

GENERAL DYNAMICS
C4 Systems

3 April 2006

In reply, refer to:
DMR370

Department of the Navy
Space and Naval Warfare Systems Command
4301 Pacific Highway
San Diego, CA 92110-3127

Attention: Mr. Mark Lopez, Contracting Officer

CDRL: A011-002A

Subject: Interface Design Description (IDD) – (UHF PA) Interface Control Documents
ICD for the DMR External RF 100W and 200W VHF/UHF High Power RF Amplifiers

References: (a) Contract N00039-98-D-0029 / Contract Modification P00045
(b) Disapproval email from J. Staggs to K. Loper dated 3 February 2006

Enclosures: (1) 70-P46173F Revision B, Responses to Comments, and supporting documentation

Mr. Lopez:

In accordance with References (a) and (b), General Dynamics C4 Systems is submitting revised documentation for your review and approval. The customer has 60 days to review this submittal.

General Dynamics C4 Systems looks forward to your favorable review and approval of the subject CDRL. If additional information is needed, please contact the undersigned at (480) 441-6553 or fax at (480) 441-8551.

GENERAL DYNAMICS

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Digital Modular Radio (DMR) AN/USC-61 (C)



**Interface Description Document
For the DMR External RF
100W and 200W VHF/UHF
High Power RF Amplifiers**

CDRL No. A011-002A
Document No. 70-P46173F
Revision B
Contract Mod P00045

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San Diego, CA

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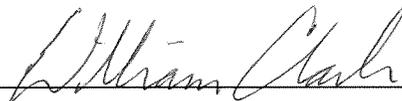
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Approval Page

**Interface Description Document
For The DMR External RF
100W and 200W VHF/UHF
High Power RF Amplifier**

CDRL No. A011-002A

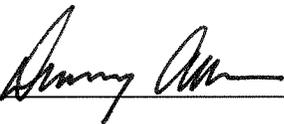
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DOCUMENT REVISION HISTORY

REV	DESCRIPTION OF CHANGE	DATE	APPROVED
-	RN H41411-151 – Formal Release	7/29/04	G. Ash
A	SMCO H45376	12/22/05	D. Westhafer
B	SMCO H45483	4/3/06	D. Westhafer

DOCUMENT TECHNICAL HISTORY

REV	DESCRIPTION OF CHANGE	EDITOR
-	Original release, revised from draft XA document. This document replaces two vendor-supplied documents: HPA 200-DMRM RF Power Amplifier (document ID 10328), HPA 100-DMRM RF Power Amplifier (document ID 10339)	B. Clark
A	<ul style="list-style-type: none"> - removed dimensions, referenced to ICDs - added references to 100W-A amplifiers - added 'notational' statements, and reference to HPA specs - added PA nomenclature and common name matrix 	B. Clark
B	<ul style="list-style-type: none"> - updated document per customer comments, including: - consistent use of TX Enable and TX Inhibit - merge J5, J6 signals into single port for Fig 4 and Fig 9 - label AC signals as 'Delta' in table 6 - include doc and dwg numbers in references - conversion to use of PA 'common names' - general edit to update document to include the 100WA and 100WB PA 	B. Clark

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TABLE OF CONTENTS

1.0	GENERAL INFORMATION	6
1.1	SCOPE.....	6
1.2	AMPLIFIER OVERVIEW	6
1.3	ABBREVIATIONS AND ACRONYMS	7
2.0	REFERENCE DOCUMENTS	8
3.0	PHYSICAL CONFIGURATIONS	9
3.1	PHYSICAL INTERFACES.....	9
3.2	ELECTRICAL (CONNECTOR) INTERFACES.....	10
3.2.1	RF Paths	11
3.2.2	ETHERNET I/O (J7).....	13
3.2.3	EXT I/O (J8)	14
3.2.4	AC IN (J9).....	16
3.3	OPERATOR CONTROLS AND INDICATORS.....	16
3.3.1	AC Power Switch.....	16
3.3.2	Operator Control Panel	17
3.4	HPA LOGICAL MODEL.....	20
3.4.1	HPA Control Sources.....	20
3.4.2	HPA RF path logic.....	21
3.5	ADDITIONAL INFORMATION.....	22
3.5.1	Power Amplifier Timing	22
3.5.2	Power Parameters.....	22
3.5.3	Thermal Parameters	22
3.5.4	Airflow	22
3.5.5	Weight.....	22

LIST OF FIGURES

Figure 1	RF Power Amplifier Context Diagram.....	6
Figure 2	Representative Front Panel, 100W 100WA, and 100WB Power Amplifiers	9
Figure 3	Representative Rear Panel, 100W, 100WA, and 100WB Power Amplifiers	9
Figure 4	Representative Front Panel, 200W Power Amplifier	10
Figure 5	Representative Rear Panel, 200W Power Amplifier	10
Figure 6	HPA RF Paths	11
Figure 7	ETHERNET I/O (J7) RJ-45 Connector.....	13
Figure 8	EXT I/O (J8) DB9 Connector	14
Figure 9	AC IN (J9) Connector	16
Figure 10	Notational Illustration, HPA Operator Panel.....	17
Figure 11	HPA Logical Model	20

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LIST OF TABLES

Table 1 DMR Power Amplifier Nomenclature.....	6
Table 2 HPA Mechanical Diagrams and RF Connector Configurations	9
Table 3 HPA Electrical Interfaces	11
Table 4 DMR VHF/UHF HPA RF Paths.....	12
Table 5 HPA Transmit Path RF Characteristics	12
Table 6 ETHERNET I/O (J7) Pin Assignments	13
Table 7 Ethernet Port Messages	14
Table 8 EXT I/O (J8) Signals	15
Table 9 AC IN (J9) Single Phase Electrical Characteristics	16
Table 10 HPA Operator Panel Keypad.....	17
Table 11 HPA Operator Panel Menu Controls	18
Table 12 DMR VHF/UHF HPA Operator Panel Indicators	18
Table 13 DMR VHF/UHF HPA Input Power Ranges.....	19
Table 14 DMR VHF/UHF HPA Output Power Ranges	19
Table 15 DMR VHF/UHF HPA Performance /Fault Monitors	19
Table 16 HPA Control / Interface Matrix	20
Table 17 HPA RF Path Truth Table	21
Table 18 Nominal HPA In-to-Out Air Flow.....	22

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1.0 General Information

1.1 Scope

This document describes the physical, electrical, and operator interfaces of the DMR 100 watt and 200 watt high power VHF/UHF RF power amplifiers (HPA). The VHF/UHF HPA is designed to operate with the Digital Modular Radio (AN/USC-61).

This document is an overview of the HPA interfaces. Per DI-IPSC-81436A recommendations, specific interface details are referenced to applicable requirement documents rather than copied, to minimize the risk of contradicting existing requirements.

1.2 Amplifier Overview

The DMR has four VHF/UHF power amplifier (HPA) models that operate in the 30 to 400 MHz frequency range (Table 1). HPA 'Common Names' (100W, 100WA, 100WB, 200W) are used throughout this document. The 100W and 200W HPAs are the original power amplifiers used with the DMR. The 100WA and 100WB HPAs extend the usable power range of the 100W HPA from 25W to 45W, when operated with AM waveforms. The 100WB HPA has automatic level control (ALC) capability. Special calibration procedures may be used to boost 100W HPA AM output power to 27W.

Table 1 DMR Power Amplifier Nomenclature

Common Name	Nomenclature	Manufacturer	Architecture
200W	AM-7584/USC-61(C)	Talla-Com Industries	Dual RX path, 200W CW, 50W AM
100W	AM-7585/USC-61(C)	Talla-Com Industries	Dual RX path, 100W CW, 25W AM
100WA	AM-7585A/USC-61(C)	Talla-Com Industries	Single RX path, 100W CW, 45W AM
100WB	AM-7585B/USC-61(C)	Herley Industries	Single RX path, 100W CW, 45W AM, ALC

All DMR VHF/UHF HPAs have a similar architecture (Figure 1). The 100W and 200W HPAs have two receive (RX) paths: J4 to J3, and J6 to J5. The 100WA and 100WB HPAs have a single RX path (J4 to J3). The HPAs can be remotely controlled through an Ethernet port (J7), locally controlled through a discrete signal port (J8), or operator-controlled through a keypad and display located on the HPA front panel.

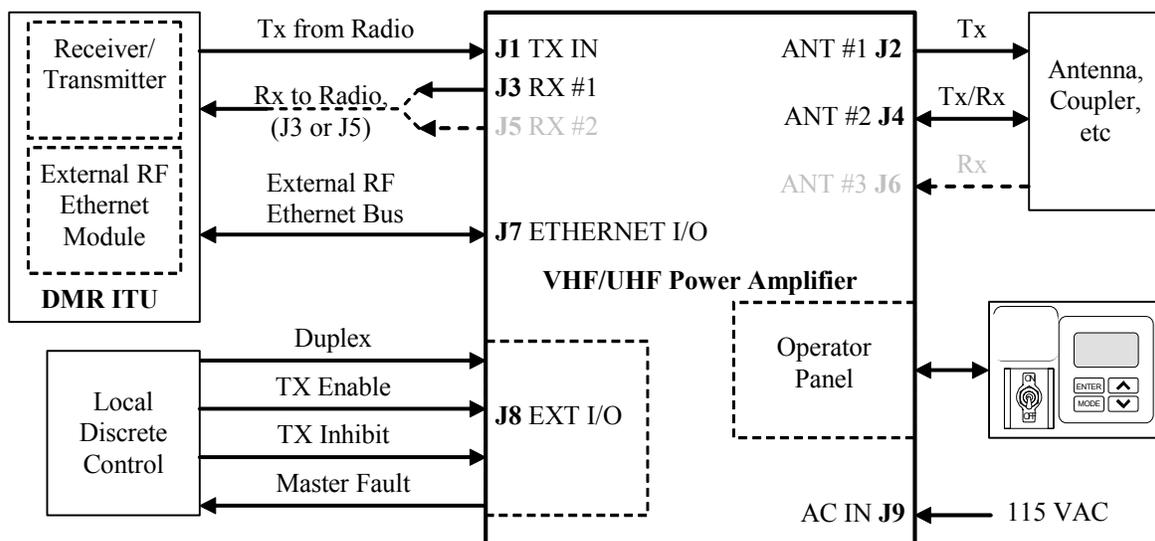


Figure 1 RF Power Amplifier Context Diagram

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1.3 Abbreviations and Acronyms

AC	Alternating Current
ALC	Automatic Level Control (of output power)
DMR	Digital Modular Radio
FDX	Full duplex
HDX	Half duplex
HPA	High Power Amplifier
ICD	Interface Control Document
I/O	Input / output
RF	Radio Frequency
RX	Receive
TTL	Transistor-Transistor Logic
TX	Transmit
UHF	Ultra High Frequency
VHF	Very High Frequency
VAC	Voltage, Alternating Current
VSWR	Variable Standing Wave Ratio

The terms “keyOFF” and “keyON” are used throughout this document to express the state of the transmit path output. “keyOFF” indicates the transmit path is inhibited, and is not producing power. “keyON” indicates the transmit path is enabled.

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2.0 Reference Documents

The following documents are referenced within this document. The listed documents are normally available from the organization that prepares or distributes the documents. In the event of a conflict between the text of this document and the references cited herein, the text of the referenced documents take precedence over this document.

Document	Description
--	Appendix J, DMR External Power Amplifier: Performance Specification Communications Set. Digital Modular Radio and Power Amplifier
--	Appendix K, DMR External Power Amplifier: Performance Specification Communications Set. Digital Modular Radio and Power Amplifier
10088	Product Specification: 200W, 30 MHz to 400 MHz Radio Frequency Power Amplifier with Ethernet Interface, Talla-Com Industries, Inc.
10329	Product Specification: 100W, 30 MHz to 400 MHz Radio Frequency Power Amplifier with Ethernet Interface, Talla-Com Industries, Inc.
EIA-310-D	Cabinets, Racks, Panels and Associated Equipment
DI-IPSC-81436A (N7361)	Data Item Description, Interface Design Description (IDD), NAVY/EC
IEEE-802.3/ (u, z)	Ethernet Physical Protocol Layer Specifications (IEEE-802.3u/100 Mbps, IEEE-802.3z/Full Duplex)
62-P43920J	Specification for DMR 100W CW, 45W AM VHF/UHF Power Amplifier
70-P43900J	Appendix W of the DMR External RF Control Interface: Ethernet Message Details for the 100W-A and 200W-A VHF/UHF RF Power Amplifiers
70-P41401M	Appendix C of the DMR External RF Control Interface: Ethernet Messages
70-P45106G	Interface Control Drawing, DMR External 100W-A VHF/UHF High Power RF Amplifier
70-P45956F	Installation Control Drawing, DMR, CIA, and Power Amp.

Talla-Com 100W and 200W HPA specifications (10088 and 10329) are derived from the DMR Appendix J External Power Amplifier specification.

DMR specification 62-P43920J (100WA, 100WB HPA) is derived from the DMR Appendix K External Power Amplifier specification.

DMR document titles: 70-P43900J and 70-P45106G; refer to 100W-A and 200W-A power amplifiers. The '-A' suffix indicates the HPA is a second-generation DMR power amplifier. "100W-A" indicates a 100WA or 100WB HPA. "200W-A" represents a (future) 200WB HPA. 100W-A HPA documentation is derived from the DMR Appendix K External Power Amplifier specification. 200W-A HPA documentation is derived from the (future) DMR Appendix L External Power Amplifier specification.

Document 70-P45106G applies to installation of 100WA and 100WB power amplifiers

Document 70-P45956F applies to installation of 100W and 200W power amplifiers

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3.0 Physical Configurations

3.1 Physical Interfaces

The HPA is designed for installation into an EIA-310-D compliant 19-inch equipment rack. Absolute enclosure dimensions, electrical connector locations, equipment rack slides, and equipment rack alignment pin receptacle locations are illustrated in applicable interface control drawings (Table 2).

Figure 2 and Figure 3 are representative illustrations of the 100W, 100WA, and 100WB HPA front and rear panels. Figure 3 illustrates the 100W HPA rear panel configuration. Per DMR Appendix J, the 100W PA rear panel has six (6) RF connectors (J1– J6). The 100WA and 100WB HPA rear panels are physically similar to the 100W HPA. Per DMR Appendix K, the 100WA and 100WB HPA rear panel has four (4) RF connectors (J1– J4).

Figure 4 and Figure 5 are representative illustrations of the 200W HPA front and rear panels. Per DMR Appendix J, the 200W PA rear panel has six (6) RF connectors (J1– J6).

Table 2 HPA Mechanical Diagrams and RF Connector Configurations

PA Model	Physical ICD	RF Connector Configuration	
100W, 200W	70-P45956F	Half duplex TX: J1 to J4 Full Duplex TX: J1 to J2	Half/Full duplex RX: J4 to J3 Full Duplex RX: J6 to J5
100WA, 100WB	70-P45106G	Half duplex TX: J1 to J4 Full Duplex TX: J1 to J2	Half/Full duplex RX: J4 to J3

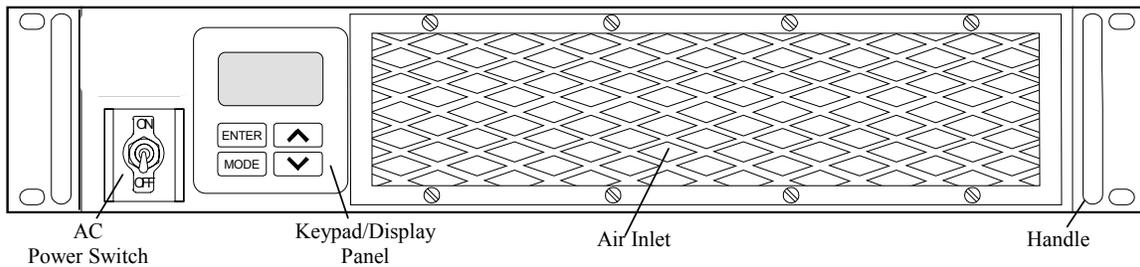


Figure 2 Representative Front Panel, 100W 100WA, and 100WB Power Amplifiers

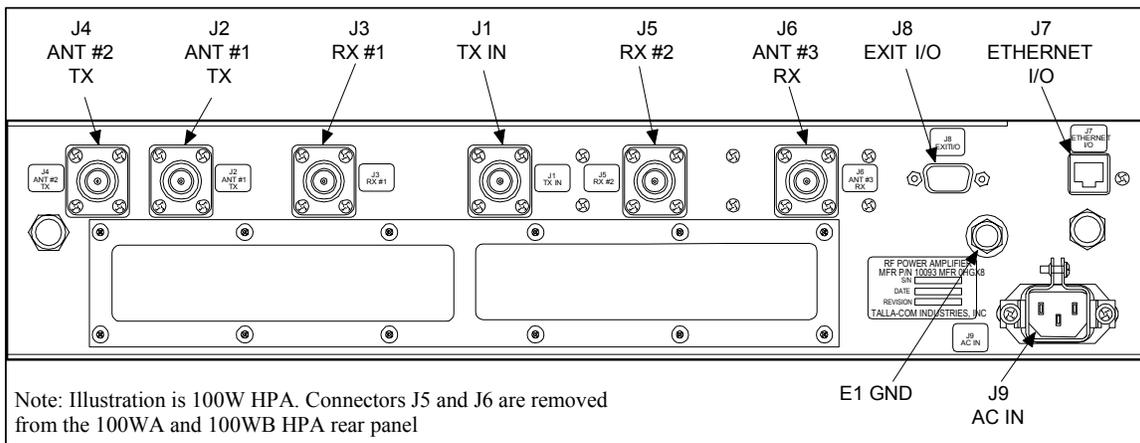


Figure 3 Representative Rear Panel, 100W, 100WA, and 100WB Power Amplifiers

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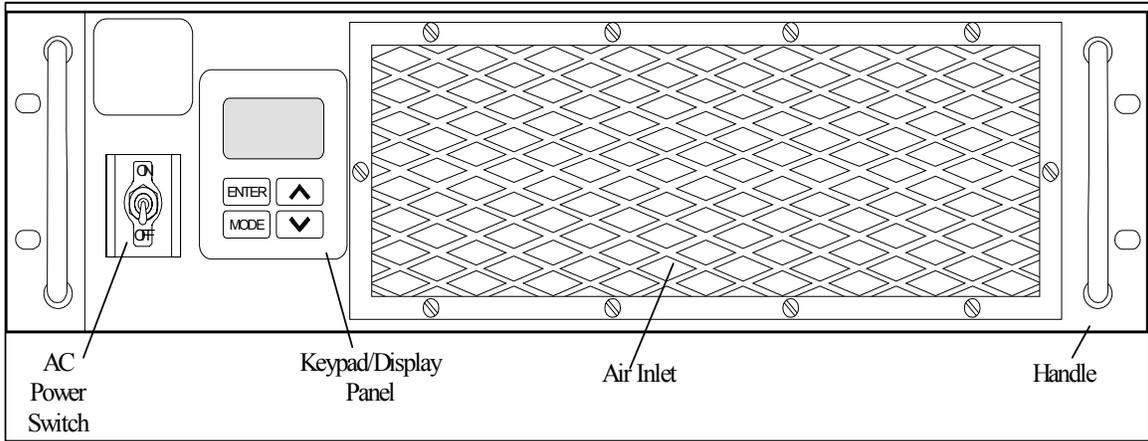


Figure 4 Representative Front Panel, 200W Power Amplifier

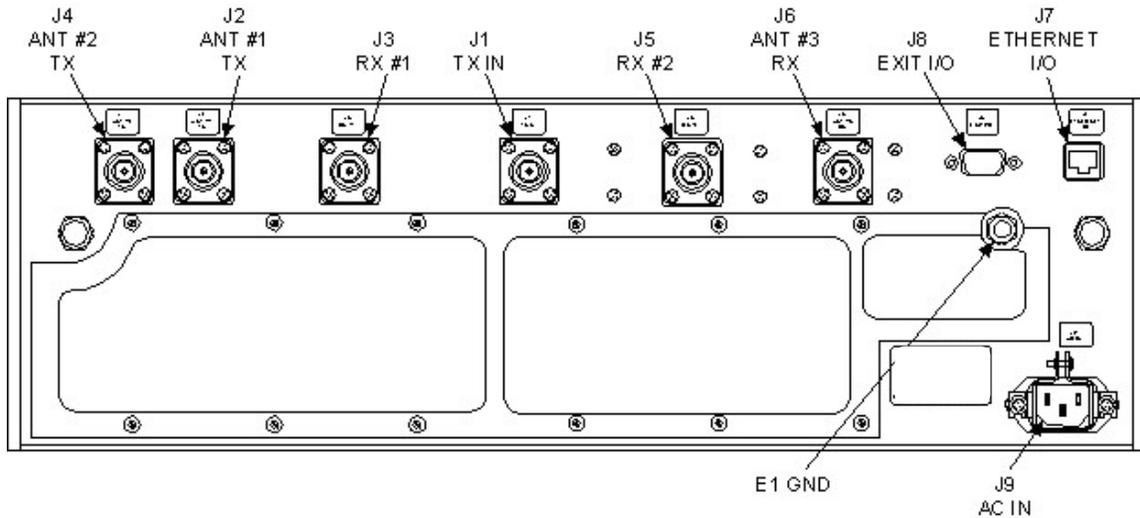


Figure 5 Representative Rear Panel, 200W Power Amplifier

3.2 Electrical (Connector) Interfaces

Per DMR Appendix J, the DMR VHF/UHF 100W and 200W HPAs have nine (9) electrical connectors. Per DMR Appendix K, the DMR 100WA and 100WB HPAs have seven (7) electrical connectors. All DMR HPAs have a single chassis ground stud (Table 3). All connectors are located on the HPA rear panel (Figure 3, Figure 5). Connector labels are representative.

The 100W and 200W power amplifiers have six RF connectors (J1 through J6). 100WA and 100WB power amplifiers have only four RF connectors (J1 through J4). The secondary RF receive path (J5 and J6), has been removed from the 100WA and 100WB HPAs. .

Specific electrical connector performance requirements are defined in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

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Table 3 HPA Electrical Interfaces

Ref	Type	Label	Direction	Description
J1	N - socket	TX IN	Radio to HPA	RF input - full or half duplex TX path
J2	N - socket	ANT #1 TX	HPA to antenna	RF output - full duplex TX path
J3	N - socket	RX #1	HPA to radio	RF output - primary RX path
J4	N - socket	ANT #2 TX/RX	HPA to antenna antenna to HPA	RF output - half duplex TX path RF input - full or half duplex RX path
J5*	N - socket	RX #2	HPA to radio	RF output - auxiliary RX path
J6*	N - socket	ANT #3 RX	Antenna to HPA	RF input - auxiliary RX path
J7	RJ45 - sockets	ETHERNET I/O	Between HPA and radio (bi-directional)	IEEE 802.3 100 Base-TX Fast Ethernet, remote (DMR) control of HPA
J8	DB9 - pins	EXT I/O	Discrete control to HPA Discrete status from HPA	Discrete inputs: RF path Duplex TX Enable TX Inhibit Discrete output: Master Fault indicator
J9	IEC-320 - pins	AC IN	Input	115 VAC power source for HPA
E1	Stud	GND	N/A	Chassis ground

* DMR Appendix J, J5 and J6 apply to 100W and 200W HPAs only. Per DMR Appendix K, 100WA and 100WB HPAs have a single RX path (J4 to J3), and do not have connectors for secondary RX path (J6 to J5).

3.2.1 RF Paths

Figure 6 is a simplified illustration of the DMR VHF/UHF power amplifier RF paths. Table 4 lists transmit and receive RF paths by HPA model. All VHF/UHF HPA RF paths operate over the 30 to 400 MHz frequency range.

HPA path RF interface characteristics are summarized in Table 5. Absolute RF characteristics are listed in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

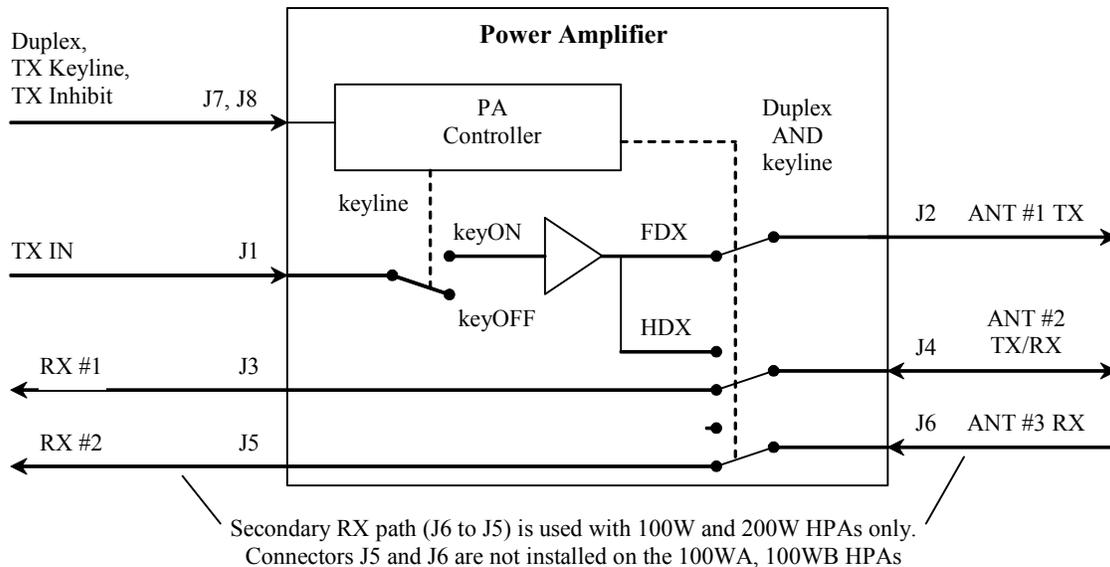


Figure 6 HPA RF Paths

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Table 4 DMR VHF/UHF HPA RF Paths

HPA Models	RF Path	Input port	Output port
100W, 100WA, 100WB, 200W	Half duplex TX path	J1 TX IN	J4 ANT #2
100W, 100WA, 100WB, 200W	Half duplex RX path	J4 ANT #2	J3 RX #1
100W, 100WA, 100WB, 200W	Full duplex TX path	J1 TX IN	J2 ANT #1
100W, 100WA, 100WB, 200W	Full duplex RX path	J4 ANT #2	J3 RX #1
100W, 200W	2 nd Full duplex RX path ¹	J6 ANT #3	J5 RX #2

¹Per DMR Appendix J HPA specifications, the 100W and 200W HPAs have two RX paths: J4 to J3, and J6 to J5. Per DMR appendix K specifications, the 100WA and 100WB HPA have only a single RX path: J4 to J3.

Table 5 HPA Transmit Path RF Characteristics

RF Port	RF Path	RF Characteristics
J1, TX IN	TX Full, TX Half	TX in port frequency range: 30 to 400 MHz Input power range: 100W, 200W HPA -20 dBm to +20 dBm +/- 0.1 dB 100WA, 100WB HPA -20 dBm to +15 dBm +/- 3.0 dB
J2, ANT #1	TX Full	Full duplex TX out port frequency range: 30 to 400 MHz Output power range: 100W HPA: 43 dBm to 50 dBm 200W HPA: 43 dBm to 53 dBm 100WA, 100WB HPA: 40 dBm to 50 dBm CW waveforms 100WA, 100WB HPA: 37 dBm to 46.5 dBm AM waveforms
J3, RX #1	RX Half, RX Full	RX out port frequency range: 30 to 400 MHz Insertion loss: 1.5 dB max J4 to J3
J4, ANT #2	TX Half, RX Half, RX Full	Half duplex TX out port frequency range: 30 to 400 MHz Half /Full duplex RX in port frequency range: 30 to 400 MHz Output power range: 100W HPA: 43 dBm to 50 dBm 200W HPA: 43 dBm to 53 dBm 100WA, 100WB HPA: 40 dBm to 50 dBm CW waveforms 100WA, 100WB HPA: 37 dBm to 46.5 dBm AM waveforms Insertion loss: 1.5 dB max J4 to J3
J5, RX #2 ¹	RX Full	Full duplex RX out port frequency range: 30 to 400 MHz Insertion loss: 1.5 dB max J6 to J5
J6, ANT #3 ¹	RX Full	Full duplex RX in port frequency range: 30 to 400 MHz Insertion loss: 1.5 dB max J6 to J5

¹Per DMR Appendix J HPA specifications, the 100W and 200W HPAs have two RX paths: J4 to J3, and J6 to J5. Per DMR appendix K specifications, the 100WA and 100WB HPA have only a single RX path: J4 to J3.

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3.2.2 ETHERNET I/O (J7)

The ETHERNET I/O port (J7) provides ‘REMOTE’ control capability of the DMR VHF/UHF power amplifiers (Figure 7). While connected to the HPA through the Ethernet port, the DMR has access to all HPA controls and status information, including detected fault conditions. Selected controls (TX Enable and Duplex) can be configured for ‘LOCAL’ control through the EXT I/O port (paragraph 3.2.3) while the HPA is otherwise controlled through the ‘REMOTE’ Ethernet port.

The Ethernet port is electrically compliant with the IEEE-802.3 Base 100-TX Fast Ethernet standard. Connector J7 is an 8-conductor RJ-45 socket-style connector, having pin assignments listed in Table 6.

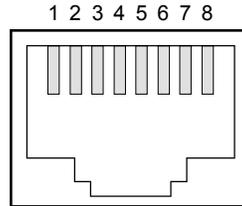


Figure 7 ETHERNET I/O (J7) RJ-45 Connector

Table 6 ETHERNET I/O (J7) Pin Assignments

Pin #	Direction	Signal	External Cable Conductor Colors	Functional Description
1	Output	TX +	White/Orange	Transmit Data (+ side of differential signal)
2	Output	TX –	Orange/White	Transmit Data (– side of differential signal)
3	Input	RX +	White/Green	Receive Data (+ side of differential signal)
4	N/A	N/A	Blue/White	Reserved
5	N/A	N/A	White/Blue	Reserved
6	Input	RX –	Green/White	Receive Data (– side of differential signal)
7	N/A	N/A	White/Brown	Reserved
8	N/A	N/A	Brown/White	Reserved

The DMR communicates with the VHF/UHF power amplifiers through the Ethernet I/O port, using a vocabulary of DMR-proprietary messages. HPA control and status information is embedded in the payload field of physical (MAC) Layer 2 DMR-defined Ethernet packets. The Ethernet messages are specifically designed to control DMR external RF devices, including the HPAs.

The DMR external RF control message ‘vocabulary’ configures HPA operating parameters such as: operating frequency, transmit path duplex mode: output power, keyON/keyOFF (TX Enable/TX Inhibit) state; and software download. HPA Ethernet control is apparent to the operator through status indications displayed on the HPA operator panel, and by HPA performance. Three of the command functions: Duplex mode, TX Enable, and TX Inhibit are duplicated in the EXT I/O port (paragraph 3.2.3).

The DMR also has access to HPA BIT and operating status through the Ethernet port. All HPA programmable and operating status parameters are reported to the radio through radio-requested status messages.

Table 7 is a summary of ETHERNET I/O port messages. Additional details of HPA Ethernet control messages are contained in the DMR 100WA/100WB High Power Amplifier Requirements Specifications (62-P43920J). DMR uses the same Ethernet messages to control all VHF/UHF power amplifiers (100W, 100WA, 100WB, and 200W). ALC-specific messages are applicable to the 100WB HPA only.

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A complete listing of all DMR external RF control Ethernet messages, including those listed in VHF/UHF HPA specifications and ICDs, are contained in Appendix C of the DMR External RF Control Interface: Ethernet Messages (70-P41401M). The Appendix C document is the master ‘dictionary’ for the DMR private External RF control network message protocol. The document provides detailed information of all messages used in the control of DMR external RF devices.

Ethernet messages and message field descriptions are contained in the Appendix C document. Low-level details of HPA message processing are contained in Appendix W of the DMR External RF Control Interface: Ethernet Message Details for the 100W-A/200W-A VHF/UHF Power Amplifier (70-P43900J).

Table 7 Ethernet Port Messages

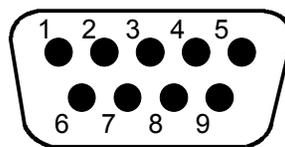
Control	Description
TX (control) Mode	Selects source of transmit path TX Enable controls
Duplex Mode	Selects RF TX and RX paths for half duplex and full duplex operation
Frequency	Sets HPA operating frequency: filter band, 1 MHz steps, or 10 MHz steps
Input Power	Sets anticipated input RF power level: -20 to +20 dBm or -20 to +15 dBm, 0.5 dB steps
Output Power	Sets HPA output power level: 40 to 50 dBm, 43 to 50 dBm, or 43 to 53 dBm. 1 dB steps
ALC ON/OFF ¹	Sets ALC ON/OFF state: ON or OFF, HPA defaults to ALC ON at reset (100WB only)
ALC Slew Rate ¹	Sets ALC Slew Rate: FAST or SLOW (100WB only)
Status Request	Requests HPA operational/configuration status
Status Response	HPA-generated message, reports operational/configuration status
Query Request	Requests HPA properties such as hardware/software versions, and PA ID
Query Response	HPA-generated message, reports properties such as hardware/software versions, and PA ID

¹ ALC ON/OFF and ALC Slew Rate messages are applicable only to the 100WB HPA

3.2.3 EXT I/O (J8)

The EXT I/O port (J8) provides ‘LOCAL’ electrical control capability of DMR VHF/UHF power amplifier TX Enable, TX, and Duplex controls; and ‘LOCAL’ access to the HPA Master Fault status indicator (**Error! Reference source not found.**). ‘LOCAL’ control of EXT I/O TX Enable and Duplex inputs is most effective when used in conjunction with other ETHERNET I/O port controls (paragraph 3.2.2) or the HPA operator panel (paragraph 3.3.2). ‘LOCAL’ assertion of the EXT I/O TX Inhibit input is always allowed, regardless of any other remote of operator panel configuration. The Master Fault indicator represents a summary of overall HPA operational status. The indicator outputs a fault condition when TX path output power has been interrupted.

Connector J8 is a 9-pin (DB9) ‘pins’ style connector, having pin assignments listed in Table 8.



DB9 ‘pins’
connector

Figure 8 EXT I/O (J8) DB9 Connector

The EXT I/O port consists of 5V TTL-compatible circuitry for three discrete inputs: TX Enable, TX Inhibit (MUTE), and Duplex; and 5V TTL circuitry for a single output: Master Fault indicator.

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The TX Enable input provides transmit path keyON/keyOFF control when the HPA is configured for 'LOCAL' operation by the radio or through the HPA operator panel.

The TX Inhibit input enables the use of the TX Enable control. When asserted, TX Inhibit disables the TX path – sets the HPA to keyOFF – whether the TX path TX Enable control is provided by EXT I/O port (LOCAL control) or Ethernet port (REMOTE control).

The TX Enable and TX Inhibit inputs are internally pulled-up to +5V or pulled-down to ground through at least 10K ohm resistors. Internal control logic ensures EXT I/O controls operate as described in Table 8.

The Master Fault output is 5V TTL compatible, having a maximum current sink capability of 4 mA when the HPA drives output to a logic "LOW" (asserted-fault) state.

The Duplex input routes transmit path power from J1 to the full duplex (J2) or half duplex (J4) output port (Figure 6, Table 4) when the HPA is configured for 'LOCAL' operation by the radio.

Additional EXT I/O port details, including operational definitions of port controls and indicators are contained in the applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

Connector J8 pin assignments and signal characteristics are summarized in Table 8. The listed signal characteristics are notational only. Absolute EXT I/O electrical and functional characteristics are listed in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

Table 8 EXT I/O (J8) Signals

Pin #	Signal	Direction	Voltage	Functional Description
1	Ground	--	--	Signal (ground) reference for EXT I/O port
2	Duplex	Input	5V TTL	Connects Transmit path input (J1) to output (J2 or J4) Logic '0' = FULL duplex, TX IN (J1) to ANT #1 TX (J2) Logic '1' = HALF duplex, TX IN (J1) to ANT #2 TX (J4) Open input is logic '1', Half duplex
3	Spare	--	--	Reserved for future use
4	Spare	--	--	Reserved for future use
5	Ground	--	--	Signal (ground) reference for EXT I/O port
6	Master Fault	Output	5V TTL	Indicates overall HPA operational status Version "D1" hardware, 3.0.0 software and later. Logic '0' = internal fault detected Logic '1' = no faults detected, HPA status OK Prior to version "C1" hardware, 2.0.1 and prior Logic '0' = no faults detected, HPA status OK Logic '1' = internal fault detected
7	TX Enable/	Input	5V TTL	Local source of transmit path TX Enable control: Logic '0' = transmit path OFF (keyOFF) Logic '1' = transmit path ON (keyON) Open input is logic '0', transmit path keyOFF
8	TX Inhibit	Input	5V TTL	Local source of transmit path TX Inhibit control: Logic '1' = enables use of the TX Enable control Logic '0' = overrides TX Enable, sets HPA to keyOFF state Open input is logic '1', enables use of TX Enable
9	Spare	--	--	Reserved for future use

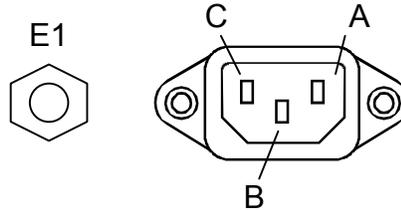
Note: logic levels '0', '1' refer to TTL logic states: '0' = low voltage, '1' = high voltage

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3.2.4 AC IN (J9)

The HPA AC IN is a single-phase, IEC-320 compatible, 15-Amp, male connector (Figure 9). AC connector pins ‘A’ and ‘C’ are the (AC) voltage inputs for the HPA. Compliant with shipboard delta-configuration AC connector pin (B) is connected to HPA chassis ground, but is not a current-carrying conductor.

A chassis ground is provided through a hardware stud (E1) located on the rear panel (Figure 3, Figure 5). Connector J9 pin assignments are listed in Table 9. External cable color labels are notational only. Absolute AC IN electrical characteristics and power consumption requirements are listed in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).



View : HPA rear panel male connector

Figure 9 AC IN (J9) Connector

Table 9 AC IN (J9) Single Phase Electrical Characteristics

Pin #	External Cable Conductor Color	Description
A	White	115 VAC, 60 Hz Delta
C	Black	115 VAC, 60 Hz Delta
B	Green	Mate-first safety ground, connected to HPA chassis

3.3 Operator Controls and Indicators

The HPA operator control interface consists of an AC power switch, a keypad, and an illuminated display panel. All operator controls and indicators are located on the HPA front panel (Figure 2, Figure 4).

3.3.1 AC Power Switch

The HPA has a single power switch / circuit breaker, located on the front panel. Setting the power switch to ON applies (115 VAC) power to all HPA circuits. Setting the power switch to OFF disconnects the HPA from external AC power. Additional details of the HPA power switch/circuit breaker is contained in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

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3.3.2 Operator Control Panel

The HPA Operator Panel (Figure 10) provides ‘LOCAL’ operator control capability of the DMR VHF/UHF power amplifiers. The operator can scroll through a list of all HPA controls and indicators, set through the ETHERNET I/O port (paragraph 3.2.2) or the EXT I/O port (paragraph 3.2.3). The operator can change the value of most HPA controls through the operator panel. The Maximum Output Power control (MAX PWR) can only be set through the HPA operator panel. Although always enabled by the 6.4.1 DMR, the radio has the capability to temporarily lock out the HPA operator panel. ‘LOCKOUT’ status is displayed on the HPA operator panel and can be overridden if necessary by cycling HPA power.

The HPA Operator Panel consists of two components: a 4-button keypad, and an illuminated 2-line text display. The four keypad buttons: “MODE”, “UP” (arrow), “DOWN” (arrow), and “ENTER” provide the means to navigate through the HPA controls and indicators menu (Table 10). The display panel has variable-intensity illumination.

Table 10 HPA Operator Panel Keypad

Control	Description
MODE	Scrolls through list of operator panel menu controls and indicators
“UP” arrow	Scrolls (UP) through list of options available for HPA controls and indicators
“DOWN” arrow	Scrolls (DOWN) through list of options available for HPA controls and indicators
ENTER	Selects displayed option for displayed control. Option indicates selected status

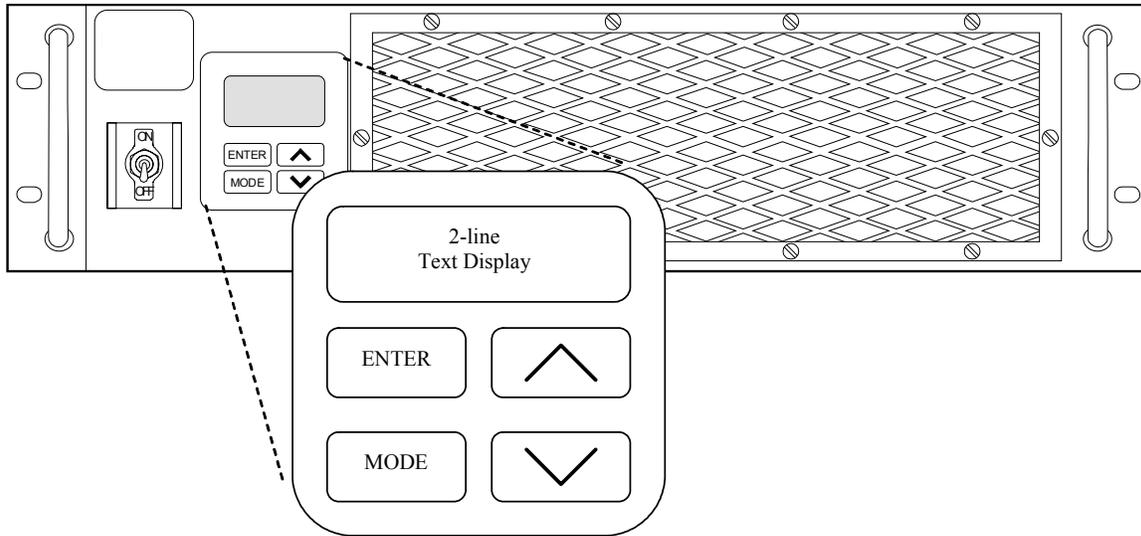


Figure 10 Notational Illustration, HPA Operator Panel

The menu-driven HPA control panel provides operator access to HPA parameters such as operating frequency, input power, output power, and local/remote control mode. The 100W, 100WA, and 200W HPAs have operator panel access to the transmit path duplex control. The 100WB operator panel displays remote or local status of the transmit path duplex control, but does not allow operator panel selection of the duplex control. This is OK since the 100WB HPA duplex mode can be set through the remote (Ethernet) or local (EXT I/O) control ports.

The menu-listed indicators display the operational status of HPA performance parameters such as: transmit path duplex mode, operating frequency, keyOFF/keyON state, measured output power, and BIT status. 100WA and 100WB HPAs are capable of displaying measured applied RF (input) power. Pop-up notices for monitored faults such as: excessive input power, excessive output power, excessive VSWR, excessive internal temperature, low power supplies, and low output power are also displayed on the operator panel menu.

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Table 11 is a representative list of HPA parameters accessible through the control panel.
 Table 12 is a representative list of HPA indicators viewable through the control panel.
 Table 13 summarizes display formats for HPA input power ranges
 Table 14 summarizes display formats for HPA output power ranges
 Table 15 is a representative list of HPA performance monitors viewable through the control panel

HPA operator panel controls, indicators, and performance monitors, along with HPA performance details are contained in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

Detailed information regarding the interaction between the HPA operator panel and the Ethernet (remote) control port is contained in Appendix W of the DMR External RF Control Interface: Ethernet Message Details for the 100W-A / 200W-A (100WA, 100WB, 200W) VHF/UHF Power Amplifier (70-P43900J). All Ethernet messages are used with the 100W, 100WA, 100WB, and 200W HPAs. ALC messages apply only to the 100WB HPA.

Table 11 HPA Operator Panel Menu Controls

Control	Description
TX (control) Mode	Selects source of transmit path TX Enablecontrols
Duplex Mode	Selects RF TX and RX paths for half duplex and full duplex operation
Frequency	Sets HPA operating frequency: filter band, 1 MHz steps, or 10 MHz steps
Input Power	Sets anticipated input RF power level: -20 to +20 dBm or -20 to +15 dBm, 0.5 dB steps
Output Power	Sets HPA output power level: 40 to 50 dBm, 43 to 50 dBm, or 43 to 53 dBm. 1 dB steps
Maximum Power ¹	Sets maximum limit of transmit path output power: same ranges as Output Power control
ALC ON/OFF ²	Sets ALC ON/OFF state: ON or OFF, HPA defaults to ALC ON at reset (100WB only)
ALC Slew Rate ²	Sets ALC Slew Rate: FAST or SLOW (100WB only)
Display Intensity	Sets illumination (brightness) of Operator Panel

Note: HPA controls are also indicators

¹ Maximum output power is set only at the HPA operator panel, and is not accessible through the Ethernet port

² ALC ON/OFF and ALC Slew Rate controls applicable only to the 100WB power amplifier

Table 12 DMR VHF/UHF HPA Operator Panel Indicators

Indicator	Description
Ethernet MAC address	Displays unique Ethernet address assigned to PA during manufacture.
DMR RF Channel ID	Displays RF channel assigned by DMR radio.
TX (Control) Mode	Displays source of transmit path TX Enable control.
Frequency	Displays operating frequency of transmit path
Input Power (set)	Displays input power control setting
Input Power (measured) ¹	Displays measured RF power applied to transmit path input.
Output Power (set)	Displays output power control setting.
Output Power (measured)	Displays measured RF power at transmit path output.
Maximum Power	Displays maximum power limit of transmit path
ALC ON/OFF ²	Displays ALC ON/OFF state
ALC Slew Rate ²	Displays ALC slew rate state
TX Indicator	Displays TX path TX Enable (keyON/keyOFF) state

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Indicator	Description
Mute (TX Inhibit)	Displays PA TX Inhibit (Mute) state.
Temperature	Displays nominal (internal) chassis temperature.
Software Version ID	Displays version ID of PA software program(s).

¹ Measured input power available only with the 100WA and 100WB power amplifiers

² ALC ON/OFF and ALC Slew Rate indicators applicable only to the 100WB power amplifier

Table 13 DMR VHF/UHF HPA Input Power Ranges

HPA Models	Input Power Range	Displayed As	Waveform Type
100W	-20 to +20 dbm -26 to +14 dbm	-20 to +20 dbm -20 to +20 dbm	Constant Amplitude Amplitude Modulated
100WA, 100WB	-20 to +15 dbm (10 to 300 mW) -26 to +9 dbm (2.5 to 8 mW)	-20 to +15 dbm (10 to 300 mW) -26 to +9 dbm (2.5 to 8 mW)	Constant Amplitude Amplitude Modulated
200W	-20 to +20 dbm -26 to +14 dbm	-20 to +20 dbm -20 to +20 dbm	Constant Amplitude Amplitude Modulated

Table 14 DMR VHF/UHF HPA Output Power Ranges

HPA Models	Output Power Range	Displayed As	Waveform Type
100W	20 to 100W 5 to 25W	20 to 100W 20 to 100W ¹	Constant Amplitude Amplitude Modulated
100WA, 100WB	10 to 100W, (40 to 50 dBm) 5 to 45W, (37 to 47 dBm)	10 to 100W, (40 to 50 dBm) 5 to 45W, (37 to 47 dBm)	Constant Amplitude Amplitude Modulated
200W	20 to 200W 5 to 50W	20 to 200W 20 to 200W	Constant Amplitude Amplitude Modulated

¹ Special calibration procedures may be used to increase 100W PA output power to 27W for AM waveforms

Table 15 DMR VHF/UHF HPA Performance /Fault Monitors

The following list is representative of power amplifier fault indicators. Fault labels may vary between PA models.

Indicator	Description
Excessive Input Power	Indicates RF power applied to RF input exceeds selected input power control
Excessive Output Power	Indicates RF power output exceeds selected output power control
Excessive VSWR	Indicates reflected RF power affecting HPA performance
Excessive Temperature	Indicates excessive internal (chassis) temperature affecting HPA performance
Low Output Power	Indicates RF power output less than selected output power control
Low Power Supply	Indicates decreased internal power supply output affecting HPA performance

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3.4 HPA Logical Model

3.4.1 HPA Control Sources

The HPA transmit and receive RF paths are controlled by a combination of three interfaces: Discrete (EXT I/O), Ethernet (ETHERNET I/O), and Operator Panel (Figure 11).

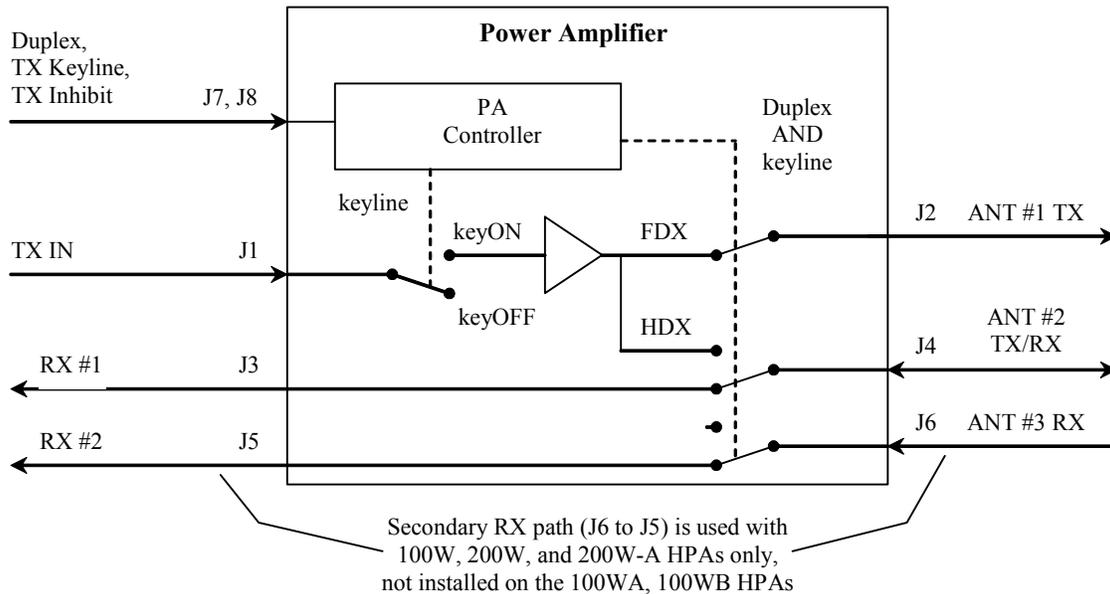


Figure 11 HPA Logical Model

RF path controls: duplex, TX Enable, and TX Inhibit are available through the Ethernet (J7) or EXT I/O (J8) ports. The duplex control is also accessible through the operator panel of the 100W, 100WA, and 200W HPAs, when configured for REMOTE operation. The duplex mode control state may be monitored but not set through the 100WB operator panel.

The Ethernet port and the EXT I/O port duplex and TX Enable controls are mutually exclusive. Only one set of controls (EXT I/O or Ethernet) may be enabled at any time. The TX Inhibit control is always enabled, whether set through the EXT I/O port or the Ethernet port.

For the 100W, 100WA, and 200W HPAs, the most recent Ethernet port or operator panel duplex mode selection sets the transmit path duplex mode. This contention is intentionally designed out of the 100WB HPA.

Table 16 is a notational summary of the associations between HPA sources control interfaces and primary HPA controls and indicators. Complete listings of HPA control interface associations are contained in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

Table 16 HPA Control / Interface Matrix

Control	ETHERNET I/O	Operator Panel	EXT I/O
TX (Control) Mode	Y	Y	N
Duplex Mode	Y	Y ¹	Y
Frequency	Y	Y	N
Input Power	Y	Y	N
Output Power	Y	Y	N

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Control	ETHERNET I/O	Operator Panel	EXT I/O
Maximum Power	N	Y	N
ALC Modes ²	Y	Y	N
HPA Status	Y	Y	N
TX Enable	Y	N	Y
TX Inhibit	Y	N	Y

Note 1: operator panel access to duplex mode selection is available for the 100W, 100WA, and 200W power amplifiers only. The 100WB HPA does not have operator panel (control) access to duplex mode.

Note 2: ALC mode controls applicable only to 100WB power amplifier

3.4.2 HPA RF path logic

Table 17 is the HPA RF path logic/truth table. The HPA operates the same for local or remote control modes. The table is aligned with Duplex mode, and then by TX Enable (Transmit Enable). An asserted TX Inhibit (Transmit Inhibit or MUTE) control always has authority over the TX Enable control.

For each duplex mode, the PA State column lists the results of logical ANDing the TX Enable and TX Inhibit controls. The Transmit Path and Receive Path columns show transmit and receive path RF signal routing through the PA. The 100W and 200W power amplifiers have two receive paths: J4 to J3, and J6 to J5. The 100WA and 100WB power amplifiers have a single receive path: J4 to J3.

Table 17 HPA RF Path Truth Table

Duplex	TX Enable	TX Inhibit (a.k.a. MUTE)	PA State	Transmit Path	Receive Path
Full	keyOFF	TX path enabled	keyOFF	J1 to J2 isolated	J4 to J3 J6 to J5 ¹
Full	keyON	TX path enabled	keyON	J1 to J2	J4 to J3 J6 to J5 ¹
Full	N/A	TX path inhibited	keyOFF	J1 to J2 isolated	J4 to J3 J6 to J5 ¹
<hr/>					
Half	keyOFF	TX path enabled	keyOFF	J1 to J4 isolated	J4 to J3 J6 to J5 ¹
Half	keyON	TX path enabled	keyON	J1 to J4	None enabled
Half	N/A	TX path inhibited	keyOFF	J1 to J4 isolated	J4 to J3 J6 to J5 ¹

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3.5 Additional Information

3.5.1 Power Amplifier Timing

HPA timing is defined in applicable 100W, 100WA, 100WB, and 200WHPA specifications (10088, 10329, and 62-P43920J documents). The specifications address timing between: 1) TX path TX Enable controls and TX path output power transitions, and 2) the effect of ALC slew rates on transmit path output power transitions (100WB HPA only). ETHERNET I/O port and EXT I/O port control operation, including TX Inhibit (mute), is considered in specified HPA timing.

3.5.2 Power Parameters

HPA power parameter requirements, including: power-on in-rush current, RX and TX operation power consumption, and continuous and emergency line voltage; are listed in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

3.5.3 Thermal Parameters

HPA thermal parameter requirements, including: operating temperature, storage temperature, temperature stability, and thermal design (heat dissipation); are listed in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

3.5.4 Airflow

The DMR VHF/UHF power amplifiers have cooling fans located on the rear panel of the HPA chassis (Figure 3, Figure 5). The cooling fans are always ON while power is applied to the amplifier. Nominal air flow values are listed in Table 18.

Table 18 Nominal HPA In-to-Out Air Flow

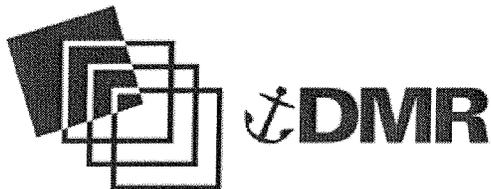
	AM7584 200W	AM7585 100W	AM7585A 100WA	AM7585B 100WB
Air flow (CFM)	125	75	100	150

3.5.5 Weight

HPA weight limitations are listed in applicable 100W, 100WA, 100WB, and 200W HPA specifications (10088, 10329, and 62-P43920J documents).

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Digital Modular Radio (DMR) AN/USC-61 (C)



**Responses to Comments on the
IDD for the DMR External RF 100W and 200W VHF/UHF
High Power RF Amplifiers, 70-P46173F, Revision A**

CDRL No.	A011-002A
Contract	N00039-98-D-0029
Contract Mod	P00045
Delivery Order	N/A

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WARFARE SYSTEMS COMMAND
San Diego, CA**

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Date **27 March 2006**

Item #	SPAWAR COMMENTS	GDC4S RESPONSES
1	<p>1. Virtually no mechanical interface information included. A plan & elevation view should be added to the ICD identifying the Height (inches and U), width (inches) and depth (inches), the CG and weight for the items identified below as well as the measurements:</p> <ul style="list-style-type: none"> a. connector locations b. specific locations of the shock pins c. the size of the shock pins d. specifics of the EIA-310-D mounting schemes e. overall size f. show the protrusion of the switches and air filter off of the front panel g. protrusion of connectors/fans off the rear panel 	<p>Mechanical interface details are referenced to released DMR drawings 70-P45106G and 70-P45956F where applicable in the IDD.</p> <p>Referencing, rather than including drawing details in the HPA IDD is recommended in DI-IPSC-81436A: section 3 (Format), section 3.1 (Interface identification and diagrams), and section 4g (Content, Substitution of existing documents).</p>
2	<p>The power definition indicates the AC power input is designed for shipboard delta power, yet the connector pin definition shows a 115 VAC neutral. There is no neutral in delta power.</p> <p>The definition could be interpreted that this neutral is grounded to the chassis, as is the case of many shore based systems. The connector pin definition should be revised to read 115 VAC, 60 Hz Delta for both power pins.</p>	<p>Updated paragraph 3.2.4 and table 8 to recommended label for connector pins 'A' and 'B'</p>
3	<p>The statement that "legacy" units only have the J5 and J6 connections is not adequate. It should identify the range of serial numbers of the units that have these connections available.</p> <p>This information will not change over the life of the program, so there is no danger in having to update or correct it over time.</p>	<p>Removed "legacy" term. Defined and used nomenclature and "common name" for all HPA references throughout document. Specific statements were added to clarify scope and applicability of J5/J6 RX path by PA type.</p>

Item #	SPAWAR COMMENTS	GDC4S RESPONSES
4	<p>There was a fairly lengthy discussion which it was agreed upon that the SATCOM receive signal should not be processed by the PA. In fact, the J5/J6 would not be available on the newer PAs, and that appears to be true.</p> <p>The truth tables show the states of the connections for the PA in this ICD. Table 15 - HPA Receive Path Truth Table, indicates that the J4/J3 connection could be used as a Full-Duplex (SATCOM) receive path and it provides a maximum loss value for that path of 1.5 dB in an untitled table in Paragraph 3.2.1.</p> <p>Utilizing this signal path would allow the DMR exciter to be an RX port and be directly connected to the PA with no external switching. Switching would be necessary on the interface between the PA and RFIU in the submarine design. So there may be some advantage to using this connection.</p> <p>On the other hand, it was directed, not in this ICD, that the SATCOM receive signal path should NOT pass through the PA. This ICD indicated differently. This is conflicting information.</p> <p>If the SATCOM receive path should NOT be processed via the PA for Full-Duplex operation, then that should be clearly stated. As it is currently written, it looks like a viable configuration and maybe even advantageous.</p>	<p>The IDD describes the PA RF paths, and RF path control logic.</p> <p>The IDD intentionally avoids descriptions for use of the PA with specific waveforms or external RF components.</p> <p>Extending PA description beyond the PA interfaces so is beyond the scope of the PA IDD.</p>
5	<p>The UHF PA ICD does not ever define the frequency ranges that it covers and any constraints.</p> <p>The HF does mention 2 to 30 MHz, but only in the overview. These items should be clearly stated in the interface descriptions as well.</p>	<p>The IDD now lists HPA operating frequency in the "Amplifier Overview" section, in RF path intro paragraph 3.2.1, and for each connector listed in table 4.</p>
6	<p>AC Power requirements are not defined in terms of start on power, receive state and full transmit output.</p>	<p>Added "Power Parameters" paragraph to new "Additional Information" section of the IDD, which references: in-rush current, RX and TX power consumption, and continuous and emergency line voltage references to the PA specification.</p>

Item #	SPAWAR COMMENTS	GDC4S RESPONSES
7	Heat dissipation is not defined for receive and transmit states.	Added "Thermal Parameters" paragraph to new "Additional Information" section of the IDD. which references: storage temperature, operating temperature, thermal stability, and heat dissipation sections in the PA specification.
8	<p>The specification is a document that defines the limits, constraints and requirements of the design. The ICD should be describing the physical implementation of the equipment that was developed to meet that specification.</p> <p>There is too much reliance on the equipment specification. This information should be included here and will not necessarily be a repeat of the specification information.</p> <p>The purpose for having the ICD is so all of the information is located in a single document for interfacing with the equipment.</p> <p>This document would have been used to determine how to integrate the power amplifier into the CSRR design.</p> <p>The fact that it did not exist forced referring to the Specifications, IETMS and other non-specific documentation which probably lead to some of the issues the CSRR had with implementing the DMR.</p> <p>This ICD document should completely describe the terminal functionality with respect to interfaces electrical, mechanical and thermal.</p>	<p>PA physical dimensions are implemented per the mechanical (hardware) ICD.</p> <p>The PA control interface implementation is compliant with the DMR external RF control (Ethernet) network protocol.</p> <p>The PA operator interface and the local electrical control interface implementations are compliant with details listed in the PA specification.</p> <p>Data Item Description DI-IPSC-81436A, specifically: sections section 3 (Format), section 3.1 (Interface identification and diagrams), and section 4g (Content, Substitution of existing documents); recommend referencing rather than copying details contained in pre-released documents.</p> <p>The referenced documents are used by all PA development teams, are therefore considered to be 'living'. PA specifications and drawings are updated on an as-needed basis, which has been at a rate more frequent than updates to this IDD..</p> <p>DMR provides the latest version PA specifications, interface control documents and hardware drawings upon request.</p>
9	There should be some estimate of airflow and required temperature.	Added "Airflow" paragraph to new "Additional Information" section, which addresses PA cooling fans, cooling fan operation, and airflows typical for idle, RX, and transmit operating conditions.