voice reception, all PCM voice packets sent to the RIU **shall**$_{(438)}$ contain the same number of 16-bit PCM samples, N_{PCM}, where: $120 \leq N_{PCM} \leq 200$.

d) The last PCM voice packet in a voice reception sent to the RIU **shall**$_{(439)}$ contain less than or equal to N_{PCM} PCM samples.

e) For N=1 and N=2, the receive MDR **shall**$_{(440)}$ complete transmission of the HDLC end FLAG for the Nth PCM message in a downlink DSB-AM voice reception no later than 0.0075 + [(N+1) * T_{VF}] seconds after squelch break, where:

N = PCM message number since squelch break; N = 1,2,3…

T_{VF} = K / 8,000 seconds, and

K = number of PCM samples in the Nth PCM message (LEN field / 16).

f) For N>2, the receive MDR **shall**$_{(441)}$ complete transmission of the HDLC end FLAG for the Nth PCM message in a downlink DSB-AM voice reception no later than 0.0075 + [(N-2) * T_{VF}] seconds after the HDLC end Flag for the 2nd PCM message(N=2) has been transmitted over the T1 link, where:

N = PCM message number since squelch break; N = 3,4,5…

T_{VF} = K / 8,000 seconds, and

K = number of PCM samples in the Nth PCM message (LEN field / 16).

g) In DSB-AM, the N1 parameter for non-PCM messages **shall**$_{(442)}$ not exceed 512 bits.

h) In DSB-AM, the N1 parameter for PCM messages **shall**$_{(443)}$ be less than or equal to 3,264 bits.

3.2.2.1.2 Uncorrected Bit Error Rate (BER)

3.2.2.1.2.1 VDL Mode 3

a) The uncorrected BER performance of equal to or better than 10^{-3} **shall**$_{33}$ be achieved under the conditions specified in sections 3.2.2.1.3, 3.2.2.1.7, 3.2.2.1.17 through 3.2.2.1.22 and 3.2.2.1.25. *Note: An external test set, which is not part of the MDR, may generate a test sequence for the desired signal, add appropriate training sequences and map the resulting test sequence directly into the VDL Mode 3 frame structure without bit scrambling. The test set will also include other transmitter functions to generate appropriate VDL Mode 3 RF signals at the desired channel frequency. These RF test signals combined with the undesired signals (also generated by the test set) will be input to the MDR receiver (in test state) for uncorrected BER measurement.*

3.2.2.1.2.2 DSB-AM

Not Applicable.

3.2.2.1.3 Receiver Sensitivity

a) The MDR receiver RF input **shall** $_{(367)}$ have a 50 ohm characteristic impedance.

3.2.2.1.3.1 VDL Mode 3

a) In the absence of added external noise, the specified uncorrected BER (see section 3.2.2.1.2.1) **shall**$_{36}$ be achieved at a signal level of -100 dBm at the MDR receiver antenna connector from a modulated VDL Mode 3 signal source.

3.2.2.1.3.2 DSB-AM

a) The MDR receiver **shall**$_{37}$ produce a SINAD (ratio of (Signal plus Noise plus Distortion) to (Noise plus Distortion)) of 10 dB or greater at the main and local audio outputs when an RF signal of no more than -102 dBm (modulated at 30 percent with a 1004 Hz tone) is present at the MDR receiver antenna input.

3.2.2.1.4 Receiver Rejection of Signals Inside the VHF Band

See section 3.2.2.1.18.

3.2.2.1.5 Receiver Selectivity

VDL Mode 3 and DSB-AM

a) The selectivity of the MDR receiver **shall**$_{38}$ conform to Table 3-2 with respect to the tuned channel center frequency across the entire frequency band:

Table 3-2: Selectivity Profile

Level	VDL Mode 3 and DSB-AM Bandwidth(25 kHz Ch.)	DSB-AM Bandwidth(8.33 kHz Ch.)
- 6.0 dB	± 9 kHz Minimum	± 3.5 kHz Minimum
- 60.0 dB	± 25 kHz Maximum	± 8.33 kHz Maximum
- 80.0 dB	± 50 kHz Maximum	± 25 kHz Maximum

3.2.2.1.6 Receiver Image Rejection

VDL Mode 3 and DSB-AM

a) There **shall**$_{39}$ be no image frequencies within the 112.000 MHz to 136.975 MHz frequency band.
b) The sensitivity requirements of section 3.2.2.1.3 **shall**$_{40}$ not be degraded more than 3 dB in the presence of an unmodulated carrier at any image frequency of the receiver applied to the receiver input at a level 80 dB above the desired signal.

3.2.2.1.7 Receiver Distortions

3.2.2.1.7.1 Receiver Intermodulation

VDL Mode 3 and DSB-AM

a) The sensitivity requirements defined in 3.2.2.1.3 **shall$_{41}$** not be degraded by more than 3 dB in the presence of two –5 dBm FM modulated interfering signals, with 75 kHz deviation, modulated with a 400 Hz tone, with the interfering frequencies chosen in the 87.5 MHz to 107.9 MHz range, such that one of the 3rd order products is located on the chosen receive frequency.
b) In addition, the sensitivity requirements defined in 3.2.2.1.3 *should* not be degraded by more than 3 dB in the presence of two +5 dBm interfering signals, one FM modulated with 75 kHz deviation modulated with a 400 Hz tone and the other interferer a CW signal, with the interfering frequencies chosen in the 87.5 MHz to 107.9 MHz range, such that one of the 3rd order products is located on the chosen receive frequency.
c) The sensitivity requirements defined in section 3.2.2.1.3 **shall$_{42}$** not be degraded by more than 3 dB in the presence of two –35 dBm interfering signals 90 percent AM modulated with a 400 Hz tone, in the 112.000 MHz to 136.975 MHz band, with the frequencies of the interfering signals offset from the desired channel by +2.0 MHz and +4.0 MHz, or –2.0 MHz and –4.0 MHz, respectively.

3.2.2.1.7.2 Cross Modulation

3.2.2.1.7.2.1 VDL Mode 3

Not Applicable.

3.2.2.1.7.2.2 DSB-AM

a) An on-channel signal (modulated 30 percent with a 1004 Hz tone) adjusted to produce a 10.0 dB SINAD ratio, **shall$_{43}$** produce not less than 8.0 dB SINAD ratio in the presence of an off-channel signal modulated 30 percent with a 400 Hz tone as defined below:
   1) An off-channel signal separated from the desired on-channel signal by ± 0.5 MHz, at a level 70.0 dB above the desired signal.
   2) An off-channel signal separated from the desired on-channel signal by ± 1.0 MHz, at a level 75.0 dB above the desired signal.
   3) An off-channel signal separated from the desired on-channel signal by ± 1.5 MHz, at a level 80.0 dB above the desired signal.

3.2.2.1.8 Receiver Frequency Tolerance

VDL Mode 3 and DSB-AM

a) The receiver local oscillator frequency tolerance **shall$_{47}$** be ± 0.0001 percent (± 1 PPM) for a period of one year following alignment over the full frequency range specified in section 3.2.1.1.1, and the temperature range specified in Section 3.4.3.1.
b) The oscillator **shall$_{(444)}$** have a tuning adjustment adequate to compensate for 10 years of operational use.
c) As a minimum, the adjustment range **shall$_{(445)}$** be ± 3 PPM.
d) The frequency **shall$_{(446)}$** be adjustable within ± 1 PPM.

3.2.2.1.9 Receiver Audio Output Control

a) With an RF input consisting of a -87 dBm carrier AM modulated 30 percent with a 1004 Hz tone, the main audio output level of the MDR receiver **shall**$_{48}$ be adjustable between -25 dBm and +20 dBm in 1 dB steps.
b) With an RF input consisting of a -87 dBm carrier AM modulated 30 percent with a 1004 Hz tone, the front panel headphone jack audio level **shall** $_{(368)}$ be continuously adjustable with the front panel volume control from –25 dBm to +20 dBm.

3.2.2.1.10 Receiver Audio Level Regulation

3.2.2.1.10.1 VDL Mode 3

Not Applicable.

3.2.2.1.10.2 DSB-AM

a) With an RF input signal of -87 dBm (modulated 30 percent with a 1004 Hz tone) and the receiver adjusted for an audio output level of +20 dBm, the audio signal **shall**$_{49}$ not vary more than ± 1.0 dB as the modulation is increased to 100 percent.
b) With an initial audio output of +20 dBm into a 600 ohm load resistance at the main audio output, the audio output **shall**$_{50}$ not drop more than 4.0 dB with a reduction of the load resistance to 120 ohms.

3.2.2.1.11 Receiver Audio Automatic Level Stabilization

3.2.2.1.11.1 VDL Mode 3

Not Applicable.

3.2.2.1.11.2 DSB-AM

a) With a -50 dBm RF input signal modulated 30 percent with a 1004 Hz tone as a reference, the audio output of the receiver **shall**$_{51}$ not differ more than ± 2 dB from the reference level for any RF input signal between -95 dBm and -7 dBm.

3.2.2.1.12 Receiver Audio Mute and Attenuation

3.2.2.1.12.1 VDL Mode 3

Not Applicable.

3.2.2.1.12.2 DSB-AM

a) The MDR receiver **shall**$_{52}$ have a control input for muting the receiver main audio output.
b) Muting **shall**$_{53}$ be activated or deactivated via the MDT and/or RIU.
c) The muting function attenuation **shall**$_{54}$ be selectable from 0 dB (no mute), 15 dB, 20 dB, or more than 40 dB (no audio).

d) The tolerances for the selectable attenuation **shall**$_{55}$ be ± 3 dB.
e) The default **shall**$_{56}$ be more than 40 dB attenuation (no audio).

3.2.2.1.13 Receiver Average Audio Output

3.2.2.1.13.1 VDL Mode 3

Not Applicable.

3.2.2.1.13.2 DSB-AM

a) With the RF settings given in section 3.2.2.1.9 and the test tone audio output level adjusted to a level between +20 dBm and –25 dBm, the audio output level of speech averaged over 3 seconds **shall**$_{57}$ be within –3 dB to –7 dB of the adjusted test tone audio output level.
b) The maximum audio level of speech **shall**$_{58}$ be < +8 dB relative to the adjusted test tone audio output level.
c) The speech used to test this condition will consist of five different ATC voices that will be provided by the FAA in addition to a 1004 Hz calibration tone. This calibration tone will be used to set the 90 percent AM level of the RF input signal.

3.2.2.1.14 Receiver Audio Distortion

3.2.2.1.14.1 VDL Mode 3

Not Applicable.

3.2.2.1.14.2 DSB-AM

a) The total distortion in the main and local audio output **shall**$_{59}$ not be more than 2.0 percent for 30 percent modulation or more than 5.0 percent for 90 percent modulation with any RF input level between -67 dBm and -27 dBm, for input tones varying between 300 Hz and 3.0 kHz.

3.2.2.1.15 Receiver Audio Frequency Response

3.2.2.1.15.1 VDL Mode 3

Not Applicable.

3.2.2.1.15.2 DSB-AM

a) With an RF input signal between -102 dBm and -7 dBm modulated 90 percent, the maximum variation in the main and local audio output **shall**$_{60}$ not be more than ± 2.0 dB between 300 Hz and 3.0 kHz.
b) Above 3.0 kHz, the main and local audio output **shall**$_{61}$ decrease as the frequency increases.
c) The main and local audio output **shall**$_{62}$ be down at least 20.0 dB at 10.0 kHz.
d) Below 300 Hz, the main and local audio output **shall**$_{63}$ decrease as the frequency decreases and be down at least 10.0 dB at 100 Hz.

3.2.2.1.16 Receiver Squelch

3.2.2.1.16.1 Squelch

3.2.2.1.16.1.1 VDL Mode 3

For VDL Mode 3 see Coded Squelch defined in the MASPS. See also Appendix C, section 1.1.9.

3.2.2.1.16.1.2 DSB-AM

a) The MDR receiver **shall**$_{64}$ have a carrier to noise type of squelch system.
b) In the squelch-on condition, there **shall**$_{65}$ be no audio output with an RF input of -97 dBm, AM modulated 30 percent with a 1004 Hz tone.
c) Main and local audio level spikes due to squelch **shall**$_{66}$ be 20.0 dB below the audio alignment level under any operating conditions. (The alignment level may be between -25 dBm to +20 dBm; in general, it is –8 dBm.)

3.2.2.1.16.2 Receiver Squelch Adjustment, Sensitivity, and Hysteresis

3.2.2.1.16.2.1 VDL Mode 3

Not Applicable.

3.2.2.1.16.2.2 DSB-AM

a) The squelch adjustment **shall**$_{67}$ provide the means to control squelch sensitivity locally using the MDT and/or remotely via RIU.
b) The MDR receiver main and local audio **shall**$_{68}$ be enabled when both an audio Signal-to-Noise ratio and RF power level exceed threshold values defined in c) and d) below.
c) The audio Signal-to-Noise threshold value **shall**$_{69}$ be adjustable (± 2 dB) anywhere in the range of +5 dB (minimum) to +15 dB.
d) The RF Continuous Wave (CW) power level threshold value **shall**$_{70}$ be adjustable (± 2 dB) from –102 dBm to –50 dBm.
e) Squelch closing histeresis on the RF power level **shall**$_{72}$ be not less than 2 dB and not greater than 5 dB with respect to the RF CW threshold level to which the MDR receiver is adjusted.

3.2.2.1.16.3 Receiver Squelch Attack and Release Times

3.2.2.1.16.3.1 VDL Mode 3

Not Applicable.

3.2.2.1.16.3.2 DSB-AM

a) With any RF input signal level between -97 dBm and -7 dBm, AM modulated 30 percent with a 1004 Hz tone, the squelch attack time **shall**$_{73}$ not exceed 10 ms.
b) The release time **shall**$_{74}$ not exceed 35 ms.

3.2.2.1.17 Collocation

3.2.2.1.17.1 VDL Mode 3

a) While in a fixed tuned configuration, the VDL Mode 3 sensitivity requirements defined in section 3.2.2.1.3 **shall**$_{75}$ not be degraded by more than 8 dB (-92 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt output, DSB-AM modulated 90 percent with a 400 Hz tone or a 15 watt VDL Mode 3 transmitter with four slots active and in time synchronization with the desired signal, when the frequency separation and transmit-receive path isolation in Case A or Case B below is provided.

b) While in a remotely tunable configuration, the VDL Mode 3 sensitivity requirements defined in section 3.2.2.1.3 **shall**$_{(387)}$ not be degraded by more than 14 dB (-86 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt output, DSB-AM modulated 90 percent with a 400 Hz tone or a 15 watt VDL Mode 3 transmitter with four slots active and in time synchronization with the desired signal, when the frequency separation and transmit-receive path isolation in Case A below is provided.

c) While in a remotely tunable configuration, the VDL Mode 3 sensitivity requirements defined in section 3.2.2.1.3 **shall**$_{(388)}$ not be degraded by more than 28 dB (-72 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt output, DSB-AM modulated 90 percent with a 400 Hz tone or a 15 watt VDL Mode 3 transmitter with four slots active and in time synchronization with the desired signal, when the frequency separation and transmit-receive path isolation in Case B below is provided.

Case A

(1) VHF Path isolation of 42 dB (80 feet/24 meters) between receive and transmit antennas
(2) Transmit/Receive frequency separation of 0.5 MHz or greater

Case B

(1) VHF Path isolation of 28 dB (8 feet/2.4 meters) between receive and transmit antennas
(2) Transmit/Receive frequency separation of 2.0 MHz or greater

Note: For a definition of fixed tuned configuration and remotely tunable configuration see section 6.2.12.

3.2.2.1.17.2 DSB-AM

a) While in a fixed tuned configuration, the DSB-AM sensitivity requirements defined in section 3.2.2.1.3 **shall**$_{77}$ not be degraded by more than 10 dB (-92 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt output, DSB-AM modulated 90 percent with a 400 Hz tone or in the presence of a 15 watt VDL Mode 3 transmitter with four slots active, when the frequency separation and transmit-receive path isolation in Case A or Case B below is provided.

b) While in a remotely tunable configuration, the DSB-AM sensitivity requirements defined in section 3.2.2.1.3 **shall$_{(389)}$** not be degraded by more than 16 dB (-86 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt output, DSB-AM modulated 90 percent with a 400 Hz tone or in the presence of a 15 watt VDL Mode 3 transmitter with four slots active, when the frequency separation and transmit-receive path isolation in Case A below is provided.

c) While in a remotely tunable configuration, the DSB-AM sensitivity requirements defined in section 3.2.2.1.3 **shall$_{(390)}$** not be degraded by more than 30 dB (-72 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt output, DSB-AM modulated 90 percent with a 400 Hz tone or in the presence of a 15 watt VDL Mode 3 transmitter with four slots active, when the frequency separation and transmit-receive path isolation in Case B below is provided.

Case A

(1) VHF Isolation of 42 dB (80 feet/24 meters) between receive and transmit antennas

(2) Transmit/Receive frequency separation of 0.5 MHz or greater

Case B

(1) VHF Isolation of 28 dB (8 feet/2.4 meters) between receive and transmit antennas

(2) Transmit/Receive frequency separation of 2.0 MHz or greater

3.2.2.1.18 Receiver Adjacent Channel Rejection

3.2.2.1.18.1 VDL Mode 3

a) The uncorrected BER requirement as defined in section 3.2.2.1.2 **shall$_{79}$** be achieved in the presence of a -53 dBm adjacent channel (centered on ± 25 kHz) interfering VDL Mode 3 signal in addition to a -97 dBm desired signal applied to the receiver input.

3.2.2.1.18.2 DSB-AM

a) The AM sensitivity requirement as defined in section 3.2.2.1.3 **shall$_{80}$** not be degraded by more than 3 dB in the presence of a -53 dBm adjacent channel (centered on ± 25 kHz) interfering AM signal, modulated 90 percent with a 400 Hz tone.

3.2.2.1.19 Receiver Rejection of Signals Outside the VHF Band

VDL Mode 3 and DSB-AM

a) The BER requirement for a VDL Mode 3 receiver **shall$_{81}$** be achieved when any of the below specified unwanted signals is applied in addition to the wanted signal set at an RF signal level of -98 dBm at the receiver antenna connector.

b) The DSB-AM sensitivity (see section 3.2.2.1.3.2) **shall$_{82}$** not be degraded to a value worse than 10 dB SINAD when any of the below specified unwanted signals is applied in addition to the wanted signal set at an RF signal level of -100 dBm at the receiver antenna connector.

Unwanted signal, requirement A:
Level : - 33 dBm
Modulation : None
Frequency range : 108-156 MHz (excluding the range 111.975-137.000 MHz)
Note: A degradation of 10 dB in sensitivity is allowed for signals within 3 MHz of the range limits of 112.000 to 137.000 MHz

Unwanted signal, requirement B:
Level : - 7 dBm
Modulation : None
Frequency range : 50 kHz-1215 MHz (excluding the range 87.5-156 MHz)

Unwanted signal, requirement C:
Level : - 4 dBm
Modulation : None
Frequency range : 87.5-107.9 MHz
Note: The level should be +5 dBm (goal).

3.2.2.1.20 Reserved

3.2.2.1.21 Receiver Desired Signal Dynamic Range

3.2.2.1.21.1 VDL Mode 3

a) The MDR receiver **shall**$_{84}$ achieve the uncorrected BER requirement (see section 3.2.2.1.2) when operating with desired signal levels from –100 dBm up to -7 dBm at the MDR receiver antenna input.

3.2.2.1.21.2 DSB-AM

a) The MDR receiver **shall**$_{85}$ achieve a SINAD of 10 dB or greater when operating with desired signals modulated 90 percent with a 1004 Hz tone at an RF level from –102 dBm up to – 7 dBm at the MDR receiver antenna input.
b) The MDR receiver **shall**$_{86}$ not be blocked with inputs up to +13 dBm where blocking is defined as a 3 dB reduction in the audio output level referenced to the audio level setting at an RF input level of –7 dBm.

3.2.2.1.22 Receiver Symbol Rate Capture Range

3.2.2.1.22.1 VDL Mode 3

a) The sensitivity requirement of section 3.2.2.1.3 **shall$_{87}$** be achieved when a desired signal is applied to the MDR receiver antenna connector, with a symbol rate offset of seven (7) PPM (5 PPM airborne tolerance +2 PPM Doppler shift) from the nominal symbol rate of 10,500 symbols per second (see section 3.2.1.2.1).

3.2.2.1.22.2 DSB-AM

Not Applicable.

3.2.2.1.23 Receiver Frequency Capture Range

3.2.2.1.23.1 VDL Mode 3

a) The MDR receiver **shall$_{88}$** support synchronization acquisition and meet the sensitivity requirement of section 3.2.2.1.3 with a maximum carrier frequency offset of ± 825 Hz from nominal for air/ground communications.

Note: This value takes into account the transmitter frequency error (685 Hz) from an airborne transmitter, and the air to ground transmission Doppler shift (140 Hz).

3.2.2.1.23.2 DSB-AM

a) The MDR receiver **shall$_{(369)}$** meet the sensitivity requirement of section 3.2.2.1.3 with a maximum carrier frequency offset of ± 825 Hz from nominal for air/ground communications.

Note: This value takes into account the transmitter frequency error (685 Hz) from an airborne transmitter, and the air to ground transmission Doppler shift (140 Hz).

3.2.2.1.24 Receiver Doppler Rate

3.2.2.1.24.1 VDL Mode 3

a) The sensitivity requirement of section 3.2.2.1.3 **shall$_{89}$** be met with a carrier frequency change rate of 18 Hz/s within the entire range of Doppler shift ± 140 Hz, and meeting the requirement of section 3.2.2.1.23.1.

3.2.2.1.24.2 DSB-AM

a) The MDR receiver **shall$_{(370)}$** meet the sensitivity requirement of section 3.2.2.1.3 with a carrier frequency change rate of 18 Hz/s within the entire range of Doppler shift ± 140 Hz .

3.2.2.1.25 Receiver Co-Channel Interference

3.2.2.1.25.1 VDL Mode 3

a) The uncorrected BER requirement under a co-channel interference condition **shall**$_{90}$ be achieved when a ratio of wanted to unwanted signal of at most 20 dB is applied at the receiver antenna input connector. The co-channel interference protection will be measured using a VDL Mode 3 signal at a desired signal level of -87 dBm and –50 dBm.

Note: The interfering signal will be a continuous D8PSK waveform modulated with a pseudo-random sequence. The symbol rate clocks of the desired and the interfering signal will differ by at least 1 ppm. The pseudo-random sequences used for the desired and undesired signal will be different lengths and the ratio of lengths will not be an integer. The difference of 1 ppm in symbol rate clocks between the desired and interfering signals will guard against continual bit alignment between desired and undesired signals that could lead to non-repeatable BER measurements.

3.2.2.1.25.2 DSB-AM

Not Applicable.

3.2.2.1.26 Receiver Automatic Gain Control (AGC) Stabilization

3.2.2.1.26.1 VDL Mode 3

Not Applicable.

3.2.2.1.26.2 DSB-AM

a) It **shall**$_{92}$ be possible to obtain 10 dB SINAD with the minimum signal specified (see section 3.2.2.1.17.2, Case B) not later than 20 milliseconds after insertion of a +14 dBm CW signal ±2 MHz away from the frequency to which the MDR receiver is tuned.

b) It **shall**$_{93}$ be possible to obtain 10 dB SINAD with the minimum signal specified (see section 3.2.2.1.3) not later than 150 milliseconds after removal of a +14 dBm CW signal ±2 MHz away from the frequency to which the MDR receiver is tuned.

3.2.2.1.27 Receiver Internal Noise Level

3.2.2.1.27.1 VDL Mode 3

Not Applicable.

3.2.2.1.27.2 DSB-AM

a) For a –85 dBm RF input signal AM modulated at 30 percent with a 1004 Hz tone, the SINAD at the MDR receiver audio output **shall**$_{94}$ be at least 25 dB.

3.2.2.2 MDR Transmitter Requirements

a) There **shall**$_{95}$ be two configurations of transmitters: 1) one configuration with an output power level adjustable from 2 watts to 15 watts, and 2) a configuration with an output power level adjustable from 10 watts to 50 watts.

3.2.2.2.1 Transmitter Digital and Audio Interfaces

a) There **shall**$_{96}$ be three audio inputs to the transmitter: 1) analog voice from the control site, 2) analog local voice from the jack on the front panel of the transmitter, and 3) PCM voice from the RIU.
b) The transmission of the voice input **shall**$_{97}$ be PTT controlled except for PCM voice, where the presence and absence of the voice packets implies a PTT.
c) Only one of the three audio inputs **shall**$_{98}$ be active at one time.
d) The MDR transmitter **shall**$_{(371)}$ receive a PTT signal from the RCE or RIU for analog voice originating from the control site.
e) Remote PTT and audio from the control site **shall**$_{(372)}$ have priority over local PTT and audio.

3.2.2.2.1.1 VDL Mode 3

a) The digital interface **shall**$_{100}$ carry digitized voice with time-multiplexed user data, control signals, timing signals, and RMMC information between the transmitter and the RIU.
b) Voice **shall**$_{101}$ have priority over monitoring data. See section 3.2.3.3.

3.2.2.2.1.2 DSB-AM

a) The MDR transmitter **shall**$_{102}$ have a main audio input at the rear of the transmitter. See section 3.3.1.4.
b) The main audio input **shall**$_{103}$ have a balanced 600 ohm (± 10 percent) impedance.
c) There **shall**$_{104}$ be provisions for a local audio input from a push-to-talk microphone. See section 3.3.1.6.
d) The microphone **shall**$_{105}$ plug directly into the front panel of the transmitter. See section 3.3.1.6.

3.2.2.2.1.2.1 DSB-AM PCM Voice Transmission

a) The transmit MDR **shall**$_{(447)}$ perform DSB-AM modulation on the linear Pulse Code Modulation (PCM) sample stream provided by the RIU at a sampling rate of 8,000 16-bit PCM samples per second. The format of the PCM messages sent by the RIU is specified in NAS-IC-41033502.
b) At the start of a new uplink PCM voice transmission that requires more than one PCM message (EOM field = 0 in first PCM message), the transmit MDR **shall**$_{(448)}$ begin DSB-AM voice modulation between 0 and 9 milliseconds after the receipt of the second complete PCM message in the voice transmission from the RIU.
c) If the entire voice transmission requires less than two PCM messages (EOM field = 1 in first PCM message), the MDR **shall**$_{(449)}$ begin DSB-AM voice modulation no later than 9 milliseconds after the receipt of the PCM message HDLC end FLAG from the RIU.
d) After an uplink PCM DSB-AM uplink voice transmission has begun, the MDR **shall**$_{(450)}$ continuously modulate DSB-AM voice, while the HDLC end FLAG for each PCM message is

received from the RIU at least 7.5 milliseconds prior to the time when the first PCM sample in the PCM message is required to be modulated.

3.2.2.2.2 Transmitter Time-Out

3.2.2.2.2.1 VDL Mode 3

The RIU will implement the time-out for VDL Mode 3.

3.2.2.2.2.2 DSB-AM

a) The transmitter **shall**$_{106}$ contain a time-out function for protection against, and the elimination of, extended periods of inadvertent continuous keying. See Table 3-3.
b) This adjustable transmitter time-out **shall**$_{107}$ range from 5 seconds up to 5 minutes in 5-second steps (limiting the maximum continuous keying of the transmitter to this time period).
d) The time-out feature **shall**$_{108}$ have provisions for disabling (see section 3.2.3.2 and Table 3-3) to allow the transmitter unlimited continuous transmit operation.

3.2.2.2.3 Transmitter Distortion

3.2.2.2.3.1 VDL Mode 3

a) The error vector magnitude (EVM) of the D8PSK transmitted I/Q constellation **shall**$_{109}$ be not greater than 5 percent.

3.2.2.2.3.2 DSB-AM

a) With a transmitter is modulated 90 percent with an audio frequency between 300 Hz and 3.0 kHz, the modulation distortion **shall**$_{112}$ not exceed 5 percent, when the audio input level setting is varied from -25.0 dBm to +20.0 dBm.
b) Under the same conditions, with maximum limiting (see section 3.2.2.2.4.2), the modulation distortion **shall**$_{111}$ not exceed 10 percent.

3.2.2.2.4 Transmitter AM Modulation Level

3.2.2.2.4.1 VDL Mode 3

Not Applicable.

3.2.2.2.4.2 DSB-AM

a) The MDR transmitter **shall**$_{113}$ contain audio compression and limiting circuitry that prevents overmodulation of the carrier under all conditions and to retain a modulation level of 90 percent (± 10 percent) for a 1004 Hz tone under a variable audio input level from –25.0 dBm to +20.0 dBm when either the analog or PCM voice is used.

3.2.2.2.5 Transmitter RF Output Power

a) The MDR transmitter **shall$_{114}$** be stable when operating in any mode at any power level for a load Voltage Standing Wave Ratio (VSWR) up to and including 3.0:1.
b) The MDR transmitter **shall$_{115}$** not suffer any damage nor suffer subsequent performance degradation, i.e., meets all its requirements, when transmitting in any mode at any power level into a complex impedance of any magnitude and phase, including open and short circuit terminations.
c) The MDR transmitter **shall$_{116}$** operate at a VSWR of 2.0:1 or less with no damage, with no part exceeding dissipation limits and with no performance degradation.

3.2.2.2.5.1 VDL Mode 3

a) VDL Mode 3, 15 Watts Maximum Power Output
   1) The MDR transmitter RF output power averaged over a voice/data (V/D) transmit burst interval **shall$_{117}$** be adjustable in 1 dB steps over the range from 2 watts to 15 watts into a nominal 50-ohm load impedance.
   2) The MDR transmitter **shall$_{118}$** perform this function during continuous ground transmit operation in any VDL Mode 3 system configuration.
   3) The MDR transmitter **shall$_{119}$** deliver not less than 50 percent of the set RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.
b) VDL Mode 3, 50 Watts Maximum Power Output
   1) The MDR transmitter RF output power averaged over a voice/data (V/D) transmit burst interval **shall$_{120}$** be adjustable in ½ dB steps over the range from 10 watts to 50 watts into a nominal 50-ohm load impedance.
   2) The MDR transmitter **shall$_{121}$** perform this during continuous ground transmit operation in any VDL Mode 3 system configuration.
   3) The MDR transmitter **shall$_{122}$** deliver not less than 50 percent of the set RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.

3.2.2.2.5.2 DSB-AM

a) DSB-AM, 15 Watts Maximum Power Output
   1) The MDR transmitter **shall$_{124}$** deliver a minimum of 15 watts into a nominal 50 ohm load impedance when transmitting a continuous wave (CW) signal.
   2) The MDR transmitter **shall$_{125}$** be adjustable in 1 dB steps over the range from 2 watts to 15 watts.
   3) The MDR transmitter **shall$_{126}$** deliver not less than 50 percent of the set CW RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.
b) DSB-AM, 50 Watts Maximum Output
   1) The MDR transmitter **shall$_{128}$** deliver a minimum of 50 watts into a nominal 50 ohm load impedance when transmitting a CW signal.
   2) The MDR transmitter **shall$_{129}$** be adjustable in nominal 5 watt (±1 watt) steps over the range from 10 watts to 50 watts maximum unmodulated CW RF power.
   3) The MDR transmitter **shall$_{130}$** deliver not less than 50 percent of the set CW RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.

3.2.2.2.5.3 TDMA Slot Power Setting Requirements

a) The MDR transmitter **shall$_{131}$** have the ability to change the power in each TDMA slot for VDL Mode 3 operation.
Note: The power in each slot is the same for each burst. The power per slot may be changed whenever a transmitter is retuned. The power is assignable over the range of the power specified in this specification. An example of this requirement for a 15 watt transmitter may be: Slot 1 – 2 watts, Slot 2 – 7 watts, Slot 3 – 15 watts, and Slot 4 – 4 watts.

3.2.2.2.5.4 Transmitter Leakage

3.2.2.2.5.4.1 Transmit/Receive Configuration

VDL Mode 3 and DSB-AM

a) The transmitter leakage in the transmit/receive (T/R) configuration **shall$_{132}$** not interfere with the MDR receiver operation.

3.2.2.2.5.4.2 Non-Transmit/Receive Configuration

VDL Mode 3 and DSB-AM

a) In the non-transmit/receive configuration the MDR transmitter **shall$_{134}$** not produce more than -97 dBm in-band leakage when unkeyed measured at the MDR receiver.

3.2.2.2.6 Transmitter Back Intermodulation

VDL Mode 3 and DSB-AM

a) In the fixed tuned configuration, the amplitude of each radio frequency back intermodulation product **shall$_{135}$** be at least 40 dB below the amplitude of an interfering signal fed into the MDR transmitter output connector at 28 dB below the transmitter maximum output level and spaced ± 2 MHz from the MDR transmitter output frequency.

3.2.2.2.7 Transmitter Duty Cycle

3.2.2.2.7.1 VDL Mode 3

a) The MDR transmitter **shall$_{136}$** operate at a 79.5 percent unattended duty cycle at the maximum rated output.

3.2.2.2.7.2 DSB-AM

a) The MDR transmitter **shall$_{137}$** operate at a 100 percent continuous unattended duty cycle at the maximum rated output.

3.2.2.2.8 Transmitter Spurious Emissions

VDL Mode 3 and DSB-AM

a) Spurious emission levels **shall$_{138}$** meet the limits imposed by the transmit mask of section 3.2.2.2.10.

Note: Spurious emissions exclude the harmonics specified in section 3.2.2.2.9.

3.2.2.2.9 Transmitter Harmonic Output

VDL Mode 3 and DSB-AM

a) The level of each harmonic frequency of the carrier **shall**$_{139}$ be less than -80.0 dBc (-65 dBm within the Global Positioning System (GPS) band) when measured at the antenna connector. This measurement will be at full power level for both 15 watt and 50 watt transmitters for both VDL Mode 3 and DSB-AM.

Note: In order to provide adequate protection of a Global Navigation Satellite System (GNSS) receiver when a VDL transmitter is operated, special care should be taken by the manufacturer to ensure that the transmitter harmonic filter remains effective at frequencies in the band 800 to 1800 MHz.

3.2.2.2.10 Transmitter Adjacent Channel Power

a) 15 Watt and 50 Watt Transmitters, Fixed-Tuned Configuration, VDL Mode 3 and DSB-AM Modulated 90 Percent with a 1004 Hz Tone

1) While in a fixed tuned configuration, the amount of power from a MDR transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the first adjacent channel **shall**$_{140}$ not exceed -40 dBc (-62 dBc in center 16 kHz).
2) The amount of power from an MDR transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the second and third adjacent channels **shall**$_{141}$ be -65 dBc maximum, -70 dBc maximum for the fourth through seventh adjacent channels, -75 dBc maximum for the eighth through fifteenth adjacent channels, -92 dBc maximum for the sixteenth through nineteenth adjacent channels, and -113 dBc maximum for any frequency greater than 500 kHz from the tuned channel center and –137 dBc maximum for any frequency greater than 2 MHz from the tuned channel center. (See Figure 3-1 below.)

b) 15 Watt and 50 Watt Transmitters, Remotely Tunable Configuration, VDL Mode 3 and DSB-AM Modulated 90 Percent with a 1004 Hz tone)

1) While in a remotely tunable configuration, the amount of power from a MDR transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the first adjacent channel **shall**$_{(391)}$ not exceed -40 dBc (-62 dBc in center 16 kHz).
2) The amount of power from an MDR transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the second and third adjacent channels **shall**$_{(392)}$ be -65 dBc maximum, -70 dBc maximum for the fourth through seventh adjacent channels, -75 dBc maximum for the eighth through fifteenth adjacent channels, -92 dBc maximum for the sixteenth through nineteenth adjacent channels, and -107 dBc maximum for any frequency greater than 500 kHz from the tuned channel center. (See Figure 3-1 below.)

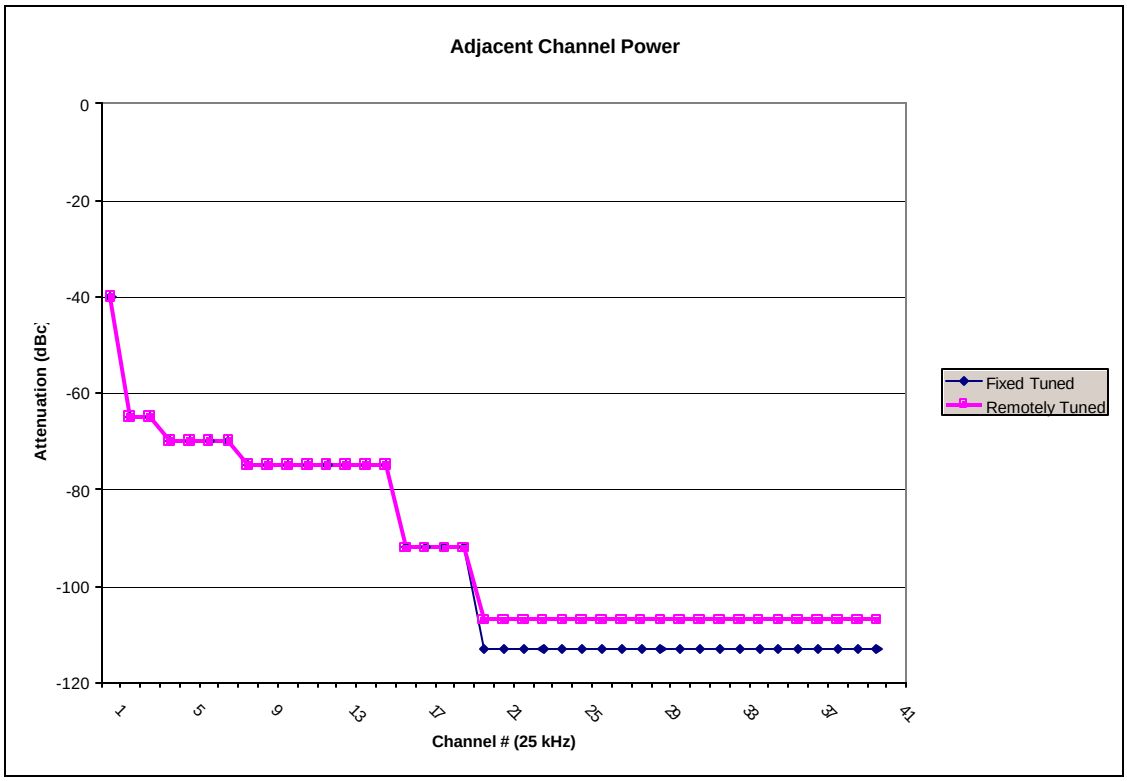


Figure 3-1, Adjacent Channel Power

3.2.2.2.11 Transmitter Carrier-Induced Noise (Residual AM)

3.2.2.2.11.1 VDL Mode 3

Not Applicable.

3.2.2.2.11.2 DSB-AM

a) The carrier induced audio noise level due to the MDR transmitting a CW signal **shall**$_{142}$ be at least 40.0 dB below the audio output measured at the MDR receiver when the carrier is modulated 90 percent with a 1004 Hz tone.

3.2.2.2.12 Transmitter Keying

3.2.2.2.12.1 VDL Mode 3

Not Applicable.

Note: The MDR transmitter keying will be controlled by the RIU.

3.2.2.2.12.2 DSB-AM

a) The MDR transmitter **shall**$_{143}$ accept both local and remote keying signals.

b) The local keying signal **shall$_{144}$** be via a push-to-talk microphone connected directly to the transmitter front panel microphone jack. See section 3.3.1.6.
c) Remote keying signals **shall$_{145}$** be via the application of a ground, or alternately, +6 VDC to +48 VDC. See section 3.3.1.4.
d) The remote keying signals for current or voltage control **shall$_{146}$** be on separate pins of the MDR transmitter remote interface connector.
e) Remote keying signals **shall$_{147}$** take priority over local keying signals when the MDR transmitter is on-line.
f) For ground keying, the source current required **shall$_{148}$** not exceed 10 milliamperes and not generate a pull-up voltage exceeding 40 volts.
g) The keying time **shall$_{149}$** not exceed 15 milliseconds as measured from the application of a key signal to the time when the MDR transmitter is at 90 percent of the full power level.
h) The MDR transmitter **shall$_{150}$** continue to transmit while the keying signal is present per item 3.2.2.2.12.2c above.
i) The sink current **shall$_{151}$** not exceed 0.5 ma with voltage keying.
j) An open keyline **shall$_{(373)}$** be interpreted as non-keyed.

3.2.2.2.13 Transmitter Frequency Tolerance

VDL Mode 3 and DSB-AM

a) The MDR transmitter frequency tolerance **shall$_{152}$** be ± 0.0001 percent (±1.0 PPM) for any period of one year over the full frequency range specified in section 3.2.1.1.1, and the temperature range specified in section 3.2.1.1.1.
b) The oscillator **shall$_{(393)}$** have a tuning adjustment adequate to compensate for 10 years of operational use.
c) As a minimum, the adjustment range **shall$_{(394)}$** be ± 3 PPM.
d) The frequency **shall$_{(395)}$** be adjustable within ± 1 PPM.

3.2.2.2.14 Antenna Transfer Relay (ATR) Operation

a) The MDR receiver and transmitter **shall$_{(374)}$** include an ATR function, supported in both DSB-AM and VDL Mode 3 modes, which connects the local MDR and remote MDR(s) to a single antenna. *Note: Envisioned configurations of multiple MDRs are described in Section 6,3. The concept of the ATR function is illustrated in Figure 6-1, Section 6.2.12.*
b) The ATR **shall$_{(375)}$** support the following antenna configurations:
   1) Transmitter/Receiver on the same frequency for transceive (T/R) operation (see Figure 6-2);
   2) Transmitter/transmitter on the same frequency for main/standby (TX M/S) operation (see Figure 6-3);
   3) Receiver/receiver on the same frequency for main/standby (RX M/S) operation (see Figure 6-4);
   4) Two transmitters/two receivers to support main/standby transceive (T/R M/S) operation with all on the same frequency (see Figure 6-5).
c) When the antenna is in use by the local MDR (actively transmitting or receiving), the ATRC (common) connector input **shall$_{(376)}$** be routed through the ATR circuitry to the ATR2 connector.

d) When the antenna is not in use by the local MDR, the ATRC (common) connector input **shall**$_{(377)}$ be routed through the ATR circuitry to the ATR1 connector.
e) The MDR **shall**$_{(378)}$ have priority access to the ATRC to ATR2 connector path to permit the MDR to access the transmission.
f) Failure of the MDR **shall**$_{(379)}$ not prevent or degrade the ATRC to ATR1 path (e.g., the failed or default Path is ATRC to ATR1).
g) The ATR **shall**$_{(380)}$ switch fast enough for interslot and intraslot VDL Mode 3 operation. *(This includes receiving an M Burst from a maximum range aircraft and then having to transmit a V/D burst.)*
h) In the T/R configuration, the ATR **shall**$_{(381)}$ provide sufficient isolation between the ATR1 and ATR2 connector paths during MDR transmissions (ATRC to ATR2) to prevent signals stronger than –7 dBm from reaching the MDR receiver (ATR1).
i) In the T/R configuration, the ATR **shall**$_{(382)}$ provide sufficient leakage from the MDR transmitter (ATR2) to the MDR receiver (ATR1) to allow the MDR receiver(s) to monitor if the MDR transmitter is operating, without damaging the MDR receiver(s).
j) In the TX M/S configuration, the ATR **shall**$_{(383)}$ provide sufficient isolation between the ATR1 and ATR2 connector paths during standby MDR transmissions (ATRC to ATR1) to prevent damage to the main MDR transmitter (ATR2).
k) The ATR operation **shall**$_{(384)}$ allow for the use of the internal cavity filter and/or an external RF filter in any configuration (see Figures 6-2 through 6-5).
l) MDR **shall**$_{(385)}$ be equipped with external, removable jumpers capable of operational use to provide connectivity between the MDR RF and ATR2 connectors, the MDR RF to CF1 (In) connectors, and the CF2 (Out) to ATR2 connectors.

3.2.3 Site Control and Monitoring

a) The MDR **shall**$_{155}$ contain an embedded agent to provide status monitoring and operational control capability. The managed subsystem agent provides a user interface capability, wherein the users are defined as the controllers at Air Traffic Control (ATC) facilities and/or the Airway Facilities (AF) system specialists at the radio site, and personnel using the NAS Infrastructure Management System (NIMS) to monitor and control the NEXCOM System via the RIU.
b) The monitoring of functional requirements and verification methods **shall**$_{156}$ be in accordance with FAA-E-2911.

3.2.3.1 MDR Control

a) The MDR control functions **shall**$_{157}$ support real-time system management actions from the following two control points:
   1) Maintenance Data Terminal (MDT) connector located on the front of the MDR receiver and transmitter provides local control. See section 3.3.2.1.
   2) RIU data connector located on the rear of the MDR receiver and transmitter provides remote control. See section 3.3.2.2.

3.2.3.1.1 Maintenance Data Terminal (MDT) Interface

Appendix D contains a description of the MDT functionality. The following requirements, which support the MDT operation, apply to the MDR receiver and transmitter:

a) The MDR **shall**$_{158}$ accept control input, provide monitoring output and alarm/alert indications via the MDT connector.
b) The MDR **shall**$_{159}$ require the MDT to perform a valid log-on procedure, in accordance with Section 3.2.3.9, before accepting any commands or outputting monitoring parameters via the MDT connector.
c) The MDR **shall**$_{(451)}$ log out an MDT that has been logged in but inactive for more than 30 minutes.
d) The MDR **shall**$_{160}$ continue to operate upon removal of the MDT.

3.2.3.1.2 Remote Maintenance Monitoring and Control

a) The MDR/RIU data connector **shall**$_{161}$ provide the means to control and monitor the MDR via the RIU.
b) The monitor and control attributes **shall**$_{162}$ be in accordance with the MDR/RIU ICD, NAS-IC-410335022.

3.2.3.2 Site Control Parameter Adjustments

a) The MDR **shall**$_{163}$ provide the means to modify various control parameters of the MDR receiver and transmitter summarized in Table 3-3.
b) The MDR site adaptable parameters **shall**$_{164}$ be such that authorized personnel can select and modify any of the site adaptable parameters stored in the MDR.
c) The initiation and control of the site adaptation function **shall**$_{165}$ be performed using either the MDT or the RIU.
d) It **shall**$_{166}$ be possible to adjust parameters while the system is in operation (online) without affecting the operation of the system.
e) The MDR receiver and transmitter **shall**$_{167}$ provide a means to control the parameters defined in Table 3-3.
f) The MDR receiver and transmitter **shall**$_{(452)}$ set parameters to within the tolerance of the associated monitoring parameter (i.e., same Parameter ID). Note that in some cases the step size is finer than the resolution to allow for finer tuning of the parameters using exterior test equipment.
g) The MDR **shall**$_{(453)}$ refuse any attempt to alter parameter settings until a valid, authenticated Log-In parameter is received via the interface attempting control.
h) The control parameter value ranges, maximum step sizes and default values are summarized in Table 3-3.

Table 3-3: Receiver and Transmitter Control Parameters

ID	Parameter	Type	Min	Max	Step	Initialization Default	Applicability: TX, RX, Both
1	**Log-In/Log Out**: The Log-In/Log Out parameter allows the log-in through an MDT/RIU and allows the MDT/RIU initiated Log-Out.	Discrete values: Date/Time, User ID, User Terminal ID, Security Token	N/A	N/A	N/A	N/A	Both
2	**Current Frequency**: The Current Frequency parameter sets the desired current frequency of the MDR receiver and transmitter.	Multiple discrete frequency values	112.000 000 MHz or Lowest Tunable Freq.	136.975 00 MHz	8.33 kHz	118.00000 MHz	Both
3	**Lowest Tunable Frequency**: The Lowest Tunable frequency parameter sets the minimum frequency that the MDR can be tuned.	Multiple discrete frequency values	112.000 000 MHz	118.000 000 MHz	25 kHz	118.00000 MHz	Both
4	**Mode of Operation**: The Mode of Operation parameter sets whether MDR component is in the 25kHz DSB-AM, 8.33kHz DSB-AM, or VDL Mode 3.	Three values (representing the modes)	N/A	N/A	N/A	25 kHz DSB-AM	Both
5	**MDR State** : The MDR State parameter instructs the MDR component to alter its operational state (four discrete values: Power Up, Power Down, Offline, Online).	One of four discrete values (representing the controllable states)	N/A	N/A	N/A	Offline	Both
6	**Threshold Setting**: The Threshold Setting parameter provides new alert and alarm threshold values for the various monitoring parameters. This parameter includes the parameter ID and the new alert and alarm thresholds.	Parameter values (see Table 3-4) Anywhere in range of parameter	-	-	-	See Table 3-4	Both
7	**Time:** The Time parameter sets the time of the clock in the MDR receiver and MDR transmitters used for time stamping log entries.	Time in the format MM/DD/YYYY HH:MM:SS.SS	N/A	N/A	N/A	01/01/2000 00:00:00.00	Both
8	**Squelch Setting (AM)**: The receiver Squelch Setting parameter sets the RF power squelch thresholds for the DSB-AM modes.	Discrete Settings	0	63	1	3	RX
9	RESERVED	--	-	-	-	-	-
10	**Audio Output Level (AM)**: The Audio Output Level parameter sets the desired audio output level on the main audio connector of the MDR receiver.	Power in dBm	-25 dBm	20 dBm	1 dB	-8 dBm	RX
11	**Receiver Mute (AM)**: The Receiver Mute parameter mutes or unmutes the MDR receiver for DSB-AM.	Two values: Muted, Unmuted	N/A	N/A	N/A	Unmuted	RX
12	**Power Output (AM)**: The Power Output parameter sets the MDR Transmitter RF output power (CW). (Values in upper Part: 15W max TX, values in lower part 50W max TX).	Power values in dBm	33 dBm 40 dBm	42 dBm 44 dBm	1 dB 0.5 dB	33 dBm 40 dBm	TX

Table 3-3: Receiver and Transmitter Control Parameters (Continued)

ID	Parameter	Type	Min	Max	Step	Initialization Default	Applicability: TX, RX, Both
13	**Transmitter Modulation % (AM)**: The Transmitter Modulation % parameter sets the MDR Transmitter modulation percentage for DSB-AM modes.	Percent	0%	100%	100 steps	90%	TX
14	**ATR Switch Configuration:** The ATR Switch Configuration parameter indicates how the MDR controls the connection to the antenna. (The 2 discrete values are: Local and Remote).	Two Discrete values: Local, Remote	N/A	N/A	N/A	Local	TX
15	**Switch Software Version:** This is an action signal that indicates to the equipment to reboot to the stored software image indicated. (For safety the MDR requires two successive switch signals within a defined short time period (less than 1 sec)).	One Value: Switch SW Version	N/A	N/A	N/A	N/A	Both
16	**N1 (Number of Information Bits):** This parameter sets the value of the number of bits in the information fields.	Number of Bits	128	4096	8	512; 1976 for PCM Voice	N/A
17	**T1 (Link Response Timer):** This parameter sets the link response timer.	Ms	100	500	1	200	N/A
18	**T3 (Reassembly Timer):** This parameter sets the reassembly timer.	Ms	50	240	1	100	N/A
19	**HDLC Channel Number**: HDLC channel to use for MDR per NAS-IC-41033502	Five Discrete numbers	1	5	1	1	Both
20	**Transmission Timeout (AM)**: The Transmission Timeout parameter sets the time-out value or disables the timer. Setting the value for a disabled timer will re-enable the timer.	Seconds	0 sec (Disabled)	300 sec	5 sec	35 sec	TX
21	**Squelch On/Off**: This command activates or deactivates the squelch feature of the MDR.	Two Discrete: On, Off	N/A	N/A	N/A	ON	RX
30	**Request Read Back**: The Read Back Request parameter informs the MDR component to send the applicable information for the desired monitoring parameter	Three Words: Monitoring Parameter ID, Iterations, Interval	N/A	N/A	N/A	N/A	Both
31	**Audio Input level (AM)**: The transmitter Audio Input Level parameter sets the desired audio input level on the main audio connector of the MDR transmitter.	Power in dBm	-25 dBm	+20 dBm	0.5 dB	-8 dBm	TX
32	RESERVED	-	-	-	-	-	-
33	RESERVED	-	-	-	-	-	-

Table 3-3: Receiver and Transmitter Control Parameters (Continued)

ID	Parameter	Type	Min	Max	Step	Initialization Default	Applicability: TX, RX, Both
34	**MAC Timing Offset Correction (VDL Mode 3)**: The VDL MAC Timing Offset Correction parameter indicates the relative time correction, in microseconds, that should be applied to all MDR M-burst and V/D-burst operations, relative to the previous perceived MAC 6-second epoch in the MDR, which is derived from the receive T1 framing and Timing Channel from the RIU.	Time in µs	-32768 µs	32767 µs	1 µs	0	Both
35	**Suppress Alert/Alarm:** The Suppress Alert/Alarm parameter is an action signal to command the MDR to cease transmitting alert and alarm messages to the MDT and RIU, or resume normal alert and alarming.	Two discrete values: Suppress, Normal	N/A	N/A	N/A	Normal	Both
36	**Reset to Default**: This is an action signal that sets the equipment to default values for all parameters. (For safety the MDR requires two successive reset signals within a defined short time period (less than 1 sec)).	One value: Reset	N/A	N/A	N/A	N/A	Both
37	**Software Upload On/Off**: This is an action signal that prepares the equipment for uploading operational software. After uploading, the upload function is turned off.	Two values: Prepare Upload, Turn off Upload	N/A	N/A	N/A	Turn off Upload	Both
38	**Software Upload**: This is the mechanism for actually uploading the operational software executable image. This parameter is used in conjunction with parameter 37.	Three Fields: Block Number, Total Blocks, Binary Data (variable length)	N/A	N/A	N/A	N/A	Both
39	**Receiver Mute Level (AM)**: This command sets the attenuation level of the receiver muting.	Three Discrete values: -15dB, -20dB, no audio	N/A	N/A	N/A	No audio	RX
40	**Test PTT (AM):** This command keys the transmitter for testing purposes.	Two Discrete: KEYED, NO_KEY	N/A	N/A	N/A	NO_KEY	TX
41	**Public Key Maintenance:** Allows the MDT/RIU to add or delete MDR-stored Public keys..	Date/Time, User, User Terminal, Add/Subtract Indicator, Key, Security Token	N/A	N/A	N/A	N/A	Both

Notes:

1. The default values for each parameter represents the "hard-coded" factory settings required upon MDR initialization/power-up.
2. The parameters are numbered (parameter ID) as follows:

- 1 through 29 are control/monitor parameters that have an associated monitor/control parameter.
- 30 through 49 are control parameters that do not have an associated monitor parameter.
- 50 through 69 are monitor parameters that do not have an associated control parameter.

3. The parameter ID corresponds to the CTYPE field as defined in NAS-41033502.
4. Values in the upper part of each row are for the 15W max transmitter, values in the lower part of each row are for the 50 W max transmitter.

3.2.3.2.1 Log-In (ID = 1)

a) The log-in/log-out parameter **shall**$_{(454)}$:
   1) Allows the log-in through the MDT/RIU and allows the MDT/RIU initiated log-out.
   2) Include a date/time field, the user identifier, the user terminal identifier, and the security token.
   3) Have only the date/time, username, and terminal identifier recorded in the maintenance log.
   4) Be applicable to MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.2 Current Frequency (ID = 2)

a) The current frequency control parameter **shall**$_{(455)}$:
   1) Set the desired frequency of the MDR receiver and MDR transmitters
   2) Be a set of multiple discrete frequency values
   3) Have a minimum value of 112.00000 MHz
   4) Have a maximum value of 136.97500 MHz
   5) Have a step value of 8.33 kHz
   6) Have a default value of the last tuned frequency on Restore, 118.00000 MHz on Initialization
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.3 Lowest Tunable Frequency (ID = 3)

a) The lowest tunable frequency parameter **shall**$_{(456)}$:
   1) Set the lowest tunable frequency of the MDR receiver and MDR transmitters.
   2) Be a set of multiple discrete frequency values
   3) Have a minimum value of 112.00000 MHz
   4) Have a maximum value of 118.00000 MHz
   5) Have a step value of 25 kHz
   6) Have a default value of 118.00000 MHz
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.4 Mode of Operation (ID = 4)

a) The mode of operation parameter **shall**$_{(457)}$:

1) Set the MDR receiver and MDR transmitters in the 25 kHz DSB-AM, 8.33 kHz DSB-AM, or VDL Mode 3 modes
2) Be a set of three discrete values representing the modes
3) Have a default value of 25 kHz DSB-AM mode
4) Be applicable to the MDR receiver and MDR transmitters
5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.5 MDR State (ID = 5)

a) The MDR state parameter **shall**$_{(458)}$:
   1) Instruct the MDR receiver and MDR transmitters to alter its operational status
   2) Be one of four discrete values representing the states (Power Up, Power Down, Online, Offline)
   3) Have a default value of Offline
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.6 Threshold Setting (ID = 6)

a) The threshold setting parameter **shall**$_{(459)}$:
   1) Provide new alert and alarm threshold values for the various monitoring parameters, including the parameter ID and the new alert and alarm thresholds
   2) Be a variable type anywhere in the range of the parameter values specified in Table 3-4
   3) Have a default value (of the selected parameter) as specified in Table 3-4
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.7 Time (ID = 7)

a) The time parameter **shall**$_{(460)}$:
   1) The Time parameter sets the time of the clock in the MDR receiver and MDR transmitters used for time stamping log entries.
   2) Be in the time format of MM/DD/YYYY/HH:MM:SS.SS
   3) Have a default value of 01/01/2000/00:00:00.00
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.8 Squelch Setting (AM) (ID = 8)

a) The squelch setting (AM) parameter **shall**$_{(461)}$:
   1) Set the RF power squelch threshold for the DSB-AM modes
   2) Be a discrete setting
   3) Have a minimum value of 0
   4) Have a maximum value of 63
   5) Have a step value of 1
   6) Have a default value of 3

7) Correlate settings of 0 to 63 to denote RF input power levels in the range of –105 dBm to –50 dBm.
8) Be applicable to the MDR receiver
9) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.9 Reserved (ID = 9)

3.2.3.2.10 Audio Output Level (AM) (ID = 10)

a) The receiver audio output level (AM) parameter **shall**$_{(462)}$:
   1) Set the desired audio output level on the main audio connector of the MDR receiver
   2) Be a power level in dBm
   3) Have a minimum value of -25 dBm
   4) Have a maximum value of 20 dBm
   5) Have a step value of 0.5 dB
   6) Have a default value of –8 dBm
   7) Be applicable to the MDR receiver
   8) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.11 Receiver Mute (AM) (ID = 11)

a) The receiver mute (AM) parameter **shall**$_{(463)}$:
   1) Mute or Unmute the MDR receiver for the DSB-AM modes
   2) Be a set of two discrete values: Muted or Unmuted
   3) Have a default value of Unmuted
   4) Be applicable to the MDR receiver
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.12 Power Output (AM) (ID = 12)

a) The output power parameter **shall**$_{(464)}$:
   1) Set the MDR transmitter RF output power (CW)
   2) Be an RF power level in dBm
   3) Have a minimum value for the 15 watt MDR transmitter of 33 dBm
   4) Have a minimum value for the 50 watt MDR transmitter of 40 dBm
   5) Have a maximum value for the 15 watt MDR transmitter of 40 dBm
   6) Have a maximum value for the 50 watt MDR transmitter of 44 dBm
   7) Have a step value for the 15 watt MDR transmitter of nominal 1 dB
   8) Have a step value for the 50 watt MDR transmitter of nominal 0.5 dB
   9) Have a default value for the 15 watt MDR transmitter of 33 dBm
   10) Have a default value for the 50 watt MDR transmitter of 40 dBm
   11) Be applicable to the MDR transmitter in DSB-AM mode
   12) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.13 Transmission Modulation % (AM) (ID = 13)

a) The transmission modulation % (AM) parameter **shall**$_{(465)}$:
   1) Sets the MDR transmitter modulation percentage for the DSB-AM modes
   2) Be in percent of modulation
   3) Have a minimum value of 0 percent
   4) Have a maximum value of 100 percent
   5) Have a step value of 1 percent
   6) Have a default value of 90 percent
   7) Be applicable to the MDR transmitter
   8) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.14 ATR Switch Configuration (ID = 14)

a) The ATR switch configuration parameter **shall**$_{(466)}$:
   1) Indicate how the MDR controls the connection to the antenna
   2) Be two discrete values: Local and Remote
   3) Have a default value of: Local
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.15 Switch Software Version (ID = 15)

a) The switch software version parameter **shall**$_{(467)}$:
   1) Indicates to the MDR receiver and the MDR transmitter to reboot to the stored software image indicated
   2) The MDR receiver and MDR transmitters require two successive reset signals within a defined short period of time (less than 1 second)
   3) Be one value: Switch Software Version
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.16 N1 (Number of Information Bits) (ID = 16)

a) The N1 parameter **shall**$_{(468)}$:
   1) Sets the value of the number of bits in the information fields
   2) Be in Number of Bits
   3) Have a minimum value of 128 bits
   4) Have a maximum value of 4096 bits
   5) Have a step value of 8 bits
   6) Have a default value of 512, except for PCM Voice, which is 1976
   7) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.17 T1 (Link Response Timer) (ID = 17)

a) The T1 parameter **shall**$_{(469)}$:
   1) Sets the link response timer

2) Be in milliseconds
3) Have a minimum value of 100 milliseconds
4) Have a maximum value of 500 milliseconds
5) Have a step value of 1 millisecond
6) Have a default value of 200 milliseconds
7) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.18 T3 (Reassembly Timer) (ID = 18)

a) The T3 parameter **shall**$_{(470)}$:
   1) Sets the reassembly timer
   2) Be in milliseconds
   3) Have a minimum value of 50 milliseconds
   4) Have a maximum value of 240 milliseconds
   5) Have a step value of 1 millisecond
   6) Have a default value of 100 milliseconds
   7) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.19 HDLC Channel Number (ID = 19)

a) The HDLC channel number parameter **shall**$_{(471)}$:
   1) Set the HDLC channel for the MDR receiver or MDR transmitter to use to communicate with the RIU (for DACS operation where many MDRs are collocated)
   2) Be a range of 5 values
   3) Have a minimum value of 1
   4) Have a maximum value of 5
   5) Have a step value of 1
   6) Have a default value of 1
   7) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.20 Transmission Timeout (AM) (ID = 20)

a) The transmission timeout (AM) parameter **shall**$_{(472)}$:
   1) Sets the MDR transmitter timeout value or disables the timeout timer
   2) Be in seconds
   3) Have a minimum value of 0 seconds (disabled)
   4) Have a maximum value of 300 seconds
   5) Have a step value of 5 seconds
   6) Have a default value of 35 seconds
   7) Be applicable to the MDR transmitter
   8) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.21 Squelch On/Off (ID = 21)

a) The squelch on/off parameter **shall**$_{(473)}$:
   1) Set whether the squelch function of the MDR receiver is active or not

2) Be two discrete settings: ON or OFF
3) Have a default value of ON
4) Be applicable to the MDR receiver
5) Have a format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.22 Request Read Back (ID = 30)

a) The request read back parameter **shall**$_{(474)}$:
   1) Inform the MDR receiver and MDR transmitters to send the applicable information for the desired monitoring parameter indicated in the Monitoring Parameter ID. For monitoring parameters with non-iterating read-backs, the Iteration Field must be 1 and the Interval Field must be 0.
   2) Contain three fields: Monitoring parameter ID, Iterations, and Interval
   3) Be applicable to the MDR receiver and MDR transmitters
   4) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.23 Audio Input Level (AM) (ID = 31)

a) The audio input level (AM) parameter **shall**$_{(475)}$:
   1) Sets the desired audio input level on the main audio connector of the MDR transmitter
   2) Be power in dBm
   3) Have a minimum value of –25 dBm
   4) Have a maximum value of +20 dBm
   5) Have a step value of 1 dB
   6) Have a default value of –8 dBm
   7) Be applicable to the MDR transmitter
   8) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.24 Reserved (ID = 32)

3.2.3.2.25 Reserved (ID = 33)

3.2.3.2.26 MAC Timing Offset Correction (VDL Mode 3) (ID = 34)

a) The MAC timing offset correction (VDL Mode 3) parameter **shall**$_{(476)}$:
   1) Indicate the relative time correction, in microseconds, that should be applied to all MDR M-Burst and V/D Burst operations, relative to the previous perceived MAC 6 second epoch in the MDR, which is derived from the receiver T1 framing and Timing Channel from the RIU
   2) Be timed in microseconds
   3) Have a minimum value of -32768 microseconds
   4) Have a maximum value of 32767 microseconds
   5) Have a step value of 1 microsecond
   6) Have a default value of 0 microseconds
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.27 Suppress Alert/Alarm (ID = 35)

a) The suppress alert/alarm parameter **shall**$_{(477)}$:
   1) Sets the MDR receiver and MDR transmitter to cease or resume transmitting alert and alarm messages to the MDT or RIU
   2) Be two discrete values: Suppress or Normal
   3) Have a default value of Normal
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.28 Reset to Default (ID = 36)

a) The reset to default parameter **shall**$_{(478)}$:
   1) Sets the MDR receiver and MDR transmitters the default values for all parameters
   2) Require two successive reset signals within a defined short time period (less than 1 second)
   3) Be one discrete value: Reset
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.29 Software Upload Start/Stop (ID = 37)

a) The software upload start/stop parameter **shall**$_{(479)}$:
   1) Prepare the MDR receiver and MDR transmitters for uploading operational software and after the uploading is complete, the upload function is turned off
   2) Have two discrete values: Prepare Upload and Turn Off Upload
   3) Have a default value of Turn Off Upload
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.30 Software Upload (ID = 38)

a) The software upload parameter **shall**$_{(480)}$:
   1) Communicate blocks of the new operational software executable image to reprogram the MDR.
   2) Have Three Fields: Block Number, Total Blocks, Binary Data (variable length)
   3) Be applicable to the MDR receiver and MDR transmitters
   4) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.31 Receiver Mute Level (ID = 39)

a) The receiver mute level parameter **shall**$_{(481)}$:
   1) Sets the level of attenuation associated with muting a MDR receiver
   2) Be three discrete settings: -15dB, -20dB, No Audio
   3) Have a default value of: “No Audio”
   4) Be applicable to the MDR receiver
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.32 Test PTT (ID = 40)

a) The Test PTT parameter **shall$_{(482)}$**:
   1) Key the MDR transmitter
   2) Be two discrete settings: KEYED or NO_KEY
   3) Have a default value of NO_KEY
   4) Be applicable to the MDR transmitter
   5) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.33 Public Key Maintenance (ID = 41)

a) The Public Key Maintenance parameter **shall$_{(532)}$**:
   1) Allow the MDT/RIU to add or delete MDR-stored Public keys
   2) Be six discrete settings: Time/Date, User, User Terminal, Add/Subtract Indicator, Key, Security Token
   3) Be applicable to the MDR receiver and MDR transmitter

3.2.3.3 MDR Monitoring and Reporting

a) The MDR monitoring function **shall$_{169}$** perform real-time system performance monitoring and provide real-time system performance reporting.
b) The system monitoring function **shall$_{170}$** consist of:
   1) The active acquisition of various MDR monitoring parameters,
   2) The execution of measurements on those parameters to obtain collected/calculated data,
   3) The comparison of the collected/calculated data to the stored system parameter thresholds and/or element status to determine whether each data element and/or element status is within the specified limits; and
   4) The reporting of the results of those parameter and/or element status determinations.
c) There **shall$_{171}$** be two instances where monitoring messages are sent to the local MDT and to the RIU: 1) Upon request, and 2) When an alert or alarm threshold is crossed.
d) The alert or alarm status messages **shall$_{172}$** be sent when the parameter being monitored crosses the threshold level.
e) The MDR **shall$_{(483)}$** send a Link Status word every MAC cycle to the RIU to report on its current status per NAS-IC-41033502.

3.2.3.3.1 Non-Congesting Monitoring

a) The system monitoring function **shall$_{173}$** be performed automatically on a continuous basis without blocking or delaying operational communications and management and without the need for the insertion of an external command.
b) The system monitoring function **shall$_{174}$** not cause the radio function to degrade below requirements during operation of the system.
c) Regardless of the frequency of alarm and alert status messages, the system monitoring function **shall$_{175}$** not prevent the reception and processing of commands.

3.2.3.3.2 Alarm/Alert Monitoring Suppression

a) The MDR receiver and transmitter **shall**$_{176}$ suppress alarm and alert status messages to the MDT and RIU upon command.
b) The MDR receiver and transmitter **shall**$_{177}$ send the alert event acknowledging the command to suppress alarm and alert status messages before suppressing alarm and alert status messages.
c) Upon MDT log-out, if alert and alarm monitoring is suppressed on the MDT interface, the MDR **shall**$_{178}$ automatically revert to normal alert and alarm transmission to the MDT interface.
d) Upon log-out of a remote RIU user, if alert and alarm monitoring is soppressed on the RIU interface, the MDR **shall**$_{(484)}$ automatically revert to normal alert and alarm transmission to the RIU interface.

3.2.3.4 Alarm/Alert Processing

a) The MDR parameters to be monitored **shall**$_{179}$ be described by three states:
   1) Normal
   2) Alert
   3) Alarm
b) The states **shall**$_{180}$ be defined by a range of values that are adjoined such that the value range of the alert state is bordering on the normal state at one end of its range and the alarm state on the other side of its range. Figure 3-2 illustrates Normal, Alert and Alarm Range for a Parameter.
c) A state change **shall**$_{181}$ constitute the parameter value crossing from one state to another state.

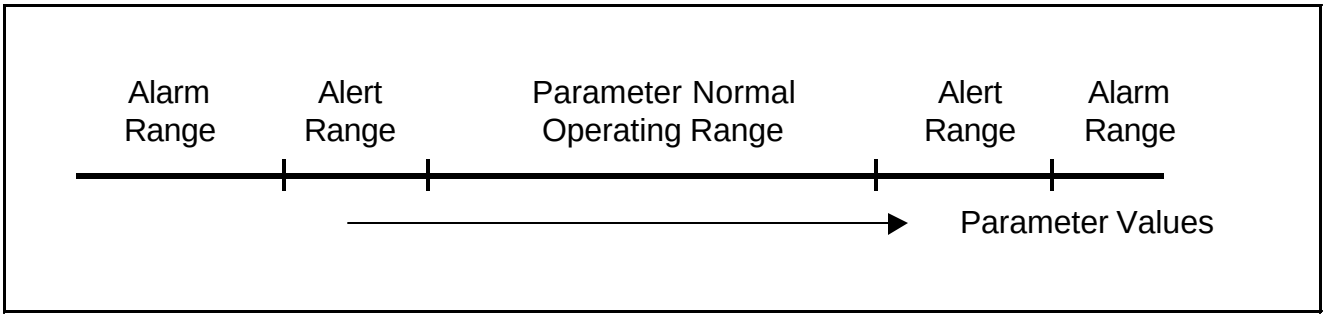


Figure 3-2, Illustration of Normal, Alert and Alarm Range for a Parameter

d) The MDR monitoring function **shall**$_{182}$ determine the change between normal state, alert state, and alarm state of MDR status parameters by comparing data to pre-established thresholds.
e) A discriminating function **shall**$_{183}$ be used to minimize the declaration of alarms and alerts for transient conditions.
f) The system monitoring function **shall**$_{184}$ automatically declare an alert event when a monitored parameter and/or element status changes to a value that is outside the normal range but within the alert range.
g) The alert event **shall**$_{185}$ be automatically reported once per occurrence.

h) The system monitoring function **shall$_{186}$** automatically declare a return to normal event when a monitored parameter and/or element status that was previously outside the normal range changes to a value that is inside the normal range.
i) The return to normal event **shall$_{187}$** be automatically reported once per occurrence.
j) The system monitoring function **shall$_{188}$** automatically declare an alarm event when a monitored parameter and/or element status changes to a value crossing from the alert range to the alarm range.
k) The alarm event **shall$_{189}$** be automatically reported once per occurrence.
l) The system monitoring function **shall$_{190}$** automatically declare a state change event when the value changes for a monitored parameter and/or element status that indicates a configuration or mode change to the MDR.
m) The state change event **shall$_{191}$** be automatically reported once per occurrence.
n) Parameters and/or element statuses that are reportable as alarm/alert events **shall$_{192}$** not be reportable as state changes.
o) The MDR **shall$_{193}$** provide event notification within a maximum time of 4 seconds. The response time is measured from the time that the MDR determines the condition to the time the first byte of the notification is reported by the MDR.

3.2.3.5 MDR Monitoring Parameters

a) The MDR **shall$_{194}$** include all of the sensors, devices and algorithms required to provide for the monitoring functions specified in FAA-E-2911, sections 3.1 and 3.2.1 and associated subsections.
b) The MDR receiver and transmitter **shall$_{195}$** provide a means for monitoring the status parameters defined in Table 3-4.
c) The monitoring parameter value ranges, resolutions, tolerances and default values are summarized in Table 3-4.

Table 3-4: Receiver and Transmitter Monitoring Parameters

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Read Back	Applica-bility: TX, RX, Both
1	**Control Log**: The Control Log parameter indicates previous accesses and access attempts as requested. This parameter is used for the RMMC control point to access the control log of the MDR components.	Discrete fields: Date, Username, Terminal ID, # of Log Entries, Action	N/A	N/A	N/A	N/A	N/A	N/A	X	Both
2	**Current Frequency**: The Current Frequency parameter indicates the current frequency to which the MDR component is tuned.	Multiple Discrete Frequency Values	112.00000 MHz	136.97500 MHz	8.33 kHz	N/A	N/A	N/A	X	Both
3	**Lowest Tunable Frequency**: The Lowest Tunable Frequency value indicates the minimum frequency that the MDR can be tuned.	Multiple discrete frequency values	112.00000 MHz	118.00000 MHz	25 kHz	N/A	N/A	N/A	X	Both
4	**Mode of Operation**: The Mode of Operation (also called system mode) parameter indicates whether the MDR component is in 25kHz DSB-AM, 8.33kHz DSB-AM, or VDL Mode 3 modes.	Three discrete values (represent-ing the modes)	N/A	N/A	N/A	N/A	N/A	N/A	X	Both
5	**MDR State**: The MDR State parameter indicates that the MDR is in one of six states: Power-Up, Power-Down, Online, Offline, Recovery, or Fail.	One of 6 discrete values (states)	-	-	-	N/A	N/A	Alarm on Fail	X	Both
6	**Threshold Setting**: The Threshold Setting Parameter indicates the readback values for alert and alarm threshold settings for a specified parameter..	Set of three fields: ID, Alert, Alarm	N/A	N/A	N/A	N/A	N/A	N/A	X	Both
7	**Time**: The Time read back parameter indicates the current time of the real-time clock within the MDR component.	Time in the format MM/DD/YYYY HH:MM:SS.SS	-	-	0.01sec	+/-0.1 sec	N/A	N/A	X	Both
8	**Squelch Setting (AM)**: The Squelch Setting parameter indicates the RF power settings needed to break the DSB-AM squelch of the MDR Receiver.	Discrete Settings	0	63	1	N/A	N/A	N/A	X	RX
9	RESERVED	-	-	-	-	-	-	-	-	-

Table 3-4: Receiver and Transmitter Monitoring Parameters (continued)

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Read Back	Applica-bility: TX, RX, Both
10	**Audio Output Level (AM)**: The Audio Output Level indicates the setting of the DSB-AM audio signal power level output in dBm presented to the main audio output connector of the MDR Receiver.	Power in dBm	-25 dBm	20 dBm	1 dB	N/A	N/A	N/A	X	RX
11	**Receiver Mute (AM)**: The Receiver Mute parameter indicates whenever the MDR Receiver is muted or unmuted for DSB-AM.	Two values: Muted, Unmuted	N/A	N/A	N/A	N/A	N/A	N/A	X	RX
12	**Power Output (AM)**: The Power Output parameter indicates the current RF transmission power at the antenna port of the transmitter.	Power values in dBm	33 dBm 40 dBm	40 dBm 47 dBm	1 dB 0.5 dBm	+/- 2dBm +/- 2 dBm	± 10 Percent from Setting	± 20 Percent from Setting	X	TX
13	**Transmitter Modulation % (AM)**: The Transmitter Modulation % parameter indicates the modulation percentage of the DSB-AM transmissions of the MDR transmitter.	Percent	0%	100%	100 steps	+/- 5%	60%	99%	X	TX
14	**ATR Switch Configuration**: The ATR Switch Configuration parameter indicated the configuration of the transmitter and receiver connection to the antenna. Two discrete values indicating Local and Remote.	Two discrete values: Local, Remote	N/A	N/A	N/A	N/A	N/A	N/A	X	Both
15	**Software Version**: The Software Version parameter indicates the current version of the software active in the MDR component, as well as the standby software version.	Pair of fields: One of 255 discrete values	1	255	1	N/A	N/A	N/A	X	Both
16	**N1 (Number of Information Bits):** This parameter sets the value of the number of bits in the information fields.	Number of Bits	128	4096	8	N/A	N/A	N/A	X	Both
17	**T1 (Link Response Timer):** This parameter sets the link response timer.	ms	100	500	1	N/A	N/A	N/A	X	Both
18	**T3 (Reassembly Timer):** This parameter sets the reassembly timer.	ms	50	240	1	N/A	N/A	N/A	X	Both

Table 3-4: Receiver and Transmitter Monitoring Parameters (continued)

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Read Back	Applica-bility: TX, RX, Both
19	**HDLC Channel Number**: HDLC channel to use for MDR per NAS-IC-41033502	Five Discrete numbers	1	5	1	N/A	N/A	N/A	X	Both
20	**Transmission Timeout (AM)**: The Transmission Timeout parameter sets the time-out value or disables the timer. Setting the value for a disabled timer will re-enable the timer.	Seconds	0 sec (Disabled)	300 sec	5 s	0.5 s	N/A	N/A	X	TX
21	**Squelch On/Off**: The Squelch Status parameter indicates that the MDR Receiver has either activated or deactivated its squelch break function for the DSB-AM modes of operation.	Two Discrete Values: On, Off	N/A	N/A	N/A	N/A	N/A	N/A	X	RX
50	**MDR ID Number**: The MDR ID Number parameter indicates the unique identification number assigned to the LRU(s) of the MDR component.	Discrete numerical values	1	65535	1	N/A	N/A	N/A	X	Both
51	**RF Input Power Level (AM)**: The receiver RF Input Power Level parameter indicates the estimate of the received signal level present at the MDR receiver antenna port.	Power values in dBm	-110 dBm	+15 dBm	1 dB	+/-3 dB	-33 dBm	+13 dBm	X	RX
52	**Squelch Break Status (AM)**: The Squelch Break Status parameter indicates whenever the MDR Receiver determines a valid transmission is being received. For DSB-AM operation, this is achieved by the RF signal exceeding the squelch thresholds.	Two discrete values: Squelch Broken, No Voice	-	-	-	N/A	N/A	N/A	X	RX
53	**In-Service Time** : The In-Service Time parameter indicates the number of hours the MDR component has been continuously powered.	Hours	0 hrs	2^{24}-1 hrs	1 hr	+/-1hr	N/A	N/A	X	Both
54	**RIU Timing Offset Change (VDL Mode 3)**: The RIU Timing Offset Change parameter indicates whenever the RIU's timing reference varies more than 10 µs for the MDR component. This is used to identify if there has been a timing slip on the RIU/MDR link.	Two discrete values: Yes - there is a time slip No - there is no time slip	N/A	N/A	N/A	N/A	ALERT on change	N/A	-	Both

Table 3-4: Receiver and Transmitter Monitoring Parameters (continued)

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Read Back	Applica-bility: TX, RX, Both
55	**Transmit Antenna VSWR**: The Transmit Antenna VSWR parameter indicates whether the VSWR of the transmit antenna is within an acceptable operating range.	Two Discrete Values: Good, Bad	N/A	N/A	N/A	N/A	N/A	>= 3:1 (Bad)	X	TX
56	**AM Signaling (AM)**: The AM Signaling parameter indicates the PTT signal status (the signal is not logged in the MDR).	Two discrete values: PTT confirm, PTT clear	N/A	N/A	N/A	N/A	N/A	N/A	X	TX

Notes:

1. The parameters are numbered (parameter ID) as follows:
   - 1 through 29 are control/monitor parameters that have an associated monitor/control parameter.
   - 30 through 49 are control parameters that do not have an associated monitor parameter.
   - 50 through 69 are monitor parameters that do not have an associated control parameter.
2. The parameter ID corresponds to the CTYPE field as defined in NAS-41033502.
3. Values in the upper part of each row are for the 15W max transmitter, values in the lower part of each row are for the 50 W max transmitter.

Table 3-4a. Error Codes

Error Code	Definition	User Data
0	RESERVED	N/A
1	5 successive Illegal User Log-in Attempts	Attempted User ID(s), MDT# or REMOTE
2	Illegal Parameter ID	Unknown Parameter received
3	Parameter Out of Range	Illegal control parameter requested
4	Parameter Not Allowed	Parameter attempted
5-255	RESERVED	N/A

3.2.3.5.1 Control Log (ID = 1)

a) The control log parameter **shall**$_{(485)}$:

1) Indicate previous accesses and access attempts as requested and used for the RMMC control point to access the control log of the MDR receiver and MDR transmitters
2) Include the following fields: Date, Username, Terminal ID, Number of Log Entries, and Action
3) Have a readback
4) Be applicable to the MDR receiver and MDR transmitters
5) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.2 Current Frequency (ID = 2)

a) The current frequency parameter **shall**$_{(486)}$:
   1) Indicate the current frequency to which the MDR receiver and MDR transmitters are tuned
   2) Be a frequency readout
   3) Have a minimum value of 112.000 MHz
   4) Have a maximum value of 136.975 MHz
   5) Have a resolution (step size) of 8.33 kHz
   6) Have a readback
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.3 Lowest Tunable Frequency (ID = 3)

a) The lowest tunable frequency parameter **shall**$_{(487)}$:
   1) Indicate the channel label for the minimum frequency that the MDR receiver and MDR transmitters can be tuned
   2) Be multiple discrete frequency values
   3) Have a minimum value of 112.00000 MHz
   4) Have a maximum value of 118.00000 MHz
   5) Have a resolution (step size) of 25 kHz
   6) Have a readback
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.4 Mode of Operation (ID = 4)

a) The mode of operation (also called system mode) parameter **shall**$_{(488)}$:
   1) Indicate mode of operation the MDR receiver and MDR transmitters are
   2) Be one of 3 values representing the modes: 25 kHz DSB-AM, 8.33 kHz DSB-AM, or VDL Mode 3 modes
   3) Have a readback
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.5 MDR State (ID = 5)

a) The MDR state parameter **shall**$_{(489)}$:
   1) Indicate the MDR receiver and MDR transmitters are in one of six states

2) Be one of 6 discrete values: Offline, Online, Power Up, Power Down, Recovery, or Fail
3) Have an alarm value if transition to Fail state
4) Have a readback
5) Be applicable to the MDR receiver and MDR transmitters
6) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.6 Threshold Setting (ID = 6)

a) The parameter threshold value parameter **shall**$_{(490)}$:
   1) Indicate the threshold settings for the MDR transmitter and receiver
   2) Be one of variable values.
   3) Have a readback
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.7 Time (ID = 7)

a) The time readback parameter **shall**$_{(491)}$:
   1) Indicate the current time within the MDR receiver and MDR transmitters
   2) Be in a format of MM/DD/YYYY HH:MM:SS.SS
   3) Have a resolution (step size) of 0.01 second
   4) Have a tolerance (acceptable error) of ±0.1 second
   5) Have a readback
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.8 Squelch Setting (AM) (ID = 8)

a) The squelch setting parameter **shall**$_{(492)}$:
   1) Indicate the RF power settings needed to break the DSB-AM squelch of the MDR receiver.
   2) Be discrete values
   3) Have a minimum value of 0
   4) Have a maximum value of 63
   5) Have a resolution (step size) of 1
   6) Have a readback
   7) Be applicable to the MDR receiver
   8) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.9 Reserved (ID = 9)

3.2.3.5.10 Audio Output Level (AM) (ID = 10)

a) The audio output level (AM) parameter **shall**$_{(493)}$:
   1) Indicate the setting of the DSB-AM audio signal power level output presented to the main audio output connector of the MDR receiver
   2) Be power in dBm

3) Have a minimum value of –25 dBm
4) Have a maximum value of 20 dBm
5) Have a resolution (step size) of 1 dB
6) Have a tolerance (acceptable error) of ±0.5 dB
7) Have a readback
8) Be applicable to the MDR receiver
9) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.11 Receiver Mute (AM) (ID = 11)

a) The receiver mute (AM) parameter **shall**$_{(494)}$:
   1) Indicate whenever the MDR receiver is muted or unmuted for DSB-AM
   2) Be one of 2 values: Muted or Unmuted
   3) Have a readback – N/A
   4) Be applicable to the MDR receiver
   5) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.12 Power Output (AM) (ID = 12)

a) The output power parameter **shall**$_{(495)}$:
   1) Indicate the current RF transmission power at the antenna connector of the MDR transmitter
   2) Be a power level in dBm
   3) Have a minimum value for the 15 watt MDR transmitter of 33 dBm
   4) Have a minimum value for the 50 watt MDR transmitter of 40 dBm
   5) Have a maximum value for the 15 watt MDR transmitter of 40 dBm
   6) Have a maximum value for the 50 watt MDR transmitter of 47 dBm
   7) Have a resolution (step size) of 1 dB for the 15 watt MDR transmitter, and 0.5 dB for the 50 watt MDR transmitter
   8) Have a tolerance (acceptable error) of ±2 dB for all MDR transmitters
   9) Have an alert value of ±10 percent of the power setting for both the 15 watt and 50 watt MDR transmitters
   10) Have an alarm value of ±20 percent of the power setting for both the 15 watt and 50 watt MDR transmitters
   11) Have a readback
   12) Be applicable to the MDR transmitters
   13) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.13 Transmitter Modulation % (AM) (ID = 13)

a) The transmitter modulation % parameter **shall**$_{(497)}$:
   1) Indicate the modulation percentage of the DSB-AM transmission of the 15 watt and 50 watt MDR transmitters
   2) Be in percent
   3) Have a minimum value of 0 percent
   4) Have a maximum value of 100 percent

5) Have at least 100 steps
6) Have a tolerance (acceptable error) of ±5 percent
7) Have an alert value of 60 percent
8) Have an alarm value of 99 percent
9) Have a readback
10) Be applicable to the MDR transmitters
11) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.14 ATR Switch Configuration (ID = 14)

a) The ATR switch configuration parameter **shall**$_{(498)}$:
   1) Indicate the configuration of the MDR receiver and MDR transmitter to the antenna
   2) Be one of two discrete values: Local or Remote
   3) Have a readback
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.15 Software Version (ID = 15)

a) The software version parameter **shall**$_{(499)}$:
   1) Indicate the current version of the software active in the MDR receiver and MDR transmitters, as well as the version number of the standby software version
   2) Be one of 255 discrete values for each field
   3) Have a minimum value of 1
   4) Have a maximum value of 255
   5) Use a value of 0 to indicate an invalid or non-existent version
   6) Have a resolution (step size) of 1
   7) Have a tolerance (acceptable error) of 0
   8) Have an alert value – N/A
   9) Have an alarm value – N/A
   10) Have a readback
   11) Be applicable to the MDR receiver and MDR transmitters
   12) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.16 N1 (Number of Information Bits) (ID = 16)

a) The N1 parameter **shall**$_{(500)}$:
   1) Indicate the value of the number of bits in the information fields
   2) Be the value of bits
   3) Have a minimum value of 128
   4) Have a maximum value of 4096
   5) Have a resolution (step size) of 8
   6) Have a readback
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.17 T1 (Link Response Timer) (ID = 17)

a) The T1 parameter **shall**$_{(501)}$:
   1) Indicate the link response time
   2) Be a value in milliseconds
   3) Have a minimum value of 100 milliseconds
   4) Have a maximum value of 500 milliseconds
   5) Have a resolution (step size) of 1 millisecond
   6) Have a readback
   7) Be applicable to the MDR receivers and MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.18 T3 (Reassembly Timer) (ID = 18)

a) The T3: reassembly timer parameter **shall**$_{(502)}$:
   1) Indicate the time value of the T3: reassembly timer
   2) Be a value in microseconds
   3) Have a minimum value of 50 microseconds
   4) Have a maximum value of 240 microseconds
   5) Have a resolution (step size) of 1 microsecond
   6) Have a readback
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.19 HDLC Channel Number (ID = 19)

a) The HDLC channel number parameter **shall**$_{(503)}$:
   1) Indicate the HDLC channel for the MDR receiver or MDR transmitter to use to communicate with the RIU (for DACS operation where many MDRs are collocated)
   2) Be a range of 5 values
   3) Have a minimum value – 1
   4) Have a maximum value – 5
   5) Have a resolution (step size) – 1
   6) Have a readback
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.20 Transmission Time-Out Value (AM) (ID = 20)

a) The transmission time-out value (AM) parameter **shall**$_{(504)}$:
   1) Indicate the current time-out value after which the voice transmission will be terminated by the MDR transmitters
   2) Be time in seconds
   3) Have a minimum value of 0 seconds
   4) Have a maximum value of 300 seconds
   5) Have a resolution (step size) of 5 seconds

6) Have a tolerance (acceptable error) 0.5 second
7) Have a readback
8) Be applicable to the MDR transmitters
9) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.21 Squelch On/Off (AM) (ID = 21)

a) The squelch status parameter **shall**$_{(505)}$:
   1) Indicate the squelch break function has either activated or deactivated for the DSB-AM modes in the MDR receiver
   2) Be two discrete values: On or Off
   3) Have a readback
   4) Be applicable to the MDR receiver
   5) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.22 MDR ID Number (ID = 50)

a) The MDR ID number parameter **shall**$_{(506)}$:
   1) Indicate the unique identification number assigned to each of the MDR receiver and MDR transmitters
   2) Be discrete numerical values
   3) Have a minimum value of 1
   4) Have a maximum value 65535
   5) Have a resolution (step size) of 1
   6) Have a readback
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.23 RF Input Power Level (AM) (ID = 51)

a) The RF input power level parameter **shall**$_{(507)}$:
   1) Indicate an estimate of the received signal level present at the MDR receiver antenna connector
   2) Be power values in dBm
   3) Have a minimum value of –110 dBm
   4) Have a maximum value of 15 dBm
   5) Have a resolution (step size) 1 dB
   6) Have a tolerance (acceptable error) of ±3 dB
   7) Have an alert value of –33 dBm
   8) Have an alarm value of +13 dBm
   9) Have a readback
   10) Be applicable to the MDR receiver
   11) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.24 Squelch Break Status (AM) (ID = 52)

a) The squelch break status (AM) parameter **shall**$_{(508)}$:

1) Indicate whenever the MDR receiver determines a valid transmission is being received
2) For DSB-AM operation, this is achieved by the RF signal exceeding the squelch thresholds
3) Be two discrete values: Squelch Broken or No Voice
4) Have a readback
5) Be applicable to the MDR receiver
6) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.25 In-Service Time (ID = 53)

a) The in-service time parameter **shall**$_{(509)}$:
   1) Indicate the number of hours the MDR receiver and MDR transmitters has been continuously powered
   2) Be provided in hours
   3) Have a minimum value of 0 hours
   4) Have a maximum value of 2^{24}-1 hours
   5) Have a resolution (step size) of 1 hour
   6) Have a tolerance (acceptable error) of ±1 hour
   7) Have a readback
   8) Be applicable to the MDR receiver and MDR transmitters
   9) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.26 RIU Timing Offset Change (VDL Mode 3) (ID = 54)

a) The RIU timing offset change (VDL Mode3) parameter **shall**$_{(510)}$:
   1) Indicate whenever the RIU's timing reference varies more than 10 microseconds for the MDR receiver and MDR transmitters.
   2) Be used to identify if there has been a timing slip
   3) Be 2 discrete values: Yes (there is a time slip) or No (there is no time slip)
   4) Have an alert value to Alert on change
   5) Be applicable to the MDR receiver and MDR transmitters
   6) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.27 Transmit Antenna VSWR (ID = 55)

a) The transmit antenna VSWR parameter **shall**$_{(511)}$:
   1) Indicate whether the VSWR of the transmit antenna path is acceptable
   2) Be one of two discrete values: Good or Bad
   3) Have an alarm value of Bad when the VSWR equals or exceeds 3:1
   4) Have a readback
   5) Be applicable to the MDR transmitters
   6) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.5.28 AM Signaling (AM) (ID = 56)

a) The AM signaling (AM) parameter **shall**$_{(512)}$:
   1) Indicate the PTT signal status (the signal is not logged in the MDR)

2) Be one of two discrete values: PTT confirm and PTT clear
3) Have a readback
4) Be applicable to the MDR receiver and MDR transmitters
5) Have a bit/message format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.6 Event Time Tagging

a) All events (MDT log in, alarm, alert, return to normal, state change) reported by the MDR control and monitoring functions **shall**$_{197}$ be tagged with the time of the event.

3.2.3.7 Data Storage

a) The MDR control and monitoring functions **shall**$_{198}$ maintain initialization tables, threshold values, parameter state values, adjustable parameter values, and equipment status and performance data.
b) The data **shall**$_{199}$ be stored in the MDR receiver and transmitter in such way that it is maintained through power loss (internal or otherwise) for the life of the equipment.
c) Equipment status and performance data **shall**$_{200}$ include all critical performance parameter data, including certification data, and the last 5000 logged entries with a time tag for each entry.
d) The MDR **shall**$_{201}$ log all control attempts as well as all alerts and alarms.
e) The stored data **shall**$_{202}$ be configured in such a way that individual or groups of data can be retrieved and transmitted separately when requested.
f) The stored data **shall**$_{203}$ be logically grouped according to physically segregated hardware, common functions, or conditions with functional/physical commonality.
g) For restart after power-down or power failure, the equipment **shall**$_{204}$ store the last state of the settable parameters.

3.2.3.8 Data Retrieval

a) The MDR control and monitoring functions **shall**$_{205}$ provide for data retrieval.
b) Data retrieval **shall**$_{206}$ be executed upon request from the RIU and/or the MDT.

3.2.3.9 INFOSEC Requirements

3.2.3.9.1 Verification

a) The MDR **shall**$_{(513)}$ verify the authenticity, integrity and time validity of the digital signed information received via the MDT or RIU interfaces.
b) The digital signature algorithm that performs this verification **shall**$_{(514)}$ correspond to at least one of the algorithms defined in FIPS 186-2.
c) The digital signature function **shall**$_{(515)}$ meet or exceed security level 1 as defined in FIPS 140-1.
d) The digital signature function **shall**$_{(516)}$ be validated according to FIPS 140-1 by an accredited FIPS 140-1 testing laboratory.

3.2.3.9.2 Keys

a) The MDR **shall**$_{(517)}$ provide storage for at least 10 public key certificates, any of which may be used in verifying the digital signature defined in 3.2.3.9.1.

b) The storage for public keys **shall**$_{(518)}$ be in non-volatile memory and be maintained through power loss and restoral.
c) The MDR **shall**$_{(519)}$ provide a mechanism to add and delete public keys via the MDT or RIU interface.

3.2.3.9.3 Security Procedures

a) All control parameter commands **shall**$_{(520)}$ be accepted only if the requesting device provides a valid digitally signed authorization token ("security token").
Note: The "security token" will consist of the MDT- or RIU-supplied, FAA-generated digital signature of an FAA-selected data field, and the FAA-selected data field that may be unique to each User Terminal.
b) The MDR **shall**$_{(521)}$ receive the security token using one of the following procedures, (1) The security token can accompany each control request, or (2) the security token can be demanded by the MDR after receiving a control request, or (3) a session can be initiated after receipt of a Log-In with a security token during which all transactions are valid.

3.2.3.9.3.1 Rejection

a) Software uploads that are not digitally signed or contain an invalid digital signature **shall**$_{(522)}$ be rejected.
b) All control parameter commands associated with a security token that fails digital signature verification **shall**$_{(523)}$ be rejected.

3.2.3.9.3.1.1 Procedure 1

a) If procedure 1 in Section 3.2.3.9.3 is employed, then control parameter commands, except control parameter command ID#1:LogIn/LogOut, when used for Logout, that are not accompanied by a valid security token **shall**$_{(524)}$ be rejected.

3.2.3.9.3.1.2 Procedure 2

a) If procedure 2 in Section 3.2.3.9.3 is employed, then the MDR **shall**$_{(525)}$ reject control parameter commands that are not followed by a valid security token reply (to the MDR request) within 1 (one) +/-1 seconds.

3.2.3.9.3.1.3 Procedure 3

If procedure 3 in Section 3.2.3.9.3 is employed,
a) as long as a valid session is active on one control interface, the MDR **shall**$_{(526)}$ reject all control requests from the other control interface,
b) the MDR **shall**$_{(527)}$ terminate the MDTS session upon User logout, MDT disconnection or after 30 minutes of MDT interface inactivity.

3.2.3.9.4 Boot Cycle

a) The MDR boot cycle or equivalent **shall**$_{(528)}$ be secured such that the possibility of an illegitimate reconfiguration of the MDR operating software during the boot cycle or equivalent is extremely low.

3.2.3.10 Vendor Built In Test

a) The vendor **shall**$_{211}$ make their built-in test accessible to the FAA.

3.2.3.11 MDR Reset to Default

a) When the MDR receives ID#36, Reset to Default control parameter command, the MDR **shall**$_{(570)}$ restore all control parameters to their default values, transition to the Power Up state, initiate the Power Up sequence (i.e., warm boot), and upon successful completion, transition to the Offline state.

3.3 Interfaces

3.3.1 Legacy Interfaces Between RCE and MDR

a) MDR receiver and transmitter equipment **shall**$_{212}$ support the existing interfaces for remote receiver interfaces, remote transmitter interfaces, local receiver audio and local microphone.
b) Remote Maintenance Monitoring and Control will be a requirement of the final Segment One interface and is not required as part of the legacy interface.

3.3.1.1 Radio Frequency (RF) Connectors

a) External Radio Frequency (RF) connectors **shall**$_{213}$ be 50 ohm coaxial type N female.

3.3.1.2 Electrical Input Power Connectors

a) Electrical input power connectors **shall**$_{214}$ be of the following male types: two-conductor polarized for DC inputs and three-conductor National Electrical Manufacturers Association (NEMA) type for AC inputs.
b) Both power connectors **shall**$_{215}$ conform to FAA-G-2100. Commercial equivalent connectors are acceptable if available.

3.3.1.3 Receiver Remote Interface

a) This electrical connector **shall**$_{216}$ be located on the rear of the MDR receiver.
b) Signals and their levels **shall**$_{217}$ be as below:

Receiver Remote Connector				
Signal	**Level**	**Impedance (Ohms)**	**Input / Output**	**Notes**
Voice Audio	0 dBm ± 2 dB (test tone)	600 ± 60	Output	
Squelch Break	24 VDC ± 6 V	600 ± 60	Output	150 mA draw

3.3.1.4 Transmitter Remote Interface

a) This electrical connector **shall$_{218}$** be located on the rear of the MDR transmitter.
b) Signals and levels **shall$_{219}$** be as below:

Transmitter Remote Connector				
Signal	**Level**	**Impedance (Ohms)**	**Input / Output**	**Notes**
Voice Audio	-10 dBm ± 0.5 dB (test tone)	600 ± 60	Input	
Transmitter Key (Current Controlled)	0 V_{DC} ± 1V (Ground) - Keyed Open - No Key	600 ± 60	Input	10 mA max. Grounded for duration of key
Transmitter Key (Voltage controlled)	+6 V_{DC} to +48 V_{DC}- Keyed Open - No Key	600 ± 60	Input	0.5 mA max Sink Current Applied for duration of key
Transmit Indication (PTT Confirm)	24 VDC ± 6 V	600 ± 60	Output	150 mA max

3.3.1.5 Receiver Local Headset Connector

a) The MDR receiver local headset connector **shall$_{220}$** be located on the front panel of the MDR receiver and interface with a type NT49985A or equivalent headset.

Receiver Local Headset Connector	
Pin Number	**Signal**
1 (Ring)	Headset Audio Output
2 (Sleeve)	Headset Audio Return

3.3.1.6 Transmitter Local Microphone Connector

a) The MDR transmitter local microphone connector **shall$_{221}$** be located on the front panel of the MDR transmitter and mate with plug type PH068 for use with either an M85/U carbon microphone, or equivalent, or with an MS3106A-14S-5S dynamic microphone or equivalent.

Transmitter Local Microphone Connector	
Pin Number	**Signal**
1 (Ring)	Microphone Audio Input
2 (Sleeve)	Ground
3 (Tip)	Keyline

3.3.2 MDR Additional Connectors

3.3.2.1 MDT Connector

a) The connector for the MDT **shall**$_{222}$ be located on the front panel of the MDR receiver and transmitter.
b) The connector **shall**$_{223}$ be a female DB-9, RS-232 serial interface.

3.3.2.2 RIU Connector

a) The MDR receiver and transmitter **shall**$_{224}$ each have a single digital data bus interfacing with the RIU.
b) The MDR receiver and transmitter **shall**$_{(529)}$ receive epoch timing from the timing channel and voice/data/signaling communications from the HDLC data channel per NAS-IC-41033502.
c) The connector for the RIU **shall**$_{225}$ be located on the rear of the MDR receiver and transmitter.
d) The connector **shall**$_{226}$ be a female RJ-48.
Note: The signals for the RIU Connector will be T-1 formatted as defined in the MDR/RIU ICD, NAS-IC-410335022.

3.3.2.3 Transmitter Antenna I/O Connector

a) This RF connector **shall**$_{227}$ be used in the configurations of transmit/receive (half-duplex) and transmit/transmit (chaining two or more transmitters together).

3.4 Construction Requirements

a) The MDR equipment **shall**$_{228}$ be constructed and fabricated to be installed and integrated into rack configurations at FAA A/G radio communication facilities.

3.4.1 Physical Requirements

3.4.1.1 Mechanical Construction

a) For routine servicing and maintenance, unsoldering of wires, wire harnesses, parts, or assemblies **shall**$_{232}$ not be required.
b) The structural strength and rigidity of the MDR equipment **shall**$_{233}$ be such that normal handling in loading, shipping, unloading, and installing into an FAA standard rack configuration and later reloading, shipping, unloading, and installing into another FAA standard rack configuration or facility will not result in any permanent set or deformation that could impair or interfere with the operation or the ease of maintenance.

c) The MDR **shall**$_{234}$ be such that where plug-in modules or assemblies are used, they can be easily inserted in the proper location when correctly oriented without damage to MDR equipment or parts being engaged.
d) Guide pins, locating pins, slides, or equivalent **shall**$_{235}$ be employed for mechanical alignment and to prevent binding or damage to parts during installation.

3.4.1.1.1 Workmanship

a) Workmanship **shall**$_{239}$ be in accordance with the requirements of this specification, FAA-G-2100, and MIL-HDBK-454, Guideline 9.

3.4.1.1.2 Equipment Size

a) The MDR receivers and transmitters **shall**$_{252}$ be constructed to allow for installation into a standard EIA 19" equipment rack.
b) Mounting hole dimensions, spacing, and panel size **shall**$_{253}$ be as specified in EIA-310E (old designation EIA-RS-310D).
c) Each MDR receiver **shall**$_{254}$ not exceed 2 units in height and 18.5 inches in depth. (1 unit is equal to 1.75 inches)
d) Each low power MDR transmitter **shall**$_{255}$ not exceed 3 units in height and 18.5 inches in depth.
e) Each high power MDR transmitter **shall**$_{256}$ not exceed 4 units in height and 18.5 inches in depth.

3.4.1.1.3 Equipment Weight

The individual MDR receiver and transmitter weight **shall**$_{257}$ not exceed 37 pounds for each unit in accordance with FAA-G-2100, Section 3.3.6.3, male and female maximum weight lift.

3.4.1.1.4 Equipment Slides

a) The MDR equipment **shall**$_{258}$ allow access to control, monitoring and maintenance activities with the equipment bolted to the standard FAA equipment rack.
b) The MDR equipment **shall**$_{259}$ have provisions for slides.

3.4.1.1.5 Nameplates

a) Each MDR receiver and transmitter furnished **shall**$_{260}$ have a nameplate mounted on the front of the chassis as specified in FAA-G-2100, section 3.3.3.1 and associated subsections.

3.4.1.1.6 Pin Layout Identification

a) Numbering or lettering on, or immediately adjacent to, the connectors **shall**$_{261}$ identify all connector pins.

3.4.1.1.7 MDR Installation/Removal

a) The MDR receiver and transmitter **shall**$_{264}$ be constructed to be installed, removed, and reinstalled with a minimum of common tools and without extensive disassembly.

3.4.1.1.8 MDR Set-Up

a) The MDR receiver and transmitter **shall**$_{265}$ be initially set up and adjusted under normal operating conditions (see section 3.4.3.1), following the procedures in the technical instruction book.

3.4.1.1.9 MDR Warm-up

a) The MDR receiver and transmitter **shall**$_{266}$ meet the requirements of full power operation within 30 seconds of turn on.

3.4.1.1.10 Thermal Protection

a) The MDR receiver and transmitter **shall**$_{267}$ contain a thermal circuit for protection against overheating.
b) The thermal circuit **shall**$_{268}$ not cause a reduction in operation (power output) when operating within the duty cycle and environmental conditions specified.

3.4.1.1.11 Shock and Vibration Protection

a) Shock and vibration protection **shall**$_{269}$ conform to MIL-STD-810, Method 516.3, Procedure VI-Bench Handling.
b) In all cases, no fixed part **shall**$_{270}$ become loose.
c) No movable part or permanently set adjustment **shall**$_{271}$ shift its setting or position.
d) No degradation in MDR receiver and transmitter performance **shall**$_{(272)}$ occur under the environmental service and operational conditions specified herein.

3.4.1.1.12 Grounding, Bonding, and Shielding

a) The MDR receiver and transmitter grounding, bonding, and shielding protection **shall**$_{273}$ be as specified in FAA-STD-020, sections 3.8, 3.9, and 3.10, and associated subsections.

3.4.1.1.13 Acoustical Noise Criteria Requirement

a) The acoustic noise criteria requirement of the MDR receiver and transmitter **shall**$_{274}$ apply to all equipment located in areas normally requiring verbal communications.
b) Sound pressure and acoustic noise levels generated by the MDR equipment in normal operation **shall**$_{275}$ not exceed the limits as specified in FAA-G-2100, section 3.3.6.1, subsection c.

3.4.1.1.14 Materials, Processes, and Parts

a) All parts and materials used in the MDR receiver and transmitter **shall**$_{276}$ be new.
b) The components **shall**$_{278}$ be equal to or better than those components meeting the applicable EIA standards and suitable for the purpose intended.
c) All parts used in the MDR receiver and transmitter **shall**$_{279}$ be operated within their electrical ratings and the environmental requirements of this specification.

3.4.1.1.14.1 Ferrous Materials

a) Ferrous materials, if used, **shall**$_{280}$ be corrosion-resisting types.

b) They **shall**$_{281}$ be suitably protected to withstand a salt spray test for a minimum of 48 hours as specified in FAA-G-2100, section 3.3.1.1.2.1.

3.4.1.1.14.2 Adhesives

a) Adhesives, if used, **shall**$_{282}$ be resistant to swelling or other deterioration caused by contact with air, moisture, fungus, gases, ozone, or solvents.
b) Incompatible adhesives **shall**$_{283}$ not be used.
c) For assemblies that may be flexed or subject to impact, a brittle adhesive **shall**$_{284}$ not be used.

3.4.1.1.14.3 Arc-Resistant Materials

a) Arc-resistant materials **shall**$_{285}$ be used for insulation of electrical power circuits where arcing is likely to occur.

3.4.1.1.14.4 Dissimilar Metals

a) Selection and protection of dissimilar metal combinations **shall**$_{286}$ be in accordance with FAA-G-2100, section 3.3.1.1.1 and MIL-STD-889.

3.4.1.1.14.5 Fibrous Material

a) Fibrous material **shall**$_{287}$ not be used.

3.4.1.1.14.6 Flammable Materials

a) Flammable materials **shall**$_{288}$ not be used without prior FAA approval in accordance with FAA-G-2100, section 3.3.1.1.3.

3.4.1.1.15 Safety

a) An MDR equipment malfunction **shall**$_{290}$ in no way contribute to the destruction of the equipment or any part of its environment.
b) Safety **shall**$_{291}$ conform to the requirements of FAA-G-2100, section 3.3.5 and associated subsections.

3.4.1.1.16 Human Performance/Human Engineering

a) The MDR receiver and transmitter **shall**$_{292}$ conform to the applicable criteria contained in FAA-G-2100, section 3.3.6 and the FAA Human Factors Design Guide, section 12.10.1.

3.4.1.1.17 Removable Parts and Mating Connectors

a) Each MDR receiver and transmitter **shall**$_{294}$ be complete with an installed set of fuses, lamps, plug-in type components, and other similar parts that are used in the equipment and are constructed for quick removal and replacement.
b) When two or more pieces of equipment require interconnection, the necessary mating connectors (except coaxial) **shall**$_{295}$ be supplied for both the MDR and associated equipment that interfaces with the MDR in accordance with FAA-G-2100, section 3.1.2.1.

3.4.1.2 Controls

a) The MDR receiver and transmitter **shall**$_{296}$ have provisions for both local and remote control operation.

3.4.1.2.1 Frequency Change Time

a) The time required to completely retune the MDR receiver or transmitter to a new frequency, including any required realignment **shall**$_{297}$ not exceed 30 minutes including retuning of the cavity filters.
b) MDR receivers and transmitters **shall**$_{298}$ include protective features to guard against inadvertent frequency changes.

3.4.1.2.2 Detents

a) The controls with an "OFF" position **shall**$_{299}$ have a detent or equivalent in the ON position to prevent inadvertent operation.

3.4.1.2.3 Adjustment Range

a) The adjustment range of the MDR receiver and transmitter operator and maintenance controls **shall**$_{300}$ be constructed to preclude damage to the equipment or its subassemblies when adjusted to the limits of the control travel.
b) The range of control **shall**$_{301}$ be constructed to reduce the sensitivity and criticality of the adjustment task to the maximum extent possible.

3.4.1.2.4 Power Switches/Power On Indicators

a) The MDR receiver and transmitter **shall**$_{302}$ have front panel mounted AC and DC power switches.
b) Corresponding power on indicators **shall**$_{303}$ also be provided.
c) Light emitting diodes (LED) **shall**$_{304}$ be used for power-on indicator use.
d) Power switches **shall**$_{305}$ have detents in order to avoid inadvertent action.

3.4.1.2.5 Front Panel Display

a) The MDR receiver and transmitter front panel **shall**$_{306}$ provide a display of: 1) the selected frequency, 2) mode of operation, and 3) operational state.
b) The MDR receiver and transmitter **shall**$_{(530)}$ provide visual indications on the front panel that
   1) A failure event occurred
   2) An alarm event occurred
   3) An alert event occurred
c) The visual indications for failure events, alarm events and alert events **shall**$_{(531)}$ remain until a MDT logs into the MDR, or the event log is read.
d) The front panel display **shall**$_{307}$ be back-lit, and viewable for at least ± 30 degrees off horizontal or vertical axis.

3.4.1.2.6 Functions and Labeling

a) Labeling **shall**$_{309}$ be permanent, legible, and mounted so that the data are visible to personnel without the need to disassemble the part or adjacent functional or structural parts.
b) Connectors **shall**$_{310}$ be identified on the plug-in side by labels that describe their specific functions.
c) All fuse positions **shall**$_{311}$ be marked with the rated current capacity, voltage rating, and type of fuse to be used.
d) Delayed action fuses **shall**$_{312}$ have the additional designation "SLOW".
e) All fuse markings **shall**$_{313}$ be on the insertion side, so as to be visible when replacing fuses.
f) The following functions and corresponding labels **shall**$_{314}$ be available on the MDR receiver and transmitter as specified in Table 3-5:

Table 3-5: MDR Functions and Labeling

Functions	Labeling
AC Power ON/OFF Switch (Rx & Tx)	AC PWR ON
DC Power ON/OFF Switch (Rx & Tx)	DC PWR ON
AC Power ON Indication Light (Rx & Tx)	AC PWR
DC Power ON Indication Light (Rx & Tx)	DC PWR
Transmitter Local Microphone Connector (Tx only)	MIC
Receiver Local Headset Connector (Rx only)	HEADSET
AC Fuse Holder/Circuit Breaker AMP (TBS) (Rx & Tx)	120 VAC/60 Hz
DC Fuse Holder/Circuit Breaker AMP (TBS) (Rx & Tx)	24 VDC
AC Input Power Connector (Rx & Tx)	120 VAC/60 Hz
DC Input Power Connector (Rx & Tx)	24 VDC
MDR Antenna RF Out Connector (Rx & Tx) *	MDR RF
Internal Cavity Filter Input Connector (Rx & Tx) *	CF1
Internal Cavity Filter Output Connector (Rx & Tx) *	CF2
Antenna Transfer Relay (Common) Connector (Rx & Tx) *	ATRC
Antenna Transfer Relay Connector #1 (Rx & Tx) *	ATR1
Antenna Transfer Relay Connector #2 (Rx & Tx) *	ATR2
MDT Connector (Rx & Tx)	MDT
RIU Connector (Rx & Tx)	RIU
Remote Connector (Rx & Tx)	RCE
Tuning of Internal Filter (Rx & Tx)	TUNING

* See Figure 6-1.

3.4.1.2.7 Filter Tuning

a) If the cavity filter is manually tunable, it **shall**$_{(386)}$ be tunable via the front panel.

3.4.1.3 Interchangeability

a) Functional interchangeability **shall**$_{315}$ be maintained between each MDR receiver and transmitter described herein and existing receivers and transmitters operating as A/G equipment in accordance with FAA-G-2100, section 3.3.4.

3.4.2 Electrical Requirements

3.4.2.1 Input Power Requirements

a) The MDR equipment **shall**$_{316}$ meet the requirements of this specification with primary line input voltage of 120 VAC (±10 percent), 60 Hz (±3 Hz) single phase and with an alternate line input voltage of 24 VDC, negative ground, (-10/+20 percent).
b) During the loss of primary AC line input voltage (or non-availability of AC voltage) the equipment **shall**$_{317}$ have an internal automatic line voltage switchover.
c) Activation of this internal automatic line voltage switchover **shall**$_{318}$ allow for equipment operation from a DC voltage source.
d) The MDR equipment **shall**$_{319}$ operate under varying conditions, such as slow variations of AC and DC line voltages and AC line frequency, within the ranges specified herein.
e) The MDR equipment **shall**$_{320}$ automatically resume normal operation when subjected to power interruptions and/or outages in accordance with FAA-G-2100, section 3.1.1.8.
f) Both AC and DC voltage inputs **shall**$_{321}$ be from the rear of the MDR equipment, and when practical, be located on the lower right side of the MDR equipment as viewed from the rear.
g) The maximum current limits for the MDR equipment **shall**$_{322}$ be as listed in Table 3-6.

Table 3-6: Maximum Current Limits

Component	AC Current (AMPERES)	DC Current (AMPERES)
MDR Receiver	0.5	1.0
MDR Transmitter (15 Watt RF Output Maximum)	2.5 (300 VA)	10.0
MDR Transmitter (50 Watt RF Output Maximum)	5.0 (600 VA)	20.0

Note: The actual average current values will be supplied by the vendor.

3.4.2.1.1 Power Cords

a) The equipment **shall**$_{323}$ be provided with: 1) a removable six-foot, three-conductor AC power cord, and 2) a removable six-foot, two-conductor DC power cord, each matching with the respective connector on the MDR receiver and transmitter.
b) The AC cord(s) **shall**$_{324}$ have the AC protection ground lead configured to ground the chassis as specified in FAA-G-2100, section 3.1.1.9.

3.4.2.2 Reverse Polarity Protection

a) The MDR receiver and transmitter **shall**$_{325}$ incorporate reverse polarity protection to prevent damage to the MDR equipment if the polarity of the 24 VDC input voltage is reversed.

3.4.2.3 Circuit Protection

a) All MDR receiver and transmitter input/output circuits **shall**$_{326}$ include circuit protection which prevents opens or shorts at the input/output terminals from damaging the equipment.
b) When the short or open is removed, circuit performance **shall**$_{327}$ show no sign of performance degradation in accordance with FAA-G-2100, section 3.1.1.7.

3.4.2.3.1 Current Overload Protection

a) Current overload protection for the MDR receiver and transmitter **shall**$_{328}$ be provided by fuses, circuit breakers, or other protective devices for primary input AC and DC circuits as specified in FAA-G-2100, section 3.3.1.3.2 and associated subsection.

3.4.2.3.2 Protective Caps

a) Protective caps for mating with normally unmated or infrequently used connectors (i.e., local microphone input jacks or test/diagnostic input/output connectors) on the MDR receiver and transmitter **shall**$_{329}$ be provided in accordance with FAA-G-2100, section 3.3.1.3.3.4.

3.4.2.3.3 Electrostatic Discharge Control

a) Control provisions, methods, and techniques to reduce and prevent the susceptibility to Electrostatic Discharge (ESD) damage **shall**$_{330}$ be implemented in the production of the MDR receiver and transmitter.
b) All circuits and components used in the MDR equipment that are susceptible to damage by ESD **shall**$_{331}$ be protected as specified in FAA-G-2100, section 3.2.7 and FAA-STD-020, section 3.12.3.

3.4.2.3.4 AC Harmonic Content

a) The total harmonic content of the input current caused by the MDR receiver and transmitter (in all of their configurations) and fed back into the AC power source **shall**$_{332}$ not exceed 5 percent of the fundamental AC power line frequency (60 Hz).
b) No single harmonic **shall**$_{333}$ be greater than 3 percent of the fundamental AC power line frequency. See FAA-G-2100, section 3.1.1.4.

3.4.2.3.5 AC Inrush Current Limiting

a) The MDR receiver and transmitter AC inrush current characteristics (in all of the equipment configurations) **shall**$_{334}$ not exceed 1.5 times overcurrent shown in Figure 3-3.
b) The duration of the inrush current **shall**$_{335}$ be measured from the point at which the power is turned on to the point to which the current returns within 110 percent of its normal value. See FAA-G-2100, section 3.1.1.2.2.

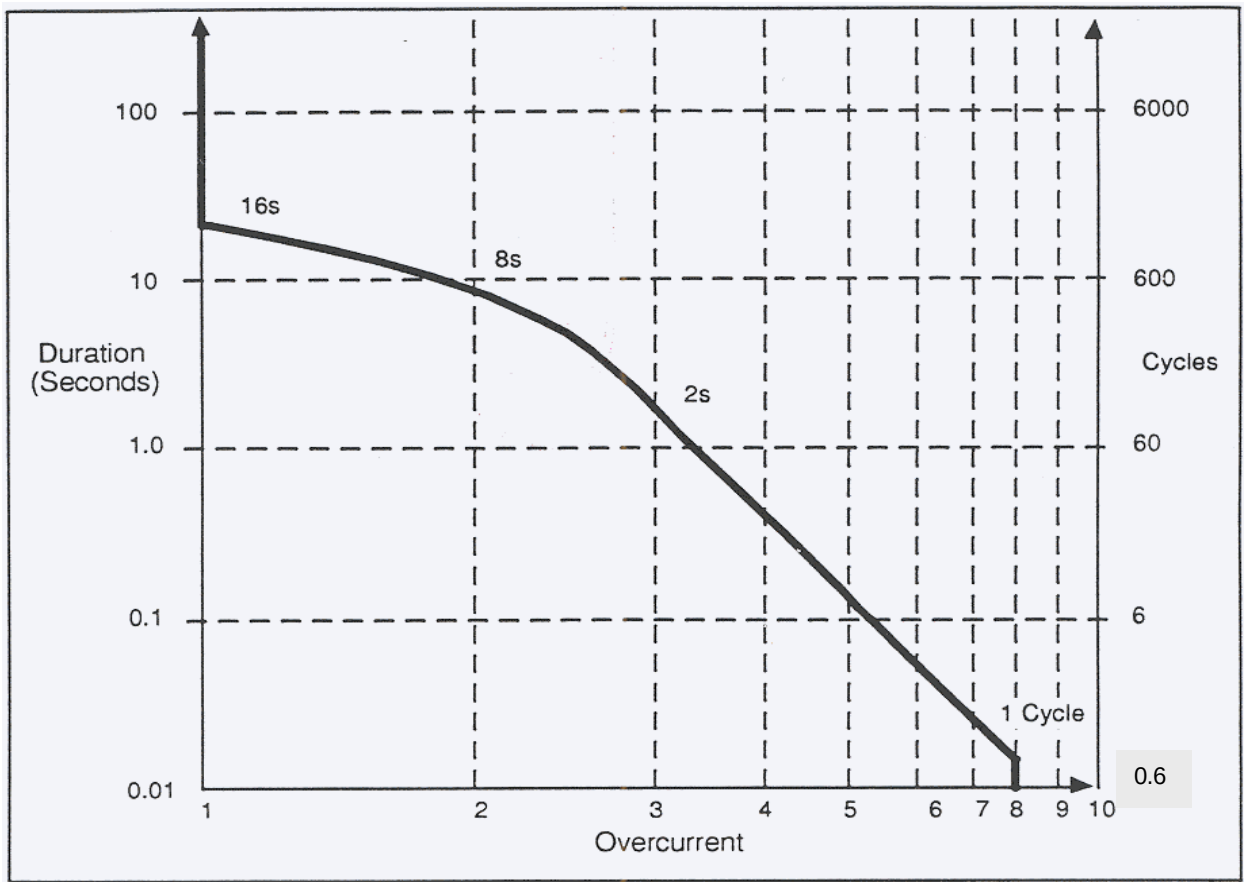


Figure 3-3. Inrush Current Limiting Requirements

3.4.2.3.6 AC Power Factor

a) The MDR receiver and transmitter (in all of their configurations) **shall**$_{336}$ present a power factor to the AC power source of not less than 0.7 leading or lagging when operating under steady state conditions, from 25 percent to 100 percent of full load at the nominal line voltage (120VAC). See FAA-G-2100, section 3.1.1.2.1.

3.4.2.3.7 Transient Protection

a) The MDR receiver and transmitter **shall**$_{337}$ contain protective devices in the audio circuits that conform to IEEE/ANSI Standards C62.36-1994, (Surge Protectors Used in Low-voltage Data, Communications, and Signaling Circuits), in the RF circuits that conform to IEEE/ANSI Standards C62.31-1987, (Gas-Tube Surge-Protective Devices), and in the AC power circuits that conform to IEEE/ANSI Standards C62.41-1991, (IEEE Recommended Practice on Surge Voltages in Low-voltage AC Power Circuits).

b) The MDR receiver and transmitter **shall**$_{338}$ provide overall unit protection as outlined in IEEE/ANSI Standard C62.47-1992, (IEEE Guide on Electrostatic Discharge (ESD)).

3.4.2.4 Test Points

a) External test points **shall**$_{340}$ be female BNC type connectors.

3.4.2.5 Semiconductor Devices

a) The choice, specification, and application of semiconductor devices in the MDR receiver and transmitter **shall**$_{341}$ be in accordance with MIL-HDBK-454, Guideline 30.
b) Maximum use of multisource devices **shall**$_{342}$ be made.

3.4.2.6 Loss of Input Voltage

a) The loss or variance of input voltage, including loss of voltage caused by activation of circuit protector devices, **shall**$_{344}$ not cause or induce any damage to any component in the MDR receiver and transmitter or other interfacing equipment.

3.4.3 Environmental Conditions

a) The MDR receiver and transmitter **shall**$_{345}$ be constructed of materials to withstand any combination of environmental and service conditions specified below without causing damage or degradation of performance below the requirements of this specification.

3.4.3.1 Operating Conditions

a) The MDR receiver and transmitter **shall**$_{346}$ be able to operate in a facility under the operating conditions specified in Table 3-7:

Table 3-7: Operating Conditions

Temperature Range	-10^{o} C to +50^{o} C
Relative Humidity	5 to 90 percent (above 40 °C, the relative humidity is based on the dew point of 40°C)
Altitude	0 to 15,000 Feet

3.4.3.2 Non-Operating Conditions

a) Non-operating conditions for the MDR receiver and transmitter are those conditions affecting equipment in storage, in shipment, in the process of being installed at a site, and installed at a site but non-operating. The MDR equipment **shall**$_{347}$ meet the requirements for a non-operating conditions in Table 3-8:

Table 3-8: Non-Operating Conditions

Temperature Range	-10° C to +70^{o} C
Relative Humidity	up to 100 percent including condensation due to temperature changes
Altitude	0 to 50,000 Feet

3.4.3.3 Equipment Ventilation and Cooling

a) The MDR receiver and 15 watt maximum MDR transmitter **shall**$_{348}$ operate in a room environment without need for heating or external forced-air ventilation.
b) The 50 watt maximum MDR transmitter **shall**$_{349}$ operate in a room environment without need for heating.
c) No accessible area on the MDR equipment **shall**$_{351}$ exceed 140^{o} Fahrenheit (momentary contact) and 110^{o} Fahrenheit (continuous contact) that would constitute a thermal contact hazard to personnel in accordance with FAA Human Factors Guide, section 12.10.2.

3.4.4 Electromagnetic Compatibility Requirements

a) For purposes of this procurement, this equipment **shall**$_{(569)}$ be classified and tested as Army Ground equipment as detailed in MIL-STD-461.
b) Electromagnetic emission and susceptibility of the MDR receiver and transmitter **shall**$_{352}$ not exceed the limits in MIL-STD-461 requirements CE-102, CS-101, CS-114, CS-115, CS-116, RE-102 and RS-103. Where conflict exists between "Navy Procurement", "Air Force Procurement", and "Army Procurement", the "Army Procurement" takes precedence.

3.5 Quality Factors

3.5.1 Reliability

3.5.1.1 Mean Time Between Failure

a) The predicted Mean Time Between Failure (MTBF) for the MDR receiver and transmitter **shall**$_{353}$ be not less than 26,280 hours.

3.5.2 Maintainability

a) The MDR receiver and transmitter **shall**$_{354}$ provide parameter adjustments for routine maintenance.
b) The MDR receiver and transmitter each **shall**$_{355}$ be an LRU.
c) This concept is that site repair **shall**$_{356}$ be limited to the exchange of a LRU(s) in restoring service.

3.5.2.1 Mean Time To Repair

The Mean Time To Repair (MTTR) of the MDR receiver or transmitter **shall**$_{357}$ not be greater than 30 minutes at the site (LRU Replacement).

3.5.2.2 Periodic Maintenance

a) The MDR receiver and transmitter **shall**$_{363}$ be configured so that periodic maintenance can be performed without disrupting the on-line component.
b) Periodic maintenance intervals **shall**$_{364}$ meet or exceed one year.

3.5.3 Service Life

a) The MDR receiver and transmitter **shall**$_{365}$ have a minimum useful service life of 10 years.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Testing Conditions

a) Unless otherwise specified, all testing **shall** be performed under the following conditions:
   1) Temperature: Room Ambient, +19°C (+67°F) to +25°C (+77°F)
   2) Pressure: Nominal atmospheric pressure of 29.92 inches of Mercury
   3) Humidity: Greater than 25 percent relative humidity

4.2 Tests

4.2.1 Electromagnetic Compatibility Tests

a) The MDR equipment EMC compatibility requirements are as follows: Electromagnetic emission and susceptibility testing **shall** be performed on the equipment.
b) The test requirements and test procedures of MIL-STD-461 **shall** be used for this testing.
c) For the purposes of this procurement, this equipment **shall** be classified and tested as class A3 equipment as detailed in MIL-STD-461.
d) Where conflict exists between "Navy Procurement" and "Army Procurement", the "Army Procurement" **shall** take precedence. The tests required by this section are all considered "applicable" as defined in MIL-STD-461.
e) As a minimum, the testing **shall** include the following requirements: CE102, CS101, CS114, CS115, CS116, RE102 and RS103.

4.3 Verification Methods

a) Verification methods **shall** be utilized in measuring equipment performance and compliance of individual requirements contained in this specification. The four verification methods, TEST, DEMONSTRATION, ANALYSIS, and INSPECTION, listed in decreasing order of complexity, are described as follows:
   1) TEST. Test is a method of verification wherein performance is measured during or after the controlled application of functional and/or environmental stimuli. Quantitative measurements are analyzed to determine the degree of compliance. The process uses laboratory equipment, procedures, items, and services.
   2) DEMONSTRATION. Demonstration is a method of verification where qualitative determination of properties is made for an end item, including the use of technical data and documentation. The items being verified are observed, but not quantitatively measured, in a dynamic state.
   3) ANALYSIS. Analysis is a method of verification that consists of comparing hardware design with known scientific and technical principles, procedures and practices to estimate the capability of the proposed design to meet the mission and system requirements.
   4) INSPECTION. Inspection is a method of verification to determine compliance without the use of special laboratory appliances, procedures, or services, and consists of a non-destructive static-state examination of the hardware, the technical data and documentation.

5.0 PREPARATION FOR DELIVERY

a) The MDR receiver and transmitter **shall** be delivered in accordance with Section F of the contract.

6.0 NOTES

6.1 Notes on Information Items

The contents of this section are for informational purposes only and are not a part of the requirements of this specification. They are not contract requirements nor binding on either the Government or the Contractor. In order for these terms to become a part of the resulting contract, they must be specifically incorporated in the schedule of the contract. Any reliance placed by the Contractor on the information in these subsections is wholly at the Contractor's own risk.

6.2 Applicable Definitions

6.2.1 Very High Frequency (VHF)

In this document the term VHF applies specifically to the frequency range 112.000 MHz – 137.000 MHz, the frequency range reserved for Aeronautical Mobile (Route) Service.

6.2.2 Ultra High Frequency (UHF)

In this document the term UHF applies specifically to the frequency range 225.000 MHz -399.975 MHz frequency range, the frequency range reserved for military navigation and communications.

6.2.3 Mean Time Between Failures (MTBF)

A basic measure of reliability for non-repairable items: the total number of life units of an item divided by the total number of failures within that population, during a particular measurement interval under stated conditions.

6.2.4 Mean Time To Repair (MTTR)

A basic measure of maintainability: the sum of corrective maintenance times at any specific level of repair, divided by the total number of failures within an item repaired at that level, during a particular interval under stated conditions.

6.2.5 Mean Time To Repair Maximum

The maximum time taken to repair a unit, at a depot level work station, to return it to an operational state.

6.2.6 Duty Cycle

The percentage of time that the transmitter is keyed in proportion to total service time.

6.2.7 Modular Construction

Equipment constructed so all subassemblies are modules that plug into the main chassis.

6.2.8 Line Replaceable Unit (LRU)

An item which may consist of a unit, an assembly (circuit card assembly, electronic component assembly, etc.), a subassembly, or a part, that is removed and replaced at the site maintenance level in order to restore the system/equipment to operational status.

6.2.9 Co-channel Interference

The power ratio of the wanted signal level to the unwanted signal level at the specified voice quality is the co-channel interference protection in dB (positive value). The co-channel interference protection for VDL Mode 3 data /digitized voice is the overall capability of a receiver to demodulate a signal properly (to achieve a defined BER performance) in the presence of an unwanted modulated signal at the same assigned frequency. The co-channel interference protection for DSB-AM voice is the overall capability of the receiver to provide intelligible voice in the presence of an unwanted modulated signal at the same assigned frequency. The co-channel interference requirement has a major impact on frequency re-use planning criteria.

6.2.10 Adjacent Channel Emissions

Adjacent channel emissions are interference signals resulting from modulated RF signal power transmitted that are outside of the assigned channel. Adjacent channel emissions include discrete frequency spurious signals, and noise like signals (including phase noise) at the transmitter output.

6.2.11 Bit Error Rate

The BER corresponds to the uncorrected bit error probability and is expressed as the ratio of the number of incorrect bits received to the number of bits received without benefits of Forward Error Correction (FEC).

6.2.12 Definitions for Fixed and Remotely Tunable Configurations and ATR Function

6.2.12.1 Fixed Tuned Configuration

The MDR receiver and transmitter configurations are similar to the present day radios in the NAS. The MDR receiver and transmitter will contain a fixed tuned internal cavity filter that is tunable by the system specialist with common hand tools. In addition, the MDR receiver and transmitter will also contain a transfer relay that allows multiple MDRs to be connected to a single antenna. This is illustrated in Figure 6-1. This configuration will differ from its present implementation in that the filter can be by-passed. The system specialist will have the option of using the internal fixed tuned filter or using the radio without the filter present.

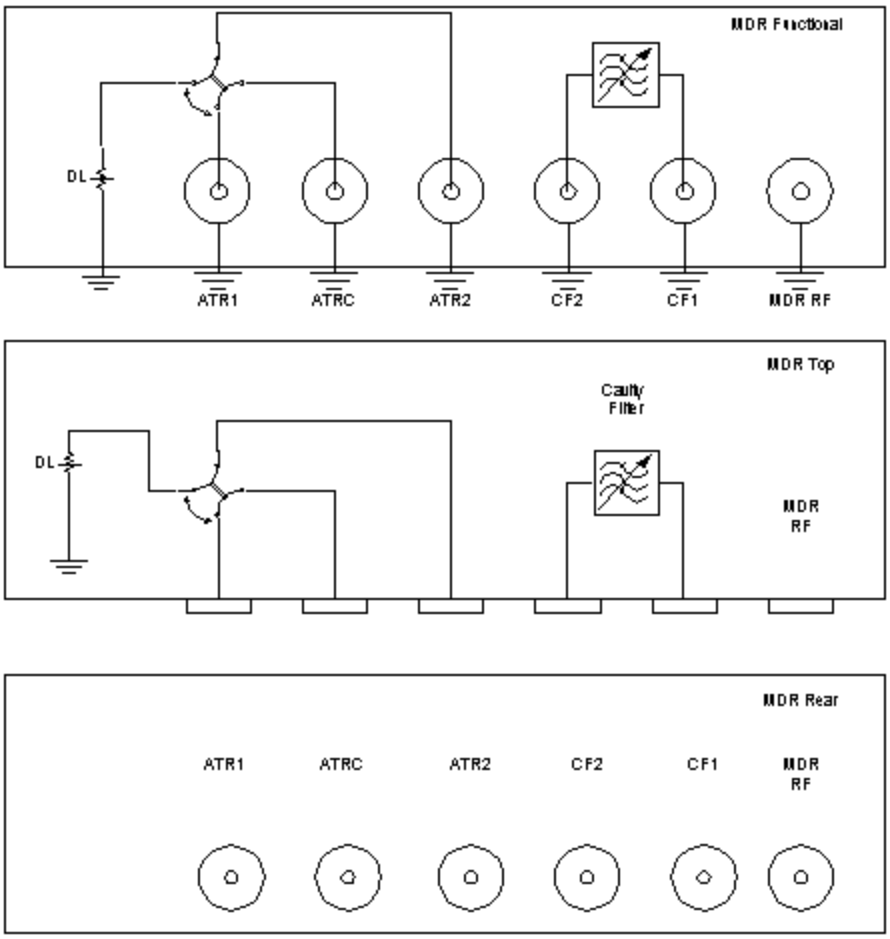


Figure 6-1, Cavity Filter/Antenna Transfer Relay Configuration

6.2.12.2 Remotely Tunable Configuration

This MDR configuration allows the radio to be tuned via the MDT connector on the radio. The only equipment required to facilitate a frequency change will be an MDT used either locally or remotely via the RIU.

6.2.13 Initialization

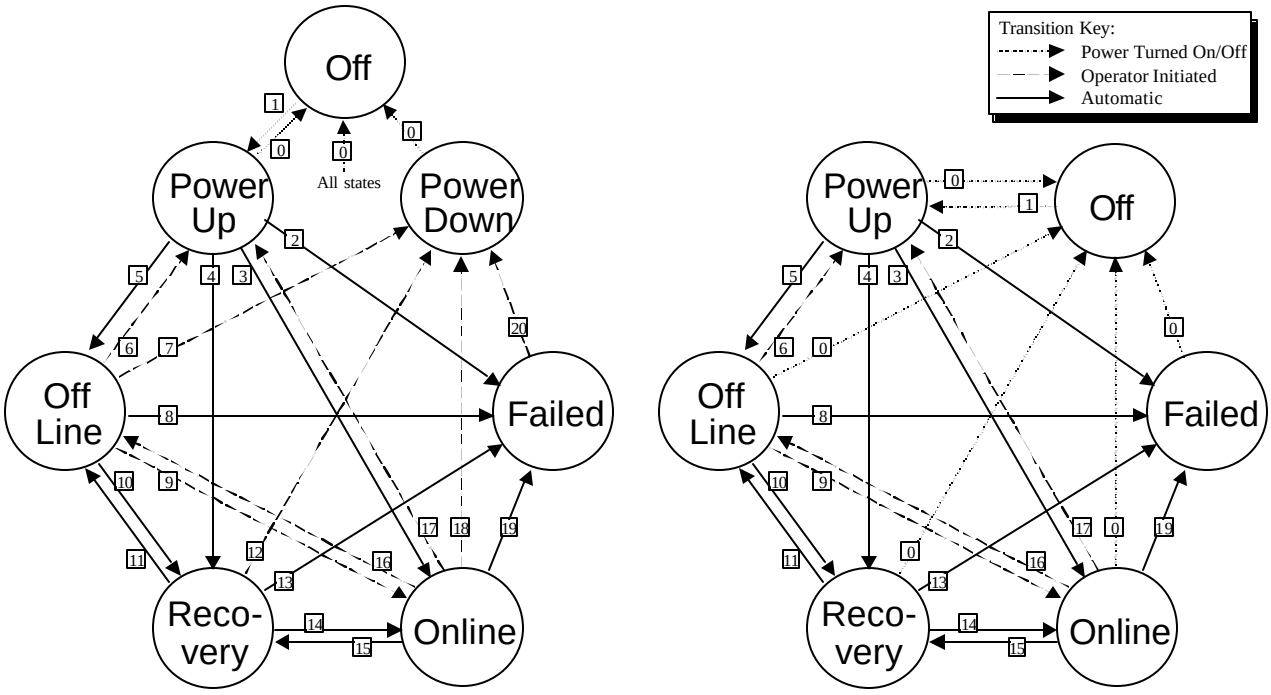
Initialization (also cold start) occurs when (a) the MDR receiver or transmitter is first turned on when delivered from the factory, an (b) when the initialization function is activated. A result of the initialization function is that all control parameters return to their default values.

6.2.14 Restoral

Restoral (also warm start) occurs when the power is returned to the MDR receiver or transmitter under all conditions other than initialization. As a result of restoral function all configuration parameters are automatically restored to the values that were in effect in the operational state before the restoral stimulus occurs.

6.2.15 MDR State Definitions

OFF	MDR does not receive either AC or DC power sufficient for MDR operation
POWER UP	The state the MDR is in during the time between power restoral, power turn on or Operator commanded Reset, and the MDR a) entering Online or Offline, or b) entering Failed state after detecting a non-recoverable failure, or c) entering Failed state after detecting that the MDR was in Failed state immediately prior to most recent power down or power loss. The MDR will conduct initial self testing (e.g BIT or POST) during the Power Up state.
OFFLINE	An operational state in which the remote user's (controller's) ability to use the MDR is disabled, but the MDR is otherwise fully operational. The MDR will conduct background built in testing to verify MDR health.
RECOVERY	A non-operational state entered after the MDR detects a potentially recoverable error, in which only certain monitor and control functions are enabled.
ONLINE	The operational state in which the MDR meets all operational requirements and all functions are enabled except local audio, local PTT and most control commands. The MDR will conduct background built in testing to verify MDR health.
FAILED	The non-operational state the MDR enters after a non-recoverable failure has been detected, or the Recovery process has failed. During Failed state, only those monitor and control functions that can be performed accurately, despite the failure are enabled.
POWER DOWN	The state the MDR enters after an Operator-commanded Shutdown, but before the power is removed. All MDR functions, except those required to complete the Power Down process, are disabled. *This is an optional state that a vendor's implementation may require. If the Vendor's implementation includes a power down sequence other than removing power (i.e. that takes any time), the Power Down state requirements apply.*



Power Down State present

No Power Down State

Figure 6-6. MDR State Diagram

Table 6-1: State Transition Table

Transition	From State	To State	Auto/Manual	Description (Condition for Transition)
0	Any	Off	M/(A)	Whenever power is turned off (or lost)
1	Off	Power Up	M/(A)	Whenever power is turned on (or restored)
2	Power Up	Failed	A	When Power Up sequence fails OR Failed State entered before last Power Down/ Off
3	Power Up	Online	A	A) Successful completion of Power Up sequence and B) State before Power Down/Off was Online or B) Power Loss Restoral Time exceeded
4	Power Up	Recovery	A	Power Up sequence completed but recoverable error detected
5	Power Up	Offline	A	A) Successful completion of Power Up sequence and B) State before Power Down/Off was Offline
6	Offline	Power Up	M	Operator commanded Reset
7	Offline	Power Down	M	Local Operator initiates power-down
8	Offline	Failed	A	MDR detects unrecoverable error (eg POST, BIT,etc)
9	Offline	Online	M	Operator commands Online mode

10	Offline	Recovery	A	Potentially recoverable error detected while Offline
11	Recovery	Offline	A	A) Recovery sequence successful and B) Previous state was Offline
12	Recovery	Power Down	M	Local Operator initiates power down
13	Recovery	Failed	A	Recovery sequence unsuccessful
14	Recovery	Online	A	A) Recovery sequence successful and B) Previous state was Online
15	Online	Recovery	A	Potentially recoverable error detected while Online
16	Online	Offline	M	Operator commands Offline
17	Online	Power Up	M	Operator commanded Reset
18	Online	Power Down	M	Local Operator initiates power-down
19	Online	Failed	A	MDR detects unrecoverable error (eg POST, BIT,etc)
20	Failed	Power Down	M	Local Operator initiates power-down

6.2.16 Non-Volatile Memory

The MDR memory storage that will retain data for the life of the equipment.

6.3 Configuration of Chaining Multiple MDRs to a Common Antenna Using the ATR

The MDR need a capability to connect multiple MDR units to a single antenna. The ATR function is the same as a single-pole double-throw relay or switch. The series of figures that follow illustrate the various cases of connections prevalent in the FAA installations.

The abbreviations used in the figures (see also Figure 6-1) mean the following:
ATR1 Connection to ATR contact 1
ATR2 Connection to ATR contact 2
ATRC Connection to the ATR center contact
CF1 Connection to the internal filter (serial input)
CF2 Connection to the internal filter (serial output)

Figure 6-2 shows the transceive configuration, i.e., transmitter and receiver sharing an antenna. The figure illustrates three cases, first without filters, the second with the use of internal filters, the third the use of external filters.

Figure 6-3 shows the configuration of a main and a standby transmitter sharing an antenna. Figure 6-4 shows the configuration of a main and standby receiver sharing an antenna.

Finally, Figure 6-5 shows a combination of a main receiver and transmitter sharing an antenna with a standby receiver and transmitter. Consequently, four MDR units are using the same antenna. Note that in Figures 6-3 to 6-5 the three cases of using filters are included in the same manner as in Figure 6-2.

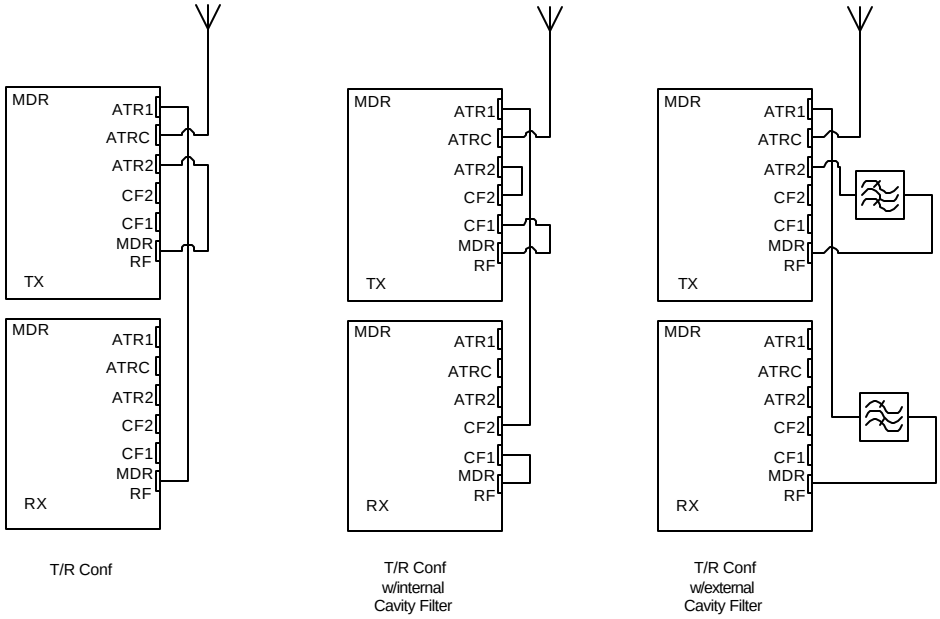


Figure 6-2, Transceive Configuration

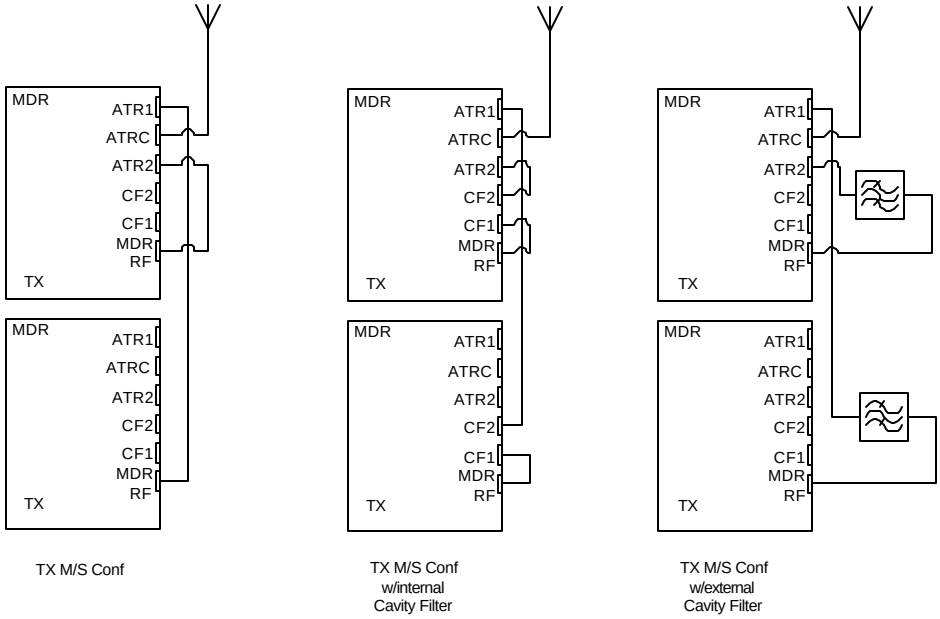


Figure 6-3, Transmitter Main/Standby Configuration

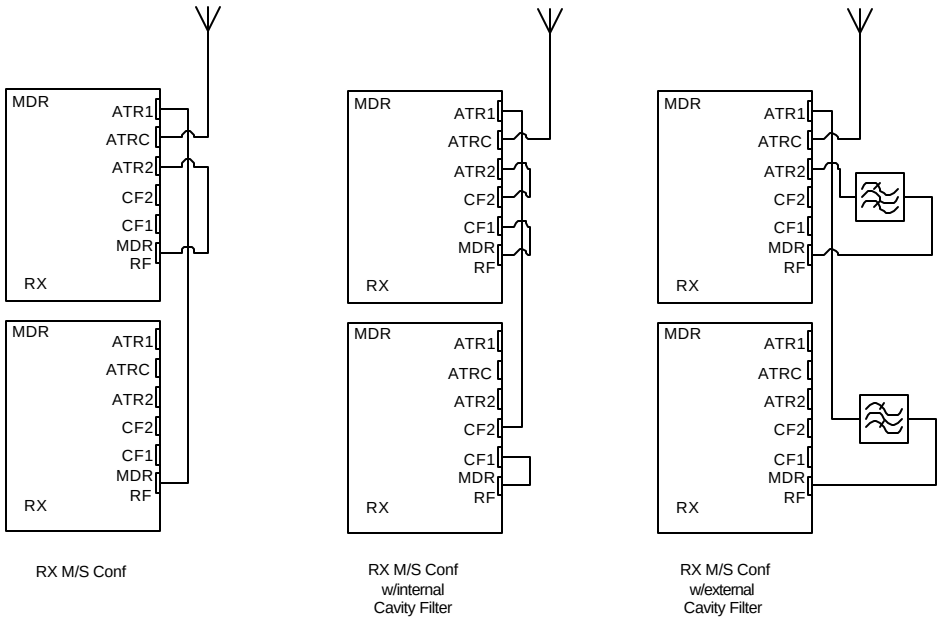


Figure 6-4, Receiver Main/Standby Configuration

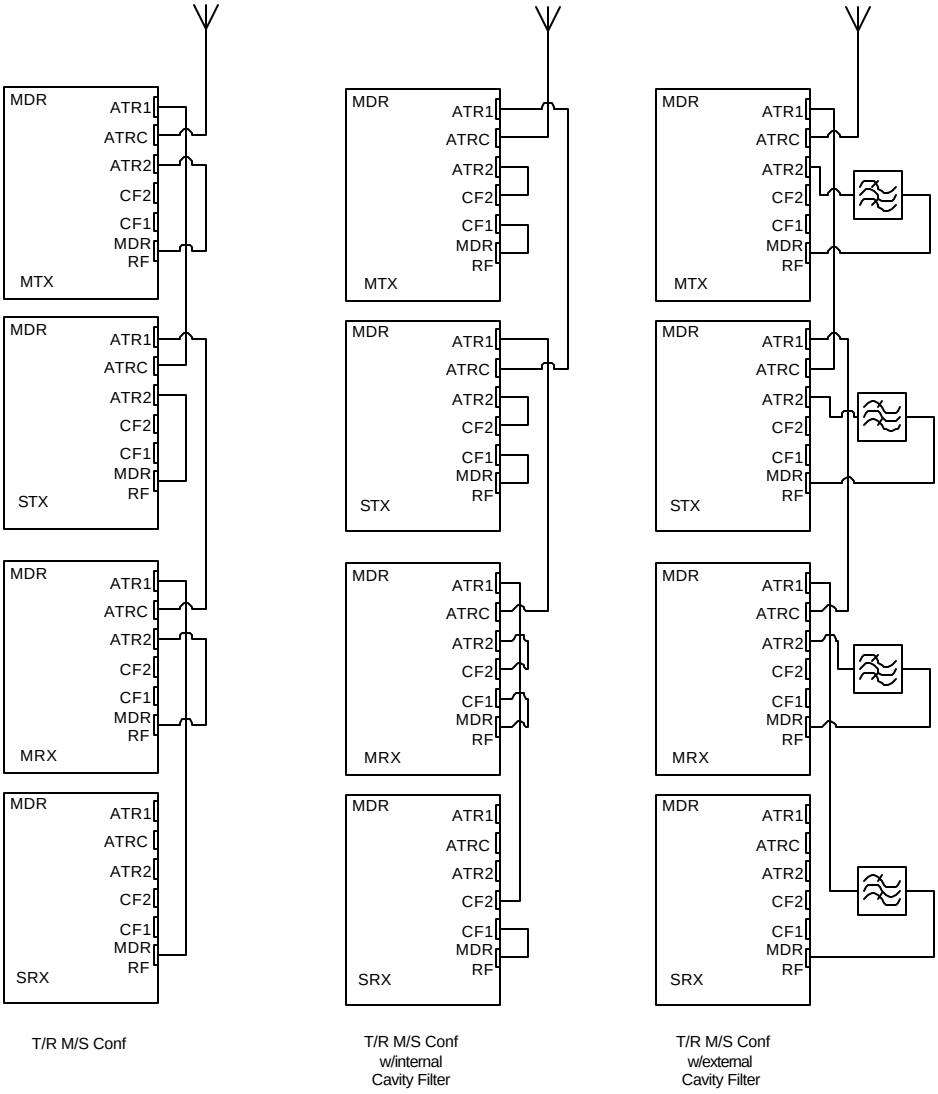


Figure 6-5, Single Antenna Transceive Main/Standby Configuration

APPENDIX A

List of Acronyms

A/G	Air-Ground
ACK	Acknowledgment
AF	Airway Facilities
AGC	Automatic Gain Control
AM	Amplitude Modulation
AM(R)S	Aeronautical Mobile (Route) Services
ASTM	American Society of Testing and Materials
ATC	Air Traffic Control
ATN	Aeronautical Telecommunications Network
BER	Bit Error Rate
C	Centigrade
CW	Continuous Wave
D8PSK	Differential 8 Phase Shift Keying
dB	Decibel
dBc	Decibels referenced to carrier
dBm	Decibels referenced to 1 milliwatt
DLS	Data Link Service
DSB-AM	Double Side-Band Amplitude Modulation
DSRCE	Down Scoped Radio Control Equipment
EMC	Electromagnetic Compatibility
EIA	Electronic Industries Alliance
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
FAA	Federal Aviation Administration
FEC	Forward Error Correction
FM	Frequency Modulation
GME	Global Management Entity
GNI	Ground Network Interface
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
Hz	Hertz
HD	Header
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Standards Organization
kHz	kilohertz
LBAC	Logical Burst Access Channel
LED	Light Emitting Diodes
LME	Local Management Entity
LRU	Line Replaceable Unit
MAC	Media Access Control
MASPS	Minimum Aviation System Performance Standards
MDR	Multimode Digital Radio
MDT	Maintenance Data Terminal
MHz	Megahertz
MS	Milliseconds
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
N/A	Not Applicable

NAS	National Airspace System
NEMA	National Electrical Manufacturers Association
NEXCOM	Next Generation Air/Ground Communications System
NIMS	NAS Infrastructure Management System
NTIA	National Telecommunications and Information Administration
OSI	Open System Interconnection
PCB	Printed Circuit Board
PPM	Parts Per Million
PTT	Push-to-Talk
RAM	Random Access Memory
RCAG	Remote Center Air/Ground
RCE	Radio Control Equipment
RCO	Remote Communications Outlet
RD	Ramp-down
RF	Radio Frequency
RIU	Radio Interface Unit
RMM	Remote Maintenance Monitoring
RMMC	Remote Maintenance Monitoring Control
RMS	Remote Monitoring Subsystem
RTCA	RTCA, Inc. (formerly Radio Technical Commission for Aeronautics)
RTR	Remote Transmitter Receiver
RU	Ramp-up and Power Stabilization
SINAD	Ratio of Signal plus Noise plus Distortion to Noise plus Distortion
SNAcP	SubNetwork Access Protocol
SOC	System Operations Centers
SRD	System Requirements Document
SSS	Sub-System Specification
TCS	Tower Communications System
TDMA	Time Division Multiple Access
TOT	Time of Transmission
TRP	Timing Reference Point
UHF	Ultra High Frequency
VA	Volt Ampere
V/D	Voice or Data
VDC	Volts Direct Current
VDL	VHF Digital Link
VHF	Very High Frequency
VRTM	Verification Requirements Traceability Matrix
VSCS	Voice Switching and Control System
VSWR	Voltage Standing Wave Ratio

APPENDIX B

B1 Ground Equipment Physical Configurations

The physical configurations presently proposed are provided in Figures B-1a through B-3b. Figures B-1 show the implementation desired to maintain compatibility down to the connector level with the legacy RCE. There are FAA sites where receivers and transmitters are located at different sites and this is indicated in B-1b.

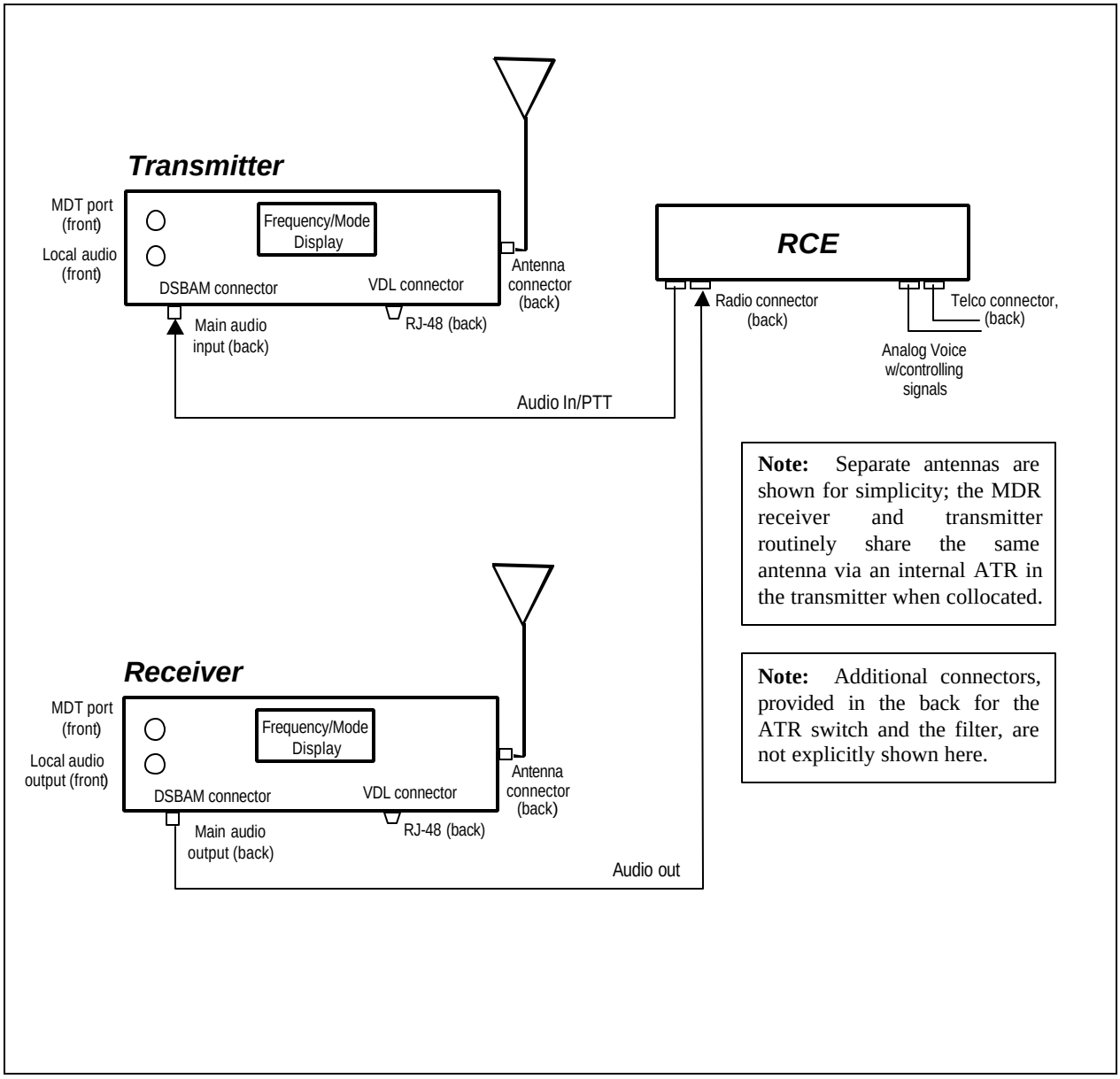


Figure B-1a: DSB-AM Collocated Transmitter/Receiver

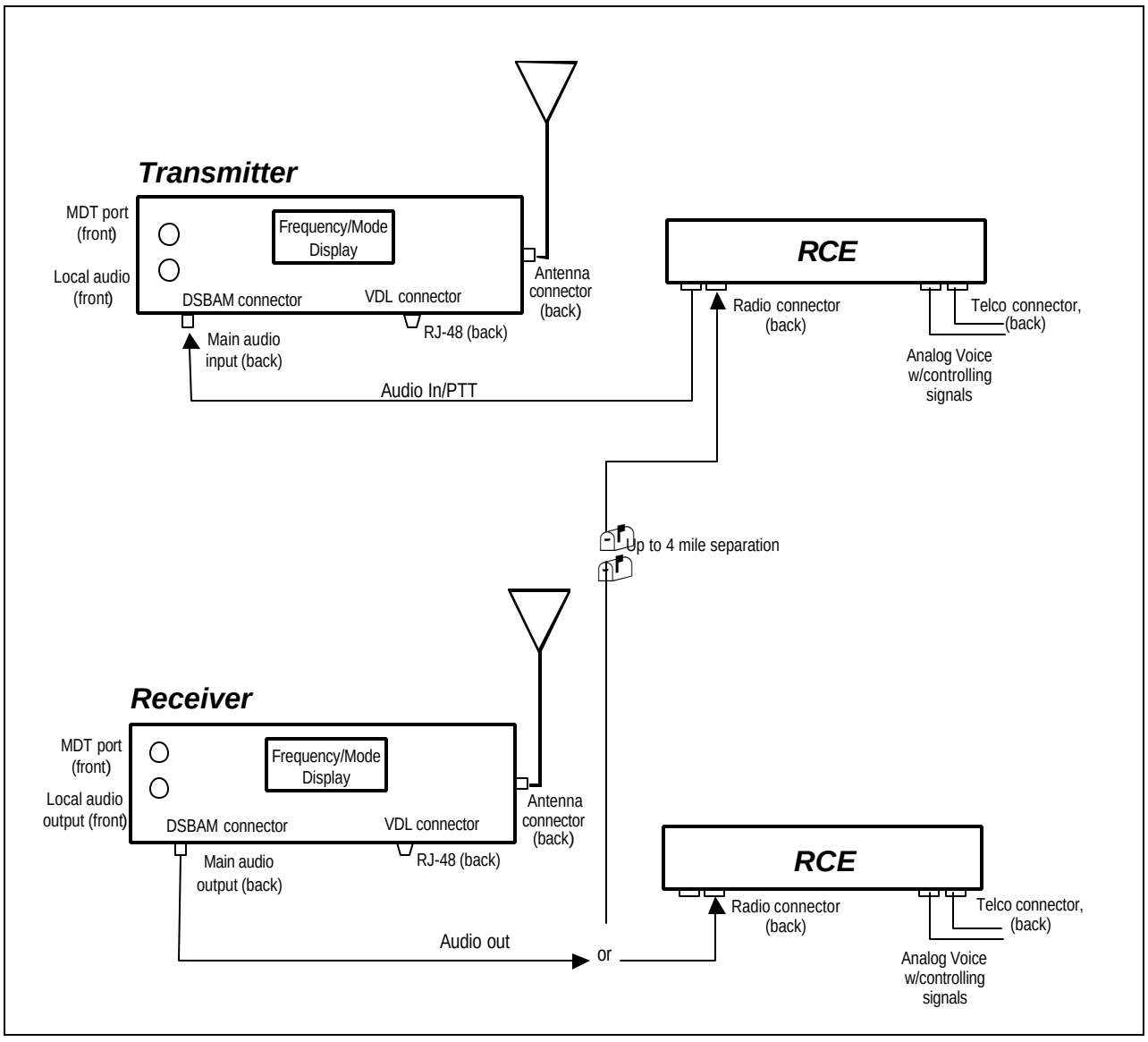


Figure B-1b: DSB-AM Receiver Located Separately

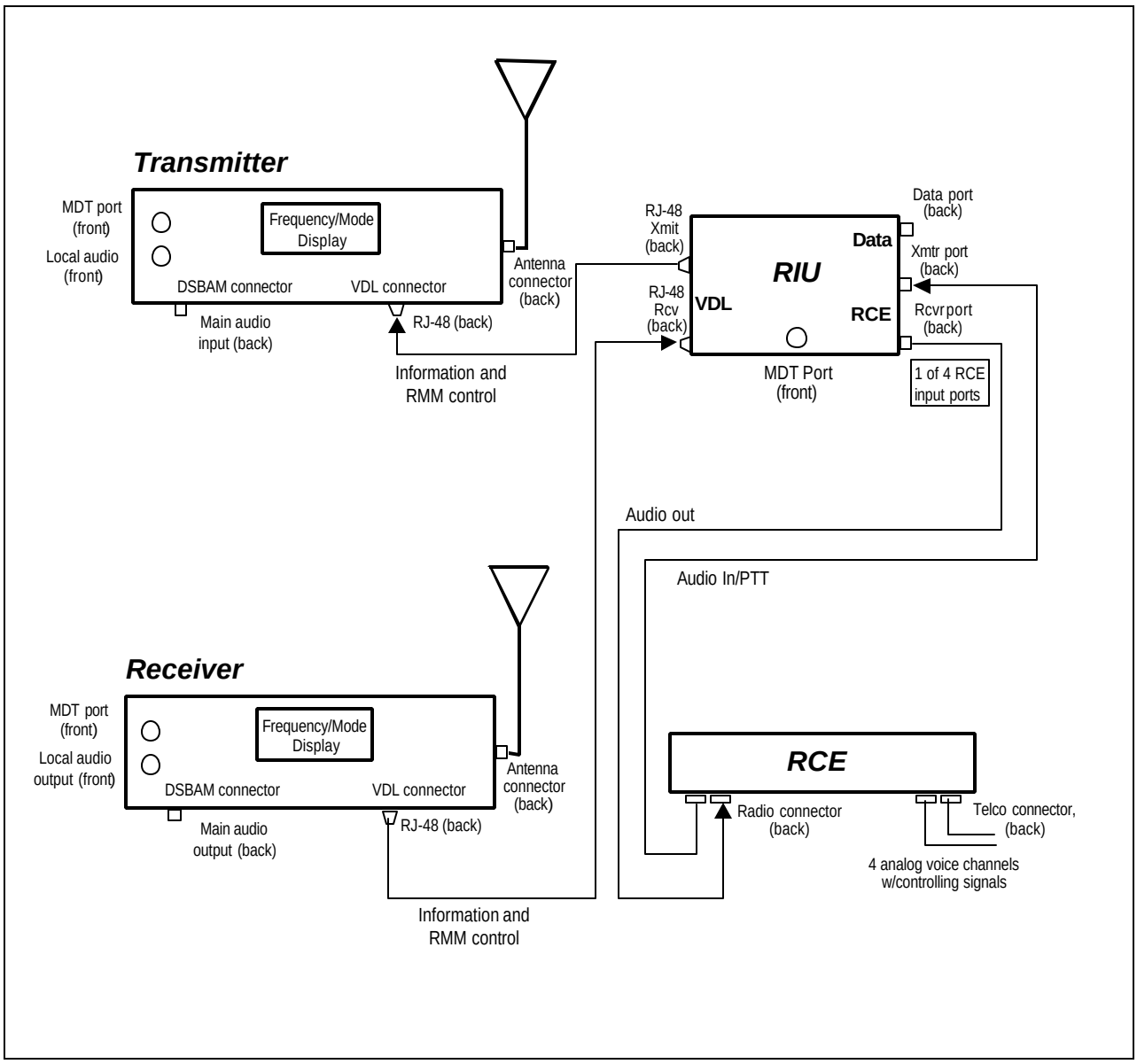


Figure B-2a: VDL Mode 3, 4V Mode, Collocated Transmitter and Receiver

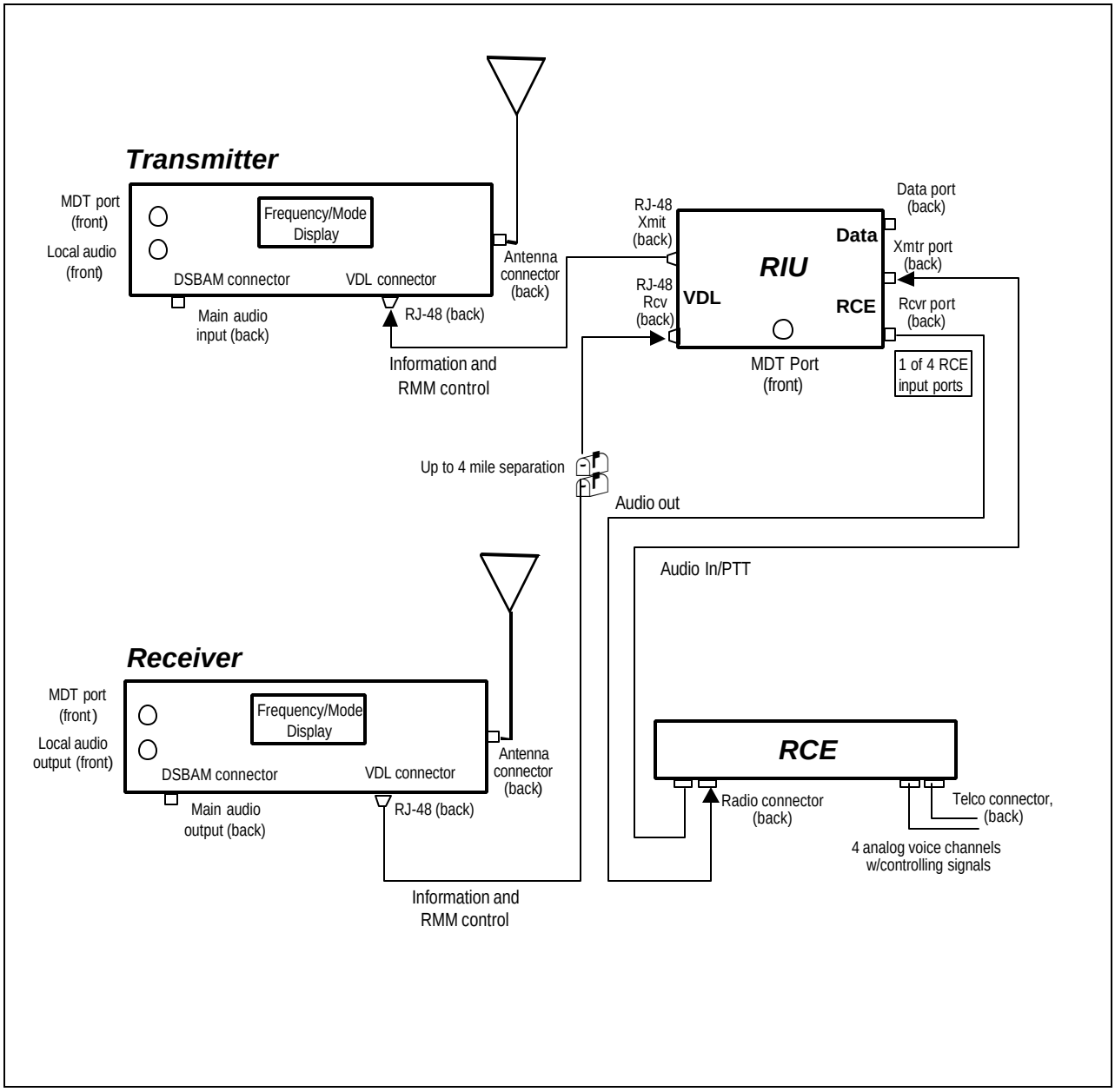


Figure B-2b: VDL Mode 3, 4V Mode, Receiver Located Separately

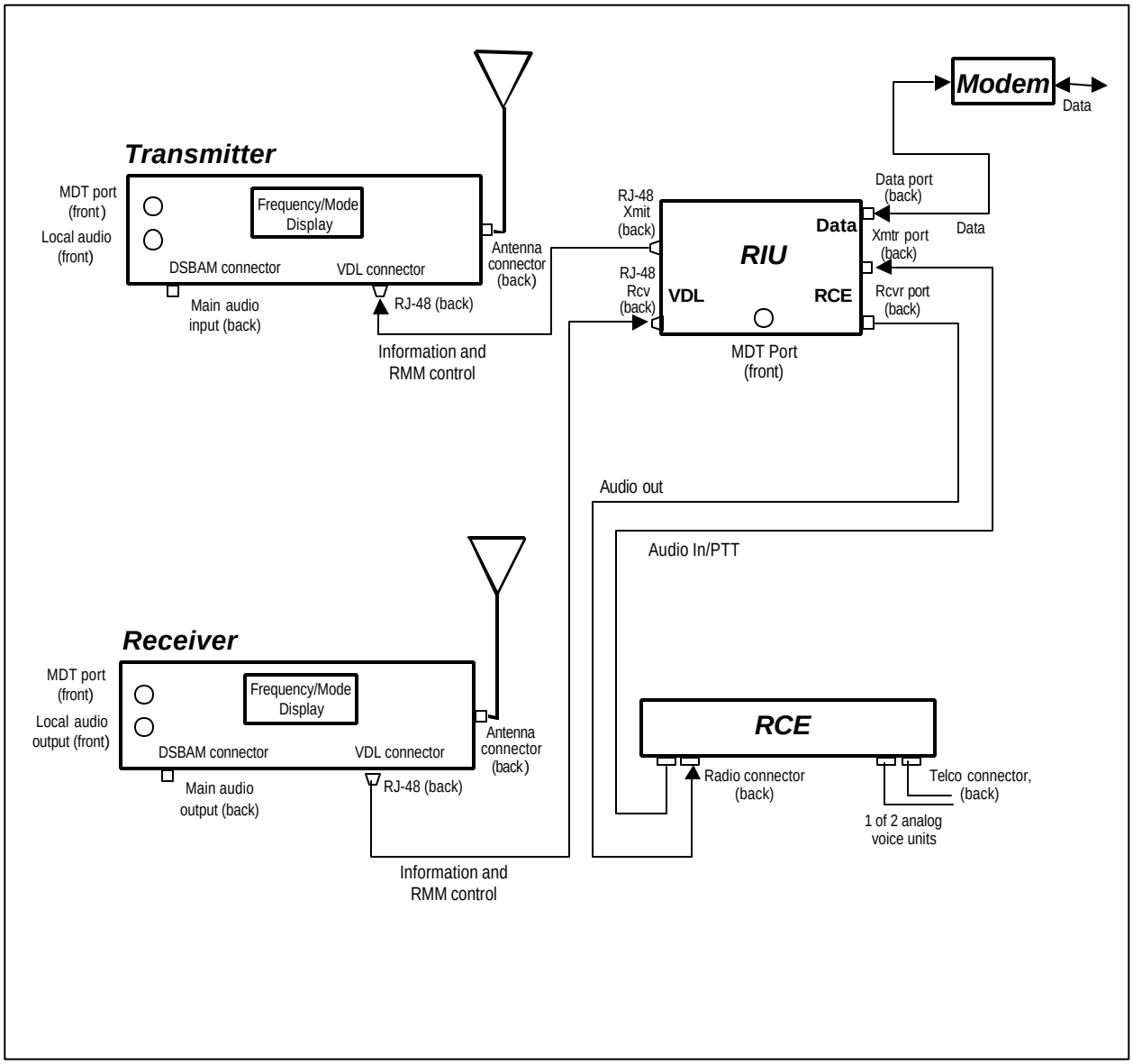


Figure B-3a: VDL Mode 3, 2V2D Mode, Collocated Transmitter and Receiver

Figures B-3a and B-3b show the connections for the 2V2D mode where data can be transferred to/from the controller site.

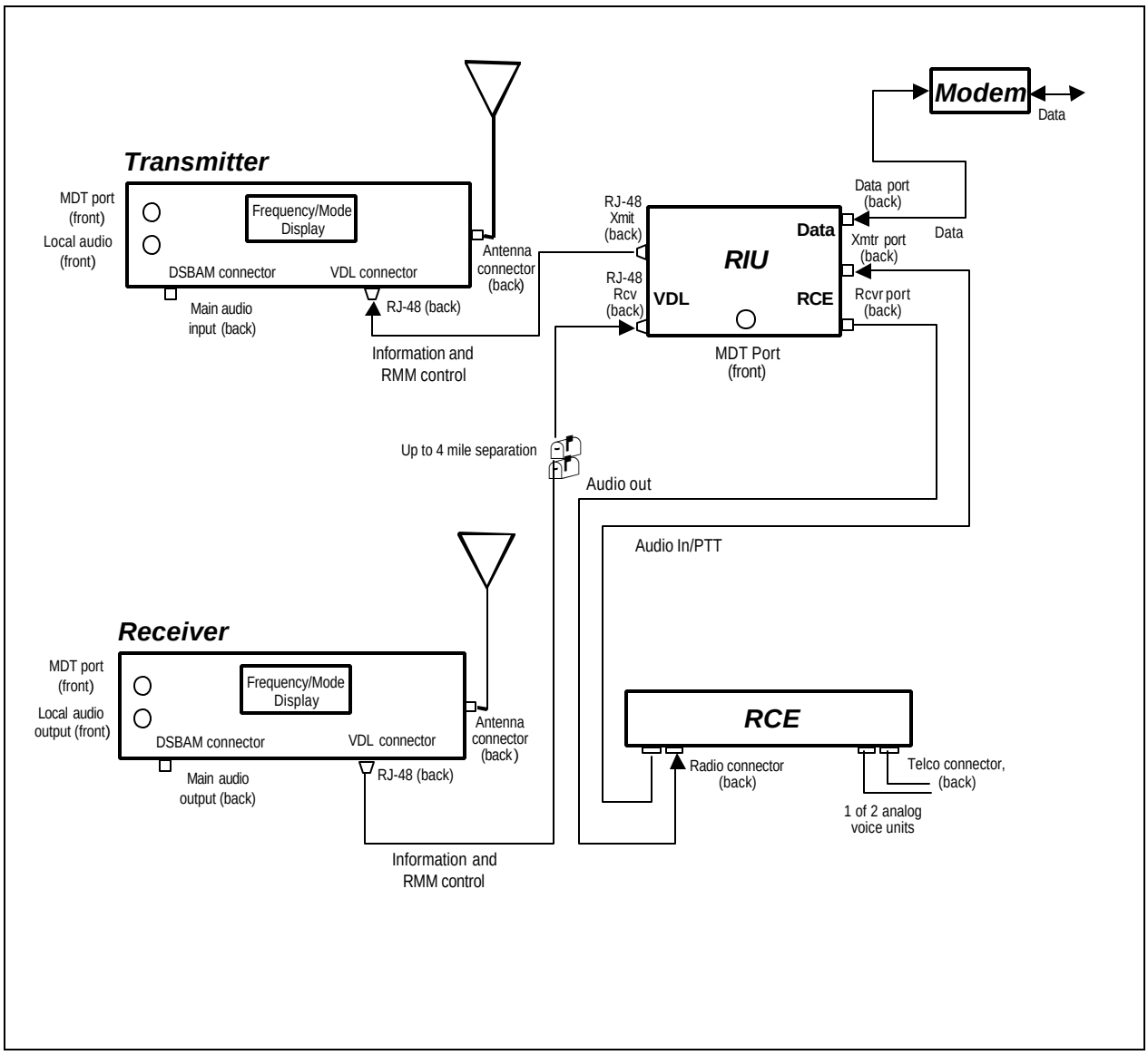


Figure B-3b: VDL Mode 3, 2V2D Mode, Receiver Located Separately

APPENDIX C

This appendix is paraphrasing a part of the MASPs. It is provided for reference only.

C1 MAC Layer

C1.1 MAC Protocol Framework

C1.1.1 Timing Structure

a) Media access for VDL Mode 3 will observe the system timing structure described in this section. Observing this timing structure is a necessary but not a sufficient condition for media access.

C1.1.2 TDMA Frame

a) The TDMA frame will be of 120 ms duration.
b) It will contain either three or four TDMA time slots as determined by the System Configuration (See section 3.2.1.4.1.3) in effect for the ground station. Two consecutive TDMA frames (an even TDMA frame followed by an odd TDMA frame) form a MAC cycle. The concept of MAC cycle is described in DO-224a.

C1.1.3 Time Slot

a) A TDMA time slot will be of 30 or 40 ms duration depending on the System Configuration in effect for the ground station.
b) A time slot will be the basic channel resource allocated to a user group for either voice or data transmission.

Note: Multiple time slots can be assigned to a single user group (e.g., voice and data).

C1.1.4 Bursts

a) A TDMA time slot will consist of either: a) one Management (M) burst and one Voice or Data (V/D) burst, b) four M bursts, or c) one M burst and one handoff check message (H) burst.
b) The format of the bursts will be as specified in Figures C1-1a, C1-1b, and C1-1c. Figure C1-1a shows a typical time slot consisting of an M burst followed by a V/D burst. Figure C1-1b shows slot A of a 3T configuration downlink consisting of four management M bursts. Figure C1-1c shows slot A of a 3T configuration uplink consisting of a Management burst and an H burst.

Note: An M burst is used for signalling and link management. A V/D burst is used for user information. An H burst is used to facilitate automated handoff of ground stations.

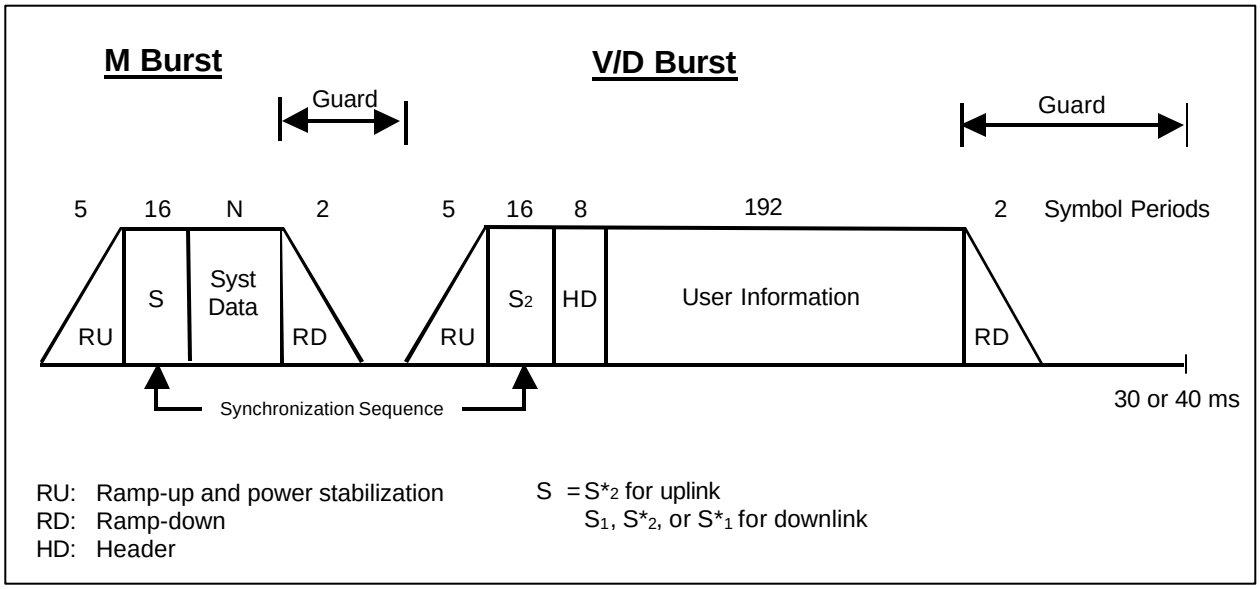


Figure C1-1a: Management (M) and V/D Bursts and Slot Components

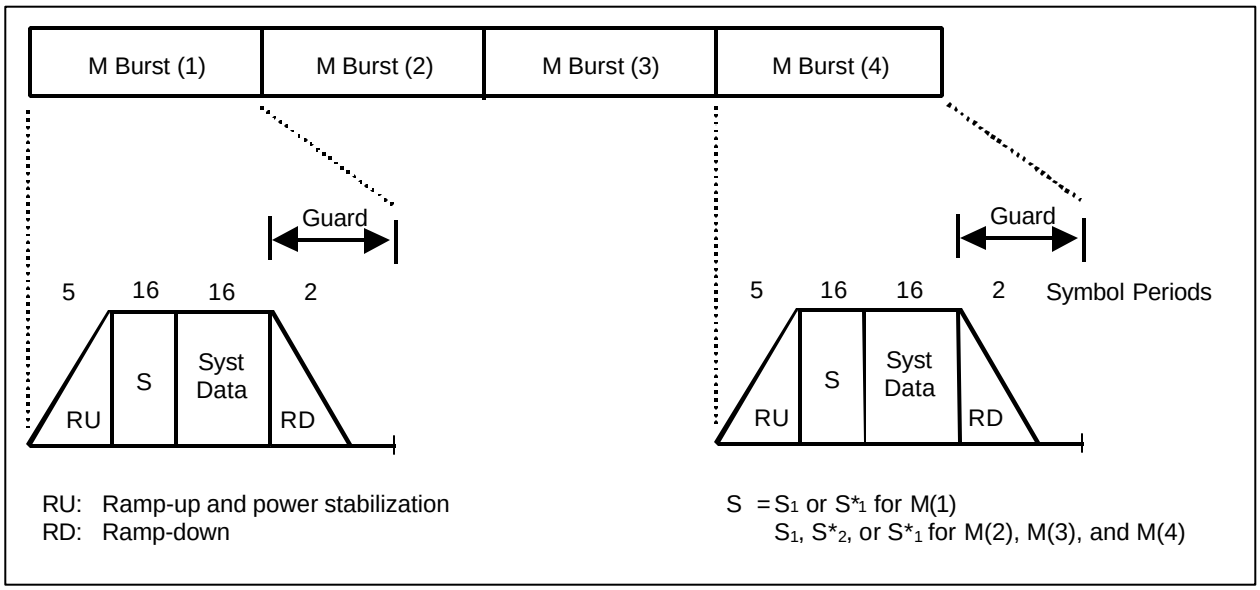


Figure C1-1b: Four Management (M) Bursts and Slot Components (Downlink of 3T)

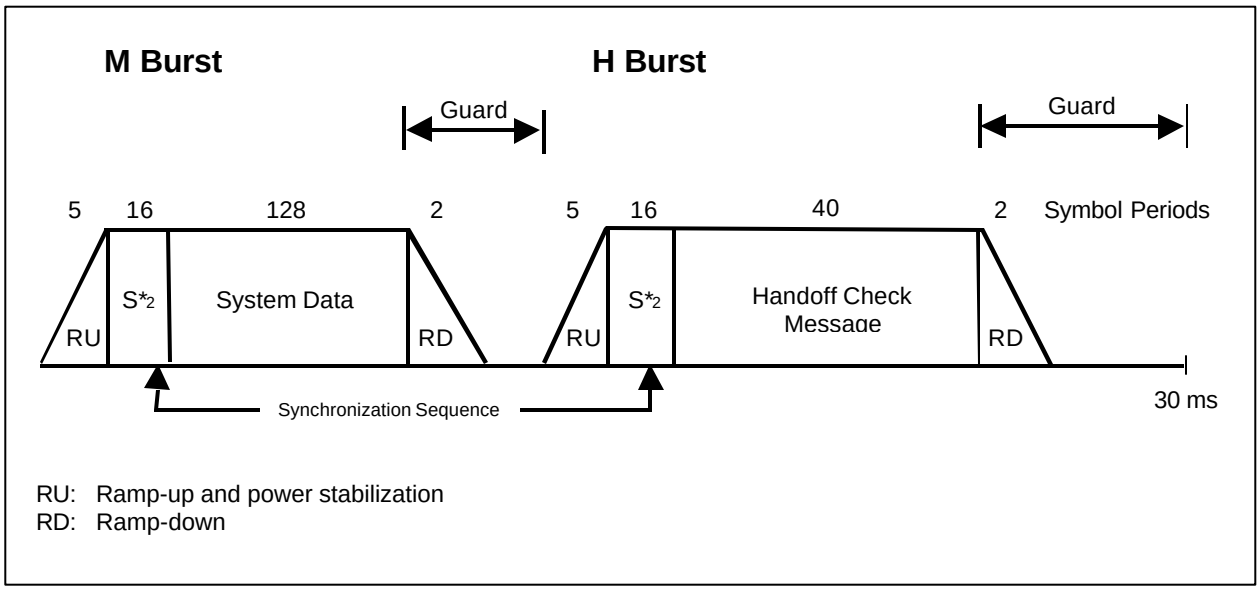


Figure C1-1c: Bursts and Slot Components for Management (M) and Handoff Check Message (H) Bursts (Uplink of 3T)

c) The time scale hierarchy for TDMA frames, time slots and bursts will be as shown in Figures C1-2a, C1-2b, and C1-2c. Figure C1-2a shows the TDMA frame structure of a normal range non-3T configuration. Figure C1-2b shows the TDMA frame structure of a normal range 3T configuration. Figure C1-2c shows the TDMA frame structure for long range configurations.

Note: The only difference in the timing structure between the Normal Range 30 ms slots and the Long Range 40 ms slots is an increased propagation guard time allowance.

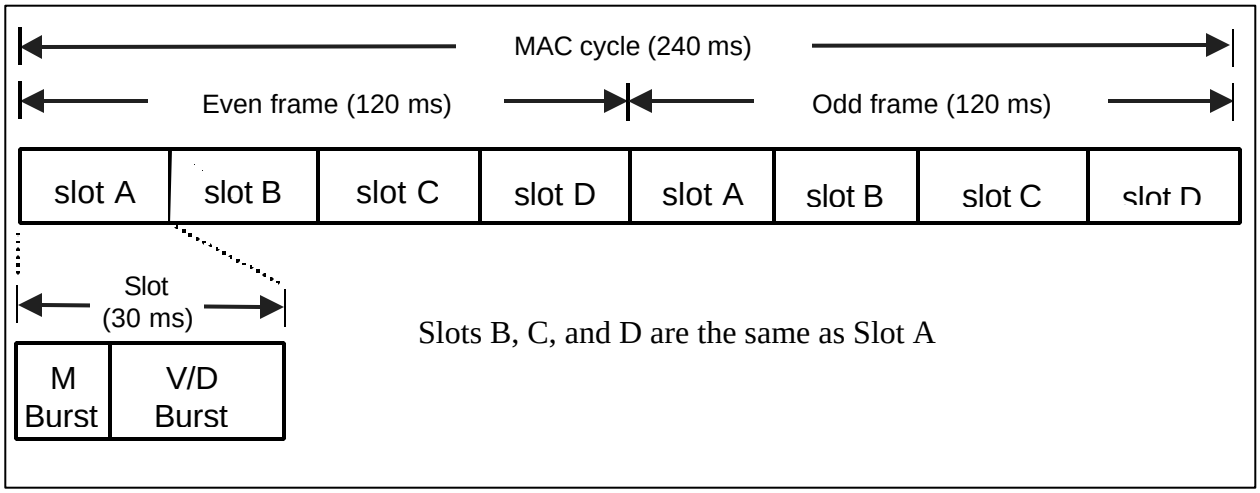


Figure C1-2a: Frame Structure for Normal Range Non-3T Configurations (See Manual on VDL Mode 3 Technical Specifications)

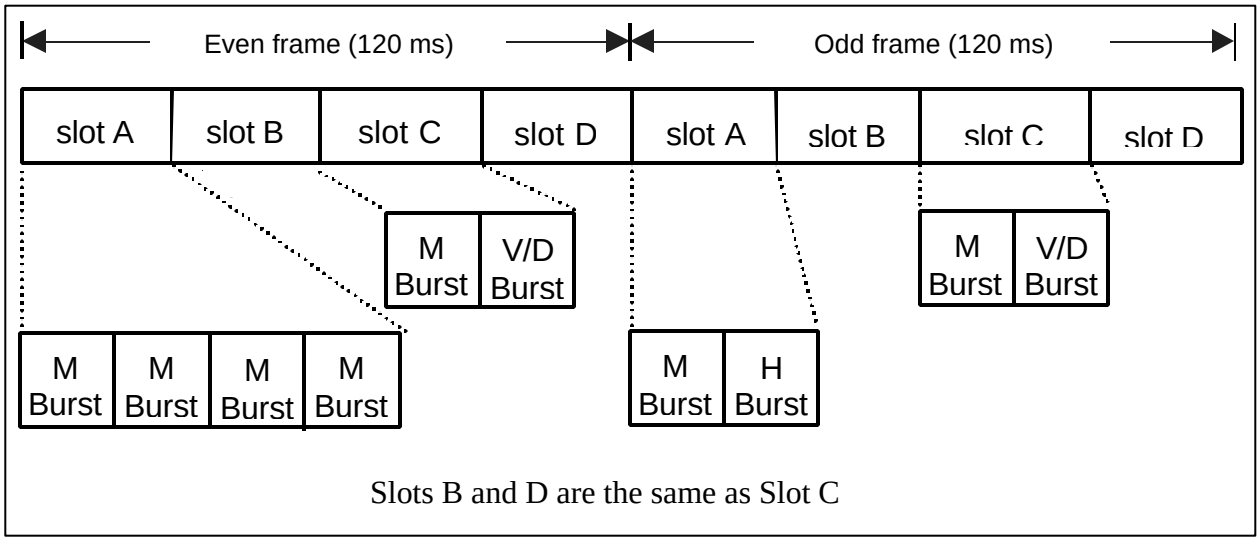


Figure C1-2b: Frame structure for Normal Range 3T Configuration (See Manual on VDL Mode 3 Technical Specifications)

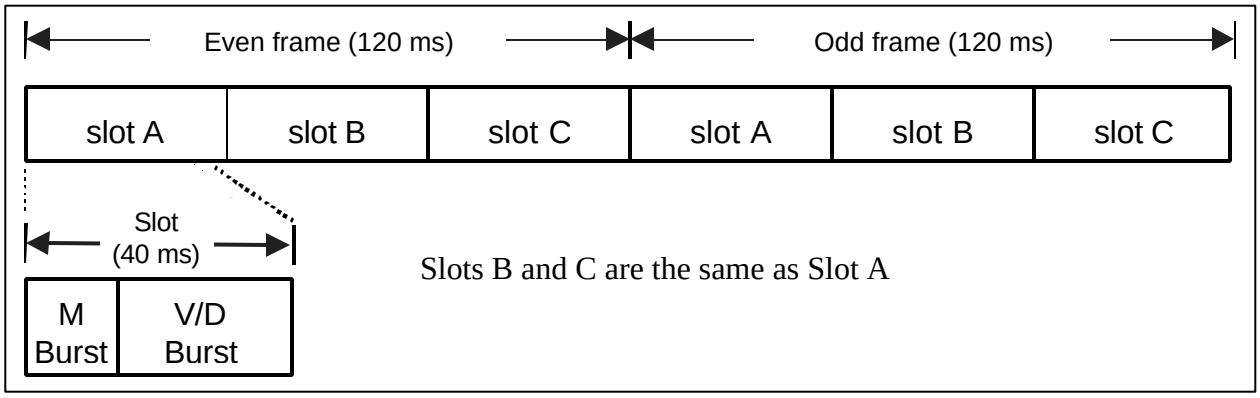


Figure C1-2c: Frame Structure for Long Range Configurations (See Manual on VDL Mode 3 Technical Specifications)

C1.1.5 User Groups

a) The MDR receiver will associate aircraft radios with a *user group* for purposes of channel access for voice and data transmissions and for aircraft addressing functions used by the ground station.
b) A single VDL frequency assignment (i.e., ground station radio) for VDL Mode 3 will support from one to four user groups depending on the System Configuration in effect for that ground station.

C1.1.6 System Configurations (RECEIVER ONLY)

a) The MDR receiver will recognize and support the set of system configurations identified in Table C1-1 (DO-224a).
Note 1: All the configurations except 3T are called non-3T configurations.
Note 2: See the Implementation Aspects for VDL Mode 3 for the applications and descriptions of each System Configuration.

Table C1-1: System Configuration

	System Configuration	User Groups Supported/ Identifying Time Slots*	Services to Each Group	V/D Slots Assigned to Each Group
Normal Range	4V	4/(A, B, C, D)	Dedicated voice ckt	1
	3V1D	3/(A, B, C)	Dedicated voice ckt w/shared data ckt	2
	2V2D	2/(A, B)	Dedicated voice ckt w/dedicated data ckt	2
	3T	1/(A)	Demand assigned voice and data	3
Long Range	3V	3/(A, B, C)	Dedicated voice ckt	1
	3S	1/(A, B, C)	Dedicated voice circuit with 3 station diversity	3
	2S1X	1/(A/C)**	Dedicated voice circuit with 2 station diversity	2

System Configuration	User Groups Supported/ Identifying Time Slots*	Services to Each Group	V/D Slots Assigned to Each Group
2V1D	2/(A, B)	Dedicated voice ckt w/shared data ckt	2

** The term "identifying time slots" is defined as the value in the Slot Number field in the Beacon2 word of the uplink M channel.*

*** The third time slot for system configuration 2S1X is available for use by another system configuration, such as 3V, which would provide a separate voice-only user group.*

C1.1.7 Logical Burst Access Channels (LBACs)

C1.1.7.1 LBACs for RECEIVER

a) For the 3T configuration, the MDR receiver will recognize each of up to 18 separate Logical Burst Access Channels (LBACs) numbered 1-18.
b) For each MAC cycle (3T), the timing for each LBAC will be as given by Table C1-2.
c) For the 3S configuration, the MDR receiver will recognize each of up to 10 separate LBACs numbered 1-10.
d) For each MAC cycle (3S), the timing for each LBAC will be as given by Table C1-3.
e) For the 2S1X, the MDR receiver will recognize each of up to 7 separate LBACs numbered 1-7.
f) For each MAC cycle (2S1X), the timing for each LBAC will be as given by Table C1-4.
g) For all other configurations (except 3T, 3S and 2S1X), the MDR receiver will recognize each of up to 8 separate LBACs numbered 1-8.
h) A description of each LBAC for these cases (other than 3T, 3S, and 2S1X) will be as given by Table C1-5.

Note: MAC cycles for each System Configuration are shown labelled with each LBAC in the Implementation Aspects for VDL Mode 3.

C1.1.7.2 LBACs for TRANSMITTER

a) The MDR transmitter will transmit bursts received from the RIU based on the Time of Transmission (TOT) field of the RIU/MDR packet. The TOT field indicates the time offset from the start of the MAC cycle measured in 1/16th of a D8PSK symbol period.

Table C1-5: Logical Burst Access Channel (LBAC) Descriptions for Configurations other than 3T, 3S and 2S1X

LBAC#*	Applicability	Description
1	air only	M downlink burst used for polling response or Random Access (RA)
2	air, ground	V/D (voice) burst even frame
3	air only	M downlink burst used for ACK or RA
4	air, ground	V/D (data) burst even frame
5	Ground only	M uplink burst and timing reference point
6	air, ground	V/D (voice) burst odd frame
7	air only	M downlink burst used for ACK or RA
8	air, ground	V/D (data) burst odd frame

* Used to identify burst opportunities in Table C1-6.

C1.1.8 Burst Access Timing (RECEIVER ONLY)

a) The MDR receivers will use the system configuration code in conjunction with the timing reference point from the RIU to establish proper burst timing.
b) For the 3T configuration, LBACs will be established according to Table C1-2;
c) For 3S configuration, LBACs will be established according to Table C1-3;
d) For 2S1X configuration, LBACs will be established according to Table C1-4; and
e) For other configurations (except 3T, 3S and 2S1X), LBACs will be established according to Table C1-6.
f) The start of the MAC Cycle will be provided per the MDR/RIU ICD. The relative timings among the Timing Reference Points (TRPs) of different user groups for the various system configurations are shown in Table C1-7.

Table C1-6: LBAC Timing Offset Values for Configurations other than 3T, 3S and 2S1X

System Config	User Group Slot ID	Media Access Timing for Each LBAC Relative to Timing Reference Point (Symbol Periods)							
		Even Frame					Odd Frame		
		1	2	3	4	5	6	7	8
4 Slots Per Frame (Normal Range)									
4V	A-D	-1260	-1195	N/A	N/A	0	65	N/A	N/A
3V1D	A	-1260	-1195	-315	-250	0	65	945	1010
	B	-1260	-1195	-630	-565	0	65	630	695
	C	-1260	-1195	-945	-880	0	65	315	380
2V2D	A-B	-1260	-1195	-630	-565	0	65	630	695
3 Slots Per Frame (Long Range)									
3V	A-C	-1260	-1142	N/A	N/A	0	118	N/A	N/A
2V1D	A	-1260	-1142	-420	-302	0	118	840	958
	B	-1260	-1142	-840	-722	0	118	420	538

Table C1-2: LBAC Description and Timing for 3T Configuration

LBAC#	Applicability	Description	Media Access Timing for Each LBAC Relative to Timing Reference Point (Symbol Periods)
1	Air only	M downlink RA	-1260
2	Air only	M downlink polling response or RA	-1182
3	Air only	M downlink polling response or RA	-1104
4	Air only	M downlink polling response or RA	-1026
5	Air only	M downlink ACK or RA	-945
6	air/ground	V/D even frame	-880
7	Air only	M downlink ACK or RA	-630
8	air/ground	V/D even frame	-565
9	Air only	M downlink ACK or RA	-315
10	air/ground	V/D even frame	-250
11	Ground only	M uplink, Timing Reference Point	0
12	Ground only	M uplink handoff check	201
13	Air only	M downlink ACK or RA	315
14	air/ground	V/D odd frame	380
15	Air only	M downlink ACK or RA	630
16	air/ground	V/D odd frame	695
17	Air only	M downlink ACK or RA	945
18	air/ground	V/D odd frame	1010

Note: See the Implementation Aspects for VDL Mode 3 for further description of 3T timing.

Table C1-3: LBAC Description and Timing for 3S Configuration

LBAC #	Applicability	Description	Media Access Timing for Each LBAC Relative to Timing Reference Point (Symbol Periods)
1	Air only	M downlink poll response or RA	-1260
2	Air, ground	V/D (voice) even frame	-1142
3	Ground only	V/D (voice) even frame	-722
4	Ground only	V/D (voice) even frame	-302
5	Ground only	M uplink and timing reference point	0
6	Air, ground	V/D (voice) odd frame	118
7	Ground only	M uplink and timing reference point	420
8	Ground only	V/D (voice) odd frame	538
9	Ground only	M uplink and timing reference point	840
10	Ground only	V/D (voice) odd frame	958

Table C1-4: LBAC Description and Timing for 2S1X portion of Configuration

LBAC #	Applicability	Description	Media Access Timing for Each LBAC Relative to Timing Reference Point (Symbol Periods)
1	Air only	M downlink poll response or RA	-1260
2	Air, ground	V/D (voice) even frame	-1142
3	Ground only	V/D (voice) even frame	-302
4	Ground only	M uplink and timing reference point	0
5	Air, ground	V/D (voice) odd frame	118
6	Ground only	M uplink and timing reference point	840
7	Ground only	V/D (voice) odd frame	958

Table C1-7: Relative Timing Relationship for TRPs of Different User Groups for All System Configurations

	Relative Timings Among TRPs of Different User Groups (Symbol Periods)							
User Group ID	4V	3V1D	2V2D	3T*	3V	3S**	2S1X***	2V1D
A	0	0	0	N/A	0	0	0	0
B	315	315	315	0	420	420	N/A	420
C	630	630	N/A	0	840	840	840	N/A
D	945	N/A	N/A	0	N/A	N/A	N/A	N/A
* For 3T configuration, Group IDs B, C, and D are treated as one user group. ** For 3S configuration, Group IDs A, B, and C are treated as one user group. *** For 2S1X configuration, Group IDs, A and C are treated as one user group.								

C1.1.9 Coded Squelch (RECEIVER ONLY)

a) The MDR receiver will reject undesired co-channel voice received outside of the squelch window.

C1.1.10 Squelch Window (RECEIVER ONLY)

a) The squelch window is used to control squelch operation in order to allow the MDR receiver to reject undesired V/D (voice) bursts based on their timing. The coding and use of the Squelch Window parameter will be as provided in DO-224a.

C1.1.11 Source Filtering (RECEIVER ONLY)

a) If the voice burst is outside the squelch window defined in DO-224a, Table 3-92 for 4-slot configurations and Table 3-93 for 3-slot configurations, the burst will be assumed to be co-channel interference and will be ignored.
   Note: This applies to the free running timing mode, where the squelch window is wide open. In this case the interfering signal is interpreted as co-channel interference.

C1.1.12 Management (M) Burst and Handoff Check Message (H) Burst Uplink

a) The M uplink burst (DO-224a) will consist of three segments, the Training Sequence followed by the System Data and the Transmitter Ramp Down.
b) The H uplink burst (DO-224a) will consist of three segments, the Training Sequence followed by the Handoff Check Message and the Transmitter Ramp Down. The M-burst and the H-burst are illustrated in Figure C1-1c.

C1.1.12.1 Training Sequence

Uplink M burst and H burst training sequences will consist of two components as follows:

1) Transmitter ramp up and power stabilization
2) Synchronization and Ambiguity resolution

C1.1.12.1.1 Transmitter Ramp-Up and Power Stabilization

The first component of the training sequence will be the transmitter ramp up and power stabilization, which will conform to the following restrictions.

The transmitter ramp-up and power stabilization component of the training sequence will be defined over t = 0 to t = 5.0. Time (t) is measured in symbol periods (95.24 μsec). Transmission of the synchronization sequence will start at t = 5.0. The RF power will be - 60 dBc (may change depending on the final spectral mask) prior to time t = 0 and greater than 90% of nominal output power between t = 2.5 and 5.0.

Note: This spectral shaping can be achieved by transmitting three 000 symbols prior to the first symbol of the Synchronization Sequence provided the raised cosine filter is truncated at ±2.5 symbol periods.

Note: It is desirable to maximize the AGC settling time. Efforts should be made to have power above 90% of nominal power at t = 2.0 symbols.

C1.1.12.1.2 Synchronization and Ambiguity Resolution

Three separate synchronization sequences, transmitted from left to right, will be used for this burst type. The standard sequence - known as S_1 - will be as follows:

000 111 001 001 010 110 000 011 100 110 011 111 010 101 100 101

The special sequence used to identify poll responses, S^*_2, will be as defined in DO-224a.

The special sequence used to identify Net Entry Requests (S^*_1) will use the following sequence and will be transmitted from left to right:

000 001 111 111 100 000 110 101 010 000 101 001 100 011 010 011

Note: The sequence S^*_1 is very closely related to the sequence S_1. The 15 phase changes between the 16 symbols of S^*_1 are each exactly 180° out of phase from the 15 phase changes associated with S_1. This relationship can be used to simplify the process of simultaneously searching for both sequences.

C1.1.12.3 Synchronization and Ambiguity Resolution for the M Uplink Burst

The second component of the training sequence, transmitted from left to right will consist of the synchronization sequence-known as S^*_2-as follows:

000 001 101 100 110 010 111 100 010 011 101 000 111 000 011 001

Note: The sequence S^*_2 is very closely related to the sequence S_2 (DO-224a). The 15 phase changes between the 16 symbols of S^*_2 are each exactly 180^o out of phase from the 15 phase changes associated with S_2. This relationship can be used to simplify the process of simultaneously searching for both sequences. The translation of the symbols into D8PSK phase changes is given in DO-224a.

C1.1.12.2 M Uplink Burst

C1.1.12.2.1 System Data and Handoff Check Message

a) The non-3T configuration (DO-224a) System Data will consist of 32 transmitted symbols.
b) The 96 transmitted bits will include 48 bits of information and 48 parity bits, generated as four Golay (24, 12) codewords.
c) The 3T configuration (DO-224a) System Data will consist of 128 transmitted symbols.
d) The 384 transmitted bits will include 192 bits of information and 192 parity bits, generated as 16 Golay (24,12) codewords.
e) The 3T configuration Handoff Check Message will consist of 40 transmitted symbols.
f) The 120 transmitted bits will include 60 bits of information and 60 parity bits, generated as five Golay (24,12) codewords.
g) The specific definition of the Golay encoder will be as follows:
h) If the 12-bit input bit sequence is written as a row vector **x**, then the 24-bit output sequence can be written as the row vector **y**, where **y** = **x** **G**, and the matrix **G** will be given by

$$\mathbf{G} = \begin{bmatrix}
1&1&0&1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0\\
0&1&1&1&1&1&0&0&1&0&0&1&0&1&0&0&0&0&0&0&0&0&0&0\\
1&1&1&0&1&0&0&1&0&1&0&1&0&0&1&0&0&0&0&0&0&0&0&0\\
0&1&1&0&0&0&1&1&1&0&1&1&0&0&0&1&0&0&0&0&0&0&0&0\\
1&1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0&0&0\\
1&0&1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0&0\\
1&0&0&1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0\\
0&1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0&0&0\\
0&0&1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0&0\\
0&0&0&1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0\\
1&1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&1&0\\
1&0&1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&1
\end{bmatrix}$$

Note: The extended Golay code allows for the correction of any error pattern with three or fewer bit errors and the detection of any 4-bit error pattern.

C1.1.12.1.2.2 Synchronization and Ambiguity Resolution for the M Uplink Burst

a) The second component of the training sequence, transmitted from left to right will consist of the synchronization sequence known as S^*_2 as follows:

000 001 101 100 110 010 111 100 010 011 101 000 111 000 011 001

b) Transmission of the synchronization sequence will start at t = 5.0.
Note: The sequence S^*_2 is very closely related to the sequence S_2 (DO-224a). The 15 phase changes between the 16 symbols of S^*_2 are each exactly 180^o out of phase from the 15 phase changes associated with S_2. This relationship can be used to simplify the process of simultaneously searching for both sequences. The translation of the symbols into D8PSK phase changes is given in DO-224a.

C1.1.12.1.3 Transmitter Ramp-Down

a) Following the end of the final symbol, the transmitter power will be below -20 dBc within 2 symbol periods.
b) The transmitter ramp down will be below -60 dBc within five symbol periods.
Note: For a 15 watt transmitter –83 dBm translates into –125 dBc; and for a 50 watt transmitter -83 dBm translates into –130 dBc.

C1.1.12.2 H Uplink Burst

C1.1.12.2.1 Training Sequence

C1.1.12.2.1.1 System Data and Handoff Check Message

C1.1.12.2.1.2 Transmitter Ramp Down

C1.1.12.3 Management (M) Burst Downlink

The M downlink burst (DO-224a) will consist of three segments, the Training Sequence followed by the System Data and the Transmitter Ramp Down. (See Figure 1-1a and Figure 1-1b).

C1.1.12.3.1 Training Sequence

C1.1.12.3.1.1 Transmitter Ramp-Up and Power Stabilization

C1.1.12.3.1.2 Synchronization and Ambiguity Resolution

a) Three separate synchronization sequences, transmitted from left to right, will be used for the M downlink burst. The standard sequence known as S_1 will be as follows:

000 111 001 001 010 110 000 011 100 110 011 111 010 101 100 101

b) The special sequence used to identify poll responses, S^*_2 will be as defined in section 3.2.1.4.5.1.2.
c) The special sequence used to identify Net Entry Requests (S^*_1) will use the following sequence and will be transmitted from left to right:

000 001 111 111 100 000 110 101 010 000 101 001 100 011 010 011

Note: The sequence S^*_1 is very closely related to the sequence S_1. The 15 phase changes between the 16 symbols of S^*_1 are each exactly 180^o out of phase from the 15 phase changes associated with S_1. This relationship can be used to simplify the process of simultaneously searching for both sequences.

C1.1.12.3.2 System Data and Handoff Message

a) The System Data segment will consist of 16 transmitted symbols.
b) The 48 transmitted bits will be encoded as 24 bits of System Data and 24 parity bits generated as two consecutive (24, 12) Golay code words.
c) The encoding of the (24, 12) Golay code words will be as defined in section C1.1.12.1.

C1.1.12.3.3 Transmitter Ramp-Down

a) This is defined in section C1.1.12.1.2.

C1.1.12.4 Voice or Data (V/D) Burst

a) The V/D burst will consist of four segments: the Training Sequence followed by the Header, the User Information segment, and the Transmitter Ramp Down.
b) The same V/D burst format will be used for both uplink and downlink.

C1.1.12.4.1 Training Sequence

a) This is defined in section C1.1.12.3.1 and associated subsections.

C1.1.12.4.1.1 Transmitter Ramp-Up and Power Stabilization

a) This is defined in section C1.1.12.3.1.1.

C1.1.12.4.1.2 Synchronization and Ambiguity Resolution

a) The second component of the training sequence will consist of the synchronization sequence known as S_2 as follows.
b) The synchronization sequence will be transmitted from left to right:

000 111 011 010 000 100 001 010 100 101 011 110 001 110 101 111

C1.1.12.4.2 Header

a) The Header segment will consist of eight transmitted symbols.
b) The 24 transmitted bits will be encoded as 12 bits of Header information and 12 parity bits, generated as a single (24, 12) Golay code word.
c) The encoding of the (24, 12) Golay code word will be as defined in section C1.1.12.1.

C1.1.12.4.2.1 User Information

a) The User Information segment will consist of 192 3-bit symbols.

C1.1.12.4.3 Transmitter Ramp-Down

a) This is defined in section C1.1.12.1.2.

C1.1.12.5 Bit Scrambling

a) Bit scrambling will be performed on each burst under VDL Mode 3 operation as specified in DO-224a.
b) The scrambling sequence will be reinitialized on each burst, effectively providing a constant overlay for each of the VDL Mode 3 fixed length bursts.

APPENDIX D

The information in this appendix is included for reference purposes. The requirements (shalls) are not to be interpreted as MDR requirements.

MAINTENANCE DATA TERMINAL SOFTWARE (MDTS) REQUIREMENTS

All requirements below apply to the Maintenance Data Terminal Software, hereinafter referred to as MDTS.

D1.0 Minimum Maintenance Data Terminal Platform (MDTS Host Computer) Configuration

a) The MDTS **shall** meet specified requirements while operating on industry standard laptop/notebook Personal Computers that are configured with at least the following:
   1) Windows 95, 98, 2000, and NT
   2) 100 Mb of Hard Drive space for MDTS exclusive use
   3) 32 Mb of RAM
   4) 800x600x8 display
   5) Pentium 200 processor
   6) RS-232 serial interface using DB-9 connector
   7) Single 2x CD-ROM drive
   8) Single Standard High Density Floppy drive

D1.1 Secured Access

a) The MDTS **shall** identify and authenticate the MDTS operator by Username, of up to 32 characters, and Password, of at least 8 characters/numerals, before allowing operator access to MDTS functions.
b) All passwords and password authentication data stored within the MDTS, or on the MDT platform, **shall** be encrypted.
c) The MDTS **shall** store a signed authorization token and transfer it as defined in FAA-E-2939 Section 3.2.3.9.4.
d) The signed authorization token **shall** be stored in such a way that its function is not discernable.
e) If the MDR employs procedure (1) in FAA-E-2938, section 3.2.3.9.3, the MDTS **shall** append the signed token to all control parameters commands of FAA-E-2938, Table 3-3, except ID#1, Log-In.
f) If the MDR employs procedure (2) in FAA-E-2938, section 3.2.3.9.3, the MDTS **shall** respond to the MDR authorization request with the signed token.

D1.2 Log In

a) The MDTS **shall** detect connection to an MDR, and log into the MDR, by issuing control parameter ID#1, Log-In, as specified in FAA-E-2938, Table 3-3.

b) The MDTS **shall** provide the MDT platform's unique identification number (for example, the Windows operating system OEM number) as the Terminal identification field in control parameter ID#1, Log-In, as specified in FAA-E-2938, Table 3-3.
c) The MDTS **shall** provide the MDT/MDTS-unique signed token as the Signature field in control parameter ID#1, Log-In, as specified in FAA-E-2938, Table 3-3.

D1.3 Log-Out

a) Upon operator command, the MDTS **shall** log out of the MDR by issuing control parameter ID#1, Log-In, as specified in FAA-E-2938, Table 3-3, with the Signature field set to zero.

D1.4 Display of Monitored Parameters

a) MDTS **shall** display operator selected MDR Monitored parameters and Control parameters, listed in table 3-3 and table 3-4, of the MDR specification.
b) MDTS **shall** allow operator to select either numeric or graphical (e.g. bar graph, or simulated meter) type display for each parameter selected for display.
c) MDTS **shall** allow operator to select and display at least 3 parameters simultaneously
d) MDTS **shall** allow the operator to select one-shot read, or continuous (near real time) read and display of Monitored Parameters
e) When continuous (near real time) read and display is selected for a parameter, the MDTS **shall** issue control parameter ID#30 Request Readback to the MDR at the operator-specified rate of once per second to once per 120 milliseconds.
f) MDTS **shall** update the display of operator-selected monitored parameters with each new readback sample when continuous read (near real time) read and display is selected.

D1.5 Setting of Control Parameters

a) The MDTS **shall** allow the operator to change the values of each MDR Control parameter
b) After a operator commanded control parameter change, the MDTS **shall** update the display of the current value of the Control Parameter with the then-current value by re-reading the control parameter value.
(note: steps envisioned are 1) operator selects parameter to display 2) operator inputs value to change control parameter 3) MDTS sends change to MDR 4) MDR acknowledges change 5) MDTS reads control parameter from MDR, and then displays)
c) MDTS **shall** display any error messages generated by the MDR relating to the attempt to change the value of the control parameter.
(note: range checking done by MDR, error messages generated by MDR, MDTS just displays MDR generated feedback)

D1.6 Alarm/Alert Threshold Setting

a) MDTS **shall** allow operator to read the MDR values for alarm thresholds and alert thresholds.
b) MDTS **shall** allow operator to change the alarm minimum thresholds, alarm maximum thresholds, alert minimum thresholds and alert maximum thresholds independently.

c) MDTS **shall** display any error messages generated by the MDR relating to the attempt to set the minimum thresholds equal to or greater than the maximum thresholds.

D1.7 Verification

a) Control Parameter Sets MDTS **shall** verify each control parameter setting before indicating successful control parameter set upload.

D1.8 Alarm/Alert Threshold Sets

a) MDTS **shall** store at least nine Alarm/Alert Threshold sets with operator selectable set labels, which can be selected for downloading from, or uploading to the MDR.
b) MDTS **shall** allow the operator to edit the alarm/alert threshold values in each alarm/alert threshold set
c) MDTS **shall**, upon operator command, download from the MDR the alarm/alert threshold set, apply the operator-selected file name or label and store the alartm/alert threshold set.
d) MDTS **shall**, upon operator command, upload the operator-selected alarm/alert threshold set to the MDR.
e) MDTS **shall** verify each aarm/alert threshold setting before indicating successful alarm/alert threshold set upload.

D1.9 Operating Software Sets

a) MDTS **shall** store at least four MDR Operating Software sets, which can be selected for downloading from, or uploading to the MDR.
b) MDTS **shall**, upon operator command, download from the MDR the operating software set, store and label the MDR operating software.
c) MDTS **shall**, upon double-verified operator command, upload to the MDR the operator selected MDR Operating Software set.
d) MDTS **shall** display the Digital Signature authentication result provided in by the MDR after software download to the Operating Software set.

D1.10 Recording of Monitored Parameters

a) MDTS **shall**, upon operator command, record the operator-selected continuous, real time read / displayed monitored parameters, for later review and analysis.
b) MDTS monitored parameter recording **shall** be discontinuable at any time after initiation
c) MDTS monitored parameter recording recording rate **shall** be operator selectable from 1 sample per minute to 1 sample per 120 milliseconds.
d) MDTS monitored parameter recording **shall** store up to 15,000 samples per recorded parameter.
e) MDTS monitored parameter recording **shall** record at least two parameters simultaneously, while displaying at least two monitored parameters.
f) MDTS monitored parameter recording **shall** record parameter ID, value and recording time.
g) MDTS **shall** allow control parameter setting while recording.

D1.11 Local Diagnostic Audible Indication Function

a) MDTS **shall** provide an audible alert function, which will provide an MDT generated tone when the operator-selected parameter crosses a operator-selected high and/or low threshold
b) MDTS **shall** provide an audible alert function, which will provide an MDT generated tone when the selected parameter achieves peak/valley (min/max) values.

D1.12 MDR Event Log Download

a) MDTS **shall** store at least fifty MDR Event Logs, with operator selectable Log labels, which can be selected for downloading from to the MDR.
b) MDTS **shall**, upon operator command, download from the MDR the MDR Event Log, apply the operator-selected file name or label, and store the MDR Event Log.
c) MDTS **shall** allow operator to view the MDR Event Log.

D1.13 MDTS Control Log

a) MDTS **shall** record the last 1000 control parameter commands into MDTS Operations Log.
b) The MDTS Control Log **shall** record the MDTS Username, MDR serial number, time (of command), control parameter command and MDR response for each control parameter command.
c) MDTS **shall** allow the Operator to view the MDTS Operations log, sorted by Username, MDR serial number, control parameter or time.