MILITARY SPECIFICATION

RADIO GROUP, VLF, LF, MF, AND HF

This specification is approved for use by the Naval Electronic Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the performance, design, development, and test requirements for the very low frequency (VLF), low frequency (LF), medium frequency (MF), and high frequency (HF) radio subsystem, hereinafter referred to as the Radio Group (RG).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-S-901	Shock Tests, H.I. (High-Impact), Shipboard Machinery, Equipment And Systems, Requirements For
MIL-P-15024	Plates, Tags And Bands For Identification Of Equipment
MIL-E-16400	Electronic, Interior Communication, And Navigation Equipment, Naval Ship And Shore: General Specification For
MIL-E-17555	Electronic And Electrical Equipment Accessories And Repair Parts; Packaging And Packing Of
MIL-W-21965	Water Cooling Of Ship Board Electronic Equipment; General Specification For
MIL-E-21981	Electronics Type Designations, Identification And Plates And Markings; Requirements For
MIL-H-46855	Human Engineering Requirements For Military Systems, Equipment And Facilities

STANDARDS

MILITARY

MIL-STD-12	Abbreviations For Use On Drawings And In Specifications, Standards, and Technical Documents
MIL-STD-105	Sampling Procedures And Tables For Inspection By Attributes
MIL-STD-108	Definitions Of And Basic Requirements For Enclosures For Electric And Electronic Equipment
MIL-STD-109	Quality Assurance Terms And Definitions
MIL-STD-167-1	Mechanical Vibrations Of Shipboard Equipment (Type-I Environmental And Type II-Internally Excited)
MIL-STD-188-203-1	Subsystem Design And Engineering Standards For Tactical Data Information Link (TADIL) A
MIL-STD-454	Standard General Requirements For Electronic Equipment

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Electronic Systems Command (ELEX-8111), Washington, DC 20363, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

FSC 5820

MIL-STD-461	Electromagnetic Emission And Susceptibility Requirements For The Control Of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement Of
MIL-STD-471	Maintainability Verification/Demonstration/Evaluation
MIL-STD-740	Airborne And Structureborne Noise Measurements And Acceptance Criteria Of Shipboard Equipment
MIL-STD-781	Reliability Design Qualification And Production Acceptance Tests: Exponential Distribution
MIL-STD-810	Environmental Test Methods And Engineering Guidelines
MIL-STD-831	Test Reports, Preparation Of
MIL-STD-1310	Shipboard Bonding And Grounding Methods For Electromagnetic Compatibility
MIL-STD-1364	Standard General Purpose Electronic Test Equipment
DoD-STD-1399, Section 300	Interface Standard For Shipboard Systems, Electric Power, Alternating Current (Metric)
MIL-STD-1472	Human Engineering Design Criteria For Military Systems, Equipment And Facilities
MIL-STD-1553	Aircraft Internal Time Division Command/Response Multiplex Data Bus
MIL-STD-1633	Interface Standard For Shipboard Emission, Monitor Control Set, AN/SSQ-82(V)

HANDBOOKS

MILITARY

MIL-HDBK-235	Electromagnetic (Radiated) Environment Considerations For Design And Procurement Of Electrical And Electronic Equipment
MIL-HDBK-241	Design Guide For EMI Reduction In Power Supplies

2.1.2 Other Government publications. The following other Government publications form a part of this specification to the extent specified herein.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSHIPS 0900-004-4000	Design Guide For Integrated Circuits

NAVAL ELECTRONIC SYSTEMS ENGINEERING CENTER (NESEC), PORTSMOUTH, VA

NESEC Code 05	Technical Specifications To Adapt An Emitter For AN/SSQ-82(V) MUTE Capability

(Copies of specifications, standards, handbooks, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE 200-75	Electrical And Electronic Parts And Equipments, Reference Designation For

(Application for copies should be addressed to Institute of Electrical and Electronic Engineers, 345 East 47th Street, New York, NY 10017.)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA-RS-310-C-77 Racks, Panels And Associated Equipment

(Application for copies should be addressed to Electronic Industries Association, 2001 Eye Street, NW, Washington, DC 20006.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 General. The RG shall be in accordance with MIL-E-16400, to the extent specified herein. The RG, as an integrated arrangement, shall convert terminal and modem signals to a radio frequency (RF) output and RF input to signals compatible with terminal equipment. The RG provides for tactical and strategic voice and data communications, where applicable in the VLF, LF, MF, and HF frequency ranges (14.0 kilohertz (kHz) to 29.9999 megahertz (MHz). The RG shall permit establishment of communications with other ships as well as with land-based and airborne stations. The RG shall be capable of both manual and externally computer-controlled operation and circuit configuration. The overall requirement is to have a system which will operate effectively in a Naval warfare environment. The RG shall be designed to accept signals from terminal equipments, convert those signals to RF signals for transmission in the 2.0 MHz to 29.9999 MHz frequency band, and to receive RF signals in the frequency range of 14.0 kHz to 29.9999 MHz and convert those signals for processing by the terminal equipments. The RG, as an integral part of the Exterior Communication (EXCOMM) System, shall be designed to conform to the operational requirements inherent in the missions assigned to U.S. Navy ships. The RG shall be designed to maximize its forward compatibility with the Navy's ongoing high frequency improvement program (HFIP) anti-jam (AJ) developments so that the RG will, with only minor modifications, be capable in the future of multiple simultaneous AJ channel operation. The RG shall also be capable of processing Naval Tactical Data System (NTDS) LINK-11 and LINK-14 signals in the 2.0 MHz to 29.9999 MHz band. A1 (or equivalent) emission capability (on-off continuous wave (CW) keying) shall also be provided. Conformance to radio teletype requirements shall be achieved by providing F1 and A3J processing capabilities. The RG shall be capable of simplex, half-duplex, and full-duplex implementation. The receiving equipment shall be located in the Communications Technical (Comm Tech) Control Room, and when applicable, in the Meteorological Room (METRO) and Ship's Signal Exploitation Space (SSES). The transmitting equipment shall be located in the Radio Transceiver Room and shall consist of multiple exciters driving one or more 1 kilowatt (kW) Broadband Linear Amplifier Groups (BLAG) and may or may not include stand-alone 1 kW amplifiers to be used for narrowband operation (see the APPENDIX for exact number of transmitters, receivers, and amplifiers). The BLAG shall feed an antenna configuration capable of transmitting from 2.0 MHz to 29.9999 MHz. The narrowband 1 kW amplifiers shall be capable of transmitting in the 2.0 MHz to 29.9999 MHz frequency band, and shall utilize antenna coupler groups to feed dedicated 9-meter (m) to 10.50 m (30-foot (ft) to 35-ft) whip antennas. The RG shall be designed for computer-aided as well as manual monitoring and control. When utilizing the computer-aided capability, only one operator shall be required to monitor and control the RG. All equipments requiring direct computer control shall be capable of MIL-STD-1553 bus interface. All equipments capable of MIL-STD-1553 operation shall be capable of manual operation both locally and from a remote central location. Each bus-operated equipment shall be capable of removal from the bus for maintenance, and so forth, without degrading the remaining equipment's bus operation. A total of four separate (dual redundancy) MIL-STD-1553 buses shall be provided: two for transmit equipments and two for receive equipments. The number and type of each equipment assigned to a given dual-redundant bus shall be sufficient to minimize computer-aided control degradation as a result of the loss of a single or dual bus.

3.1.1 First article. When specified, a sample shall be subjected to first article inspection (see 4.3 and 6.3).

3.1.2 Missions and primary functions. Missions and primary functions shall be as specified in 3.1.2.1 and 3.1.2.2.

3.1.2.1 Mission capabilities. The RG shall have a mission capability to permit communication over the networks specified in a through c:

a. Ship-to-shore and shore-to-ship voice and teletype networks. (Single channel and multichannel).

b. Ship-to-ship, ship-to-air, and air-to-ship, including voice, teletype (TTY), and tactical data networks such as LINK-11 and LINK-14.

c. Distress and rescue channels: Receive - 500 kHz; Transmit and Receive - 2182 kHz and 8364 kHz.

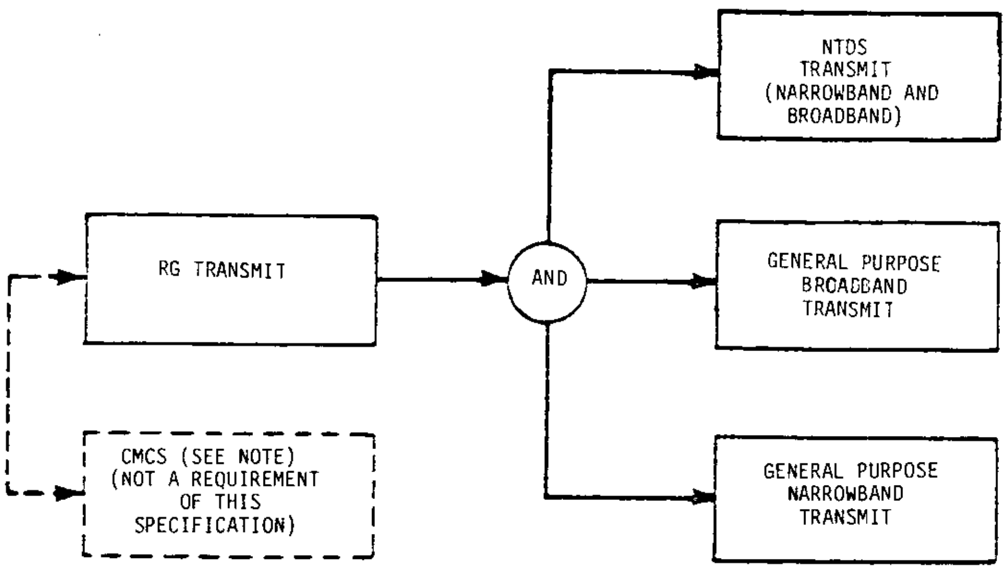
3.1.2.2 Primary functions. The primary functions of the RG are as specified in a and b:

a. To receive voice and data from the terminal equipment groups, convert voice and data to RF, and transmit them via the appropriate antenna equipment to other off-ship radio system equipments.

b. To receive via antenna equipments the RF signals from other off-ship radio system equipments, demodulate, and route these signals to the terminal equipment for processing and use.

3.1.3 Subsystem flow diagrams and allocations. RG flow diagrams and allocations shall be as specified in 3.1.3.1 and 3.1.3.2.

3.1.3.1 Functional flow diagrams (FFDs). The FFDs for the RG and its functional groups are shown in FIGURE 1 and FIGURE 2.



NOTE: Communication monitor and control system.

FIGURE 1. Transmit FFD.

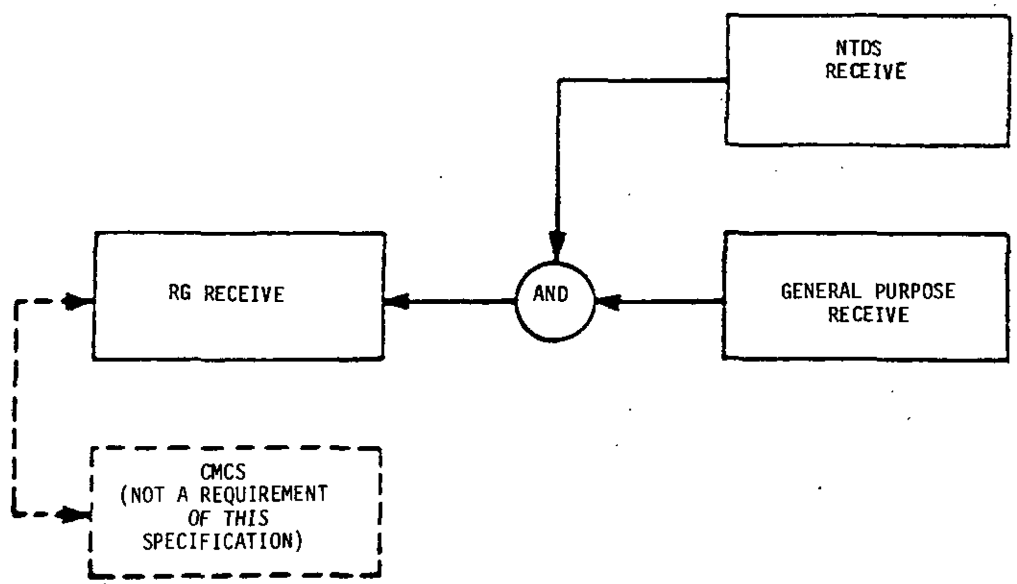


FIGURE 2. Receive FFD.

3.1.3.2 Functional allocations. The two primary subsystems, transmit and receive, shall provide the capabilities specified in a and b:

a. The transmit subsystem shall have the capability to provide separate and simultaneously usable channels in the frequency range of 2.0 MHz to 29.9999 MHz (see the APPENDIX for exact number of transmitters, exciters, and specific modes of operations). When applicable, one or more 1 kW narrowband channels shall also be included, again providing upper sideband (USB), lower sideband (LSB), and independent sideband (ISB) modes of operation. Each channel of operation shall be capable of power level control in 15 separate steps of 3 decibels (dB) and a sixteenth step for OFF. Power level control shall be available both manually and via bus control.

b. The receive subsystem shall have the capability of providing separate and simultaneously usable channels (see the APPENDIX for exact number of receivers, frequency ranges, and specific modes of operations).

Provisions shall be made to operate the critical functional groups of the system in two frequency bands, namely 2.0 MHz to 29.9999 MHz for the transmit group and 14.0 kHz to 29.9999 MHz for the receive group.

3.1.4 Interface definitions. Interface definitions shall be as specified in 3.1.4.1 through 3.1.4.3.6.

3.1.4.1 External interfaces. The RG primarily shall provide for an interface with nine subsystems as specified in a through i:

a. There shall be a transfer of baseband signals between the RG and the interfacing equipment.

b. Where applicable, the RG shall receive test and control signals from the CMCS and pass status and monitoring information back to the CMCS. The CMCS shall provide control and monitoring of the MIL-STD-1553 bus-operated and controlled RG equipments. Four buses shall be implemented in dual redundant MIL-STD-1553 configuration.

c. The RG shall receive prime frequency reference signal from an external standard.

d. The RG shall receive prime power from the ship's electrical subsystem.

e. The RG shall receive chilled water and cooling air from the ship's auxiliary subsystem.

f. The RG shall transmit and receive signals via the communication antennas.

g. The RG shall interface with the ship's hull directly via physical installation.

h. The RG transmit subsystem shall provide for an interface with an AN/SSQ-82 Multiplex Unit for Transmission Elimination (MUTE) in accordance with MIL-STD-1633. This interface shall provide an external means of establishing an emission control (EMCON) condition.

i. The RG receive subsystem shall provide for an interface with the AN/TRQ-35(V) Tactical Frequency Management System equipments.

3.1.4.2 Signal interfaces. Signal interfaces shall be as specified in 3.1.4.2.1 through 3.1.4.2.4.4.

3.1.4.2.1 Transmit signal interfaces. Transmit signal interfaces shall be as specified in 3.1.4.2.1.1 through 3.1.4.2.1.3.

3.1.4.2.1.1 Transmit RF interface. The design shall accommodate the antenna types specified in a and b:

a. Broadband antenna set with a voltage standing wave ratio (VSWR) of 5:1, or less, over the frequency range of 2.0 MHz to 29.9999 MHz.

b. 9-m to 10.50-m (30-ft to 35-ft) whip antennas for narrowband applications over the same freauency range.

3.1.4.2.1.2 Transmit audio interface. THe audio signal lines shall consist of shielded twisted pairs, balanced to ground, with a minimum longitudinal balance of 30 dB.

3.1.4.2.1.3 Keyline interface. The transmitter ON keying condition of the keyline shall have a closure of not more than 10 ohms resistance (measured at the input connector) and a maximum current capability of 100 milliamperes. An OFF keying or open keyline shall have a minimum resistance of 1 megohm. Transients caused by on-keyed or off-keyed conditions shall be settled within a maximum time of 1 millisecond (ms).

3.1.4.2.2 Receive signal interfaces. Receive signal interfaces shall be as specified in 3.1.4.2.2.1 and 3.1.4.2.2.2.

3.1.4.2.2.1 Receive RF interface. The RF interface shall be via the broadband active antenna assembly (BAAA) or equivalent.

3.1.4.2.2.2 Receive audio interface. The signal characteristics for audio signals from the receivers to the terminal equipment shall be as specified in 3.2.

3.1.4.2.3 CMCS interface. Where applicable, the RG is accessed to the CMCS via a dual-standby, redundant-configured MIL-STD-1553 internal time division command and response multiplex data bus. All major RG equipments shall contain an appropriate bus coupler to accommodate this interface. The CMCS shall provide automated control for the RG. The interface shall enable the CMCS to monitor all built-in-test (BIT) functions and to maintain the current status of all bus-controlled equipment.

3.1.4.2.4 Ship's service interfaces. Ship's service interfaces shall be as specified in 3.1.4.2.4.1 through 3.1.4.2.4.4.

3.1.4.2.4.1 Power interface. Characteristics of the prime power shall be as specified in Section 300 of DoD-STD-1399 for Type I power; the RG shall comply with all the requirements and constraints thereof. The RG shall conform to all functional characteristics when operating from this prime power.

3.1.4.2.4.2 Cooling water interface. When required, cooling water shall be in accordance with MIL-W-21965.

3.1.4.2.4.3 Cooling air interface. Cooling air shall be supplied to the cabinets at an inlet temperature in accordance with the Operating temperature range paragraph of MIL-E-16400, Range 4.

3.1.4.2.4.4 Physical interface. Th RG shall be designed in accordance with RS-310-C-77 and shall consist of physically integrated racks or cabinets. Maximum space available for equipment cabinets or racks interfacing with pallets or the ship's hull for the LHD-1 configuration shall not exceed 12.96 square meters (m^2) (144 square feet (ft^2)) in the Radio Transceiver Room, 4.86 m^2 (54 ft^2) in the Communications Technical Control Room, 0.45 m^2 (5 ft^2) in METRO, and 0.45 m^2 (5 ft^2) in SSES. For other ship classes having a lesser requirement as shown in the APPENDIX, space required shall be reduced accordingly, except that an additional 0.90 m^2 (10 ft^2) shall be allocated in the Communications Technical Control Room for a remote control and monitor console.

3.1.4.3 Internal interfaces. Internal interfaces shall be as specified in 3.1.4.3.1 through 3.1.4.3.6.

3.1.4.3.1 RF interfaces. The RF interfaces between equipments in the RG shall be by 50-ohm coaxial lines.

3.1.4.3.2 Control signal interface. Where applicable, remote control for the equipments in the RG shall utilize dual-redundant MIL-STD-1553 bus format (two independent receive and two independent transmit). For ship classes without an automated CMCS, manual remote control shall be provided from a central location in the Communications Technical Control Room.

3.1.4.3.3 Operational interface. The bus-controlled equipments that comprise the RG shall be directly or indirectly controlled from the Communications Technical Control Room. These equipments shall also be capable of local (manual) control. Where applicable, the equipments in METRO and SSES shall only be locally (manually) controlled.

3.1.4.3.4 Physical. Individual equipments, other than dummy loads, shall be cabinet or rack mounted.

3.1.4.3.5 RF cabling. Cable lengths for RF cables internal to the RG shall be kept to a minimum. Maximum losses in RF cables shall be 0.5 dB at 30 MHz.

3.1.4.3.6 Cooling. Internal cooling shall be in accordance with MIL-E-16400 for heat removal methods of cabinet or rack-mounted equipment when using the compartment air as the heat sink. The RG shall be operable in a degraded condition (one-half of the normal transmitter power output) for at least 1 hour without chill water cooling.

3.1.5 Operational and organizational concepts. The operational configuration of the RG is dictated by the requirements of the ship's mission. In order to facilitate the execution of the mission the RG shall be designed to the maximum extent practicable as a centrally controlled system. The man/machine interface at the RG shall permit easy access to the controls to minimize the workload for the operator. Under automated control, one operator shall be able to perform all required RG configuration setups.

3.1.5.1 System operation. All radio circuits shall be capable of remote operator control either manually or via computer from a central point located in the Communications Technical Control Room. The only exceptions to this shall be the circuits in METRO and in SSES (when applicable). The equipment in these two rooms shall have the same equipment capability (MIL-STD-1553 capable) as that used in the remaining RG equipments, but shall not be connected to a MIL-STD-1553 bus. Each of these non-bus-connected equipments shall be one-for-one interchangeable with the equipments used on the bus.

3.1.5.2 Transmit subsystem. All transmitter channels shall be capable of remote operator control, either manually or via computer from a central point located in the Communications Technical Control Room. The total number of channels required is specified in the APPENDIX. An expansion capability shall be provided by prewired cabinets or racks that shall accept a minimum of one additional unit each. Bus addressing, and so forth, shall be considered when addressing these future growth equipments. The APPENDIX specifies the minimum number of channels that shall be dedicated/available for narrowband operation. The narrowband channels shall operate through antenna coupler groups which are not required by this specification. The remaining channels shall be dedicated/available for BLAG application. When applicable, two of the transmit channels, as a minimum, shall be capable of NTDS operation (at least one each on the BLAG and one each on a narrowband channel). All channels shall be USB or LSB capable.

3.1.5.3 Receive subsystem. The total number of channels required and the exact location is specified in the APPENDIX. Each receiver located in the Communications Technical Control Room shall be capable of remote control, either manually or via computer through a MIL-STD-1553 bus. All units not located in the Communications Technical Control Room shall contain MIL-STD-1553 bus capable equipment but shall not be connected to the computer. These units shall be provided with manual operation (local) only. If applicable, one or more receiver channels shall cover the 14 kHz to 500 kHz frequency range, or additional channels shall be provided for this requirement. All channels located in the Communications Technical Control Room shall be capable of USB or LSB operation. One or more channels shall be NTDS capable as specified in the APPENDIX. Channels located in METRO shall be capable of USB or LSB operation. Channels located in SSES shall be capable of ISB operation. All receivers shall be capable of simplex operation. A receiver expansion capability shall be provided by prewired cabinets or racks that shall accept a minimum of one additional unit each. These future growth capabilities shall also consider bus addressing, and so forth.

3.1.6 Major element list. The major element list is dependent upon the contractor design of the RG broadband system. Actual equipment configuration of the RG shall be dependent on the equipment provided by the contractor to conform to the requirements shown in FIGURE 3 through FIGURE 16.

3.1.6.1 RG equipment configuration. The RG equipment hardware configuration (that is, number of racks, receivers, exciters, and so forth,) shall be dependent on the design configuration selected by the contractor. This design configuration shall be based on the receive and transmit channel (circuit) quantities specified in the APPENDIX. Further detail is available in FIGURE 3 through FIGURE 16 which depict typical basic configurations for the receive and transmit broadband and narrowband subsystems. The only specific requirements for equipment to be selected by the contractor are specified in 3.1.6.1.1 through 3.1.6.1.4.

3.1.6.1.1 Receiving antennas. The receiving antennas (two each switchable for redundancy) shall be active type antennas, or equivalent. These two antennas shall provide reception in the 14 kHz to 29.9999 MHz frequency range and shall be the only antennas required for reception in the receive subsystem.

3.1.6.1.2 Redundant systems. All equipments shall be capable of operation via a dual redundant MIL-STD-1553 bus. METRO and SSES equipments shall not be bus operated, but shall conform to these same MIL-STD-1553 configuration requirements as the remaining main communication equipments.

3.1.6.1.3 Future growth. A future growth capability shall be built into the equipment configuration by providing at least one prewired (terminated as necessary) location in each of the cabinets or racks. All necessary interfacing shall be prewired so all that shall be necessary will be to install and connect (cable) the added equipment. The addition of these equipments shall in no way degrade the overall operation of the RG. The selected bus control scheme shall accommodate this future growth capability without modification.

3.1.6.1.4 Equipment cabinets or racks. The design of individual cabinets or racks shall conform to the physical size restrictions imposed by the existing room locations on the ship. For the LHD-1 configuration, space is available in the Radio Transceiver Room equivalent to 29 RS-310-C-77 cabinets; space is available in the Communications Technical Control Room equivalent to 12 RS-310-C-77 cabinets; in METRO and SSES, space is available equivalent to 1 each RS-310-C-77 cabinet. For other ship classes having a lesser requirement as specified in the APPENDIX, space available shall be reduced accordingly, except that additional space is available in the Communications Technical Control Room equivalent to 3 RS-310-C-77 cabinets for a remote control and monitor console.

3.2 Characteristics. RG characteristics shall be as specified in 3.2.1 through 3.2.10.4.

3.2.1 General. RG general characteristics shall be as specified in 3.2.1.1 through 3.2.1.4.5.

3.2.1.1 System performance characteristics. The RG shall provide for reliable communication in the 14.0 kHz to 29.9999 MHz range with the capability to conform to tactical and strategic requirements. In addition, the RG shall be capable of transmitting and receiving link messages compatible with NTDS LINK-11. The subsystem shall be able to handle voice, encrypted voice, radio teletype (RATT), CW, and data signals within the 300 hertz (Hz) to 3050 Hz audio passband.

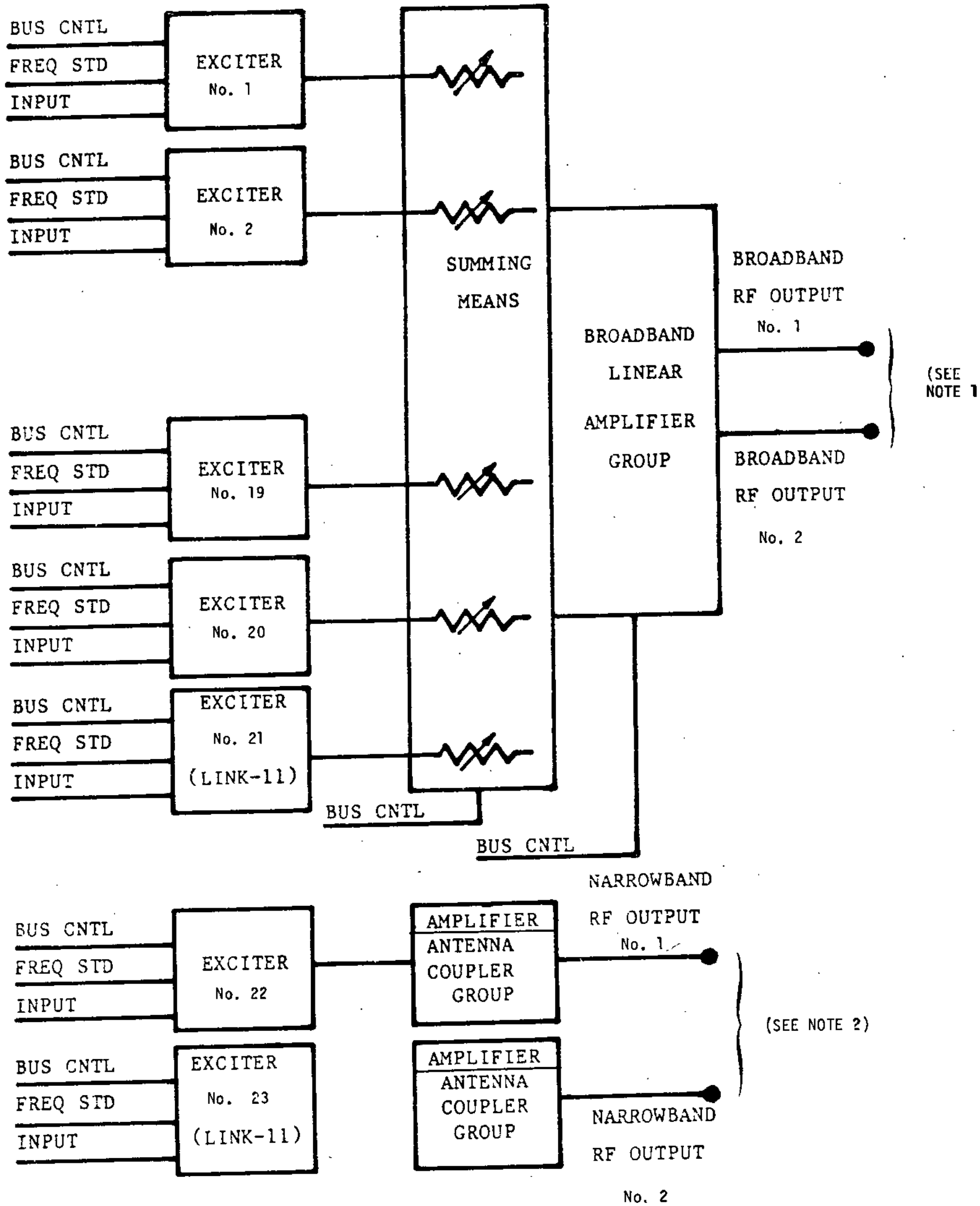
3.2.1.2 RG capabilities. The RG includes VLF, LF, MF, and HF receiving equipment plus HF transmitting equipment. The RG is characterized by the unique features specified in a through d:

a. The transmit portion employs a broadband antenna system and a BLAG fed by a multiplicity of individually modulated exciters. Each exciter functions as an individual transmitter of selectable power level.

b. A dual redundant control and monitor bus provides access to system equipment.

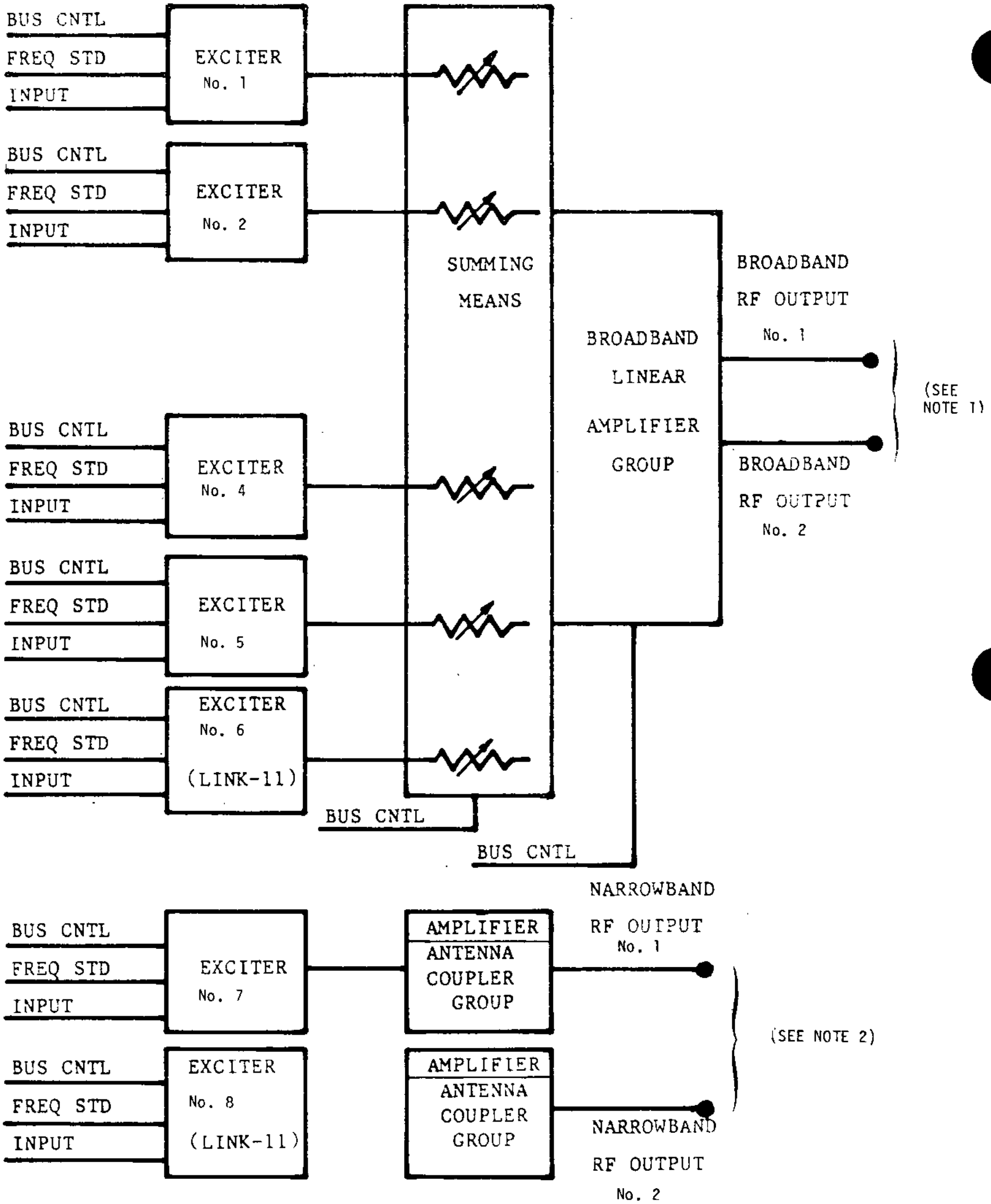
c. The receive portion utilizes a physically small active antenna, or equivalent, feeding multiple receivers through a distribution system.

d. In addition to the broadband capability of narrowband transmit channels (employing tuned antenna couplers not required by this specification) shall be provided as specified in the APPENDIX. The coupler will be capable of tuning/matching a whip antenna whose height is 9 m to 10.50 m (30 ft to 35 ft).



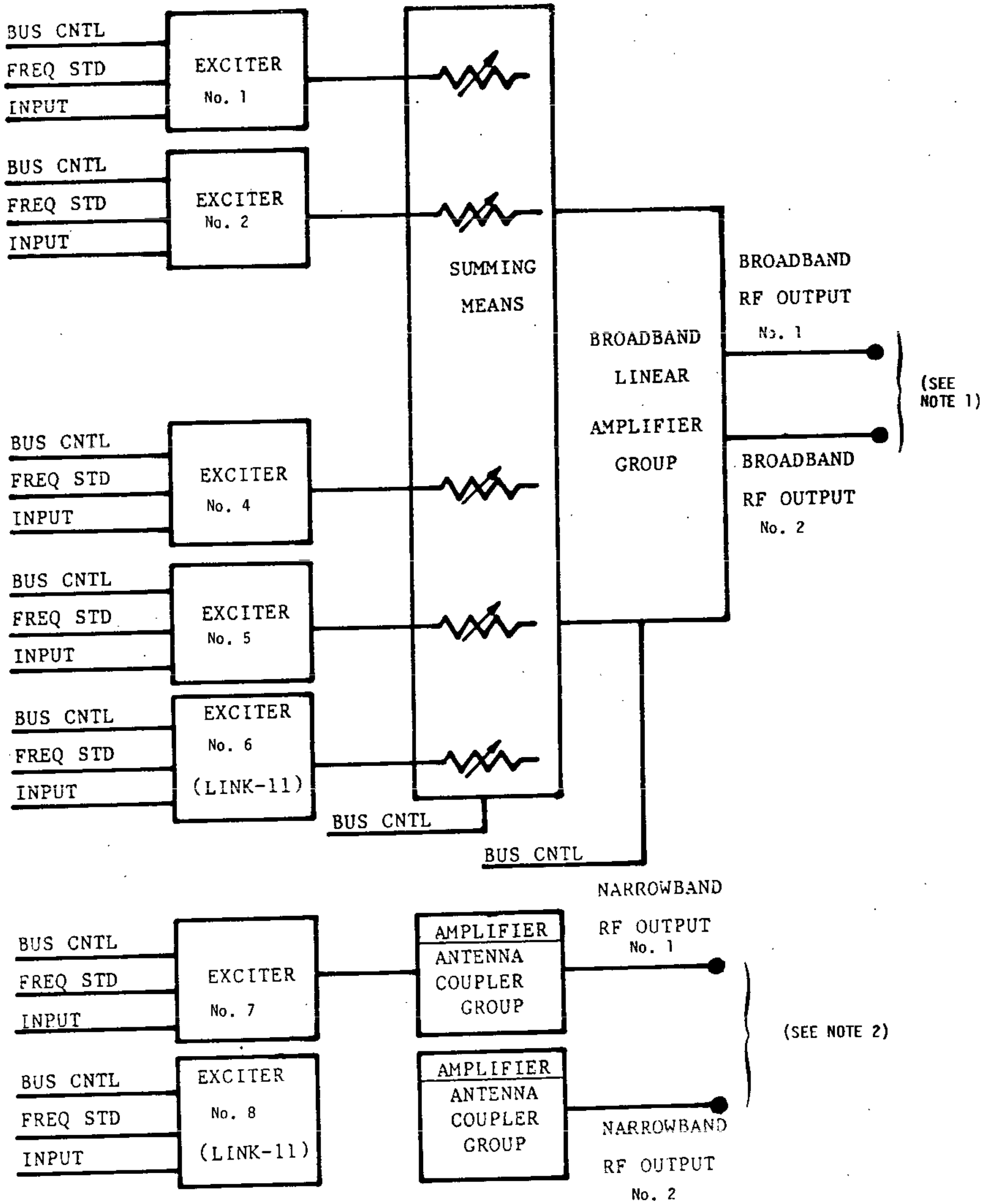
NOTES:
1. The frequency crossover point is dependent on selection of the antenna capability (see 3.2.2.3.2).
2. Antenna coupler groups (not required by this specification).

FIGURE 3. LHD-1 transmit broadband and narrowband subsystem architecture.



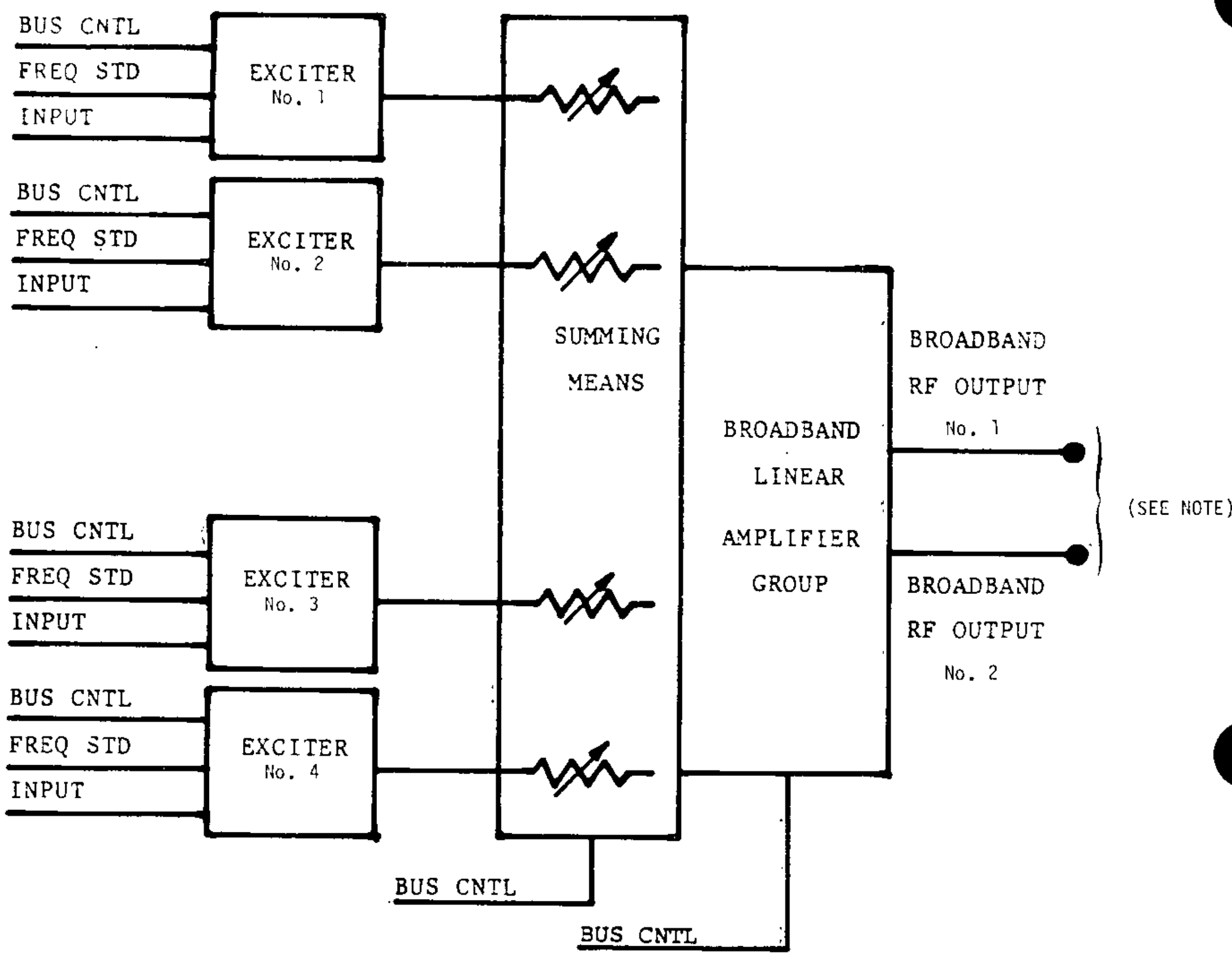
NOTES:
1. The frequency crossover point is dependent on selection of the antenna capability (see 3.2.2.3.2).
2. Antenna coupler groups (not required by this specification).

FIGURE 4. CG-47 transmit broadband and narrowband subsystem architecture.



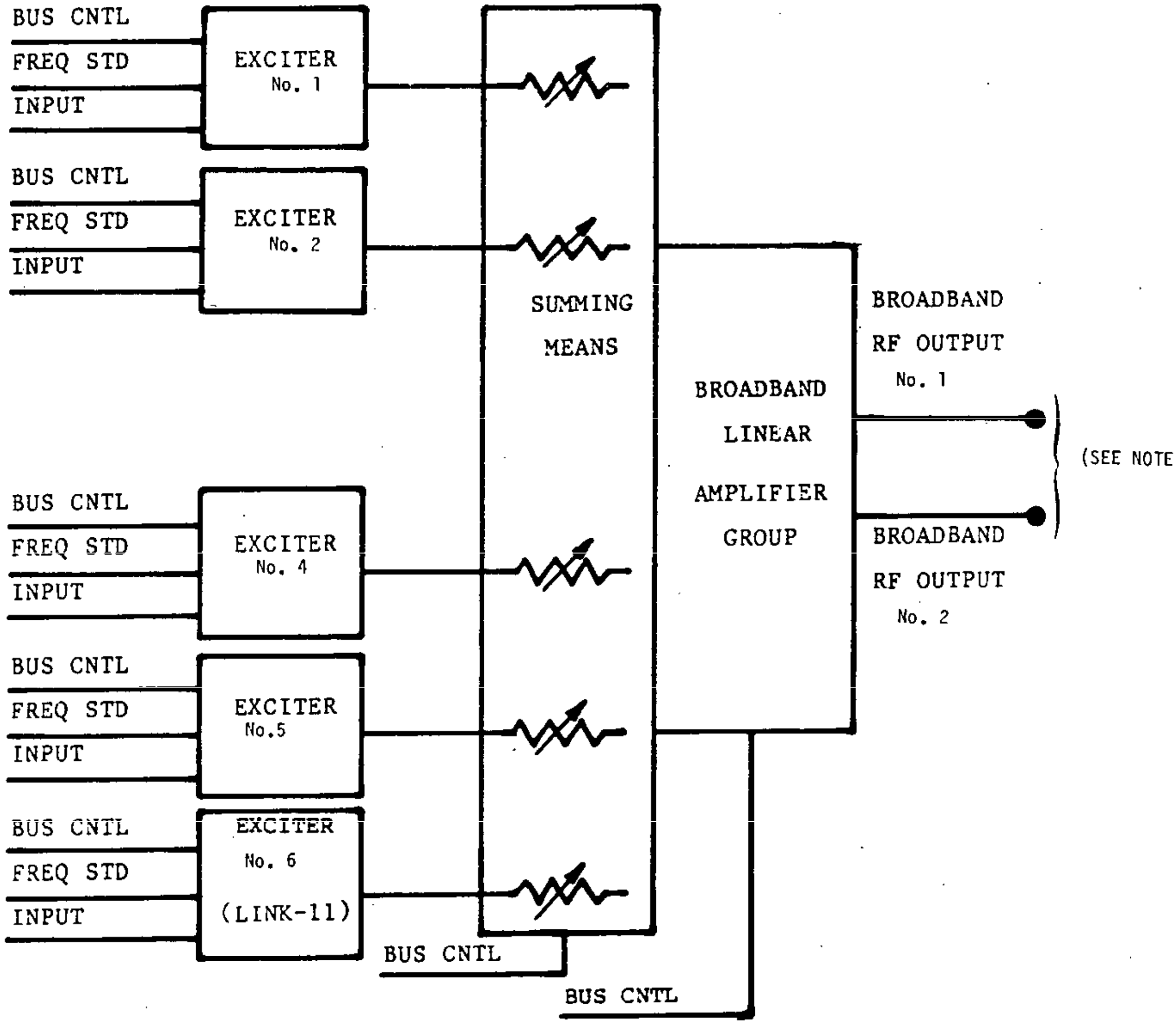
NOTES:
1. The frequency crossover point is dependent on selection of the antenna capability (see 3.2.2.3.2).
2. Antenna coupler groups (not required by this specification).

FIGURE 5. DDG-51 transmit broadband and narrowband subsystem architecture.



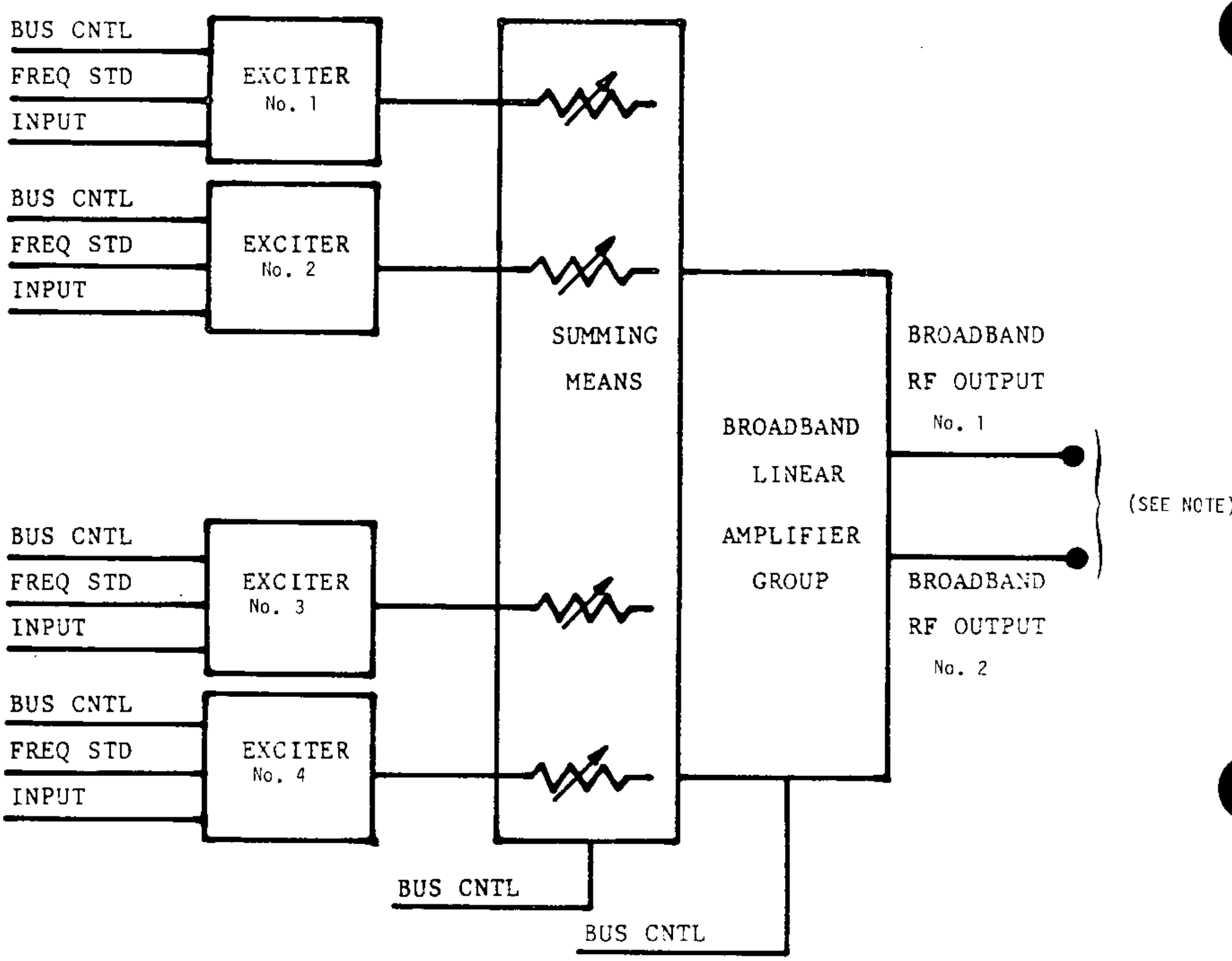
NOTE: The frequency crossover point is dependent on selection of the antenna capability (see 3.2.2.3.2).

FIGURE 6. AE-36 transmit broadband subsystem architecture.



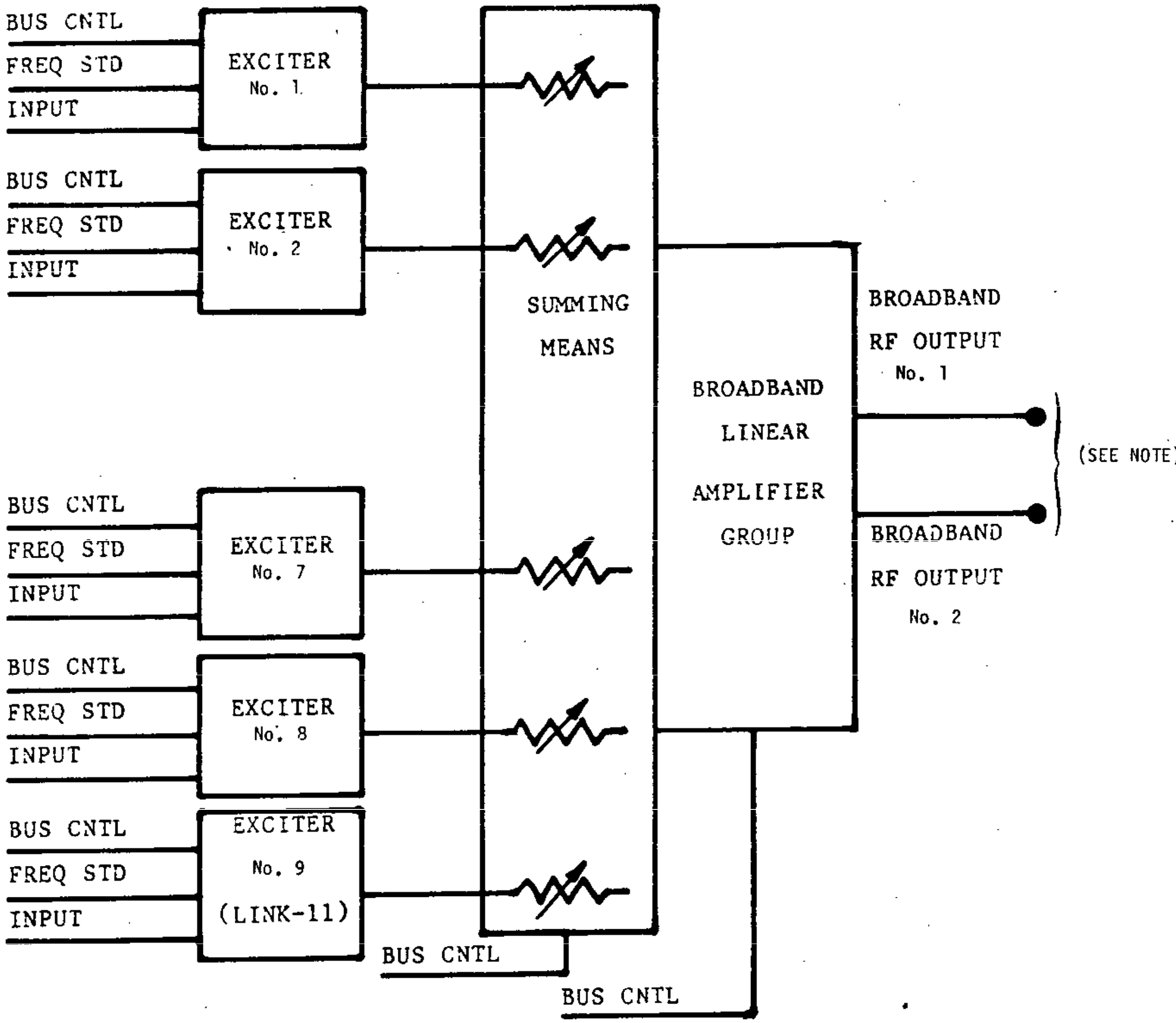
NOTE: The frequency crossover point is dependent on selection of the antenna capability (see 3.2.2.3.2).

FIGURE 7. AOE-6 transmit broadband subsystem architecture.



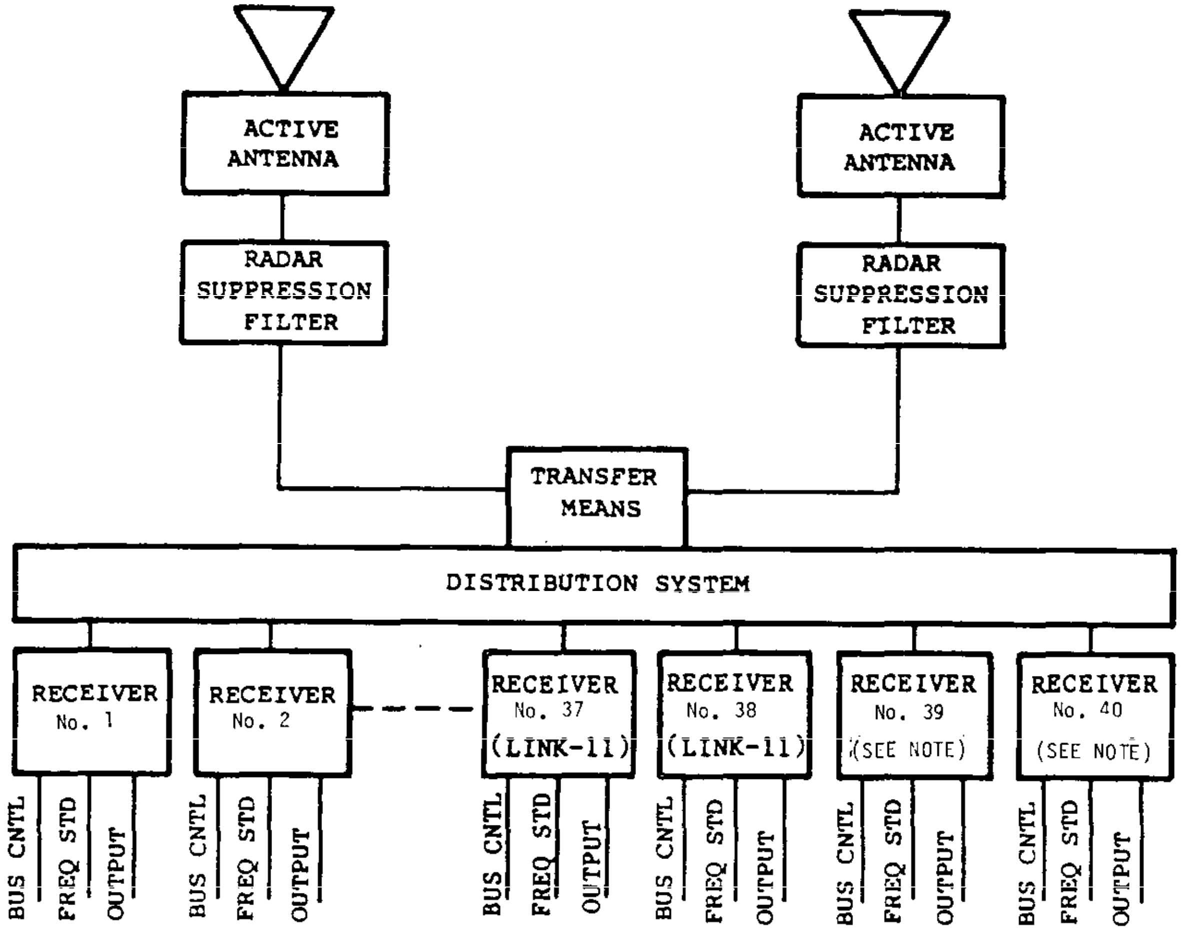
NOTE: The frequency crossover point is dependent on selection of the antenna capability (see 3.2.2.3.2).

FIGURE 8. TAO-187 transmit broadband subsystem architecture.



NOTE: The frequency crossover point is dependent on selection of the antenna capability (see 3.2.2.3.2).

FIGURE 9. LSD-41 transmit broadband subsystem architecture.



NOTE: Only 38 receivers are required if footnote 1/ of TABLE XIII in the APPENDIX is applicable.

FIGURE 10. LHD-1 receiver subsystem architecture.

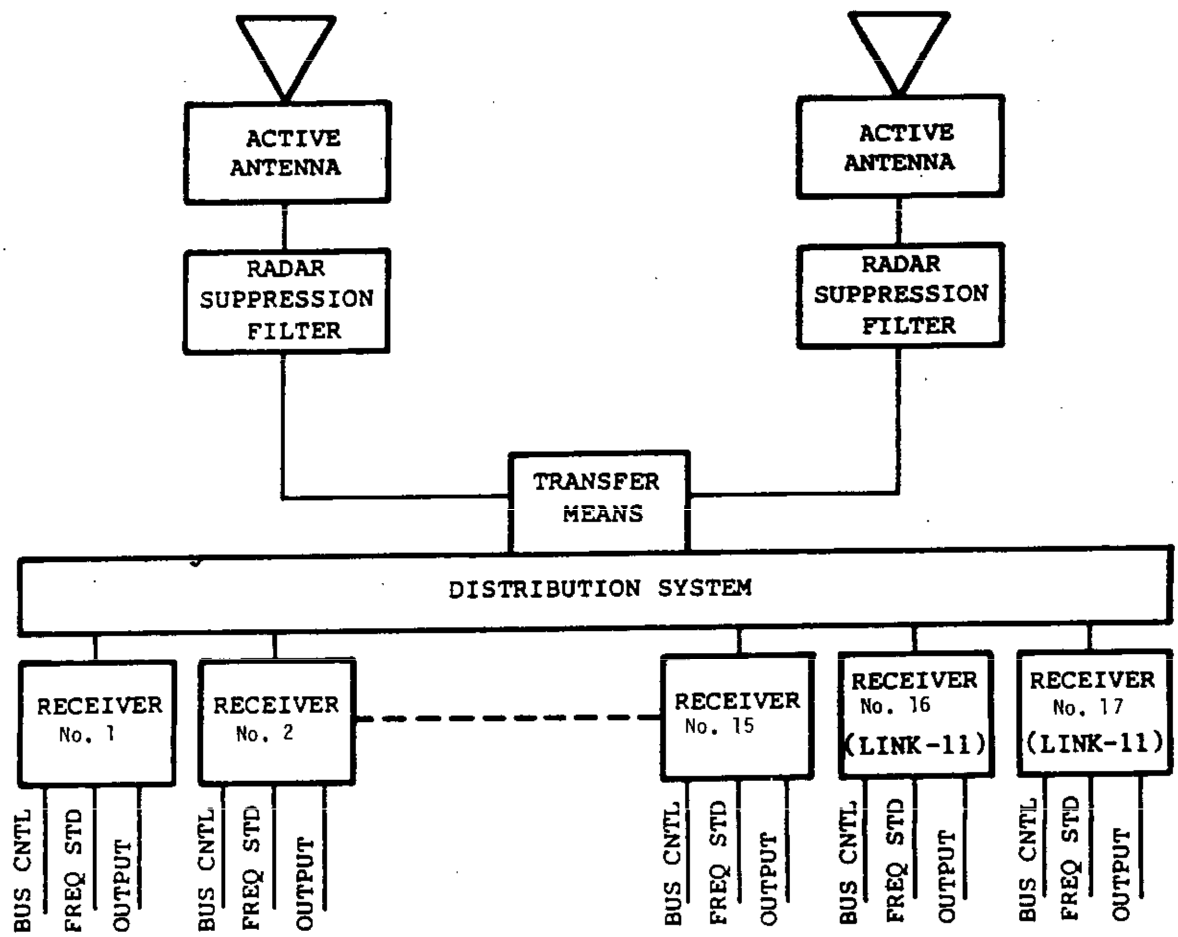


FIGURE 11. CG-47 receiver subsystem architecture.

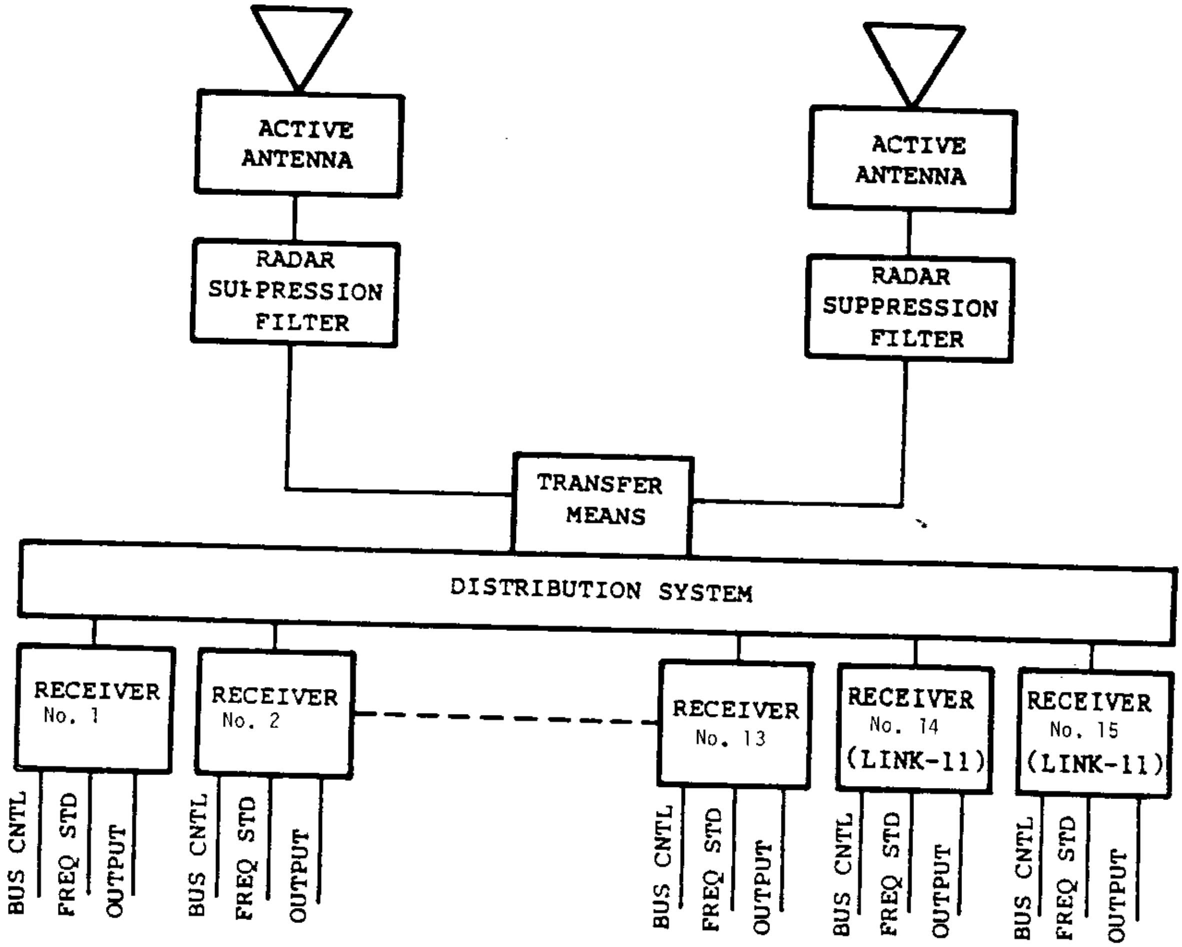


FIGURE 12. DDG-51 receiver subsystem architecture.

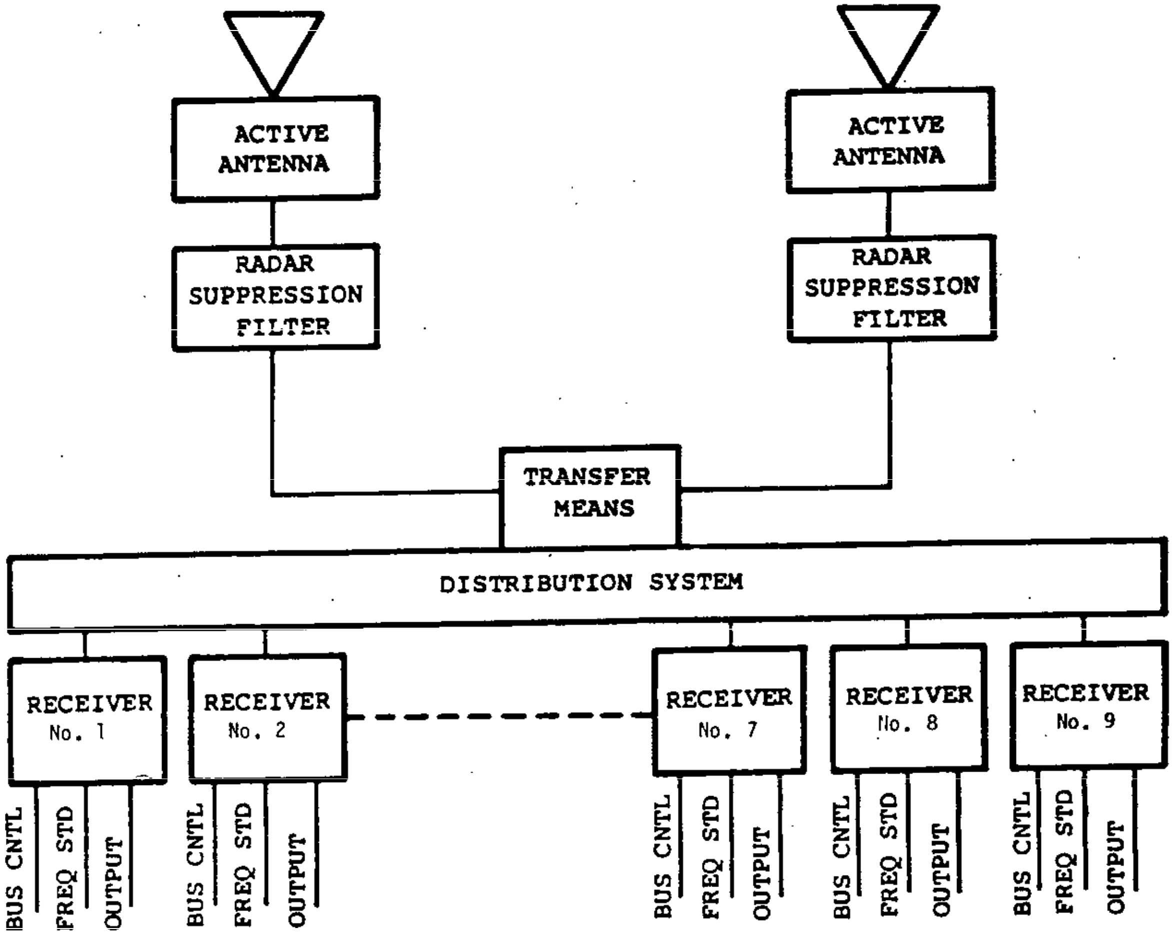


FIGURE 13. AE-36 receiver subsystem architecture.

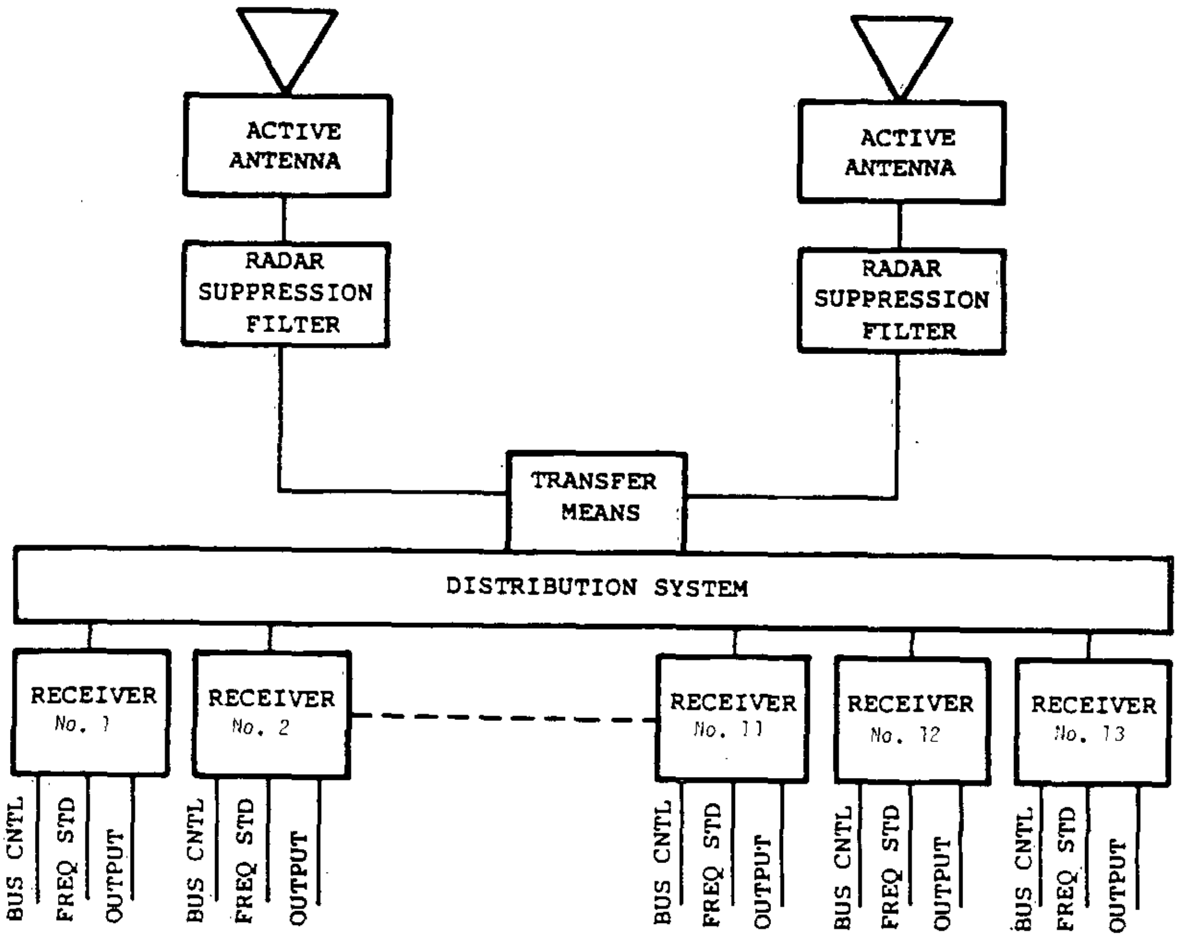


FIGURE 14. AOE-6 receiver subsystem architecture.

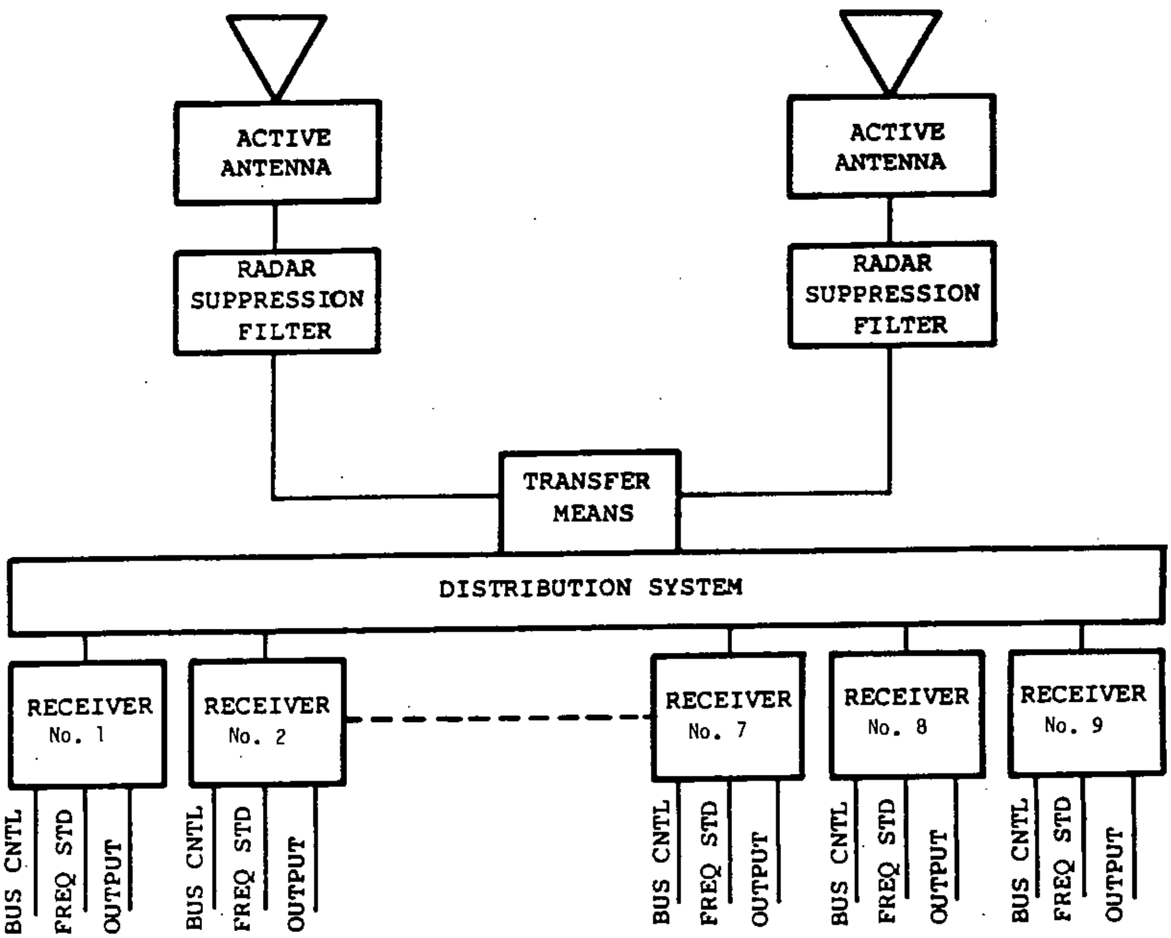


FIGURE 15. TAO-187 receiver subsystem architecture.

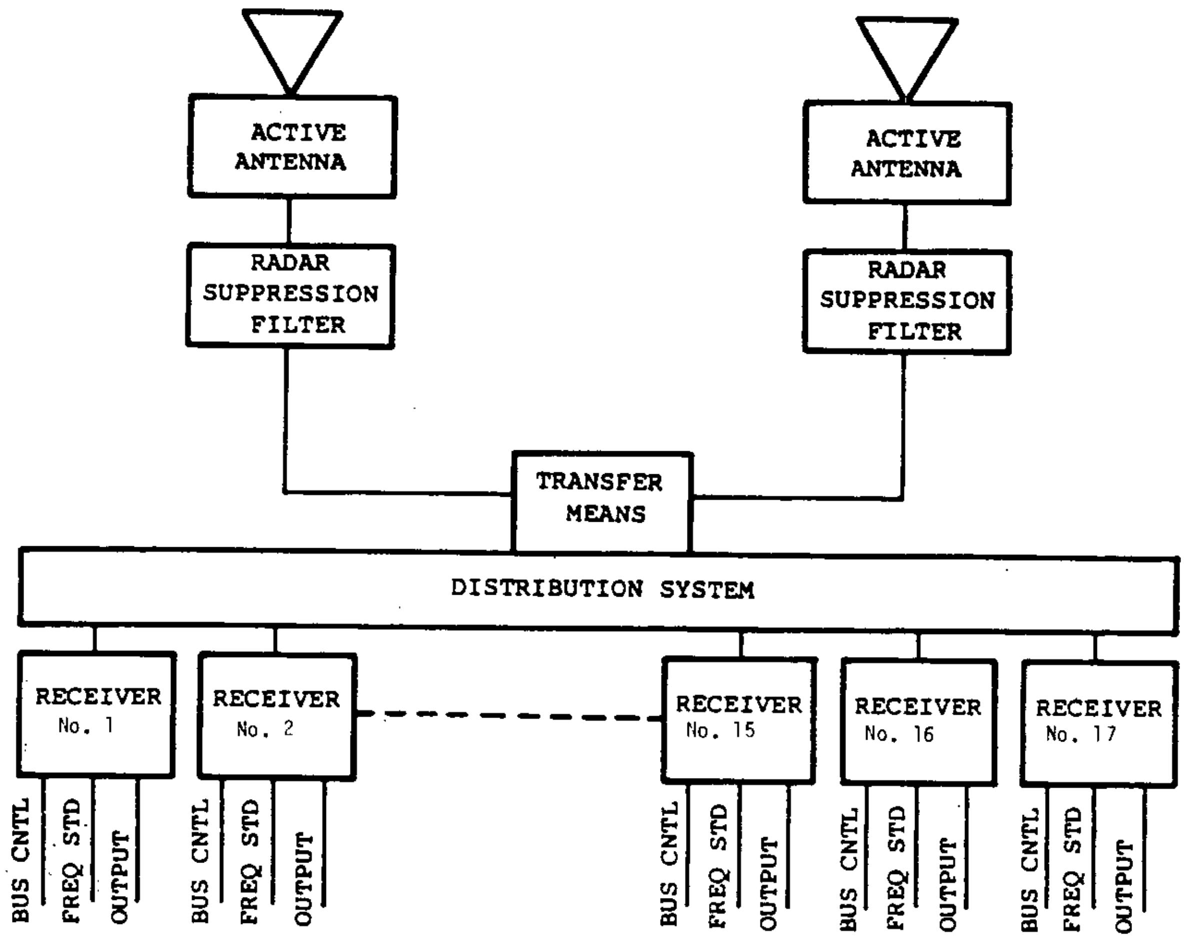


FIGURE 16. LSD-41 receiver subsystem architecture.

3.2.1.3 RG commonality and interchangeability. RG commonality and interchangeability is a prime requirement; therefore, a modular approach shall be taken in the design of the broadband and narrowband transmitting channels and the associated receivers, exciters, and power amplifiers (PAs). Like units, modules, printed circuit boards (PCBs), assemblies, subassemblies, and replaceable parts shall be physically, electrically, and functionally interchangeable with corresponding items. Individual items shall not be hand-picked for fit or performance. Interchangeability requirements shall be two-way.

3.2.1.4 RG operation. The nominal channel bandwidth shall extend from 300 Hz to 3050 Hz from the operating frequency. The RG shall be capable of operating without degradation over the frequency range specified using carrier frequency spacings as close as the spacings specified in 3.2.1.4.1 through 3.2.1.4.5.

3.2.1.4.1 Broadband transmitter-to-transmitter frequency spacing. For broadband applications, transmitter-to-transmitter frequency spacing shall be as specified in a through c:

a. 4 kHz when all USB channels are considered
b. 8 kHz when adjacent USB and LSB channels are considered
c. When ISB is transmitted, the carrier frequency for both sidebands shall be the same.

3.2.1.4.2 Narrowband transmitter-to-transmitter frequency spacing. The spacing of narrowband channels shall be determined by the characteristics of the antenna coupler.

3.2.1.4.3 Transmitter-to-receiver frequency spacing. The transmit-to-receive frequency spacing shall conform to a and b:

a. With transmitter to receiver antenna isolation of 55 dB (connector-to-connector), the receive to transmit frequency spacing shall be as close as 50 kHz over the range 2.0 MHz to 29.9999 MHz. Under these conditions, receive channel availability shall be at least 90 percent for signals equal to or greater than 4 microvolts (μv) at the receiver input.
b. With transmitter to receiver antenna isolation of 40 dB or more (connector-to-connector), no damage shall result to any element of the receive capability when any transmit circuit is operated at full power on the same frequency as a receive circuit.

3.2.1.4.4 Receiver-to-receiver frequency spacing. There shall be no restriction on receiver-to-receiver frequency spacing.

3.2.1.4.5 Maximum time delay. The maximum time delay measured between input and output of any transmitter channel or receiver used for LINK-11 operation shall be less than 2.5 ms for any modulating frequency over the range 500 Hz to 3050 Hz.

3.2.2 Transmit subsystem characteristics. Transmit subsystem characteristics shall be as specified in 3.2.2.1 through 3.2.2.3.13.

3.2.2.1 General characteristics. The APPENDIX lists the number of channels required by each class of ship. The HF transmit system shall provide a transmitting capability for channels in the 2 MHz to 29.9999 MHz band tunable by decimal digit in 100-Hz steps. The systems shall be designed to permit simultaneous transmission from all channels. The transmit system shall provide the capability to encode and decode serial digital control signals using integral or associated bus interface units provided with the equipment. The HF broadband system channel/mode change response time shall not exceed 2 seconds.

3.2.2.1.1 RF emissions. All transmit channels shall be capable of processing signals in the modes specified in a through i:

a. A1
b. A3A
c. A3B
d. A3H
e. A3J
f. A7B
g. A9B
h. F1
i. F4

The APPENDIX specifies the number of transmit channels that shall be capable of operating in the LINK-11 mode in accordance with MIL-STD-188-203-1 using using external modems. Furnishing external modems is not a requirement of this specification.

3.2.2.1.2 Sideband operation. The equipment shall be capable of operating on USB, LSB, and ISB.

3.2.2.1.3 Frequency stability. The frequency error shall be less than ±1 Hz plus proportional frequency standard error when measured in a 10-second sample taken more than 5 seconds after a frequency change.

3.2.2.1.4 Frequency pull-in time. A frequency change in the range 2.0 MHz to 29.9999 MHz shall not cause a frequency error greater than 5 Hz when measured 2 seconds after the change is completed.

3.2.2.1.5 Frequency selection. Frequency selection access shall be from either front panel control or remotely via either manual means or computer control via the control and monitor bus. Not more than 2 seconds shall elapse between the time that the RG receives a change frequency command and the time that the transmit subsystem is ready for operation on the new frequency. This time restriction is exclusive of the time required for the transmit antenna coupler tuning.

3.2.2.1.6 Phase stability. Short-term phase variations shall not exceed 4 root-mean-square (rms) in any 10 ms sampling period commencing 3 seconds or more after initiation of a frequency change.

3.2.2.1.7 Modulation input. An input level of 1.1 volts (V) peak across 600 ohms shall result in the selected channel peak envelope power (PEP) output. The modulation input circuit shall have an impedance of 600 ohms and shall contain an input transformer with an ungrounded electrostatic shield. The input transformer shall have a balance ratio of more than 46 dB. Automatic adjustment to the modulation baseline gain shall be provided so that the selected channel PEP output is generated regardless of the peak to average ratio of the modulating signal. Such signal processing within the handset is not permitted.

3.2.2.1.8 Frequency response of RF output. Within the range of 2.0 MHz to 29.9999 MHz, frequency response of RF output shall conform to a through e:

a. Relative to the maximum RF output obtained by varying the frequency of a constant level input between 300 Hz and 3050 Hz, the maximum output variation for an input signal frequency of 400 Hz to 3050 Hz shall be not more than 2 dB.

b. Relative to the maximum level in a, the maximum output variation for an input frequency of 300 Hz to 3050 Hz shall be not more than 3.5 dB.

c. Opposite sideband rejection 300 Hz or more away from the carrier shall be at least 60 dB.

d. Same sideband rejection at 4 kHz or more away from the carrier shall be at least 60 dB.

e. Differential time delay shall be less than 500 microseconds (μs) between 800 Hz and 3050 Hz from the carrier.

3.2.2.1.9 Carrier suppression. For all transmit channels, carrier suppression shall be at least 40 dB with reference to an USB 1000 Hz single tone at full rated output power.

3.2.2.1.10 Operational modes. All channels shall be capable of operating transmit only, simplex transmit and receive, half-duplex transmit and receive, or duplex transmit and receive. Push-to-talk capability shall be provided as appropriate.

3.2.2.1.11 Hum and noise amplitude modulation (AM). When measuring either the narrowband or the broadband outputs, hum and noise AM shall be suppressed more than 46 dB relative to the maximum single-tone output.

3.2.2.1.12 Warm-up time. Warm-up time shall be as specified in a through c:

a. With all external facilities available, the maximum time to bring the subsystem to full operational condition at the specified performance level (except frequency stability) shall be less than 1 minute.

b. Full phase stability as specified in 3.2.2.1.6 shall be reached within 15 minutes of switch-on at a fixed ambient temperature.

c. After 30 minutes from switch-on, the system performance shall suffer no degradation for a maximum ambient temperature change of 12.22° Celsius (C) per hour (10° Fahrenheit (F) per hour), and after 5 hours a maximum ambient temperature change of 6.66°C per hour (20°F per hour).

3.2.2.1.13 Keying time. The time for a transmit circuit to achieve 80 percent of full output shall be between 3 ms and 5 ms from receipt of key signal. For LINK-11 application, keyline operation shall be as specified in the Radio transmit keyline paragraph of MIL-STD-188-203-1.

3.2.2.1.14 Cut-off time. The time for the output of the transmit circuit to be -120 dB relative to full output shall be less than 10 ms after receipt of key-up signal.

3.2.2.1.15 Power levels. For each exciter, in addition to an RF power off capability, there shall be 15 levels of RF power output. These power levels shall be selectable either manually or by the control and monitor bus in 3-dB increments.

3.2.2.1.16 Power variations. The selected power output terminated into a 50-ohm load at the transmitter output connector shall be within ±2 dB with a 90 percent confidence factor and 3 dB worst case over the frequency range of 2.0 MHz to 28.0 MHz. Additional power variation above 28.0 MHz is allowed but shall not exceed 4 dB.

3.2.2.1.17 Exciter characteristics. The transmit portion of the RG shall utilize RF exciters employing a RF interface of 50 ohms impedance at a RF level of 20 milliwatts (mW) to 500 mW. The mechanical aspects of the exciter shall be such that a minimum of four exciters and associated control, cooling, and combining apparatus can be mounted in a single rack.

3.2.2.1.18 Exciter spurious outputs. With the exciter keyed and modulated with 1000 Hz tone, spurious outputs generated by the synthesizer, mixers, and other circuits shall be suppressed at least 50 dB below maximum single tone output with the exciter set at any carrier frequency in the range of 2.0 MHz to 29.9999 MHz.

3.2.2.1.19 Primary power. The RG shall be capable of operating from any of the power sources specified in a through c:

a. 440 volts alternating current (VAC), 60 Hz, 3-phase, Delta, ungrounded Type I, U.S. Navy shipboard power
b. 240 VAC, 60 Hz, 1-phase
c. 115 VAC, 60 Hz, 1-phase

3.2.2.1.20 Memory devices. The transmit subsystem shall employ nonvolatile memory that permits control information to remain in memory even in the absence of primary power.

3.2.2.2 Narrowband transmit capability. The narrowband transmitters, where applicable, shall utilize an exciter, PA, and an antenna coupler capable of feeding a 9-m to 10.50-m (30-ft to 35-ft) whip antenna. The antennas and couplers are not required by this specification. The narrowband transmit application shall conform to the requirements specified in 3.2.2.1 and in 3.2.2.2.1 through 3.2.2.2.14.

3.2.2.2.1 Commonality. The exciter equipment used in the narrowband transmit application shall be interchangeable with the exciters used in the broadband transmit application. The PA used in the narrowband transmit application shall be the modular building block used to make up the BLAG.

3.2.2.2.2 Power output. The power output shall be 1000 watts (W) PEP, 1000 W average, into a 50-ohm load. Power output variations shall be in accordance with 3.2.2.1.15 and 3.2.2.1.16.

3.2.2.2.3 Amplifier load impedance. The nominal output impedance shall be 50 ohms unbalanced.

3.2.2.2.4 Output load variations. The PA shall operate without damage or failure into any load producing a VSWR up to 5:1 with an input which would produce rated power output into 50 ohms as specified in 3.2.2.2.2.

3.2.2.2.5 Narrowband transmitter intermodulation (IM) products. Two-tone third order IM products shall be no worse than -38 dB relative to either tone level when delivering rated PEP into a 50-ohm load between 2.0 MHz and 29.9999 MHz.

3.2.2.2.6 Narrowband transmitter harmonics. With the transmitter PA delivering rated power into a 50-ohm load, the harmonics shall be suppressed by at least the amounts in TABLE I referenced to the fundamental.

TABLE I. Narrowband harmonic suppression.

Frequency	2nd	3rd
2 MHz to 13 MHz	39 dB	43 dB
13 MHz to 16 MHz	34 dB	50 dB
16 MHz to 30 MHz	43 dB	50 dB

3.2.2.2.7 Forward power indicator. A forward power indicator with 1200 W full scale shall be included at the output of each PA. The accuracy of indication shall be within ±15 percent of full scale when measured with a single tone. A forward power indication shall be provided to the control and monitor bus interface unit.

3.2.2.2.8 VSWR indication. A VSWR indicator shall be provided to respond to the average forward and reflected powers. The accuracy of the indication shall be such that with an actual VSWR of 2.0:1, the indication shall be between 1.7 and 2.4. A VSWR indication shall be provided to the control and monitor bus interface unit.

3.2.2.2.9 Hum sidebands. Sidebands generated by frequency components of the primary power supply shall be less than -55 dB relative to rated PEP.

3.2.2.2.10 Undesired output. When the PA is not keyed, and the exciter output is reduced to -120 dB relative to full drive, the PA output, including noise, shall be less than -140 dB relative to 1000 W when measured over any 3-kHz bandwidth.

3.2.2.2.11 Noise and spurious outputs. With the PA input and output terminated in 50 ohms and with no drive applied, the noise and discrete spurious outputs measured over any 3-kHz bandwidth shall be less than -138 dB relative to 1000 W.

3.2.2.2.12 Antenna coupling device. The antenna coupling device (not required by this specification) will match the impedance of an external 9-m to 10.50-m (30-ft to 35-ft) whip antenna to the output impedance of the PAs. The coupling device will operate automatically over the full frequency range, and will include tuning circuitry, control circuitry, weatherproof units, or other apparatus required for automatic performance. Status indications shall be provided to the control and monitor bus.

3.2.2.2.13 Broadband noise. The broadband noise, measured in a 3-kHz bandwidth and 100 kHz (or 2.5 percent, whichever is greater) away from the exciter frequency setting, with the exciter keyed but not modulated, shall be at least 127 dB below full rated PEP. This level shall be achieved over the frequency range 2.0 MHz to 29.9999 MHz into a 50-ohm load with VSWR less than 1.5:1.

3.2.2.2.14 Operating modes. When applicable, the narrowband transmit capability shall include the ability for at least one channel to operate in the ISB mode compatible with LINK-11 operation and at least one channel to operate in the USB mode. Either narrowband channel shall have the ability to operate in the LSB mode by switching or with simple subassembly exchange providing no adjustments are required to conform to all parameters specified in this specification.

3.2.2.3 Broadband transmit capability. The BLAG shall be of modular design utilizing the building block of the narrowband transmit capability. The BLAG shall be so designed that the failure of any single amplifier module or its power supply shall neither disrupt operation of the assembly nor force its reconfiguration, and the failure shall have no direct effect on performance other than a resultant reduction in RF power output capability. The broadband transmit subsystem shall be capable of operating under bus control and shall simultaneously generate, modulate, amplify, and automatically route the selected communication channels at any frequency within the 2.0 MHz to 29.9999 MHz range to their appropriate PA output ports. No RF switching is permitted beyond the exciter combining apparatus. The broadband transmit subsystem shall conform to the requirements specified in 3.2.2. and in 3.2.2.3.1 through 3.2.2.3.13.

3.2.2.3.1 Power output. The BLAG shall be capable of delivering the output power as specified in the APPENDIX. Power output variations shall be in accordance with 3.2.2.1.16. This capability shall be demonstrated by driving the BLAG to full output with two signals of equal level, the two being chosen to have a frequency anywhere within the 2.0 MHz to 29.9999 MHz range, and operating the BLAG for a period of 3 hours without failure. Each exciter shall be able to drive the BLAG to 700 W PEP.

3.2.2.3.2 Amplifier outputs. The BLAG shall be equipped with two unbalanced 50-ohm coaxial outputs. Output number 1 shall emit frequencies in the range of 2.0 MHz to X MHz, and output number 2 shall emit frequencies in the range X MHz to 29.9999 MHz, where X is any chosen crossover frequency from 7.5 MHz to 10 MHz. Implementation of a given crossover shall be made by software change at the exciter combining apparatus, and no hardware or software change shall occur in the BLAG. The BLAG shall be capable of delivering its full rated power at either output as well as divided in any proportion between outputs.

3.2.2.3.3 Output load variations. The BLAG shall operate without damage or failure into any load producing a VSWR up to 5:1 with an input drive sufficient to produce rated power outputs into a 50-ohm load as specified in 3.2.2.3.1.

3.2.2.3.4 IM products. IM products shall be as specified in 3.2.2.3.4.1 and 3.2.2.3.4.2.

3.2.2.3.4.1 Two-tone performance. With two RF signal generators feeding two frequencies (anywhere between 2.0 MHz and 29.9999 MHz) of equal amplitude to the BLAG with sufficient drive to produce the average power levels specified in TABLE II, the IM products shall be suppressed at least by the amount specified in TABLE II as referenced to the level of either tone.

TABLE II. IM product suppression.

IM product order	Full rated power	Total average power output 750 W	Total average power output 94 W
2	36 dB	45 dB	54 dB
3	38 dB	56 dB	74 dB
4	54 dB	81 dB	94 dB
5	48 dB	72 dB	81 dB
6	69 dB	96 dB	105 dB
7	50 dB	92 dB	101 dB
All others	66 dB	102 dB	111 dB

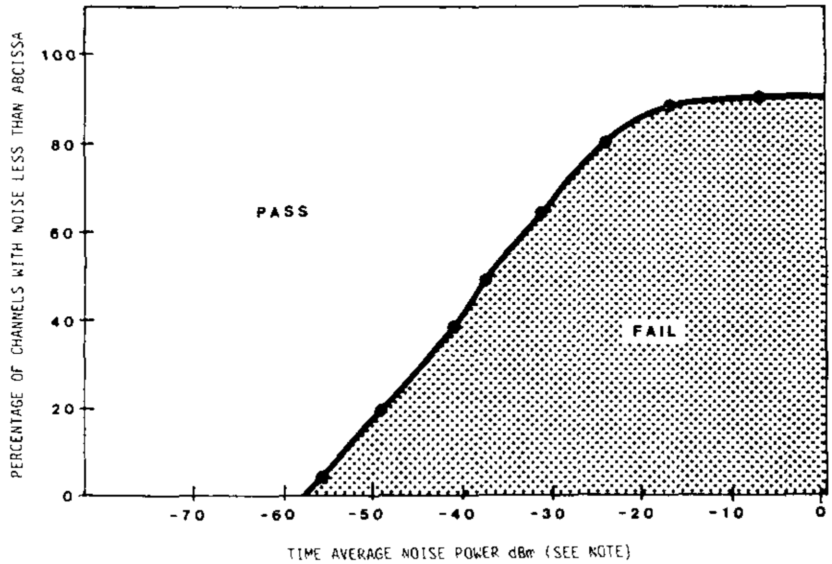
3.2.2.3.4.2 Eight-tone performance. A single tone of 1000 Hz shall be inserted in each of eight exciters. The per channel power output of the broadband transmit capability shall be set to provide 350 W per channel when each of the eight channels receives normal modulation input level. With any automatic modulation control devices disabled, the amplitude of each 1000-Hz tone shall be adjusted to produce a single tone output power level of 250 W PEP as measured across 50 ohms at the BLAG output. The exciter carrier frequencies shall be set to the frequencies specified in Column 1 of TABLE III. The power levels specified herein are for a BLAG having six PA groups. For configurations (see the APPENDIX) having a lesser number of amplifier groups, the power levels shall be reduced accordingly.

TABLE III. Tone frequencies for eight-tone IM performance.

Set number 1 (MHz)	Set number 2 (MHz)
12.4665	2.2415
8.0285	4.9415
3.2665	4.9385
9.2145	5.2015
5.0875	8.6615
16.1685	11.8015
6.2295	15.4415
6.2265	18.8015

The time average power spectrum shall be determined using a 3-kHz resolution for the frequency range 2.0 MHz to 29.9999 MHz. A cumulative distribution of power levels in 3-kHz channels shall then be computed and compared to the curve shown in FIGURE 17. The comparison shall be repeated for the frequencies in Column 2 of TABLE III. This cumulative distribution is required to be entirely within the pass region of FIGURE 17.

3.2.2.3.5 BLAG harmonics. BLAG harmonics shall be as specified in 3.2.2.3.5.1 and 3.2.2.3.5.2.



NOTE: Decibels referred to 1 milliwatt.

FIGURE 17. Cumulative Noise level distribution reference for eight-tone performance.

3.2.2.3.5.1 High level. Using a signal generator to feed the BLAG with sufficient level to create full rated power output as specified in the APPENDIX, the harmonic suppression shall be greater than the levels specified in TABLE IV referenced to the fundamental.

TABLE IV. BLAG harmonic product suppression.

Fundamental	Second	Third
2 MHz to 13 MHz	39 dB	43 dB
13 MHz to 16 MHz	34 dB	50 dB
16 MHz to 30 MHz	43 dB	50 dB

3.2.2.3.5.2 Low level. With a 1000-Hz tone feeding any exciter and the power level adjusted to produce a single tone output power from the BLAG equal to 175 W average, the second harmonic suppression shall be greater than 50 dB and the third harmonic suppression shall be greater than 55 dB.

3.2.2.3.6 Forward power indicator. A forward power indicator shall be included at each output of the BLAG. The accuracy of the indicator shall be within ±15 percent of full scale when measured with a single tone. A forward power indication shall be provided to the control and monitor bus interface unit.

3.2.2.3.7 VSWR indication. A VSWR indicator shall be provided at each BLAG output to respond to the mean forward and reflected powers. The accuracy of the indication shall be such that with an actual VSWR of 2.0:1, the indication shall be between 1.7 and 2.4. A VSWR indication shall be provided to the control and monitor bus interface unit.

3.2.2.3.8 Hum sidebands. Sidebands generated by frequency components of the primary power supply shall be suppressed more than 55 dB relative to PEP.

3.2.2.3.9 Undesired output. When the BLAG is not keyed and all exciter outputs are reduced to -120 dB relative to full drive, the BLAG output, including noise shall be less than -140 dB relative to full rated power when measured over any 3-kHz bandwidth at either output port.

3.2.2.3.10 Noise and spurious outputs. With the BLAG inputs and outputs terminated in 50 ohms and keyed with no drive applied, the noise and discrete spurious outputs measured over any 3-kHz bandwidth shall be less than -138 dB relative to full rated power.

3.2.2.3.11 BLAG broadband noise. With a single tone inserted in any exciter set for a level of 700 W, the broadband noise, excluding discrete spurious emissions (as specified in 3.2.2.1.18) at the BLAG output, measured in a 3-kHz bandwidth, shall be suppressed by at least R_n dB relative to 700 W. The value of R_n is dependent on frequency separation (Δf), between tone frequency (f_t) and the center of the noise frequency band (f_n). When f_n is between 200 kHz and 32 MHz, R_n shall be obtained from TABLE V and shall be obtained from FIGURE 18 for other frequencies.

TABLE V. Limits on relative noise levels.

$2\ \text{MHz} < f_t < 30\ \text{MHz}$ $200\ \text{kHz} < f_n < 32\ \text{MHz}$	
Δ f Limits	R_n
$20\ \text{kHz} < \Delta f < 100\ \text{kHz}$	100 dB
$\Delta f > 100\ \text{kHz}$ and $\Delta f < 0.06\ f_t$	120 dB
$\Delta f > 100\ \text{kHz}$ and $\Delta f > 0.06\ f_t$	130 dB

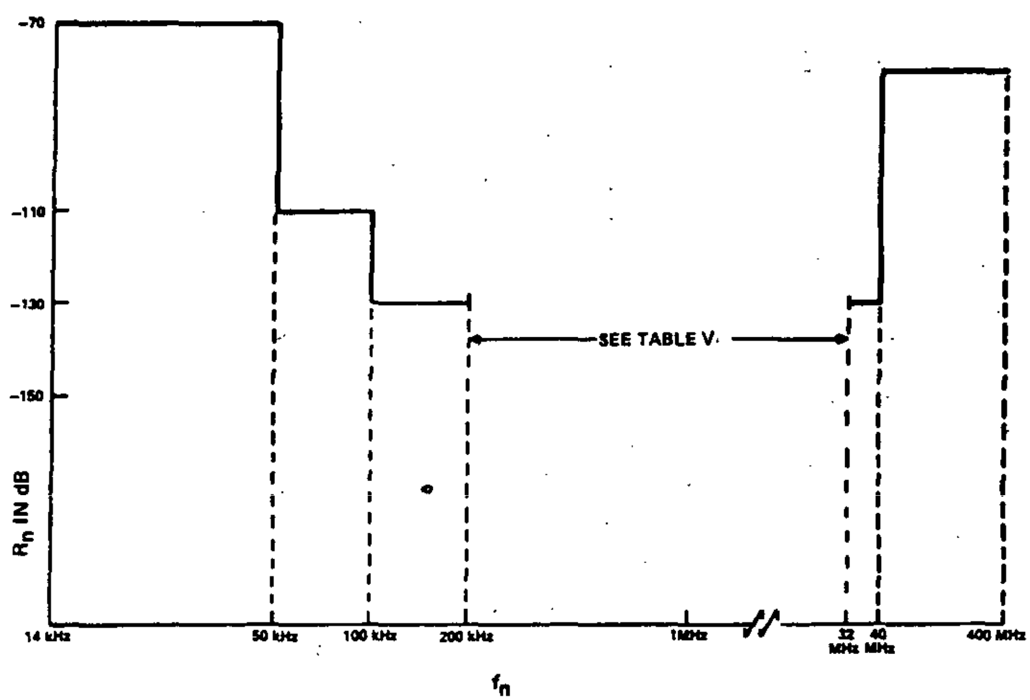


FIGURE 18. R_n values versus f_n.

3.2.2.3.12 Operating modes. Where applicable, the BLAG transmit capability shall include the ability for one channel to operate in the ISB mode compatible with LINK-11 operation. All other channels shall include the ability to operate in either the USB or LSB mode. LSB selection shall be possible by switching or with simple subassembly exchange providing no adjustments are required to conform to all parameters in this specification.

3.2.2.3.13 LINK-11 operation. When applicable, both the narrowband and broadband transmit capability shall have the ability to operate in LINK-11 mode.

3.2.3 Receive subsystem characteristics. Receive subsystem characteristics shall be as specified in 3.2.3.1. through 3.2.3.4.3.4.3.

3.2.3.1 General characteristics. The receive subsystem shall provide communications receiving capability in the 14-kHz to 29.9999 MHz range with tuning by decimal digit to increments as small as 100 Hz. Excluding digital and linear microcircuits, components shall, to the greatest extent possible, be mounted on PCBs grouped in rigid, plug-in replaceable subassemblies.

3.2.3.1.1 Receive subsystem design. The receive subsystem shall be designed to prevent the reception of electromagnetic signals by the distribution and power cables.

3.2.3.1.2 Radar suppression. Means shall be provided to suppress interference from radar signals outside the 0 MHz to 30 MHz range. The effectiveness of this suppression shall be such that attenuation is greater than 60 dB over the range 55 MHz to 1000 MHz. Insertion loss shall be less than 0.5 dB from 0 MHz to 28 MHz and less than 3.5 dB from 28 MHz to 30 MHz.

3.2.3.1.3 LINK-11 compatibility. The receive subsystem shall be capable of processing NTDS LINK-11 signals in accordance with the HF receiver characteristics paragraph of MIL-STD-188-203-1.

3.2.3.2 Active receive antenna. The receive subsystem shall employ two electrically small active receiving antennas, or equivalent. The antenna shall receive signals in the range 14.0 kHz to 29.9999 MHz and shall amplify these signals to provide matched output into a 50-ohm coaxial distribution system for feeding the receivers of the receive subsystem. The antenna shall be designed as a ruggedized weatherproof deck-mounted preamplifier (preamp) unit supporting a vertical monopole antenna whose height shall not exceed 2 m (6.562 ft). The antenna shall be designed to give specified IM performance when exposed to fields from adjacent transmitting antennas as high as 6 volts per meter (V/m). The antenna shall withstand a field of 10,000 V/m with a duration of 300 nanoseconds (ns). No damage shall occur to other parts of the subsystem when this field is applied. The antenna shall not fail when subjected to salt spray and boarding seas. Pattern performance shall be omnidirectional in azimuth over the specified operating range.

3.2.3.2.1 Sensitivity. The active receive antenna shall have a power sensitivity such that the output from the preamp is 3.3 mW across 50 ohms when the monopole is mounted on an infinite ground plane and exposed to a field strength of 2.5 V/m.

3.2.3.2.2 Noise figure. The noise power measured at the output of the preamp when the antenna is in an electromagnetically quiet environment shall be less than the levels in TABLE VI as referenced to kTB.

TABLE VI. Receive subsystem noise figure.

Frequency	Noise
0.014 MHz to 0.2 MHz	31 dB
0.2 MHz to 0.5 MHz	25 dB
0.5 MHz to 1.0 MHz	16 dB
1.0 MHz to 3.0 MHz	10 dB
3.0 MHz to 30 MHz	6 dB

3.2.3.2.3 Receive antenna redundancy and distribution. Two active antennas shall be furnished together with a switching system to permit the antenna distribution specified in a and b:

a. One antenna to feed approximately one-half of the receivers while the other antenna feeds the remainder, or

b. The entire receiver subsystem to be fed selectively from either antenna.

A distribution system shall be provided to convey the output of the active receive antenna to the various receivers.

3.2.3.2.3.1 Distribution gain. The gain as measured from either input to the distribution system to each of the multiple outputs shall be nominally 0 dB.

3.2.3.2.3.2 Distribution system redundancy. All active circuits such as amplifiers, power supplies, and so forth, that are contained within the distribution system shall be redundant with no discrete switchover in the event of failure. One power supply failure shall not impair performance, and any other failure shall not reduce the operating capability by more than 6 dB loss of gain to all outputs.

3.2.3.2.3.3 Isolation. Isolation between any two ports of the distribution system shall be greater than 20 dB.

3.2.3.2.3.4 Maximum RF signal amplitude. The distribution system shall be capable of withstanding an input signal between 1.0 MHz and 29.9999 MHz of up to 12 V without damage and shall recover to full performance within 10 ms after removal of this signal.

3.2.3.2.3.5 Desensitization. With a wanted signal level up to 400 millivolts (mV) applied immediately following the active antenna preamp, an interfering signal similarly applied between 1 MHz and 29.9999 MHz at any level up to 10 V shall not reduce the wanted output by more than 3 dB.

3.2.3.2.3.6 Active antenna IM performance. With two fields adjusted to give an antenna preamp output of 21 mW (each signal) into 50 ohms within the frequency range 2.0 MHz to 29.9999 MHz, the second order IM products shall be suppressed more than 50 dB relative to the level of either signal and third order products shall be suppressed more than 65 dB.

3.2.3.2.3.7 Active antenna desensitization. With a desired signal at any field strength up to 2.5 V/m, an interfering signal up to 37.5 V/m shall not reduce output by more than 1 dB.

3.2.3.3 Receive subsystem performance. Receive subsystem performance shall be as specified in 3.2.3.3.1 through 3.2.3.3.20.

3.2.3.3.1 Frequency range. The subsystem shall operate over the range 14.0 kHz to 29.9999 MHz tunable by decimal digit to increments of 100 Hz or smaller.

3.2.3.3.2 Reception modes. The modes specified in a through n shall be processed:

a. A1
b. A2
c. A3
d. A3A
e. A3B
f. A3H
g. A3J
h. A7B
i. A7J
j. A9B
k. F1
l. F4
m. LINK-11
n. LINK-14

The receive subsystem shall be capable of operating on USB, LSB, and ISB.

3.2.3.3.3 Information capability. The subsystem shall process voice, encrypted voice, CW, RATT, and data signals such as LINK-11, as contained within the audio passband 300 Hz to 3050 Hz.

3.2.3.3.4 Frequency and phase stability. Frequency and phase stability shall be as specified in 3.2.3.3.4.1 through 3.2.3.3.4.4.

3.2.3.3.4.1 Frequency standard. An external frequency standard of 0.1 MHz, 1.0 MHz, or 5.0 MHz providing a level of 4 V to 5 V across 50 ohms is available but not part of this RG.

3.2.3.3.4.2 Frequency pull-in time. A frequency change initiated by any means, between any two frequencies anywhere in the range 14.0 kHz to 29.9999 MHz shall not cause a frequency error greater than 5 Hz when measured 2 seconds after the change is completed.

3.2.3.3.4.3 Frequency stability. The frequency error shall be less than ±1 Hz plus proportional frequency standard error when measured in a 10-second sample taken more than 5 seconds after a frequency change.

3.2.3.3.4.4 Phase stability. Short-term phase variations shall not exceed 4 degrees rms in any 10 ms sampling period commencing 3 seconds or more after initiation of a frequency change.

3.2.3.3.5 Receive subsystem maximum RF signal amplitude. The subsystem shall withstand continuous signal levels of at least 45 V/m at the active antenna without damage. Recovery time after the removal of this signal level shall be as specified in a and b:

a. 10 ms for a signal outside the receiver passband
b. Automatic gain control (AGC) time constant within the receiver passband

3.2.3.3.6 Receive subsystem noise level. The receive subsystem noise figure measured immediately following the active antenna preamp shall be as specified in a through c:

a. Not worse than 19 dB over the frequency range 1.5 MHz to 29.9999 MHz
b. Below 1.5 MHz the noise performance shall be tailored to conform to CCIR noise levels
c. With an interfering signal at a level of 1 V spaced 100 kHz or 2.5 percent (whichever is greater) away from the tune frequency, the receive subsystem noise figure shall not be worse than 22 dB over the frequency range 1.5 MHz to 29.9999 MHz.

3.2.3.3.7 Receive subsystem IM products. With two carriers, at a level of 2 V applied immediately following the active antenna preamp spaced 100 kHz or 2.5 percent (whichever is greater) away from the tune frequency over the frequency range 1.5 MHz to 29.9999 MHz, third order IM products generated by the subsystem shall not exceed -50 dB relative to either carrier.

3.2.3.3.8 Receive subsystem desensitization. With an on channel signal of 12 µV, the introduction of an interfering signal of 2.2 V removed from the tune frequency by 100 kHz or 2.5 percent, (whichever is greater) will neither suppress the wanted output by more than 3 dB nor degrade the signal-to-noise ratio to less than 10 dB. This test shall be made with the receiver gain adjusted such that the wanted signal is just below the AGC threshold.

3.2.3.3.9 Spurious responses. Spurious responses shall be as specified in a and b:

a. With an interfering signal at a level of 400 mV in the range 2.0 MHz to 29.9999 MHz spaced 100 kHz or 2.5 percent (whichever is greater) from the tune frequency applied to the subsystem immediately following the active antenna preamp, spurious responses generated shall be at least 114 dB less than the interfering signal.
b. With a 50-ohm termination replacing the active antenna preamp, the level of any internally generated spurious response shall be not greater than 2 dB above the receive subsystem noise level in a 3-kHz bandwidth. Leakage from the reference frequency standard is excepted from this requirement.

3.2.3.3.10 Frequency response. When measured above 2.0 MHz, the subsystem frequency response shall be as specified in a through c:

a. Double sideband (DSB): The response shall not vary more than 2 dB total ripple with modulating frequencies between 300 Hz and 3050 Hz. At a frequency 10 kHz or more removed from the carrier, the response will be at least 60 dB below the signal measured within the passband.
b. Single sideband (SSB): The response between 300 Hz and 3050 Hz away from the carrier frequency in the operating sideband shall be within 2 dB total ripple. Opposite sideband rejection shall be at least 60 dB below the passband level 300 Hz or more away from the carrier frequency. Same sideband rejection shall be at least 60 dB below passband level at frequencies 4 kHz or more from carrier.
c. CW: The 3-dB bandwidth shall be ±100 Hz. Stopband shall be greater than 60 dB below passband level when measured ±300 Hz or more from the center frequency.

3.2.3.3.11 Differential time delay. The differential time delay shall be less than 500 µs between 800 Hz and 3050 Hz.

3.2.3.3.12 Audio characteristics. Audio characteristics shall be as specified in a through f:

a. The standard audio output shall be defined as 8 mW when measured across 50 ohms.

b. The output transformer shall have a balance ratio of more than 46 dB between windings over the range 300 Hz to 3050 Hz.

c. A grounded electrostatic shield shall be provided in the output transformer.

d. SSB (speech mode): Third order in-band IM products measured with two tones at a level of 10 mV applied to the distribution system input immediately following the active antenna preamp, such as to provide audio output frequencies of 425 Hz and 595 Hz, shall be more than 40 dB below either tone.

e. DSB: With a signal input level of 10 mV modulated 80 percent with 400 Hz and applied immediately following the active antenna preamp, the harmonic distortion shall not exceed 5 percent when delivering standard output.

f. With the gain of the front end circuits minimized to reduce noise from these circuits, the level of hum and noise at any receive subsystem output shall be at least 40 dB below standard output.

3.2.3.3.13 Spurious radiations. The unwanted signals measured across the receiver antenna input terminals shall not exceed -64 dBm.

3.2.3.3.14 Subsystem sensitivity. With a signal in the range 1.5 MHz to 29.9999 MHz adjusted to provide a 1-kHz received audio tone and applied immediately following the active antenna preamp at a level of 1.63 µV, the audio output shall be between +1.5 dB and -3.5 dB relative to standard output with SSB mode selected.

3.2.3.3.15 ACG time constants. For a 60-dB increase or decrease in signal level from or to +10 dB above 1 µV, the subsystem shall provide the AGC time constants specified in TABLE VII.

TABLE VII. AGC time constants.

Mode	Attack time (to within 3 dB of steady-state)	Hold time	Release time (to within 7 dB of steady-state)
DSB	400 ms		< 600 ms
ISB, SSB, or both speech	< 10 ms	1.9 seconds to 3.2 seconds	100 ms to 180 ms
ISB, SSB, or both data	< 10 ms	9.4 ms to 11 ms	< 15 ms
RATT	< 10 ms	120 ms to 220 ms	70 ms to 160 ms
CW	< 25 ms	310 ms to 470 ms	70 ms to 160 ms

3.2.3.3.16 AGC range. The receive subsystem audio output shall be within +4.5 dB and -3.5 dB relative to standard output for all input signal levels over the range 1.63 µV to 300 mV applied to the receive subsystem immediately following the active antenna preamp.

3.2.3.3.17 Muting. The receivers in the subsystem shall be desensitized by at least 60 dB within 3 ms of receipt of a MUTE command when an associated transmitter is keyed. Recovery to 90 percent of receive subsystem sensitivity shall be less than 10 ms in the absence of a signal at the tune frequency. For LINK-11 application, MUTE operation shall be as specified in MIL-STD-188-203-1.

3.2.3.3.18 Intermediate frequency (IF) rejection. With an RF input signal at a level of 800 mV with any frequency within the range of any receiver first IF applied immediately following the active antenna preamp, any receiver output level shall be at least 6 dB below its standard output when tuned to any frequency in the operating range.

3.2.3.3.19 Frequency selection. Frequency selection shall be effected either by direct entry from the receiver front panel or remotely by either manual means or computer control via the control and monitor bus. Each receiver shall contain nonvolatile memory to retain data in the event of a power failure. Not more than 2 seconds shall elapse between the time that the RG receives a change frequency command and the time that the receive subsystem is ready for operation on the new frequency.

3.2.3.3.20 Start-up time. Start-up time shall be as specified in a through c:

a. With all external facilities available, the maximum time to bring the subsystem to full operational condition at the specified performance level, with the exception of frequency stability, shall be less than 1 minute.

b. Excluding any error in the external frequency standard, the subsystem output frequency shall take no more than 5 minutes to be within ±1 Hz of the desired frequency which would be produced by a particular RF input signal.

c. Full phase stability in accordance with 3.2.3.3.4.4 shall be reached in less than 15 minutes from switch-on at a fixed ambient temperature. After 30 minutes from switch-on, the system performance shall suffer no degradation for a maximum ambient temperature change of 12.22°C per hour (10°F per hour), and after 5 hours a maximum ambient temperature change of 6.66°C (20°F per hour).

3.2.3.4 CMCS bus characteristics. The RG shall be capable of interfacing with a CMCS via four dual-redundant equipment control and monitor buses which shall use MIL-STD-1553 format in synchronous polling mode. Each bus shall be capable of addressing 30 devices.

3.2.3.4.1 Equipment. The equipment specified in a through c shall be designed and equipped to be capable of bus interface for automated monitor and control:

a. Transmitter equipment
b. Receiver equipment and receiving antenna devices
c. System control and monitor equipment

3.2.3.4.2 Control and monitor capabilities. Using MIL-STD-1553 word formats, the CMCS interface shall provide the RG control and monitor capabilities specified in a through e to a single-point control operator.

a. Equipment status
b. Frequency selection
c. Transmitter output power level
d. Transmit and receive mode selection
e. Transmit key state selection

In lieu of a CMCS, the control and monitor functions specified in a through e shall be provided to a single point remote control (manual) console.

3.2.3.4.2.1 Fault detection and reporting. As a minimum, the bus-controlled RG equipment shall be designed to detect and report, via the bus, abnormalities or faults in the categories specified in a through e:

a. AC power on/off
b. Tune complete/correct
c. Battleshort override initiate
d. Cross operational self-test
e. EMCON set (removed)

The equipment shall also report satisfactory achievement of directed state or conditions in response to the commands specified in a through e using MIL-STD-1553 data word formats. The transmitter keyline function shall be wired direct, bypassing the bus control function.

3.2.3.4.2.2 Equipment status reporting. The equipment shall be designed to self-monitor and report via the control and monitor bus the operating conditions and faults specified in a through i:

a. Equipment overheat
b. RF power overload
c. High VSWR
d. Local and remote state
e. Correct frequency/tune complete
f. Correct mode
g. Receiver gain level
h. Receiver AGC level
i. Receiver noise/level

3.2.3.4.2.3 Frequency selection. All exciters, PAs, and receivers shall be selectable and tunable via the bus in decimal digit increments as small as 100 Hz. These equipments shall provide a tune complete status report and shall be capable of continous self-test to ensure that the commanded frequency is maintained.

3.2.3.4.2.4 Power level selection. Transmit power output demand levels shall be adjustable in 15 increments of 3 dB each via the bus. A sixteenth position for OFF shall be provided. Highest reference levels shall be 1 kW for narrowband applications and 70 W for broadband applications.

3.2.3.4.2.5 Mode selection. Mode of operation shall be selectable via either the control bus or from a remote control console. Transmitting equipment shall, as a minimum, be capable of supporting the modulation types specified in the APPENDIX, TABLE XX through TABLE XXVI. Receivers shall be capable of supporting the modulation types specified in the APPENDIX, TABLE XIII through TABLE XIX.

3.2.3.4.2.6 Key state selection. The actual keyline function shall be hardwired, bypassing bus control. However, the keyline state for all transmitters shall be bus reportable. Both the ON and OFF keying states shall be reported.

3.2.3.4.2.7 Data bus characteristics. All interfaces shall be designed to accommodate the characteristics specified in 3.2.3.4.2.7.1 through 3.2.3.4.2.7.5.2.

3.2.3.4.2.7.1 Cable. The cable used for the main bus and all stubs shall be a two-conductor, twisted, shielded, jacketed cable. Distributed wire-to-wire capacitance shall not exceed 30.0 picofarads per ft. The cables shall be formed with no less than four twists per ft where a twist is defined as a 360-degree rotation of the wire pairs; and, the cable shield shall provide a minimum of 75.0 percent coverage.

3.2.3.4.2.7.2 Characteristic impedance. The nominal characteristic impedance of the cable (Z_0) shall be within the range of 70.0 ohms to 85.0 ohms at a sinusoidal frequency of 1.0 MHz.

3.2.3.4.2.7.3 Bus attenuation. At the frequency of 1.0 MHz, the cable loss shall not exceed 1.5 dB per 100 ft.

3.2.3.4.2.7.4 Bus termination. The two ends of the cable shall be terminated with a resistance equal to the cable Z_0 ±2 percent.

3.2.3.4.2.7.5 Bus coupling requirements. The two acceptable methods of coupling to the MIL-STD-1553 bus shall be as specified in 3.2.3.4.2.7.5.1 and 3.2.3.4.2.7.5.2.

3.2.3.4.2.7.5.1 Direct (stub) coupling. The terminal shall be coupled to the bus as shown in FIGURE 19. Length of stubs used in this manner shall be kept to an absolute minimum. In no case shall the stub exceed 6 m (20 ft) in length.

3.2.3.4.2.7.5.2 Transformer coupling. The terminal shall be coupled to the bus as shown in FIGURE 20. The isolation transformer shall have a turns ratio of 1:1.41 ±3.0 percent with the higher number of turns on the isolation resistor side.

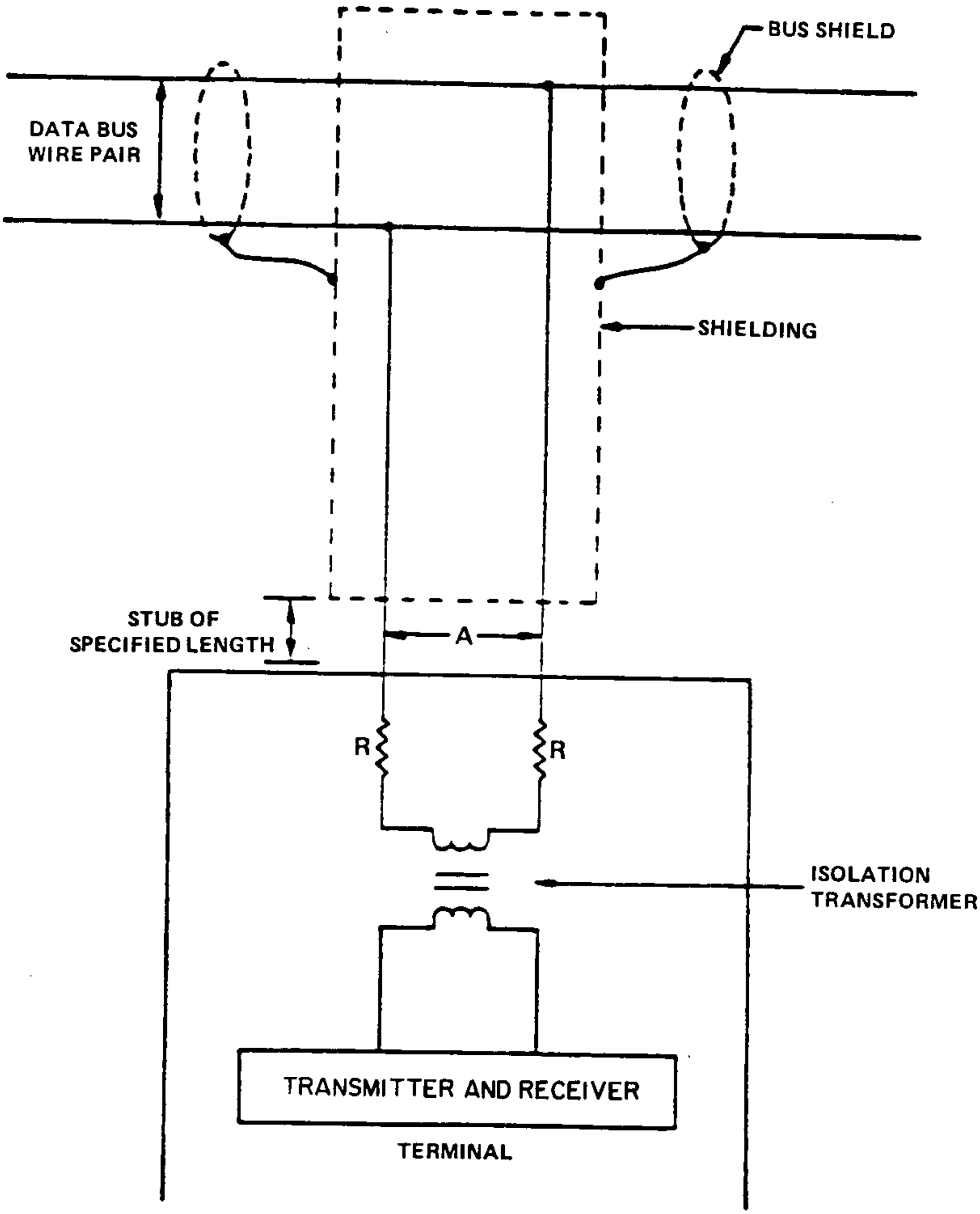


FIGURE 19. Data bus interface using direct coupling.

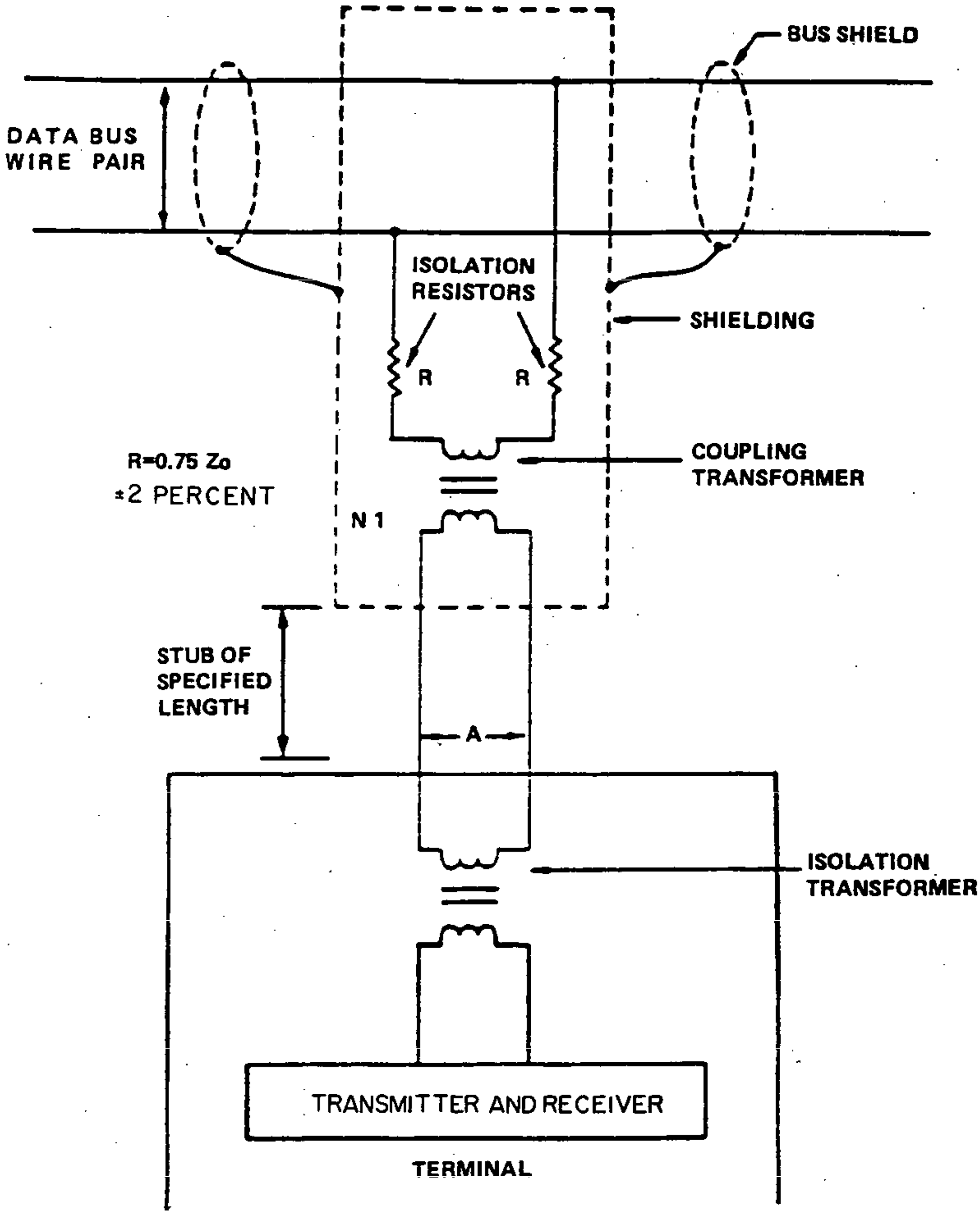


FIGURE 20. Data bus interface using transformer coupling.

3.2.3.4.3 Other bus control and data features. In addition to the control and monitor capabilities specified in 3.2.3.4.2.2 through 3.2.3.4.2.6, the states and functions specified in 3.2.3.4.3.1 through 3.2.3.4.3.4.3 shall be bus-controllable in parallel with manual controls. These additional controls and data points are necessary to fully implement the single-point-control concept on which the CMCS is based.

3.2.3.4.3.1 EMCON. The EMCON function is intended to be exercised primarily by the MUTE System.

3.2.3.4.3.2 Battle short. This override function shall also be parallel accessed to the bus.

3.2.3.4.3.3 Operational self-test. The RG shall be capable of providing internally generated test signals which are controllable, via the bus, on demand of the single-point-control operator. The RG shall further provide selected equipment performance parameters (see 3.2.3.4.2.2) on the bus in conjunction with these test signals, thus enabling the operator to make an operational assessment of the equipment.

3.2.3.4.3.4 Equipment status information. The equipment states specified in 3.2.3.4.3.4.1 through 3.2.4.3.4.3.4.3 shall be included in MIL-STD-1553 data word fomats for reporting via the bus.

3.2.3.4.3.4.1 Local and remote status. This data point shall indicate the discrete position of a control switch which shall be provided on the front panel of each item of bus-controlled equipment within the RG. The switch shall allow a changeover to be performed at the equipment front panel from bus control to manual control and vice versa. The position of this switch shall not affect the equipment status data via the bus.

3.2.3.4.3.4.2 Duplex and simplex mode. Duplex and simplex mode shall be reported via the bus and shall be used to automatically invoke protective procedures within the RG for receivers used as part of simplex configured circuits with transmitters.

3.2.3.4.3.4.3 Equipment alternating current (AC) power on and off. Equipment AC power on and off shall be reported via the bus and used to indicate the presence or absence of primary power to the individual bus-controlled equipment.

3.2.4 Frequency standard distribution interface. The RG shall contain an interface capable of accepting an external frequency standard reference signal of 4 VAC to 5 VAC. The RG shall provide for the distribution of this external signal to all equipments requiring this reference signal. Available reference frequencies are 0.1 MHz, 1 MHz, and 5 MHz.

3.2.5 Quality monitoring, diagnostic, and test measurement equipment. Quality monitoring, diagnostic, and test measurement equipment shall be as specified in 3.2.5.1 through 3.2.5.3.

3.2.5.1 Quality monitoring and test provisions. The RG shall contain the monitor and test classes specified in 3.2.5.1.1 through 3.2.5.1.5.2.

3.2.5.1.1 Class A. Means shall be provided to verify the proper on-line operation of all RG equipment. This shall be accomplished through the use of BIT and BITE, external test equipment, or any combination of the three. It shall be possible to detect at least 98 percent of equipment failures using these capabilities.

3.2.5.1.1.1 Display. Class A monitor and test parameters shall be reportable via the equipment control bus or displayed on control panels contained within the RG or CMCS equipment.

3.2.5.1.2 Class B. Means shall be provided to isolate failed equipment within the RG to the assembly level. This shall be an on-line capability which utilizes BIT, BITE, and external test equipment in any configuration and shall enable isolating 94 percent of detected equipment failures to the assembly level.

3.2.5.1.2.1 Display. Class B monitor and test parameters shall be reportable via the bus. Indicators shall be located on RG or CMCS control panels, or both, as well as on the assembly front panels.

3.2.5.1.3 Class C. Means shall be provided to fault-isolate detected equipment failures to the subassembly level. This shall be an on-line or off-line capability, or both, which utilizes BIT, BITE, and external test equipment in any combination. Fault isolation capability shall isolate to a single subassembly 90 percent of detected failures and the remaining 10 percent of detected failures to a group of three or less subassemblies.

3.2.5.1.3.1 Display. Class C monitor and test parameters may be reportable via the bus and shall be displayed by indicators on the subassembly, assembly front panel, or equipment control panel.

3.2.5.1.4 Protection from BIT and BITE failures. The ability of the RG to perform its intended function shall not be impaired by a malfunction in the BIT and BITE or external test equipment.

3.2.5.1.5 *BIT and BITE indications.* Parameters resulting from BIT and BITE evolutions, as applicable, shall be made available in either digital or analog form to provide GO or NO-GO indications.

3.2.5.1.5.1 Digital indications. As a minimum, the parameters specified in a through p shall be reportable via the MIL-STD-1553 bus interface:

a. Receiver RF overload
b. Receiver AGC level
c. Receiver noise level
d. Receiver ready or not ready, or both
e. Receiver frequency high or low, or both
f. Receiver invalid command
g. Transmitter invalid power
h. Transmitter frequency high or low, or both
i. Transmitter RF overload
j. Transmitter invalid command
k. Coupler ready or not ready, or both
l. Cabinet or equipment, or both, overheat (air)
m. Cabinet or equipment, or both, overheat (water) (if used)
n. Bus message fault
o. VSWR
p. RF amplifier power output

3.2.5.1.5.2 Analog indications. These indications shall be presented on an appropriate analog device and shall be visible to operating personnel or, if covered, made visible by the removal of no more than one cover. Facilities shall be provided to enable AC power status display at a remote location.

3.2.5.2 *Test point requirements.* *Test point requirements* shall be as specified in 3.2.5.2.1 through 3.2.5.2.4.

3.2.5.2.1 Signal quality and circuit performance. Test points, test jacks, or both, shall be provided to permit the injection of signals and the monitoring of signals at the input/output (I/O) terminals at the subassembly level.

3.2.5.2.2 Fault isolation. Test points, test jacks, or both, shall be provided to permit the injection and measurement of signals at the I/O terminals down to the subassembly level enabling fault isolation to the electrical function (for example, filter, mixer, integrated circuit (IC) chip, and so forth). Test points and test jacks shall provide means of performing fault isolation on the subassembly with the subassembly removed from the prime equipment.

3.2.5.2.3 Alignment. Test points, test jacks, or both, shall be provided to enable all normal alignment procedures to be performed on the equipment assemblies and subassemblies.

3.2.5.2.4 Calibration. All BIT and BITE functions shall be accessed by test points, test jacks, or both, to permit calibration of all equipment BIT and BITE. Calibration of these functions shall require no more than 2 hours.

3.2.5.3 General purpose electronic test equipment (GPETE). GPETE to be used at all levels of maintenance and test shall be selected from MIL-STD-1364.

3.2.6 EMCON. Provisions shall be made to eliminate electromagnetic radiations from all equipment provided as part of this system. Control of this capability shall be through an interface to the MUTE which operates independently of the CMCS.

3.2.7 METRO. In addition to the receive capabilities specified herein, an additional capability, when applicable, shall be provided. The APPENDIX specifies the exact number of receivers required.

3.2.7.1 METRO receive capability. Means shall be provided to permit the simultaneous reception of one or more channels in the 14.0 kHz to 29.9999 MHz range.

3.2.7.2 METRO RF input. RF inputs to the METRO receivers shall be provided by the MAIN COMM receive antenna distribution system.

3.2.7.3 METRO racking. The METRO receiver equipment shall be mounted in a separate rack assembly so as to permit the METRO receiver equipment installation in a location removed from the other receiving equipment.

3.2.7.4 METRO commonality. The METRO rack assembly shall be identical to corresponding receiver rack assemblies provided in the Communications Technical Control Room. The control and monitor bus interface apparatus shall be included in the rack assembly for commonality purposes. However, there is no requirement to interface this rack assembly with the control and monitor bus.

3.2.8 SSES. Where applicable, in addition to the receive capabilities specified herein, an additional capability shall be provided. The APPENDIX specifies the exact number of receivers required.

3.2.8.1 SSES receive capability. Means shall be provided to permit the simultaneous reception of one or more ISB channels in the 2.0 MHz to 29.9999 MHz range.

3.2.8.2 SSES RF input. RF inputs to the SSES receivers shall be provided by the MAIN COMM receive antenna distribution system.

3.2.8.3 SSES racking. The SSES receiver equipment shall be mounted in a separate rack assembly so as to permit the SSES receiver equipment installation in a location removed from the other receiving equipment.

3.2.8.4 SSES commonality. The SSES rack assembly shall be identical to corresponding receiver rack assemblies provided in the Communications Technical Control Room. The control and monitor bus interface apparatus shall be included in the rack assembly for commonality purposes. However, there is no requirement to interface this rack assembly with the control and monitor bus.

3.2.9 Additional receive antenna outputs. Two 50-ohm receive antenna outputs, one from each of the two receive antennas, shall be made available to feed the AN/TRQ-35(V) Tactical Frequency Management System (ionospheric sounding apparatus). In the event of failure of either antenna, only one input will be required. The AN/TRQ-35(V) system is not required by this specification.

3.2.10 Physical characteristics. The RG equipment (except for items such as antennas) shall be mounted in suitable cabinets or racks conforming to the requirements of RS-310-C-77. The equipment shall be located in the Radio Transceiver Room, the Communications Technical Control Room and where applicable, METRO and SSES.

3.2.10.1 Dimensions. The size of cabinets or racks used for equipment mounting shall not exceed the maximum requirements for interior shipboard installation (see 3.1.6.1.4), and are subject to the approval of the procuring activity. The equipment shall be designed so that the cable entry is from the top, and servicing from the front can be accomplished to the maximum extent possible. The space required to mount the RG for the LHD-1 configuration shall not exceed 12.96 m^2 (144 ft^2) in the Radio Transceiver Room, 4.86 m^2 (54 ft^2) in the Communications Technical Control Room, 0.45 m^2 (5 ft^2) in METRO, and 0.45 m^2 (5 ft^2) in SSES. For other ship classes having a lesser requirement as specified in the APPENDIX, space required shall be reduced accordingly, except that an additional 0.90 m^2 (10 ft^2) shall be allocated in the Communications Technical Control Room for a remote control and monitor console.

3.2.10.2 Weight. The weight of the RG (excluding cables) for the LHD-1 configuration shall not exceed 15,750 kilograms (kg) (35,000 pounds (lbs)). For other ship classes having a lesser requirement as specified in the APPENDIX, equipment weight shall be reduced accordingly, except that an additional 450 kg (1000 lbs) shall be allocated for a remote control and monitor console.

3.2.10.3 Mounting. The use of suitable shock mounts or leveling pads shall be permitted for mounting equipment cabinets or racks subject to the approval of the procuring activity.

3.2.10.4 Coatings, treatment, and painting. Painting shall be subject to approval of the procuring activity.

3.3 Environmental conditions. The RG will be mounted in cabinets and racks which shall conform to the requirements specified in 3.3.1 through 3.3.10 without degradation.

3.3.1 Temperature. The RG shall conform to the Operating temperature ranges paragraph of MIL-E-16400 as specified in a and b:

a. Topside-mounted equipments - Range 2
b. Interior-mounted equipments - Range 4

3.3.2 Humidity. Each equipment in the RG shall have full operational capability when subjected to a relative humidity (RH) of 0 percent to 95 percent (+5, -0)

3.3.3 Salt spray. Salt spray requirements are not applicable to equipment designed for interior shipboard installation.

3.3.4 Wind. Wind requirements are not applicable to equipment designed for interior shipboard installation.

3.3.5 Snow and ice loading. Snow and ice loading requirements are not applicable to equipment designed for interior shipboard installation.

3.3.6 Dust. The transmitter shall operate without performance degradations or malfunctions when exposed to dust encountered in closed structures.

3.3.7 Shock. Each equipment in the RG shall be capable of passing the shock test of MIL-S-901 for Grade A, Class I, Type A, medium weight. Shock mounts are not allowed. Tested equipment shall be energized and in operating condition during and after testing.

3.3.8 Vibration, operating. Each equipment in the RG shall be capable of withstanding the Type I Vibration test of MIL-STD-167-1. The frequency range shall be 4 Hz to 50 Hz. Tested equipment shall be energized and in operating condition during and after testing.

3.3.9 Ship trim and list. The RG shall be capable of operating satisfactorily, with no degradation of performance or loss of fluids under motion of the ship in a seaway without operation of any ship stabilization system, including permanent ship trim of 5 degrees and a permanent list of 15 degrees from the horizontal.

3.3.10 Ship motion. Ship motion will be assumed to give the loading factors specified herein. These factors include gravity components as well as inertia effects. To obtain forces, multiply the factors by the weight of the structure, stowed equipment, or material. Each rack or cabinet in the RG and the separately mounted dummy loads shall be capable of operation without degradation of required performance under a downward load factor of 2.5 and a horizontal load factor of 1.2 regardless of equipment location.

3.4 Transportability. Each rack, cabinet, and devices in the RG shall be designed for transportability by air, truck, rail, barge, or ship.

3.5 Airborne noise. The generated airborne noise shall conform to the requirements of TABLE VIII in accordance with MIL-STD-740 for equipments located in communication spaces.

TABLE VIII. Acceptable octave band sound pressure levels for equipment.

dB re: 0.0002 microbar									
	Octave band center frequency (Hz)								
Noise category	31.5	63	125	250	500	1000	2000	4000	8000
A-3	75	72	69	66	63	60	57	54	51

Notes:

1. 0.0002 microbar = 20 micropascal = 0.0002 dyne/cm^2
2. Noise testing in accordance with the Sound pressure level measurements paragraph of MIL-STD-740

3.6 Design and construction. Design shall be in accordance with the design standards specified in MIL-E-16400. Design and construction shall include the requirements of 3.6.1 through 3.6.2.

3.6.1 Individual selection. As specified in MIL-E-16400, the performance of equipment shall not be dependent on the selection of individual electron tubes or other parts. This limitation applies to selection based on an unspecified parameter and to selection from a series of specified values during assembly. In the latter case, where a parameter cannot be determined prior to partial completion of an assembly, a variable element shall be used.

3.6.1.1 Electrical process. Design of items interfacing with ship's electrical subsystem shall be in accordance with the Electrical design and construction paragraph of MIL-E-16400 for primary power, power equipment and circuits, equipment wiring, rotating parts, and stray magnetic fields.

3.6.1.1.1 ICs. The application of ICs shall be guided by the requirements of NAVSHIPS 0900-004-4000.

3.6.1.2 Magnetic characteristics. New development items shall be designed to have a minimum magnetic signature in accordance with the Magnetic materials paragraph of MIL-E-16400.

3.6.1.3 Protective devices. Circuit breakers shall be used in preference to fuses as circuit protection devices for all electronic equipment. The protective devices shall be clearly visible and accessible from the front of the equipment, rack, or cabinet in its installed configuration. A positive visual indication shall be provided to show the tripped or blown state of the protective device.

3.6.1.4 Mechanical process. Designs shall be in accordance with the mechanical design requirements of MIL-E-16400 to the greatest extent possible.

3.6.1.4.1 Enclosures. Enclosures shall be designed to conform to the requirements of MIL-STD-108. The degree of enclosure shall be dripproof, 15 degrees as specified in MIL-STD-108.

3.6.1.5 Thermal design and process. Thermal design shall be in accordance with the Thermal design paragraph of MIL-E-16400.

3.6.2 Interchangeability. Equipments, assemblies, components, and parts of the same configuration shall be interchangeable or replaceable, both functionally and mechanically, in accordance with Requirement 7 of MIL-STD-454.

3.7 Electromagnetic interference (EMI). EMI shall be as specified in 3.7.1 through 3.7.3.

3.7.1 EMI requirements. The VLF-HF RG shall conform to the requirements of MIL-STD-461 for Class A4 equipment. The Emission and susceptibility requirements for class A4 equipments and subsystems Table of MIL-STD-461 shall be used to determine the specific requirements. Applicable portions of MIL-HDBK-235 may be used to determine the anticipated environment for the RS03 test levels. MIL-HDBK-241 may be used for power supply design guidance.

3.7.2 Bonding and grounding. The bonding and grounding requirements for the RG shall be in accordance with MIL-STD-1310.

3.7.3 Electromagnetic pulse (EMP). The VLF-HF EXCOMM System shall be hardened or shall be intrinsically hard against the EMP resulting from an exoatmospheric nuclear burst to survive the levels specified in a and b:

a. Equipment operated external to an intentionally hardened area shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications beyond the tolerances and recovery times indicated in the individual equipment or subsystem specifications after being subjected to an EMP with a field strength of 50 kilovolts per meter (kV/m).

b. All equipment and subsystem interface pins and terminals of leads, including grounds and neutrals also, shall not exhibit any permanent malfunction, degradation of performance, or deviation from specified indications beyond the tolerances and recovery times indicated in the individual equipment or subsystem specification after being subjected to a common mode current level or a common mode voltage level induced by an EMP equivalent to 50 kV/m at all test frequencies.

3.8 Human performance and human engineering. Human performance and human engineering shall be as specified in 3.8.1 and 3.8.2.

3.8.1 Human performance. The integration design and the design of new development items and the design of modifications to Navy inventory items shall include consideration of the performance requirements of the personnel who must operate and maintain the equipment. Man/machine interface shall incorporate procedures reflecting consideration of both the applicable human engineering requirements specified in MIL-STD-1472 and results of the applicable human engineering requirements specified in MIL-STD-1472 and results of the applicable analyses specified in MIL-H-46855.

3.8.2 Human engineering. The design of the RG shall include consideration of both the applicable human engineering requirements specified in MIL-STD-472 and the results of the applicable analyses specified in MIL-H-46855.

3.9 RG functional element characteristics. Functional elements configured in cabinets or racks shall be provided to conform to the functional allocations specified in 3.1.3.2. Each cabinet or rack shall be designed to permit conformance to the performance characteristics specified in 3.2.1.1 through 3.2.9.

3.10 Support maintenance test procedure verification. When specified in the contract or purchase order (see 6.2.1), the RG system shall be subjected to a support maintenance test procedure verification as specified in 4.8.

3.10.1 Support maintenance. The support maintenance test procedure verification shall be performed by a technician selected by the Government from contractor or Government personnel.

3.10.2 Test equipment. Test equipment used to verify the support maintenance test procedures shall be selected from MIL-STD-1364. Test equipment not specified in MIL-STD-1364 may be used in the support maintenance test procedure verification only if the contractor submits a written request to the procuring activity and approval is granted.

3.10.3 Verification. The support maintenance test procedure verification shall be performed on a first article sample.

3.11 Identification and marking. Each equipment, or unit of equipment shall have an identification plate affixed in a conspicuous location. The identification plate shall contain, as a minimum, the information specified in a through i:

a. Nomenclature: Approved item name shall be developed in accordance with MIL-E-21981
b. Configuration element identifier
c. Registration number
d. Serial number
e. Procurement identification number
f. Special characteristics
g. Specification data
h. National stock number
i. U.S. Navy property

Identification plate format, material, lettering, application, and required information shall conform to MIL-P-15024. Abbreviations shall conform to MIL-STD-12.

3.11.1 Electrical designation and marking. Power, electronic, and other electrical equipment shall be identified as specified herein so that their functions in the ship may be readily determined. Information plates, label plates, and tags shall be installed on the racks and cabinets or equipment they serve, or, if this is not practicable, on adjacent structure. These plates shall be installed in readily visible locations.

3.11.2 Component reference designations. Identification and marking of elements (wiring, resistors, and so forth) shall be in accordance with the requirements of IEE 200-75.

3.11.3 Information plates. Information and label plates shall comply with MIL-P-15024. Abbreviations shall conform to Requirement 67 of MIL-STD-454.

3.12 Safety. The safety requirements for the RG shall be as specified in 3.12.1 through 3.12.4.

3.12.1 General. The RG design shall conform to the Safety criteria paragraph of MIL-E-16400. The design shall incorporate methods to protect operating and service personnel from accidental contact with electrical potentials in excess of 30 volts rms or direct current (DC). The design shall not have mechanical features which may reasonably be expected to cause injury during normal operation or because of malfunctioning of equipment.

3.12.2 Insulation of controls. All control shafts and bushings thereof shall be grounded wherever practicable or, alternatively, the control knobs or levers shall be insulated from the shaft to prevent electrical shock.

3.12.3 Temperature. Where people are involved and under any condition of operation, exposed parts, including the enclosure of the equipment, shall not achieve a temperature in excess of 60°C (140°F) at an ambient temperature of 25°C (77°F). The temperature of front panels and operating controls shall not exceed 43°C (109.4°F) at the same ambient temperature.

3.12.4 Connectors. RF connectors shall be nonferromagnetic and shall not allow RF leakage in excess of 10 microwatts per square centimeter when carrying rated RF powers.

3.13 Reliability. Reliability shall be as specified in 3.13.1 through 3.13.3.4.

3.13.1 Mean-time-between-failures (MTBF). The RG system MTBF shall be greater than 200 hours for the LHD-1 configuration. Major units (receivers, exciters, amplifiers, couplers, and combiners) shall have a MTBF greater than 2500 hours.

3.13.2 MTBF determination for new development equipments. The MTBF shall be initially determined by prediction. Initial MTBF determination shall be updated as field performance test data or laboratory test data become available. All MTBFs shall be determined for the environmental conditions specified for newly developed equipment.

3.13.3 Equipment reliability design. Equipment reliability design shall be as specified in 3.13.3.1 through 3.13.3.4.

3.13.3.1 Adverse interactions. Interactions between units which adversely affect reliability shall be eliminated. For all equipment, maximum use of isolation techniques shall be employed so that failures in one unit do not cause a cascade of secondary failures in that unit or other units.

3.13.3.2 Derating. Conservative derating practices shall be employed throughout the equipment designs. Temperature, power, and voltage stress levels and ratios, as applicable, shall be explicitly included in all MTBF estimates. Derating shall be in general accordance with Requirement 18 of MIL-STD-454.

3.13.3.3 Tolerance sensitivity. New equipment racks shall minimize failures due to parameter change (including drift) as a function of manufacturing tolerances, environmental factors, and age. The items specified in a through i shall be explicitly taken into account.

a. Normal manufacturing tolerances including soldering, wiring, etching placement, and machinery tolerances
b. Normal variations in material quality
c. Variations in applied voltage
d. Variations in power dissipation
e. Range of ambient temperatures and the rate of change
f. Vibration levels
g. Humidity
h. Operational aging
i. Nonoperational aging (storage life), shipping, and handling effects

3.13.3.4 Thermal design. Effective thermal design techniques shall be used to minimize hot spots and effectively transfer heat. When specified in the contract or purchase order (see 6.2.1) the contractor shall conduct a complete thermal survey of the RG prior to offering it for Government testing to determine the existence of hot spots which may prove to be injurious to the useful life of the RG.

3.14 Maintainability. Maintainability shall be as specified in 3.14.1 through 3.14.2.

3.14.1 Maintainability requirements. The RG equipment shall have a mean-time-to-repair (MTTR) not to exceed 0.5 hour and a maximum-time-to-repair (M_{maxct}) not to exceed 1.2 hours at the 95th percentile of a log normal distribution when repair is accomplished at the organizational level of maintenance by replacement of the lowest replaceable unit (LRU) and chassis-mounted parts (including electronic, electrical, electromechanical and mechanical parts). The MTTR includes localization, isolation, disassembly, interchange of assembly, alignment, and checkout.

3.14.1.1 Preventive maintenance. Preventive maintenance shall be minimized. The removal for servicing or replacement of filters, moisture indicators, and so forth, shall be accomplished without the removal of adjacent components except access panels. Rapid access shall be provided.

3.14.1.2 On-equipment maintenance design. Certain automatic monitoring and performance measurement facilities of the CMCS may be used as aids in isolating faults to equipment groupings. Failures within each equipment shall be detected and displayed locally using the on-line BITE or the equipment's normal local and remote indications, or both.

3.14.1.3 Subassembly repair design. The equipment design shall allow for repair of drawers in the cabinet or rack. It shall be possible for the maintenance technician to probe the equipment so that fault isolation and replacement to the plug-in module level is accomplished. The technician shall rely on his training, technical manuals, and common support equipment for this repair. Subassemblies that cannot be repaired due to lack of skills, time, or test equipment shall be returned to a shore facility.

3.14.1.4 Throw-away subassemblies. Subassemblies that are designed for discard at failure (throw-away) shall have prior approval by the procuring activity.

3.14.1.5 Repairable assemblies. Assemblies authorized for repair shall be designed for ease of maintenance. Test points and reference designations shall provide the capability for rapid isolation to the detailed part. Encapsulation potting shall not preclude repair. Conformal coatings shall be of a type easily removed and replaced. It shall not be necessary to select or match parts used for repair.

3.14.1.6 Maintenance personnel skill levels. The RG shall be designed to minimize skill levels required for maintenance personnel.

3.14.1.7 Human factors in maintainability design. The man/machine interface shall employ features which are human engineered to assist maintenance personnel in the performance of diagnostic tests. Equipment controls, indicators, displays, and so forth shall be located and integration design implementation shall be such as to minimize the number of personnel required to perform maintenance tasks and to minimize false conclusions during performance analysis.

3.14.1.8 Maintenance personnel safety. The equipment and rack integration arrangements shall be designed in accordance with MIL-E-16400 to eliminate, to the maximum extent possible, the need for maintenance personnel to work in close proximity to hazardous conditions (high voltage, radiation, moving parts, high temperature components, and so forth). Interlocks, shields, warning indicators, and so forth shall be utilized for personnel safety.

3.14.1.9 Keying. Module connectors in the equipment shall be keyed to prevent their improper insertion or insertion into an improper location.

3.14.1.10 Adjustment and alignment. The RG items or modifications to off-the-shelf designs may require mechanical or electrical adjustment or alignment of equipment upon installation in the rack or cabinet assemblies during maintenance and repair.

3.14.1.11 Elapsed time meters. Elapsed time (or cycle) meters shall be provided on standard items (modified), and on other equipment in accordance with MIL-E-16400. The meters shall be directly visible from the front of the equipment in its installed configuration.

3.14.1.12 Service and access. Service and access shall be as specified in 3.14.1.12.1 and 3.14.1.12.2.

3.14.1.12.1 Accessibility. Modules in the equipments in rack or cabinet assemblies shall be arranged so that access to any module or equipment will not require moving any other modules or parts except access panels.

3.14.1.12.2 Access panels. Access panels shall be retained by quick disconnect fasteners to provide rapid access to equipments.

3.14.1.13 Special test equipment. All requirements for special test equipment for organizational, intermediate, or depot levels of maintenance shall be subject to approval by the procuring activity.

3.14.1.14 Construction. Equipment shall be constructed of plug-in assemblies to the maximum extent possible. Eighty percent of all failures shall be located in plug-in assemblies. The ratio of plug-in assemblies to the total shall be not less than 90 percent.

3.14.2 Repair time. The equipments as installed in racks shall be designed to conform to a MTTR of 0.5 hour. The M_{maxct} shall not exceed 1.2 hours at the 95th percentile of a log normal distribution.

3.15 Probability of being available and reliable (PAR). The RG shall be designed for an inherent minimum PAR of 0.997.

3.16 Workmanship. Workmanship shall be as specified in 3.16.1 and 3.16.2.

3.16.1 General workmanship. Minimum acceptable standards of workmanship and soldering shall be in accordance with Requirement 9 and Requirement 5 of MIL-STD-454, respectively.

3.16.2 Workmanship screen. All equipment shall withstand a defect detection vibration screen (see 4.9.2.1) of random type vibration at 0.04 g^2/Hz ±3 dB from 80 Hz to 350 Hz, and temperature cycling as specified in 4.9.2.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Government verification. All quality assurance operations performed by the contractor will be subject to Government verification at any time. Verification will consist of, but is not limited to, a) surveillance of the operations to determine that practices, methods, and procedures of the written quality program are being properly applied, b) Government product inspection to measure quality of the product to be offered for acceptance, c) Government inspection of delivered products to assure compliance with all inspection requirements of this specification. Failure of the contractor to promptly correct deficiencies discovered by him or of which he is notified shall be cause for suspension of acceptance until corrective action has been taken or until conformance of the product to prescribed criteria has been demonstrated.

4.1.2 Quality assurance terms and definitions. Quality assurance terms used in this specification shall be as defined in MIL-STD-109.

4.2 Classification of inspections. The inspection requirements specified herein are classified as specified in a through c:

a. First article inspection (see 4.3)
b. Quality conformance inspection:
    1. In-process inspection (see 4.4.1)
    2. Production inspection (see 4.4.2)
    3. Periodic inspection (see 4.4.3)
c. Inspection of preparation for delivery (see 4.10)

4.3 First article inspection. Unless otherwise specified (see 6.2.1), one RG shall be required for first article inspection. First article inspection shall consist of all examination and testing necessary to determine compliance with the requirements of this specification. First article inspection shall include the tests specified in TABLE IX. Testing shall be conducted with the RG configured for operation.

4.4 Quality conformance inspection. Quality conformance inspection shall be as specified in 4.4.1 through 4.4.3.3.

4.4.1 In-process inspection. Each RG shall be subjected to the in-process inspection specified in TABLE IX.

4.4.2 Production inspection. Production inspection shall be as specified in TABLE IX. Production inspection shall be performed on a sampling basis in accordance with the inspection procedures of MIL-STD-105, using the special inspection level S-3 for normal, tightened, and reduced inspection. Production inspection shall be performed on RGs that have completed the in-process inspections (see 4.4.1). Lots shall be physically accumulated and identified prior to random selection of the sample. The Government shall make the random sample selection. Sample RGs shall satisfactorily conform to the production inspection requirements prior to releasing the lot for shipment. The acceptable quality level (AQL) shall be 6.5 percent for each attribute.

4.4.2.1 Rejected lots. If rejected, the rejected lot may be reworked to correct the defective RGs and reinspected. As a minimum, the rework shall consist of inspecting each RG in the rejected lot for the failed attribute prior to reinspection using tightened inspection. Rejected lots shall be kept separate from new lots and shall not lose their identity.

TABLE IX. Examinations and tests.

Examination or test	Requirement paragraph	Test paragraph	First article inspection	Quality conformance inspection		
				In-process inspection	Production inspection	Periodic inspection
General	3.1	4.5.3	X			
Mission capabilities	3.1.2.1	4.5.3	X			
FFDs	3.1.3.1	4.5.3				
Functional allocations	3.1.3.2	4.5.4	X		X	
External interfaces	3.1.4.1	4.5.4	X			
Transmit RF interface	3.1.4.2.1.1	4.5.4	X		X	X
Transmit audio interface	3.1.4.2.1.2	4.5.4	X		X	X
Keyline interface	3.1.4.2.1.3	4.5.4	X		X	X
Receive RF interface	3.1.4.2.2.1	4.5.12	X			
Receive audio interface	3.1.4.2.2.2	4.5.12	X			
CMCS interface	3.1.4.2.3	4.5.4	X			
Power interface	3.1.4.2.4.1	4.5.4	X		X	X
Cooling water interface	3.1.4.2.4.2	4.5.4	X			X
Cooling air interface	3.1.4.2.4.3	4.5.4	X			X
Physical interface	3.1.4.2.4.4	4.5.2	X		X	X
RF interfaces	3.1.4.3.1	4.5.12	X	X	X	X
Control signal interface	3.1.4.3.2	4.5.3	X		X	X
Operational interface	3.1.4.3.3	4.5.3	X			X
Physical	3.1.4.3.4	4.5.12	X			X
RF cabling	3.1.4.3.5	4.5.5	X		X	X
Cooling	3.1.4.3.6	4.5.1	X			X
Operational and organizational concepts	3.1.5	4.5.3	X			
System operation	3.1.5.1	4.5.3	X			
Transmit subsystem	3.1.5.2	4.5.3	X	X	X	X
Receive subsystem	3.1.5.3	4.5.3	X	X	X	X
Major element list	3.1.6	4.5.12				
RG equipment configuration	3.1.6.1	4.5.12				
Receiving antennas	3.1.6.1.1	4.5.3	X			X
Redundant systems	3.1.6.1.2	4.5.3	X			X
Future growth	3.1.6.1.3	4.5.3	X		X	X
Equipment cabinets or racks	3.1.6.1.4	4.5.2	X		X	X
System performance characteristics	3.2.1.1	4.5.3	X	X	X	X
RG capabilities	3.2.1.2	4.5.3	X			
RG commonality and interchangeability	3.2.1.3	4.5.13	X			
RG operation	3.2.1.4	4.5.13	X		X	X
Broadband transmitter-to-transmitter frequency spacing	3.2.1.4.1	4.5.13	X			
Transmitter-to-receiver freqency spacing	3.2.1.4.3	4.5.4	X			
Receiver-to-receiver frequency spacing	3.2.1.4.4	4.5.13	X			
Maximum time delay	3.2.1.4.5	4.5.4	X			
General characteristics	3.2.2.1	4.5.4	X			X
RF emissions	3.2.2.1.1	4.5.3	X		X	X
Sideband operation	3.2.2.1.2	4.5.3	X		X	X
Frequency stability	3.2.2.1.3	4.5.4	X		X	X
Frequency pull-in time	3.2.2.1.4	4.5.4	X		X	X
Frequency selection	3.2.2.1.5	4.5.3	X		X	X
Phase stability	3.2.2.1.6	4.5.4	X		X	X
Modulation input	3.2.2.1.7	4.5.4	X		X	X
Frequency response of RF output	3.2.2.1.8	4.5.4	X		X	X
Carrier suppression	3.2.2.1.9	4.5.4	X		X	X
Operational modes	3.2.2.1.10	4.5.3	X		X	X

TABLE IX. Examinations and tests. (continued)

Examination or test	Requirement paragraph	Test paragraph	First article inspection	Quality conformance inspection		
				In-process inspection	Production inspection	Periodic inspec-tion
Hum and noise AM	3.2.2.1.11	4.5.13	X		X	X
Warm-up time	3.2.2.1.12	4.5.11	X		X	X
Keying time	3.2.2.1.13	4.5.13	X		X	X
Cut-off time	3.2.2.1.14	4.5.13	X		X	X
Power levels	3.2.2.1.15	4.5.13	X		X	X
Power variations	3.2.2.1.16	4.5.13	X		X	X
Exciter characteristics	3.2.2.1.17	4.5.12	X		X	X
Exciter spurious outputs	3.2.2.1.18	4.5.13	X		X	X
Primary power	3.2.2.1.19	4.5.4	X		X	X
Memory devices	3.2.2.1.20	4.5.3	X		X	X
Narrowband transmit capability	3.2.2.2	4.5.3				
Commonality	3.2.2.2.1	4.5.3	X			X
Power output	3.2.2.2.2	4.5.13	X		X	X
Amplifier load impedance	3.2.2.2.3	4.5.13	X		X	X
Output load variations	3.2.2.2.4	4.5.13	X		X	X
Narrowband transmitter IM products	3.2.2.2.5	4.5.4	X		X	X
Narrowband transmitter Harmonics	3.2.2.2.6	4.5.4	X		X	X
Forward power indicator	3.2.2.2.7	4.5.4	X			X
VSWR indication	3.2.2.2.8	4.5.4	X			X
Hum sidebands	3.2.2.2.9	4.5.4	X			X
Undesired output	3.2.2.2.10	4.5.4	X			X
Noise and spurious outputs	3.2.2.2.11	4.5.4	X			X
Broadband noise	3.2.2.2.13	4.5.4	X			X
Operating modes	3.2.2.2.14	4.5.3	X			X
Broadband transmit capability	3.2.2.1	4.5.3	X			X
Power output	3.2.2.3.1	4.5.3	X			X
Amplifier outputs	3.2.2.3.2	4.5.3	X			
Output load variations	3.2.2.3.3	4.5.3	X			X
Two-tone performance	3.2.2.3.4.1	4.5.13	X		X	X
Eight-tone performance	3.2.2.3.4.2	4.5.13	X		X	X
High level	3.2.2.3.5.1	4.5.13	X		X	X
Low level	3.2.2.3.5.2	4.5.13	X		X	X
Forward power indicator	3.2.2.3.6	4.5.4	X			X
VSWR indication	3.2.2.3.7	4.5.4	X			X
Hum sidebands	3.2.2.3.8	4.5.4	X			X
Undesired output	3.2.2.3.9	4.5.4	X		X	X
Noise and spurious outputs	3.2.2.3.10	4.5.4	X			X
BLAG broadband noise	3.2.2.3.11	4.5.13	X			X
Operating modes	3.2.2.3.12	4.5.3	X			
LINK-11 operation	3.2.2.3.13	4.5.3	X			
General characteristics	3.2.3.1	4.5.4	X			X
Receive subsystem design	3.2.3.1.1	4.5.13	X			X
Radar suppression	3.2.3.1.2	4.5.9	X			X
LINK-11 compatibility	3.2.3.1.3	4.5.4	X			X
Active receive antenna	3.2.3.2	4.5.4	X			X
RF coupling capacitor	3.2.3.2	4.5.6	X			X
Sensitivity	3.2.3.2.1	4.5.4	X			X
Noise figure	3.2.3.2.2	4.5.4	X			X
Receive antenna redundancy and distribution	3.2.3.2.3	4.5.3	X			X
Distribution gain	3.2.3.2.3.1	4.5.13	X			X
Distribution system redundancy	3.2.3.2.3.2	4.5.3	X			X

TABLE IX. Examinations and tests. (continued)

Examination or test	Requirement paragraph	Test paragraph	First article inspection	Quality conformance inspection		
				In-process inspection	Production inspection	Periodic inspection
Isolation	3.2.3.2.3.3	4.5.4	X			X
Maximum RF signal amplitude	3.2.3.2.3.4	4.5.4	X			X
Desensitization	3.2.3.2.3.5	4.5.4	X			X
Active antenna IM performance	3.2.3.2.3.6	4.5.4	X			X
Active antenna desensitization	3.2.3.2.3.7	4.5.4	X			X
Frequency range	3.2.3.3.1	4.5.3	X			X
Reception modes	3.2.3.3.2	4.5.3	X			X
Information capability	3.2.3.3.3	4.5.3	X			X
Frequency pull-in time	3.2.3.3.4.2	4.5.4	X			X
Frequency stability	3.2.3.3.4.3	4.5.4	X			X
Phase stability	3.2.3.3.4.4	4.5.4	X			X
Receive subsystem maximum RF signal amplitude	3.2.3.3.5	4.5.4	X			X
Receive subsystem noise level	3.2.3.3.6	4.5.4	X			X
Receive subsystem IM products	3.2.3.3.7	4.5.4	X			X
Receive subsystem desensitization	3.2.3.3.8	4.5.4	X			X
Spurious responses	3.2.3.3.9	4.5.4	X			X
Frequency response	3.2.3.3.10	4.5.4	X			X
Differential time delay	3.2.3.3.11	4.5.4	X			X
Audio characteristics	3.2.3.3.12	4.5.4	X			X
Spurious radiations	3.2.3.3.13	4.5.4	X		X	X
Subsystem sensitivity	3.2.3.3.14	4.5.4	X		X	X
AGC time constants	3.2.3.3.15	4.5.4	X			X
AGC range	3.2.3.3.16	4.5.4	X			X
Muting	3.2.3.3.17	4.5.4	X			X
IF rejection	3.2.3.3.18	4.5.4	X			X
Frequency selection	3.2.3.3.19	4.5.3	X		X	X
Start-up time	3.2.3.3.20	4.5.11	X		X	X
CMCS bus characteristics	3.2.3.4	4.5.3	X		X	X
Equipment	3.2.3.4.1	4.5.3	X			X
Control and monitor capabilities	3.2.3.4.2	4.5.3	X			X
Fault detection and reporting	3.2.3.4.2.1	4.5.3	X			X
Equipment status reporting	3.2.3.4.2.2	4.5.3				
Frequency selection	3.2.3.4.2.3	4.5.3	X			X
Power level selection	3.2.3.4.2.4	4.5.13	X			X
Mode selection	3.2.3.4.2.5	4.5.3	X		X	X
Calibration	3.2.5.2.4	4.5.3	X	X	X	X
GPETE	3.2.5.3	4.5.12				
EMCON	3.2.6	4.5.9	X			X
METRO	3.2.7	4.5.12	X			X
METRO receive capability	3.2.7.1	4.5.3	X		X	X
METRO RF input	3.2.7.2	4.5.12	X		X	X
METRO racking	3.2.7.3	4.5.12	X			X
METRO commonality	3.2.7.4	4.5.12	X			X
SSES	3.2.8	4.5.12	X			X
SSES receive capability	3.2.8.1	4.5.3	X			X
SSES RF input	3.2.8.2	4.5.12	X			X
SSES racking	3.2.8.3	4.5.12	X			X
SSES commonality	3.2.8.4	4.5.12	X			X

TABLE IX. Examinations and tests. (continued)

Examination or test	Requirement paragraph	Test paragraph	First article inspection	Quality conformance inspection		
				In-process inspection	Production inspection	Periodic inspection
Additional receive antenna outputs	3.2.9	4.5.12	X			X
Physical characteristics	3.2.10	4.5.12	X			X
Dimensions	3.2.10.1	4.5.12	X			X
Weight	3.2.10.2	4.5.4	X			X
Mounting	3.2.10.3	4.5.12	X			X
Coatings, treatment, and painting	3.2.10.4	4.5.12	X	X	X	X
Reliability	3.13	4.6				
MTBF	3.13.1	4.5.2.2	X			
MTBF determination for new development equipments	3.13.2	4.5.2.2	X			
Adverse interactions	3.13.3.1	4.7	X			
Derating	3.13.3.2	4.6	X			
Tolerance sensitivity	3.13.3.3	4.6	X			
Thermal design	3.13.3.4	4.5.11	X			
Maintainability	3.14	4.7				
Maintainability requirements	3.14.1	4.7	X			
Preventive maintenance	3.14.1.1	4.7	X			
On-equipment maintenance design	3.14.1.2	4.7	X			
Subassembly repair design	3.14.1.3	4.7	X			
Throw-away subassemblies	3.14.1.4	4.5.12	X			
Key state selection	3.2.3.4.2.6	4.5.3	X		X	X
Cable	3.2.3.4.2.7.1	4.5.13	X	X	X	X
Characteristics impedance	3.2.3.4.2.7.2	4.5.13	X	X	X	X
Bus attenuation	3.2.3.4.2.7.3	4.5.13	X	X	X	X
Bus termination	3.2.3.4.2.7.4	4.5.12	X	X	X	X
Direct (stub) coupling	3.2.3.4.2.7.5.1	4.5.12	X	X	X	X
Transformer coupling	3.2.3.4.2.7.5.2	4.5.12	X	X	X	X
EMCON	3.2.3.4.3.1	4.5.3				X
Battle short	3.2.3.4.3.2	4.5.3	X			X
Operational self-test	3.2.3.4.3.3	4.5.3	X			X
Local and remote status	3.2.3.4.3.4.1	4.5.3	X		X	X
Duplex and simplex mode	3.2.3.4.3.4.2	4.5.3	X		X	X
Equipment AC power on and off	3.2.3.4.3.4.3	4.5.3	X		X	X
Frequency standard distribution interface	3.2.4	4.5.3	X		X	X
Class A	3.2.5.1.1	4.5.3	X			X
Display	3.2.5.1.1.1	4.5.3	X			X
Class B	3.2.5.1.2	4.5.3	X			X
Display	3.2.5.1.2.1	4.5.3	X		X	X
Class C	3.2.5.1.3	4.5.3	X			X
Display	3.2.5.1.3.1	4.5.3	X		X	X
Protection from BIT and BITE failures	3.2.5.1.4	4.5.3	X		X	X
BIT and BITE indications	3.2.5.1.5	4.5.3	X			X
Digital indications	3.2.5.1.5.1	4.5.3	X			X
Analog indications	3.2.5.1.5.2	4.5.3	X			X
Signal quality and circuit performance	3.2.5.2.1	4.5.3	X		X	X
Fault isolation	3.2.5.2.2	4.5.3	X	X	X	X
Alignment	3.2.5.2.3	4.5.3	X		X	X
Repairable assemblies	3.14.1.5	4.7	X			
Maintenance personnel skill levels	3.14.1.6	4.8	X			

TABLE IX. Examinations and tests. (continued)

Examination or test	Requirement paragraph	Test paragraph	First article inspection	Quality conformance inspection		
				In-process inspection	Production inspection	Periodic inspection
Human factors in maintainability design	3.14.1.7	4.8	X			
Maintenance personnel safety	3.14.1.8	4.8	X			X
Keying	3.14.1.9	4.8	X			X
Adjustment and alignment	3.14.1.10	4.8	X		X	X
Elapsed time meters	3.14.1.11	4.5.1	X			X
Accessibility	3.14.1.12.1	4.8	X	X	X	X
Access panels	3.14.1.12.2	4.8	X	X	X	X
Special test equipment	3.14.1.13	4.5.12	X			X
Construction	3.14.1.14	4.5.12	X	X	X	X
Repair time	3.14.2	4.8	X			X
PAR	3.15	4.5.2.4	X			X
Environmental conditions	3.3	4.5.4.3	X			X
Temperature	3.3.1	4.5.11	X			X
Humidity	3.3.2	4.5.13	X			X
Salt spray	3.3.3	4.5.1				
Wind	3.3.4	4.5.1				
Snow and ice loading	3.3.5	4.5.1				
Dust	3.3.6	4.5.7				
Shock	3.3.7	4.5.8	X			X
Vibration, operating	3.3.8	4.9.2.1	X			X
Ship trim and list	3.3.9	4.5.13	X			X
Ship motion	3.3.10	4.5.13	X			X
Transportability	3.4	4.10	X			
Airborne noise	3.5	4.5.4	X			
Design and construction	3.6	4.5.1	X			X
Individual selection	3.6.1	4.5.1	X			
Electrical process	3.6.1.1	4.5.1	X			X
ICS	3.6.1.1.1	4.5.12	X			X
Magnetic characteristics	3.6.1.2	4.5.1	X			X
Protective devices	3.6.1.3	4.5.12	X	X	X	X
Mechanical process	3.6.1.4	4.5.1	X		X	X
Enclosures	3.6.1.4.1	4.5.12	X		X	X
Thermal design and process	3.6.1.5	4.5.1	X		X	X
EMI	3.7	4.5.9				X
EMI requirements	3.7.1	4.5.9	X	X	X	X
Bonding and grounding	3.7.2	4.5.12	X	X	X	X
EMP	3.7.3	4.5.9.1	X			
Leakage current	3.1	4.5.10	X		X	
Identification and marking	3.11	4.5.12	X		X	X
Electrical designation and marking	3.11.1	4.5.12	X		X	X
Component reference designations	3.11.2	4.5.12	X		X	X
Information plates	3.11.3	4.5.12	X			X
General workmanship	3.16.1	4.9.1	X	X	X	X
Workmanship screen	3.16.2	4.9.2	X	X	X	X
Interchangeability	3.6.2	4.7	X			X
Safety	3.12	4.5.1				
General	3.12.1	4.5.10	X	X	X	X
Insulation of controls	3.12.2	4.5.10	X	X	X	X
Temperature	3.12.3	4.5.11	X			X
Connectors	3.12.4	4.5.4	X	X	X	X
Human performance	3.8.1	4.5.12	X			
Human engineering	3.8.2	4.5.12	X			
RG functional element cabinets	3.9	4.5.12	X			X

TABLE IX. Examinations and tests. (continued)

Examination or test	Requirement paragraph	Test paragraph	First article inspection	Quality conformance inspection		
				In-process inspection	Production inspection	Periodic inspection
Support maintenance test procedure verification	3.10	4.8	X			
Support maintenance	3.10.1	4.8				
Test equipment	3.10.2	4.8	X			
Verification	3.10.3	4.8	X			

4.4.3 Periodic inspection. Periodic inspection shall be as specified in TABLE IX and shall be performed on RGs which have been subjected to, and have passed, production inspection specified in 4.4.2.

4.4.3.1 Sampling for periodic inspection. Periodic inspection shall be performed on 25 percent of the receivers and transmitters of each RG subsystem as specified in TABLE IX which have been subjected to, and have passed, production inspection.

4.4.3.2 Nonconforming periodic sample units. If a sample unit fails the inspection specified in 4.4.3, the contractor shall immediately investigate the cause of failure and shall report to the Government quality assurance representative (QAR) the results thereof and details of the corrective action taken to correct units of product which were manufactured under the same conditions, with the same materials, processes, and so forth. If the QAR does not consider that the corrective action will enable the product to conform to specified requirements, or if the contractor cannot determine the cause of failure, the matter shall be referred to the contracting officer.

4.4.3.3 Reinspection of conforming periodic sample units. Unless otherwise specified (see 6.2.1), sample units which have been subjected to, and have passed, periodic tests may be accepted on the contract provided they are resubjected to, and pass, production inspection specified in 4.4.2 after necessary rework.

4.5 Test methods. Test methods shall be as specified in 4.5.1 through 4.5.13.

4.5.1 MIL-E-16400 tests. When 4.5.1 is specified in TABLE IX, the test specified in MIL-E-16400 shall be applied.

4.5.2 Verification by analysis. When 4.5.2 is specified in TABLE IX, the test may be performed by analysis, or calculation, or both. Verification by analysis shall consist of review of tests and analytical data or performance of an analysis to verify compliance with the specified requirements. Analysis shall be performed in accordance with one of the methods specified in a through e:

a. General analysis (see 4.5.2.1)
b. Reliability analysis (see 4.5.2.2)
c. Maintainability analysis (see 4.5.2.3)
d. PAR analysis (see 4.5.2.4)
e. Environmental analysis (see 4.5.2.5)

4.5.2.1 General analysis. A general analysis shall be performed to determine conformance to design and construction requirements. The analysis shall consist of applying empirical and theoretical relationships between design parameters and test data to predict compliance with the requirements specified in Section 3.

4.5.2.2 Reliability analysis. A reliability analysis shall be performed to predict the MTBF of the RG equipments. The analysis shall consist of an evaluation of the degree of compliance of the RG design, construction, and installation to the reliability performance requirements in accordance with the criteria specified in Section 3. The MTBF requirements shall be verified by analysis in accordance with:

a. Historical data derived from controlled tests, or
b. Historical data derived from field usage

4.5.2.3 Maintainability analysis. A maintainability analysis shall be performed to predict the MTTR of the RGs. The analysis shall consist of an evaluation of the degree of compliance of RG design, construction, and installation to the maintainability performance requirements in accordance with the criteria specified in Section 3.

4.5.2.4 PAR analysis. An analysis shall be performed to verify compliance with RG PAR goals. The analysis shall consist of predicting PAR by using the reliability (MTBF) and maintainability (MTTR) data accrued to verify compliance with the criteria as specified in Section 3.

4.5.2.5 Environmental analysis. An environmental analysis shall be performed to ensure the RG is capable of functioning when subjected to the specified requirement. Environmental tests shall be allocated to the individual equipments or assemblies. The analysis shall consist of applying mathematical prediction techniques to verify compliance to the criteria specified in Section 3.

4.5.3 Verification by demonstration. Verification by demonstration shall be performed as specified in 4.5.3.1.

4.5.3.1 Functional and operational demonstration. Verification by demonstration shall consist of qualitative observations for compliance with specified requirements. Demonstration shall consist of qualitative observation of data, operations, and functional characteristics of equipments in accordance with the requirements specified in Section 3.

4.5.4 Verification by test. Verification by test shall consist of quantitative measurements to verify compliance with specified requirements. Tests shall be performed in accordance with one of the methods specified in 4.5.4.1 through 4.5.4.3.

4.5.4.1 Physical interface test. A physical interface test is a test performed to verify compliance with physical, electrical, and man/machine interface requirements. The test shall consist of quantitative measurements for conformance to the requirements specified in Section 3.

4.5.4.1.1 Equipment electrical interface. Electrical interface signal characteristics shall be measured in terms of voltage, current, impedance, frequency, and time.

4.5.4.1.2 Equipment prime power. Equipment prime power shall be as specified in a through d:

a. Prime power tests shall be performed in accordance with the Electrical tests paragraph of MIL-E-16400.

b. Power interruption tests shall be performed in accordance with the Power interruption paragraph of MIL-E-16400.

c. Supply line voltage and frequency tests shall be performed in accordance with the Electrical tests paragraph of MIL-E-16400.

d. Transient voltage and frequency tests shall be performed in accordance with the Transient voltage and Transient frequency paragraphs of MIL-E-16400.

4.5.4.1.3 Equipment physical interface. Equipment physical interface shall be as specified in a and b:

a. Weight and dimensions. The equipment crated and uncrated weights and dimensions shall be verified for conformance to the requirements specified in 3.2.10.1 and 3.2.10.2.

b. Clearance, access, and displacement. Quantitative clearance, access, and displacements shall be measured in accordance with the requirements specified in Section 3.

4.5.4.1.4 Man/machine interface test. The man/machine human factors interface tests are tests to measure accessibility, controllability, operability, and safety considerations in accordance with MIL-STD-1472.

4.5.4.2 Operational performance test. Operational performance tests are tests performed to verify equipment group or system compliance with functional and operational requirements. The tests shall consist of quantitative measurements for compliance to the requirements specified in Section 3.

4.5.4.3 Environmental test. Environmental tests are tests conducted to verify equipment compliance for shipment, storage, and operational performance requirements. These tests shall be conducted on developmental equipments and prior to ship installation.

4.5.5 Cable tests. Cables to be supplied with the end item that are not captive to the RG shall, as an assembly, be subjected to continuity and voltage tests. The continuity test shall ensure that wires terminate on the correct connector pins. The voltage to be applied to each wire or cable for the voltage test shall be equal to the highest voltage rating without exceeding the voltage rating for any constituent part of the cable assembly.

4.5.6 RF coupling capacitor test. Testing of RF coupling capacitors under a peak stress voltage of 20,000 volts direct current (VDC) shall be conducted continuously at 50°C for a period of not less than 15 minutes to verify conformance to the requirements specified in 3.2.3.2.

4.5.7 Dust test. The RG shall be subjected to the dust test specified in Method 510.2 of MIL-STD-810 (except that testing in the operating condition is excluded and the ambient temperature shall not exceed 50°C), without performance degradations or malfunctions to verify conformance to the requirements specified in 3.3.6.

4.5.8 Shock test. The RG shall be subjected to shock testing to verify conformance to the requirements of 3.3.7 without degradation or malfunction.

4.5.9 EMI test. The EMI requirements shall be tested for compliance to 3.7.1 utilizing the test methods specified in MIL-STD-462.

4.5.9.1 EMP. The EMP hardening requirements shall be verified by an analysis or test of a pulse induced from a simulated exoatmospheric nuclear explosion whose RF field is of the following form and amplitude and as shown in FIGURE 21:

$$E(t) = E_0(e^{-\alpha t} - e^{-\beta t}) \text{ and}$$

$$H(t) = \frac{E(t)}{Z_0}, \text{ where,}$$

E (t) = Electric field in V/m at time, t

H (t) = Magnetic field in amperes per meter at time, t

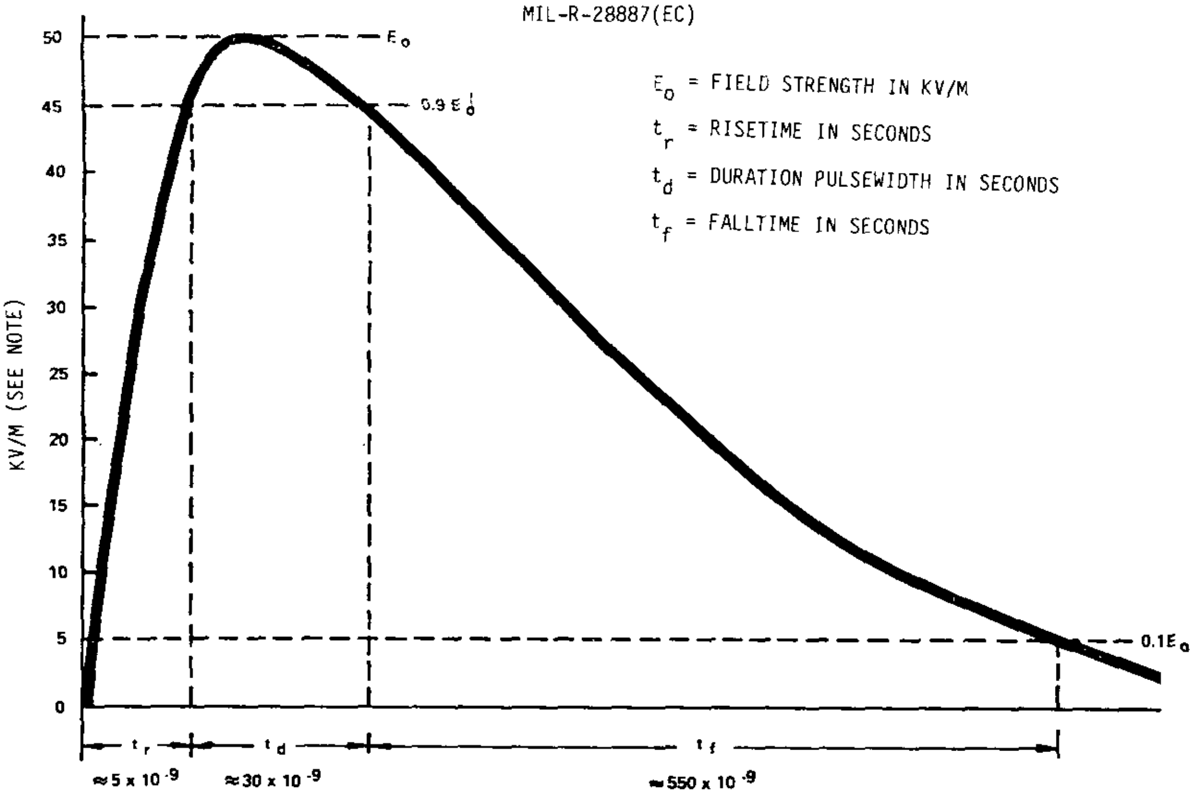
$E_0 = 5.25 \times 10^4$ v/m

$\alpha = 4.0 \times 10^6$ per second

$\beta = 4.76 \times 10^8$ per second

$Z_0 = 377$ ohms

t = Time in seconds



NOTE: Kilovolts per meter

FIGURE 21. KV/m.

4.5.9.2 Applicable test frequencies. Tests shall be performed for the injection frequencies of 0.01 MHz, 0.1 MHz, 0.5 MHz, 1 MHz, 2 MHz, 5 MHz, 10 MHz, 20 MHz, 50 MHz, and 100 MHz. In addition, tests shall be performed at the test sample's critical frequencies, such as local oscillator, power switching frequencies and harmonics, RF frequencies, clock frequencies, band-pass frequencies, and so forth, as specified in the EMI test plan.

4.5.9.2.1 Apparatus. Test apparatus shall consist of the items specified in a through d:

a. Source injection pulse generator with the capabilities specified in 1 through 4:

1. Damped sinusoidal transient as shown in the applicable limit and described by the equations specified in A and B:

A. $I_{pin}(t) = 1.05\ I(f)\ e^{-0.2\ ft}\ \mathrm{SIN}\ (2\pi ft)$

B. $V_{pin}(t) = 1.05\ V(f)\ e^{-0.2\ ft}\ \mathrm{SIN}\ (2\pi ft)$

where:

$I_{pin}(t)$ = Pin to case current in amperes at time, t
$V_{pin}(t)$ = Pin to case voltage in V at time, t
f = Specific test frequency in MHz
t = Time in seconds

I(f) = Current determined from FIGURE 22
V(f) = Voltage determined from FIGURE 23

2. Variable amplitude so the injected transient can be increased from a minimum to a maximum specified level (that is, at least 10 percent, 50 percent, and 100 percent of the amplitude must be tested at each specified test frequency)

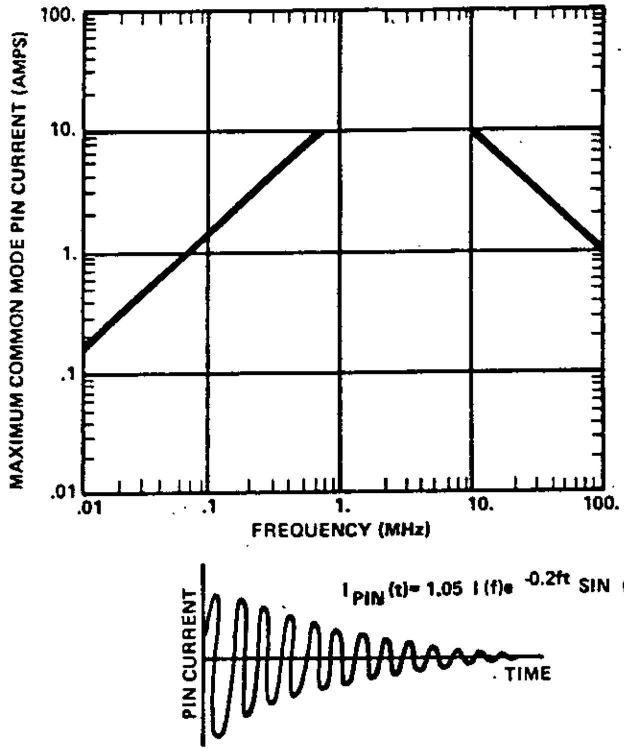
3. Frequency range capable of generating the required test frequencies

4. Current output level of at least 10 amperes into a 100-ohm load

b. Current probe

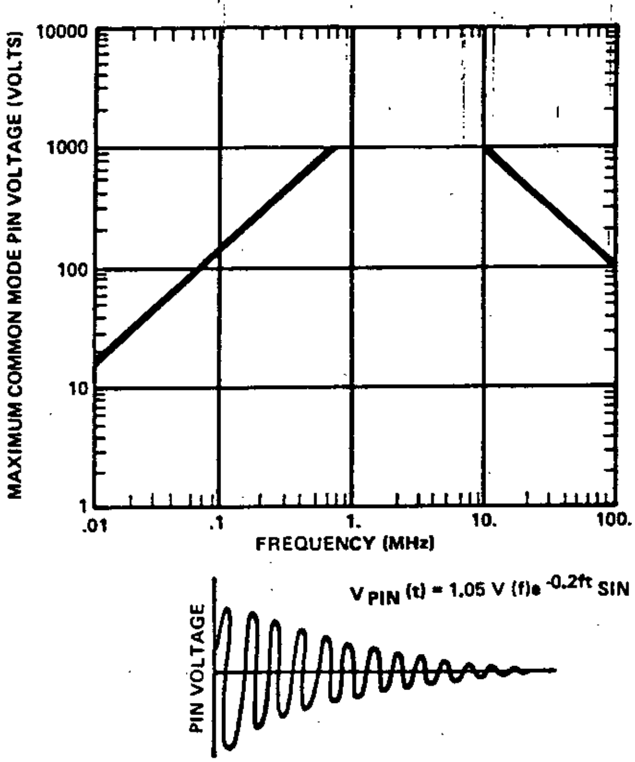
c. Oscilloscope with a minimum bandwidth capability of 100 MHz

d. Interconnecting test cable



$I_{PIN}(t) = 1.05\ I(f)e^{-0.2ft}\ SIN\ (2\pi ft)$

FIGURE 22. Interface pin current.



$V_{PIN}(t) = 1.05\ V(f)e^{-0.2ft}\ SIN\ (2\pi ft)$

FIGURE 23. Interface pin voltage

4.5.9.2.2 Functional analysis. A functional analysis shall be performed before the certification testing to identify the items specified in a through c:

a. The interface pin connectors
b. The test sample functions which must be monitored to determine system failure or transient upset
c. The additional test frequencies (that is, interface cable resonant frequency, clock frequencies, data rates, and so forth)

4.5.9.2.3 Test setup and procedure. The RG shall be configured as shown in FIGURE 24 and the test procedures specified in a through f shall be performed.

a. Apply the test signal to each interface pin of the test sample at each test frequency
b. Monitor the test sample functions in all modes of operation to determine whether there is a failure or transient upset
c. Inject one transient pulse on each interface pin and at each test frequency
d. The test sample shall be tested with its power off and on
e. Record test frequency and level at which a failure or upset occurs
Notes:
1. The test sample shall be tested on a ground plane. There shall be no insulated materials between the test setup and the ground plane.
2. The test cable running between the test sample and the damped sinusoidal generator shall be kept 4 centimeters (cm) (1.575 inches (in.)) to 6 cm (2.362 in.) above the ground plane.
f. All equipments and subsystem interfaces shall not exhibit degradation of performance, permanent malfunction, or deviation from specified indications beyond the tolerances and recovery times specified in the individual equipment or subsystem specification after being subjected to a test signal having either the waveform and common mode current level shown in FIGURE 22 or the waveform and common mode voltage level shown in FIGURE 23, whichever occurs first at the specific test frequency.

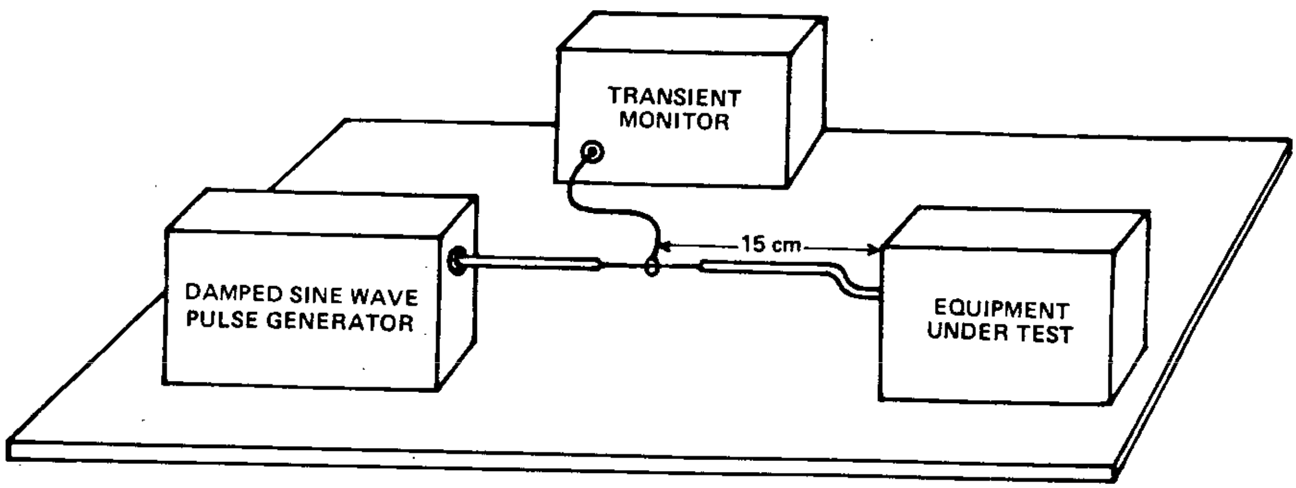


FIGURE 24. Test setup.

4.5.10 Leakage current test. The leakage current test shall be performed as specified in 4.5.10.1 and 4.5.10.2.

WARNING

THIS TEST MAY BE HAZARDOUS DUE TO THE UNGROUNDED CONDITION OF THE RG DURING THE TEST. DO NOT TOUCH EXPOSED METAL SURFACES.

THE UNITED STATES GOVERNMENT NEITHER ASSUMES NOR ACCEPTS RESPONSIBILITY FOR ANY INJURY OR DAMAGE THAT MAY OCCUR DURING OR AS A RESULT OF THIS TEST.

4.5.10.1 RG connections. Each RG directly connected to an external power source and units deriving power from the RG shall be placed on an insulated surface. All safety ground conductors between the RG and units deriving power from the RG shall be intact. The safety ground conductor between the RG under test and the source power shall be opened during the test. The RG shall be connected as shown in FIGURE 25 if it is connected to single-phase source power, and as shown in FIGURE 26 if connected to three-phase source power.

4.5.10.2 Measurement. Leakage current shall be measured on the RG in its normal operating configuration. RG controls in each operating mode shall be such that maximum power will be utilized during leakage current measurements. The leakage current shall be determined by the voltage-drop method. A true rms voltmeter shall be used. The voltage measured across the 1500-ohm resistor shall not exceed 7.5 V at the highest nominal power line voltage and the highest and lowest nominal power line frequencies for which the RG is designed. The overall measurement error shall not exceed 5 percent. The probe shall be used on all external conducting parts such as case, connector housings, recessed calibration or adjustment controls, and control shafts with knobs removed, and the voltage measured for every combination of switch positions available in FIGURE 25 and FIGURE 26. The open safety ground conductor shall be reconnected immediately after the test is completed.

4.5.11 Thermal survey testing. When specified in the contract or purchase order (see 6.2.1), a thermal survey shall be performed on those parts dissipating 1 percent, or more, of the total power dissipation of the unit in which the part is located, and to ensure that heat sensitive parts are within the thermal stress identified in the reliability prediction report and the part derating requirement.

4.5.11.1 Survey conditions. The thermal survey shall be conducted under the conditions specified in a through e:

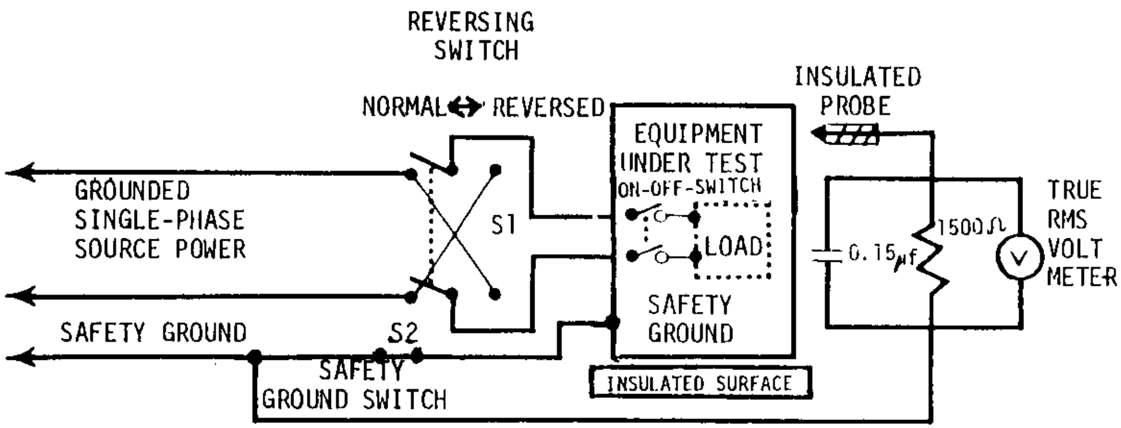
a. Maximum operating temperature range (see 3.2.2.1.12 and 3.3.1)
b. Operating mode(s) which will cause the maximum steady-state power dissipation stabilization
c. Continuous RG operation for a time span that will achieve thermal stabilization
d. Cooling system operational, if other than natural methods
e. RG cabinets closed

4.5.11.2 Proper techniques. Proper techniques such as thermocouples, infrared photography, chemicals, or calibrated thermal sensitive materials that will accurately measure temperature shall be used in the survey. The method used to measure temperature shall not affect the accuracy of the measurement as a result of the heat sink effect or for any other reason.

4.5.12 Contractor validation. When 4.5.12 is specified in TABLE IX, the contractor shall inspect the RG to determine technical compliance and adequacy for the specified characteristic or requirement. This validation shall include qualitative examination and testing whenever a function is specified.

4.5.13 Inspection by testing. When 4.5.13 is specified in TABLE IX, the contractor shall perform quantitative testing.

4.6 Reliability verification test. When specified (see 6.2.1), a reliability verification test shall be performed on the RG in accordance with Test Plan XXC of MIL-STD-781. Environmental conditions and operational duty cycles shall be as specified in 4.6.1 through 4.6.5.



GENERAL ORDER OF TEST:

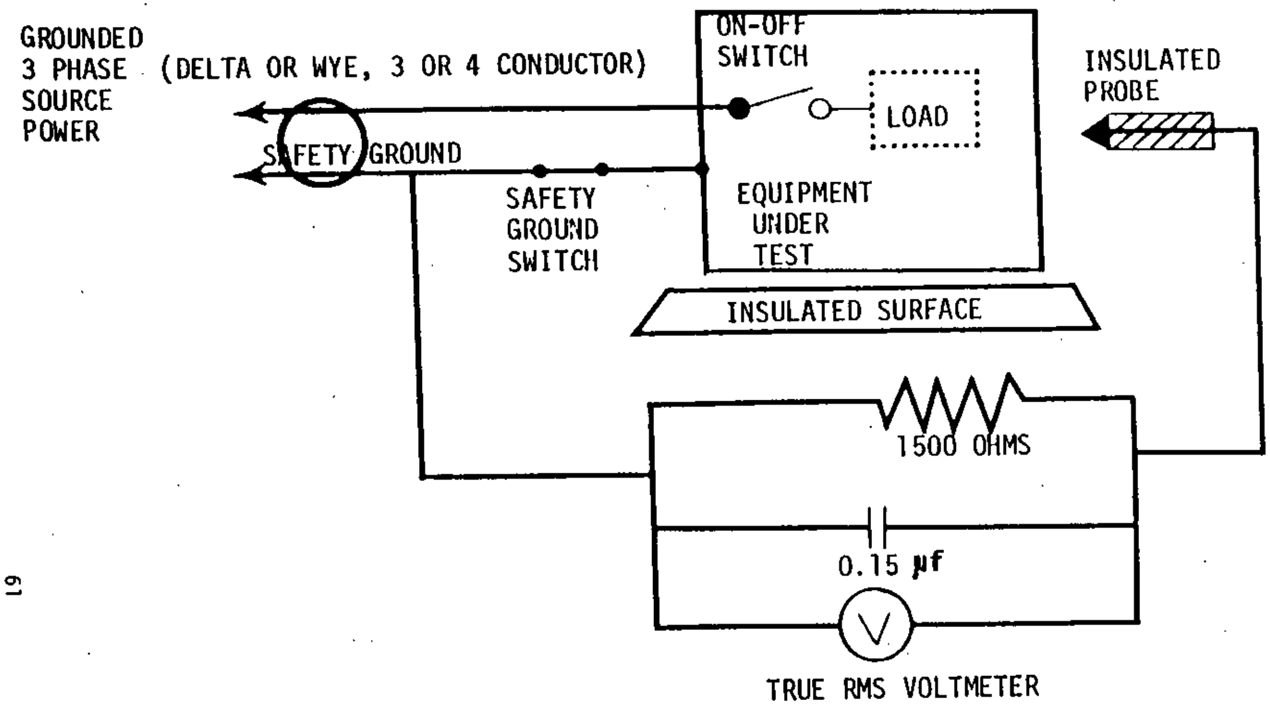
1. SOURCE POWER OFF. CONNECT EQUIPMENT PER DIAGRAM.
2. ON-OFF SW OFF. S1 SW NORMAL. S2 SW CLOSED. CONNECT SOURCE POWER.
3. OBSERVE WARNING S2 SW OPEN. ON-OFF SW ON.
4. FOR EACH PROBE POINT, RECORD VOLTMETER READING (CASE, CONNECTORS, CONTROLS, SHAFTS).
5. ON-OFF SW OFF. REPEAT STEP 4.
6. S1 SW REVERSED.
   ON-OFF SW ON. REPEAT STEP 4
7. ON-OFF SW OFF. REPEAT STEP 4.
8. S2 SW CLOSED. S1 SW NORMAL.
9. REPEAT STEP 3 THRU 8 FOR EACH MODE OF OPERATION.
10. REMOVE SOURCE POWER. DISCONNECT EQUIPMENT. SIGN RECORD SHEET.

WARNING

DO NOT TOUCH EXPOSED METAL SURFACES

THIS TEST MAY BE HAZARDOUS DUE TO THE UNGROUNDED CONDITION OF THE EQUIPMENT DURING THE TEST. THE UNITED STATES GOVERNMENT NEITHER ASSUMES NOR ACCEPTS RESPONSIBILITY FOR ANY INJURY OR DAMAGE THAT MAY OCCUR FROM THE USE OF THIS DIAGRAM FOR LEAKAGE CURRENT MEASUREMENT.

FIGURE 25. Single-phase test diagram for leakage current measurement.



GENERAL ORDER OF TESTS:

1. SOURCE POWER OFF. CONNECT EQUIPMENT PER DIAGRAM.
2. ON-OFF SW OFF. SAFETY GROUND SWITCH CLOSED. CONNECT SOURCE POWER.
3. OBSERVE WARNING. SAFETY GROUND SWITCH OPEN. ON-OFF SW ON.
4. FOR EACH PROBE POINT, RECORD VOLTMETER READING (CASE, CONNECTORS, CONTROLS, SHAFTS).
5. ON-OFF SW OFF. REPEAT STEP 4.
6. SAFETY GROUND SWITCH CLOSED.
7. REPEAT STEP 3 THRU 6 FOR EACH MODE OF OPERATION
8. REMOVE SOURCE POWER. DISCONNECT EQUIPMENT. SIGN RECORD SHEET.

NOTE: 1. All three phases shall be connected during measurement.
2. The safety ground conductor shall not carry load current.

WARNING DO NOT TOUCH EXPOSED METAL SURFACES THIS TEST MAY BE HAZARDOUS DUE TO THE UNGROUNDED CONDITION OF THE EQUIPMENT DURING THE TEST. THE UNITED STATES GOVERNMENT NEITHER ASSUMES NOR ACCEPTS RESPONSIBILITY FOR ANY INJURY OR DAMAGE THAT MAY OCCUR FROM THE USE OF THIS DIAGRAM FOR LEAKAGE CURRENT MEASUREMENT.

FIGURE 26. Three-phase test diagram for leakage current measurement.

4.6.1 Environmental conditions for reliability testing. The environmental conditions shall be as specified in a through d:

a. Input voltage: Nominal ±10 percent
b. Vibration: None
c. Temperature: +50°C
d. Moisture: 75 percent RH

4.6.2 Performance tests. At least daily, performance measurements shall be made to verify the performance characteristics specified in a through d:

a. Power out
b. Frequency and long term frequency stability
c. Modulation
d. IM

4.6.3 Test frequencies. The test frequencies specified in a through d shall be used:

a. F_1: 2.0005 MHz
b. F_2: 4.9995 MHz
c. F_3: 10.0019 MHz
d. F_4: 29.9999 MHz

4.6.4 Test schedule. The test shall consist of three 8-hour schedules per day, the first being manned, where performance measurements shall be made. The other two schedules may be unmanned and pertinent data may be automatically recorded to the extent that instrumentation permits. These schedules shall be as specified in a and b:

a. Manned schedule:
   1. Zero hours to 2 hours: RG on
   2. Two hours to 3 hours: Transmitter and receiver performance measurements
   3. Three hours to 4 hours: RG standby
   4. Four hours to 6 hours: RG on
   5. Six hours to 7 hours: Transmitter and receiver measurements
   6. Seven hours to 8 hours: RG standby
b. Unmanned schedule:
   1. Zero hours to 3 hours: RG on
   2. Three hours to 4 hours: RG standby
   3. Four hours to 7 hours: RG on
   4. Seven hours to 8 hours: RG standby

4.6.5 RG schedules. The mode of operation and frequency of transmission and reception for each transmitting ON period of the manned schedules shall occur in the sequence specified herein.

Day	Frequency	Mode of transmission and reception
1	F_1: First 4 hours of manned schedule	(into a 50-ohm dummy load) AM (A3E), 50 percent rated average power; carrier 30 percent to 50 percent, 1000 Hz modulation; transmitting for 10 minutes out of each 15-minute period
	F_2: Remainder of the day	
2	F_3: First 4 hours of manned schedule	CW (A1), full rated average power keyed at a speed of 25 dot Hz; transmitting for 10 minutes out of each 15-minute period
	F_4: Remainder of the day	
3	F_1: First 4 hours of manned schedule	Frequency shift keying, (F1), full rated average power keyed from space to mark at a 30-Hz rate (RYs); transmitting for 10 minutes out of each 15-minute period
	F_2: Remainder of the day	

Day	Frequency	Mode of transmission and reception
4	F_3: First 4 hours of manned schedule	ISB (A3B), 100 percent of rated PEP, two-tone modulation per sideband; transmitting for 10 minutes out of each 15-minute period
	F_4: Remainder of the day	

The same sequence shall be reused on the next four days, except that the sequence of frequencies shall be reversed: F_4 and F_3 on the fifth day, F_2 and F_1 on the sixth day, F_4 and F_3 on the seventh day, and F_2 and F_1 on the eighth day. These schedules shall be repeated as necessary.

4.7 Maintainability demonstration. The RG shall be subjected to a maintainability demonstration in accordance with Method 10 of MIL-STD-471 to determine conformance with specified maintainability requirements. The maintainability requirements shall be demonstrated by the replacement of LRUs (individual printed circuit cards and PCBs) and chassis-mounted electronic, electrical, electromechanical and mechanical parts at the organizational level. The demonstration shall be conducted in a space environment (including clearances) similar to that in which the equipment shall be installed.

4.7.1 Selection of faults. For the maintainability demonstration, 100 candidate corrective maintenance tasks shall be determined in accordance with APPENDIX A of MIL-STD-471. The information specified in a through c shall be made available for each candidate task:

a. Designation of specific faulty part
b. Failure mode
c. Means of introducing fault (substitution of faulty part or simulation thereof)

Failure of BITE, if applicable, shall be included as corrective maintenance tasks for the maintainability demonstration. The procuring activity, or its authorized representative, shall use the candidate tasks as a guide to select a sample of 50 tasks for the demonstration.

4.7.2 Accept or reject criteria. The accept or reject criteria for the demonstration of the corrective maintenance times shall be as specified in TABLE X. Acceptance shall occur when the number of observed corrective maintenance task times which exceed the required value for each index mean-corrective-maintenance-time (M_{ct}), M_{maxct} is less than or equal to that specified in TABLE X, corresponding to each index for the specified confidence level. The duration of each task shall be compared to the required value(s), and determined as greater or lesser than each index value. The actual value obtained shall also be determined. An acceptance decision can only be made when the values obtained for both M_{ct} and M_{maxct} have been accepted. The accept or reject criteria for preventive maintenance are based on the capability of performing each preventive maintenance task with no degradation in RG performance. Occurrence of RG performance degradation shall be cause for rejection of a preventive maintenance task.

TABLE X. Acceptance criteria.

	M_{ct}	M_{maxct}
Acceptance level	20	0
Sample size	50	50

4.7.3 Technicians. The procuring activity reserves the right to provide and select the technicians to perform the maintainability demonstration.

4.7.4 Technical documentation. Technical documentation shall be limited to the technical manual and related maintenance documentation delivered with the RGs.

4.7.5 Rejection. If a reject decision is reached, the procuring activity shall be immediately notified. The contractor shall:

a. Develop an approach for redesign or correction of all deficiencies
b. Upon approval of an approach, repeat the demonstration until an acceptance decision is reached

4.8 Verification of support maintenance test procedure. The RG shall be subjected to a verification of support maintenance test procedure as specified in a through d:

a. A technician shall be given a complete set of boards and modules, all of which are completely unaligned.

b. The technician shall align each of the modules and boards and verify that each board or module is operating properly. These tests shall be performed with the modules on the bench (modules or boards removed from the prime equipment).

c. The technician shall install the modules or boards in the prime equipment and align the prime equipment as specified in the manual.

d. The technician shall operate the equipment as specified in the approved test procedure.

4.9 Workmanship. Workmanship shall be as specified in 4.9.1 through 4.9.2.2.

4.9.1 General workmanship. The RG, including subassemblies and assemblies, shall be examined for workmanship and soldering during the fabrication and assembly process and at the end item level for conformance to the requirements of 3.16.1. Each solder connection and associated wiring or leads shall be visually examined.

4.9.2 Workmanship screen. Prior to conducting temperature cycling (see 4.9.2.2), vibration (see 4.9.2.1) shall be performed on each RG. The vibration may be performed at the module, drawer, or end item level. All the hardware, including cables and connectors, shall be exposed to vibration testing.

4.9.2.1 Vibration. The vibration shall be random, or subject to procuring activity approval, pseudo-random or complex waveform vibration, for an accumulated time of 10 minutes in the axis deemed most susceptible to vibraton excitation. All test items shall be hard-mounted (without shock isolators) and subjected to the vibration conditions of FIGURE 27. Input vibration levels shall be measured at the mounting points of the item under vibration. If variations are found at these points, the level used for control purposes shall be the average of the levels at the mounting points. Control equipment having a bandwidth no greater than 10 Hz for vibration frequencies up to 500 Hz and 100 Hz for vibration frequencies above 500 Hz shall be used for the control and analysis of the acceleration spectral density (ASD). The instantaneous acceleration peaks may be limited to three times the rms acceleration level. The test RG shall be energized during vibration and appropriate input signals applied to observe any abnormal conditions of the output functional characteristics. All failures occurring during the test shall be corrected and the test resumed.

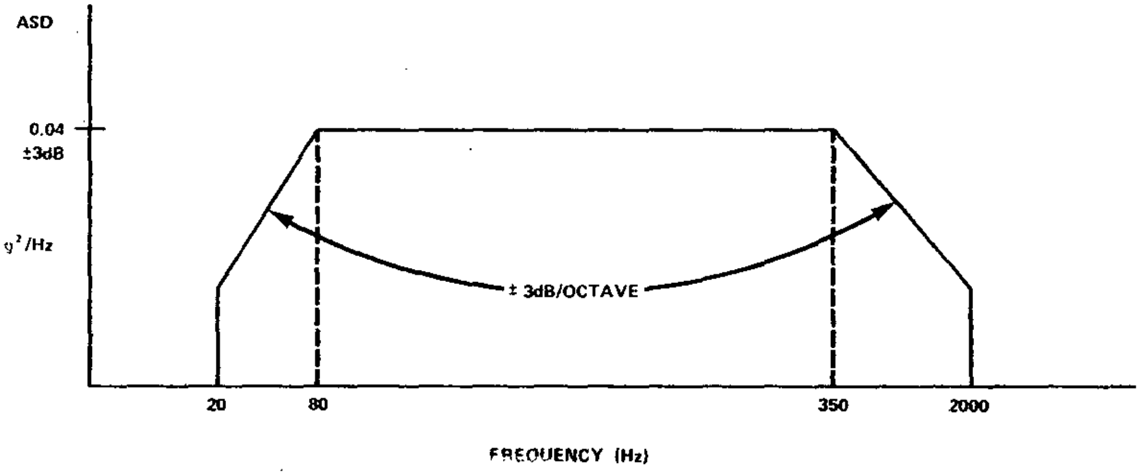


FIGURE 27. Random vibration curve.

4.9.2.2 Temperature cycling. Each RG shall be subjected to 10 cycles of the temperature curve shown in FIGURE 28. The temperature rate of change shall be not less than 5°C per minute. RG power shall be turned on and off at the indicated times. The RG shall be positioned for maximum exposure to the changing temperature. When performance measurements are called for, a minimum functional operating test shall be performed. The dwell time shall be maintained until the largest electrical or electronic part in the RG reaches 80 percent of the chamber temperature. When failures occur, the unit shall be reworked and the cycling continued for a cumulative total of 10 cycles.

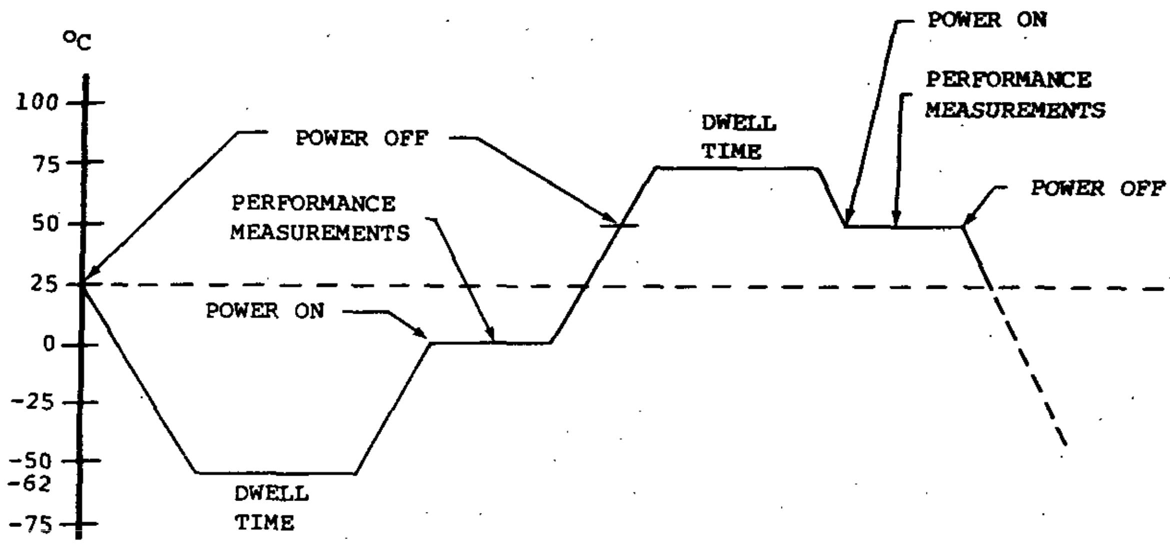


FIGURE 28. One cycle of temperature curve (not to scale).

4.10 Inspection of preparation for delivery. Inspection shall be performed to ensure conformance with the requirements of Section 5.

5. PACKAGING

(The preparation for delivery requirements specified herein apply only for direct Government procurements. Preparation for delivery requirements of referenced documents listed in Section 2 do not apply unless specifically stated in the contract. Preparation for delivery requirements for products procured by contractors shall be specified in the individual order.)

5.1 Preservation, packaging, packing, and marking. Unless otherwise specified herein, preparation for delivery shall be in accordance with the applicable levels of preservation, packaging, packing, and marking specified in MIL-E-17555 (see 6.2.1).

6. NOTES

6.1 Intended use. The RG covered by this specification is a Navy general-purpose radio subsystem for point-to-point HF communications for use on board surface ships. The RG is part of the EXCOMM system as specified in the APPENDIX.

6.2 Ordering data.

6.2.1 Procurement requirements. Procurement documents should specify:

a. Title, number, and date of this specification
b. Requirement for configuration of RG system (see 3.1.6)
c. Interchangeability requirements, if other than specified in 3.2.1.3 and 3.6.2
d. Thermal survey (see 3.13.3.4 and 4.5.11)
e. When SPETE and special tools are required (see 3.14.1.13)
f. Support maintenance test procedure verification (see 3.10 and 4.8)
g. Number of first article samples to be submitted if other than specified in 4.3
h. When reinspected periodic sample units may not be accepted (see 4.4.3.3)
i. Reliability verification test (see 4.6)
j. Maintainability demonstration (see 4.7)
k. Levels of preservation, packaging, packing, and marking required (see 5.1)

6.2.2 Data requirements. When this specification is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below will be developed as specified by an approved Data Item Description (DID) (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of Defense Acquisition Regulations 7-1049 (n)(2) are invoked and the DD Form 1423 is not used, the data specified below will be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification are cited in the following paragraphs:

Paragraph	Data requirement	Applicable DID
4.3, 4.4, and 4.5	Thermal Survey Report	DI-R-7036
	Test Procedures	UDI-T-22710
4.6	Reliability Test and Demonstration Reports	DI-R-7034
4.6	Reliability Test Procedures	DI-R-7035
4.7	Plan, Maintainability Demonstration	DI-R1-2129/ UDI-R-20440
4.7	Maintainability Demonstration Report	DI-R-2130
4.8	Support Maintenance Test Procedure Verification Report	UDI-T-22727

(DIDs related to this specification, and identified in Section 6 will be approved and listed as such in DoD 5000.19L., Vol. II, AMSDL. Copies of DIDs required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 First article. When a first article is required, it shall be tested and approved under the appropriate provisions of 52.209-3 of the Federal Acquisition Regulations. The first article should be a first production item. The first article should consist of one unit. The contracting officer should include specific instructions in all procurement instruments, regarding arrangements for examinations, tests, and approval of the first article.

6.4 Definitions. Definitions of terms used in this specification are given in 6.4.1 through 6.4.6.

6.4.1 In-band electrical noise. In-band electrical noise is defined as any signal present in the transmitter output, the frequency of which, is removed from the carrier frequency by no more than 6.3 kHz when the transmitter is conditioned for normal operation with the four audio inputs terminated resistively in their characteristic impedance of 600 ±j0 ohms and no input signal is applied.

6.4.2 In-rush current. In-rush current in the transmitter consists of the AC input current transients generated in the primary side of the high-voltage power transformer during the initial period of 106.38 ms following the application of AC line voltage to the power transformer.

6.4.3 Absolute frequency error. Absolute frequency error is the total deviation in Hz of the output carrier frequency (present in the output or fully suppressed) from that frequency indicated on the exciter frequency selection controls or their associated indicating devices.

6.4.4 Frequency calibration. Frequency calibration of the exciter and receiver is defined as a process for:

a. Determining the frequency stability
b. Determining the absolute frequency error
c. Reducing the absolute frequency error to less than 0.3 Hz at any frequency covered by the RG

6.4.5 Exciter standby condition. Exciter standby condition is defined as that condition wherein the maximum amount of power consuming circuitry in the exciter is deactivated while all circuitry which affects the stability and accuracy of the exciter output frequency remains in full operating condition.

6.4.6 Protected cabinets. An open enclosure in which all ventilated openings other than those for cooling air inlets and exhausts are limited in size and shape. The openings should be of such shape as to prevent the passage of a rod larger than 12.7 millimeters (0.50 in.) in diameter.

Preparing activity:
NAVY-EC

(Project No. 5820-N785)

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RG EQUIPMENT FREQUENCY RANGES AND
SPECIFIC MODES OF OPERATION

10. SCOPE

10.1 Scope. This APPENDIX identifies the exact number of transmitters, receivers, and amplifiers for various classes of surface ships, and the transmit and receive subsystem frequency range modulation types.

20. APPLICABLE DOCUMENTS

This section is not applicable to this APPENDIX.

30. REQUIREMENTS

30.1 Requirements. The RG transmit and receive subsystem frequency ranges, specific modes of operation, and the exact number of transmitters, receivers, and amplifiers for various classes of surface ships are specified in TABLE XI through TABLE XXVI.

TABLE XI. HF communications system overall requirements.

Items	LHD-1	CG-47	DDG-51	AE-36	AOE-6	TAO-187	LSD-41
USB exciters	23	8	8	4	6	4	9
LSB exciters	2	2	2	-	-	-	-
USB receivers	38	17	15	9	13	9	17
LSB receivers	2	2	2	-	-	-	-
PA groups	7 1/	3 1/	3 1/	1	2	1	3
Narrowband transmit channels	2	2	2	-	-	-	-

1/ One PA group split for operation of two narrowband channels.

TABLE XII. HF communications broadband transmit power requirements.

Power	LHD-1	CG-47	DDG-51	AE-36	AOE-6	TAO-187	LSD-41
PEP	12 kW	4 kW	4 kW	2 kW	4 kW	2 kW	6 kW
Average	6 kW	2 kW	2 kW	1 kW	2 kW	1 kW	3 kW

TABLE XIII. LHD-1 receive subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 1 MAIN COMM 2 METRO 1/	14 kHz to 500 kHz 14 kHz to 500 kHz	A1, A2, F1
B 2 MAIN COMM	30 kHz to 300 kHz	A7J
C 2 MAIN COMM 2 METRO	0.5 MHz to 30 MHz 0.5 MHz to 30 MHz	A1, A2, A3, F1
D 25 MAIN COMM 2 METRO 2 SSES	2 MHz to 30 MHz 2 MHz to 30 MHz 2 MHz to 30 MHz	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B
E 2 MAIN COMM	2 MHz to 30 MHz	LINK 11

1/ If receivers are provided for METRO with a coverage of 0.014 MHz to 30 MHz, METRO shall require only 4 receivers total.

TABLE XIV. CG-47 receive subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 1 MAIN COMM	14 kHz to 500 kHz	A1, A2, F1
B 1 MAIN COMM	30 kHz to 300 kHz	A7J
C 1 MAIN COMM	0.5 MHz to 30 MHz	A1, A2, A3, F1
D 10 MAIN COMM 2 SSES	2 MHz to 30 MHz 2 MHz to 30 MHz	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B
E 2 MAIN COMM	2 MHz to 30 MHz	LINK 11

TABLE XV. DDG-51 receive subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 1 MAIN COMM	14 kHz to 500 kHz	A1, A2, F1
B 1 MAIN COMM	30 kHz to 300 kHz	A7J
C 1 MAIN COMM	0.5 MHz to 30 MHz	A1, A2, A3, F1
D 10 MAIN COMM	2 MHz to 30 MHz	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B
E 2 MAIN COMM	2 MHz to 30 MHz	LINK 11

TABLE XVI. AE-36 receive subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 1 MAIN COMM	14 MHz to 500 kHz	A1, A2, F1
B 1 MAIN COMM	30 MHz to 300 kHz	A7J
C 1 MAIN COMM	0.5 MHz to 30 MHz	A1, A2, A3, F1
D 6 MAIN COMM	2 MHz to 30 MHz	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B

TABLE XVII. AOE-6 receive subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 1 MAIN COMM	14 kHz to 500 kHz	A1, A2, F1
B 1 MAIN COMM	30 kHz to 300 kHz	A7J
C 1 MAIN COMM	0.5 MHz to 30 MHz	A1, A2, A3, F1
D 10 MAIN COMM	2 MHz to 30 MHz	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B

TABLE XVIII. TAO-187 receive subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 1 MAIN COMM	14 kHz to 500 kHz	A1, A2, F1
B 1 MAIN COMM	30 kHz to 300 kHz	A7J
C 1 MAIN COMM	0.5 MHz to 30 MHz	A1, A2, A3, F1
D 6 MAIN COMM	2 MHz to 30 MHz	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B

TABLE XIX. LSD-41 receive subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 1 MAIN COMM	14 kHz to 500 kHz	A1, A2, F1
B 1 MAIN COMM	30 kHz to 300 kHz	A7J
C 1 MAIN COMM	0.5 MHz to 30 MHz	A1, A2, A3, F1
D 14 MAIN COMM	2 MHz to 30 MHz	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B

TABLE XX. LHD-1 receive subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 20 MAIN COMM	2 MHz to 30 MHz (broadband)	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B
B 1 MAIN COMM	2 MHz to 30 MHz (narrowband)	A1, A3A, A3H, A3J, F1, F4
C 2 MAIN COMM	2 MHz to 30 MHz (one each broad-band and one each narrowband)	LINK 11

TABLE XXI. CG-47 transmit subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 5 MAIN COMM	2 MHz to 30 MHz (broadband)	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B
B 1 MAIN COMM	2 MHz to 30 MHz (narrowband)	A1, A3A, A3H, A3J, F1, F4
C 2 MAIN COMM	2 MHz to 30 MHz (one each broad-band and one each narrowband)	LINK 11

TABLE XXII. DDG-51 transmit subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 5 MAIN COMM	2 MHz to 30 MHz (broadband)	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B
B 1 MAIN COMM	2 MHz to 30 MHz (narrowband)	A1, A3A, A3H, A3J, F1, F4
C 2 MAIN COMM	2 MHz to 30 MHz (one each broad-band and one each narrowband)	LINK 11

TABLE XXIII. AE-36 transmit subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 4 MAIN COMM	2 MHz to 30 MHz (broadband)	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B

TABLE XXIV. AOE-6 transmit subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 6 MAIN COMM	2 MHz to 30 MHz (broadband)	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B

TABLE XXV. TAO-187 transmit subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 4 MAIN COMM	2 MHz to 30 MHz (broadband)	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B

TABLE XXVI. LSD-41 transmit subsystem channel quantity and requirements.

Quantity and location	Frequency range	Modulation types
A 9 MAIN COMM	2 MHz to 30 MHz (broadband)	A1, A3A, A3H, A3J, F1, F4, A3B, A7B, A9B

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: ______

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional

b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional

c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional

8. DATE OF SUBMISSION *(YYMMDD)*

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