HPOD

C, X, Ku Outdoor Power Amplifier
Installation and Operation Manual

Part Number MN/HPOD.IOM
Revision 0

Errata A

Comtech EF Data Documentation Update

Subject:	Added Figure and Parts List for Ku-Band 1:1 Kit, KT/11936-1
Date:	November 23, 2005
Document:	HPOD C, X, Ku Outdoor Power Amplifier, Installation and Operation Manaual, Revision 0, August 25, 2005
Part Number:	MN/HPOD.EA0
Collating Instructions:	Attach this page to page A-5/A-6

Comments:

Add Figure A-3 and Table A-3 for the Kit KT/1-936-1

Table 0-1. Parts List for Redundant 1:1 Ku-Band Kit, P/N KT/111936-1

Item	Part No.	Description	Qty.
1	SW/WGS+28V-75SB	Switch, +28VDC	1
2	FP/WG11825-1	Waveguide, Straight	1
3	FP/WG11935-1	Waveguide, Right	1
4	FP/WG11934-1	Waveguide, Left	1
5	FP/BR11933-1	Bracket, Switch	1
6	FP/BR11424-1	Bracket, Mounting	4
7	FP/BR11931-1	Bracket, Unistrut	3
8	FP/BR11932-1	Bracket, Unistrut	2
9	GA/WR75-R-F-C	Gasket, Full Thickness	2
10	GA/WR75-R-H-C	Gasket, Half Thickness	4
11	RF/TERM75/350W	Waveguide, Termination	1
-12	Not Used		
-13	Not Used		
-14	Not Used		
-15	Not Used		
-16	Not Used		
-17	Not Used		
-18	Not Used		
-19	Not Used		
20	HW/1/4SPRINGNUT	Nut, Channel	2
21	HW/3/8SPRINGNUT	Nut, Spring	14
22	HW1/4-20X5/8SHCS	Screw 1/4-20 x 5/8 SHCS, SS	2
23	HW/1/4-SPLIT	Washer, Lock	2
24	HW/1/4-FLT	Washer, Flat	2
25	HW/38-16X1BLT	Bolt, Hex Head	38
26	HW/3/8-SPLIT	Washer, Lock	38
27	HW/3/8-FLT	Washer, Flat	38
-28	Not Used		
29	HW/3/8-16HEXNUT	Nut, Hex	24
30	HW/6-32X3/4SHCS	Screw, Socket Head	4
31	HW/6-32X5/8SHCS	Screw, Socket, Head	8
32	HW/6-SPLIT	Washer, Lock	28
33	HW/6-FLT	Washer, Flat	32
34	HW/6-32HEXNUT	Nut, Hex	4
35	HW/6-32X1/2SHCS	Screw, Socket Head	16

- Item Not Illustrated.

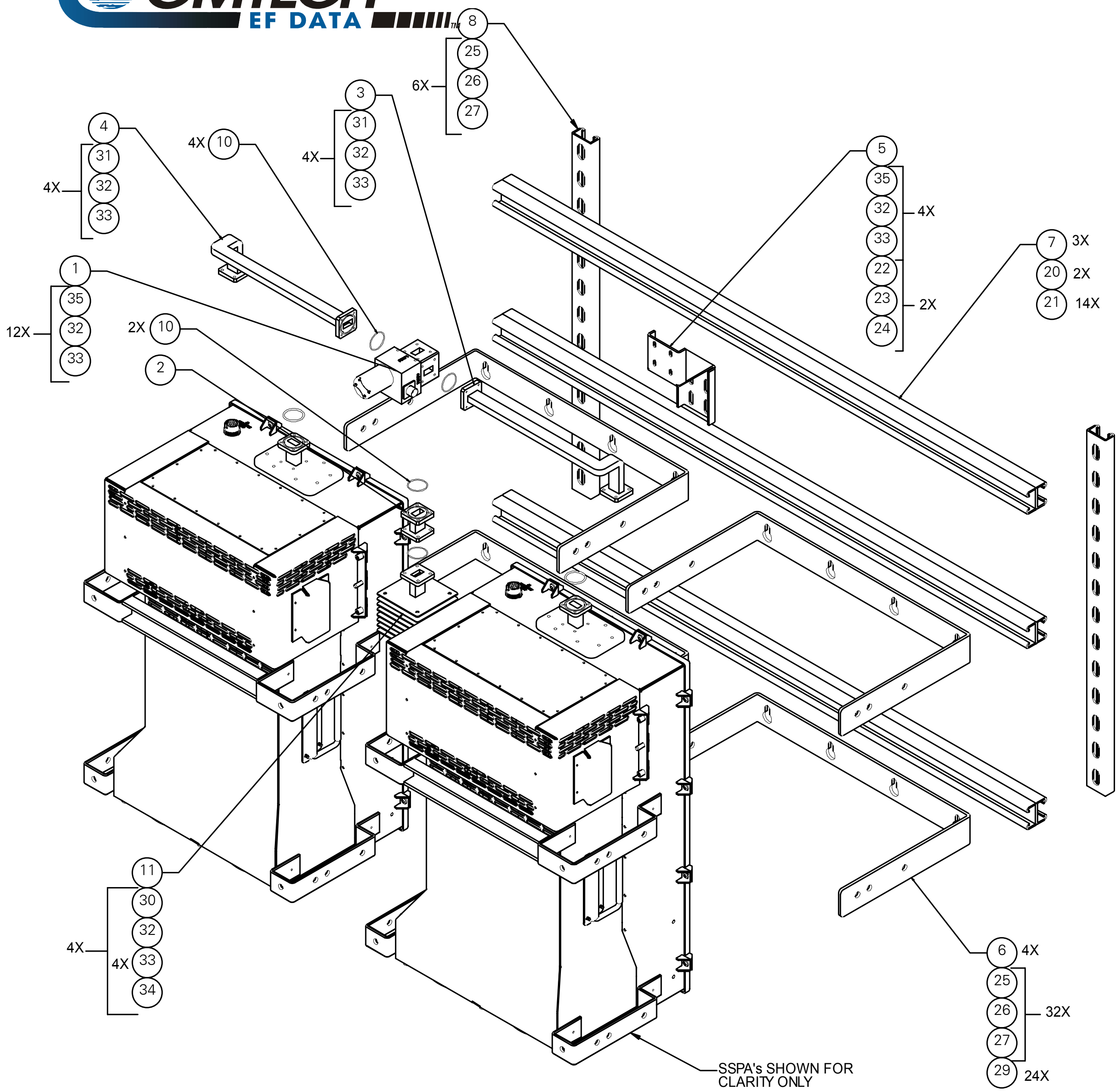

Figure A-1. Redundant 1:1 Ku-Band Kit, P/N KT/111936-1

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Errata B

Comtech EF Data Documentation Update

Subject: Add AUX Command

Date: March 2, 2006
Document: HPOD C, X, Ku Outdoor Power Amplifier, Installation and Operation Manaual, Revision 0, August 25, 2005
Part Number: MN/HPOD.EB0
Collating Instructions: Attach this page to Chapter 4.

Comments:

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
AUX	AUX=	1 byte	Command or Query. <0001/AUX=x 0=Disabled 1=Enabled Example: AUX=1 (AUX Mute enabled) Note: When enabled, Pin H of COMM 1 connector must be grounded to UN-MUTE unit. Otherwise, unit will be muted and a MUT=2 condition will be reported.	AUX= (message ok) AUX? (Received ok, but invalid arguments found) AUX* (message ok, but not permitted in current mode)	AUX?	AUX=x (Same format as command arguments)

HPOD

C, X, Ku Outdoor Power Amplifier
Installation and Operation Manual

Comtech EF Data is an ISO 9001 Registered Company.

Part Number MN/HPOD.IOM
REVISION 0
August 25, 2005

CUSTOMER SUPPORT

Contact the Comtech EF Data Customer Support Department for:

- Product support or training
- Information on upgrading or returning a product
- Reporting comments or suggestions concerning manuals

Contact Customer Support using any of the following methods:

Mail: Comtech EF Data
Customer Support Department
2114 West 7th Street
Tempe, Arizona 85281 USA

Email: service@comtechefdata.com

Internet: www.comtechefdata.com

Phone: 480.333.2200 (Main Comtech EF Data Number)
480.333.4357 (Customer Support Desk)

Fax: 480.333.2161

To return a Comtech EF Data product (in-warranty and out-of-warranty) for repair or replacement:

1. Request a Return Material Authorization (RMA) number from the Comtech EF Data Customer Support Department.

2. Be prepared to supply the Customer Support representative with the model number, serial number, and a description of the problem.

3. To ensure that the product is not damaged during shipping, pack the product in its original shipping carton/packaging.

4. Ship the product back to Comtech EF Data. (Shipping charges should be prepaid.)

For more information regarding the warranty policies, see Warranty Policy, p. vi.

Table of Contents

ABOUT THIS MANUAL

This manual provides installation and operation information for the Comtech EF Data HPOD. This is a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the HPOD.

CONVENTIONS AND REFERENCES

CAUTIONS AND WARNINGS

CAUTION ***CAUTION indicates a hazardous situation that, if not avoided, may result in minor or moderate injury. CAUTION may also be used to indicate other unsafe practices or risks of property damage.***

WARNING ***WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.***

IMPORTANT ***IMPORTANT indicates a statement that is associated with the task being performed.***

METRIC CONVERSION

Metric conversion information is located on the inside back cover of this manual. This information is provided to assist the operator in cross-referencing English to Metric conversions.

TRADEMARKS

Other product names mentioned in this manual may be trademarks or registered trademarks of their respective companies and are hereby acknowledged.

REPORTING COMMENTS OR SUGGESTIONS CONCERNING THIS MANUAL

Comments and suggestions regarding the content and design of this manual will be appreciated. To submit comments, please contact:

Comtech EF Data Technical Publications Department: techpub@comtechefdata.com

SAFETY NOTICE

This equipment has been designed to minimize exposure of personnel to hazards.

The operators and technicians must:

- Know how to work around, with and on high voltage equipment.
- Exercise every precaution to ensure personnel safety.
- Exercise extreme care when working near high voltages.
- Be familiar with the warnings presented in this manual.

CAUTION

A Neutral Fusing - Double pole/ neutral fusing used on the prime power supply input.

INSTALLATION GUIDELINES REGARDING POWER LINE QUALITY

IMPORTANT

Comtech EF Data has become familiar with the varying quality of the AC power grid around the world. The following offers some installation guidelines that should help ensure a reliable installation.

- **Surge suppression:** High voltage surges can cause failure of the power supply. These surges are typically caused by circuit switching on the main AC power grid, erratic generator operation, and also by lightning strikes. While the HPOD does have built in surge suppression, if the unit will be installed in a location with questionable power grid quality, Comtech EF Data recommends installation of additional power conditioning/surge suppression at the power junction box.

- **Grounding:** The HPOD provides a grounding terminal. This is provided to allow the user to ground the HPOD to the antenna's grounding network. All components installed at the antenna should be grounded to a common grounding point at the antenna.

- **Electrical welding:** If welding needs to take place at the antenna, disconnect all cables from the HPOD except for the ground wire. Cap all RF connections with terminations. This will prevent damage to the input/output circuitry of the HPOD.

- **Lightning:** Lightning strikes on or around the antenna will generate extremely high voltages on all cables connected to the HPOD. Depending on the severity of the strike, the HPOD's internal surge protection combined with the recommended external suppression may protect the HPOD's power supply. However, if the installation will be in an area with a high probability of lightning strikes, Comtech EF Data recommends the installation of surge suppression on the RF and IF cables. One source of these suppressors is PolyPhaser (www.polyphaser.com)

For further information, contact Comtech EF Data, Customer Support Department.

WARRANTY POLICY

This Comtech EF Data product is warranted against defects in material and workmanship for a period of 24 months from the date of shipment. During the warranty period, Comtech EF Data will, at its option, repair or replace products that prove to be defective.

For equipment under warranty, the customer is responsible for freight to Comtech EF Data and all related custom, taxes, tariffs, insurance, etc. Comtech EF Data is responsible for the freight charges **only** for return of the equipment from the factory to the customer. Comtech EF Data will return the equipment by the same method (i.e., Air, Express, Surface) as the equipment was sent to Comtech EF Data.

LIMITATIONS OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper installation or maintenance, abuse, unauthorized modification, or operation outside of environmental specifications for the product, or, for damages that occur due to improper repackaging of equipment for return to Comtech EF Data.

No other warranty is expressed or implied. Comtech EF Data specifically disclaims the implied warranties of merchantability and fitness for particular purpose.

EXCLUSIVE REMEDIES

The remedies provided herein are the buyer's sole and exclusive remedies. Comtech EF Data shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

DISCLAIMER

Comtech EF Data has reviewed this manual thoroughly in order to provide an easy-to-use guide to your equipment. All statements, technical information, and recommendations in this manual and in any guides or related documents are believed reliable, but the accuracy and completeness thereof are not guaranteed or warranted, and they are not intended to be, nor should they be understood to be, representations or warranties concerning the products described. Further, Comtech EF Data reserves the right to make changes in the specifications of the products described in this manual at any time without notice and without obligation to notify any person of such changes.

If you have any questions regarding your equipment or the information in this manual, please contact the Comtech EF Data Customer Support Department.

Chapter 1. INTRODUCTION

1.1 INTRODUCTION

The High-Power Outdoor Power Amplifier (HPOD) Solid-State Power Amplifier (SSPA) shown in Figure 1-1 delivers its rated power, guaranteed, at the 1 dB compression point, to the transmit waveguide flange. It provides a cost effective, more reliable replacement for TWT amplifiers in SatComm terminals.

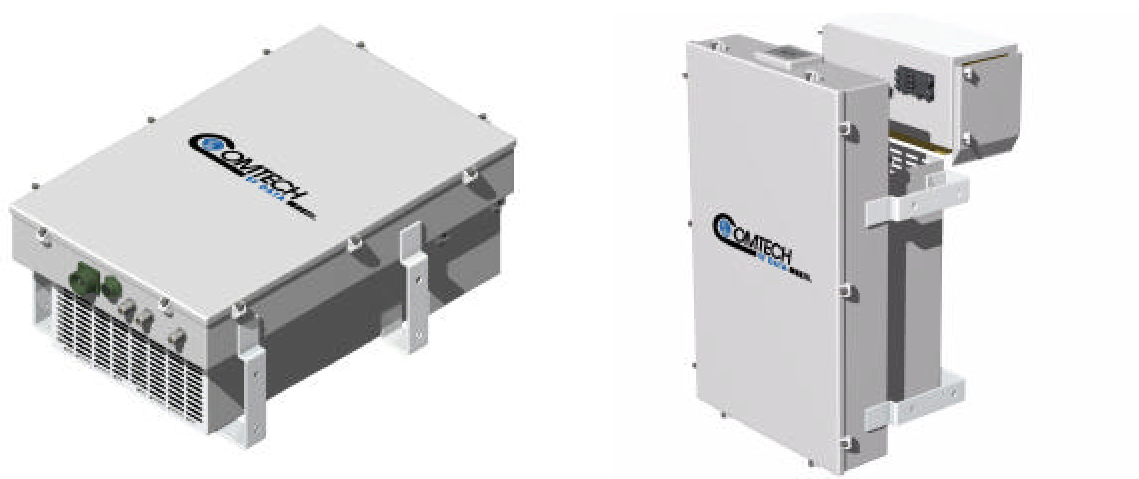

Figure 1-1. HPOD SSPAs

1.2 FIELD REPLACEABLE POWER SUPPLY

Recognizing that the MTBF limiting factor for almost all electronic equipment is the power supply, the HPOD provides for easy field replacement. Simply disconnect the AC mains, release the captive fasteners, and remove the supply from the SSPA module.

1.3 THE SOLID-STATE ADVANTAGE

Each HPOD SSPA is constructed with highly reliable GaAs FETs. With third order intermodulation products from 4 to 6 dB better than TWT ratings, the CEFD unit replaces TWTs with saturated power levels of up to twice the HPOD's rated output. The HPOD SSPAs also provide an MTBF that is 4 to 5 times greater than the typical TWT MTBF.

1.4 FUNCTIONAL DESCRIPTION

Each HPOD consists of a CEFD SSPA module with the **M**onitor/**C**ontrol **P**rocessor (MCP), a field replaceable power supply, and a field replaceable fan assembly. The amplifier features a Comtech EF Data low loss combining technique and MCP based temperature versus gain compensation.

1.5 BUILT-IN REDUNDANCY CONTROLLER

Each Comtech EF Data HPOD amplifier has the ability to function as a 1+1 (one backup for one primary) and 1+2 (one backup for two primary) redundant controller in the backup mode. The optional redundancy configuration is implemented by attaching a ganged waveguide/coax transfer switch(es) to the input and output connectors of the amplifiers with a combination coaxial cable and waveguide kit. When the backup SSPA is commanded into the controller mode, it monitors the online SSPA(s) for faults. A faulted online unit may be disconnected and replaced without affecting the online power amplifier.

1.6 OPTION FREE

Comtech EF Data's HPOD series of SSPAs come equipped with useful features that other manufacturers offer as options. Included in the base price are temperature compensation, sample ports, power monitor, field replaceable power factor corrected supply, and full remote monitor and control capabilities.

Higher power is available through the use of CEFD 1+1 and 1:2 phase combining kits.

1.7 SPECIFICATIONS

1.7.1 OUTPUT

Frequency:	**C-Band** 5.850 to 6.425 GHz **X-Band** 7.9 to 8.4 GHz **Ku-Band** 14.0 to 14.5 GHz 13.75 to 14.5 GHz (Optional)
Power:	**C-Band** 54.0 dBm minimum (250W) 55.0 typical at 1 dB Compression **X-Band** 53.0 dBm minimum (200W) 54.0 typical at 1 dB Compression **Ku-Band** 50.0 dBm minimum (100W) 48.5 dBm minimum (80W) @ 1 dB Compression
Mute:	-60 dBc
Impedance:	50Ω
VSWR:	1.25:1 Maximum
Connector:	**C-Band** CPR-137G Waveguide **X-Band** CPR-112G Waveguide **Ku-Band** WR75G Waveguide

1.7.2 Gain

Linear:

C- and X-Band

70 dB min, 75 dB typical

Ku-Band

65.0 dB min, 70.0 dB typical (100W)
61.0 dB min, 64.0 dB typical (80W)

Adjust: 20 dB in 0,25 dB steps

Full Band: ± 1.0 dB

Per 40 MHz: ± 0.25 dB

-40 to +55°C: ± 1.0 dB

1.7.3 Third Order Intermodulation

Products: -30 dBc typical, -25 dBc max @
3 dB total back-off from rated P1dB
(two tones, Δf + 1 MHz)

1.7.4 AM to PM Conversion

2° typical, 3° maximum at rated output

1.7.5 Group Delay (per 40 MHz)

Linear: ± 0.03 ns/MHz

Parabolic: ± 0.003 ns/MHz^2

Ripple: ± 1.0 ns peak to peak

1.7.6 Spurious

Second Harmonic:

C- and X-Band

-60 dB dBc max @ 1 dB below rated output

1.7.7 Input

Impedance:	50Ω
Noise Figure:	8 dB typical, 10 dB maximum @ maximum gain
VSWR:	1.25:1 Maximum
Connector:	Type N

1.7.8 Sample Ports

Output Sample:	Type N, 50Ω, -40 dBc nominal
Input Sample:	Type N, 50Ω, -20 dBc nominal

1.7.9 Remote Control

Com Port:	RS-485 or RS-232

1.7.10 Alarms

Summary Fault:	Form C

1.7.11 Environmental

Operating Temp.:	-40° to +55°C (-40° to 131°F)
Non-Operating Temp.:	-50° to +75°C (-58° to 167°F)
Operating Humidity:	0 to 100% condensing
Non-Operating Humidity:	15,000 ft above sea level (derated 2ºC/1000 ft AMSL)

1.7.12 Power Requirements

C- and X-Band

180 to 264 VAC,
47 to 63 Hz, 2000W

Ku-Band

180 to 264 VAC,
47 to 63 Hz, 1700W

1.7.13 PHYSICAL

Dimensions:	26.77L x 17.88W x 11.49H inches (67.99L x 45.41W x 29.18H cm)
Weight:	75 lbs (34 kg) nominal

1.7.14 AVAILABLE OPTIONS

Optional BUC

Chapter 2. SYSTEM OPERATION

This section contains instructions for operating the HPOD outdoor SSPA. The primary customer interface to the HPOD is via the Remote Communications port. This section defines in detail the customer interface.

2.1 INTERFACE CONNECTORS

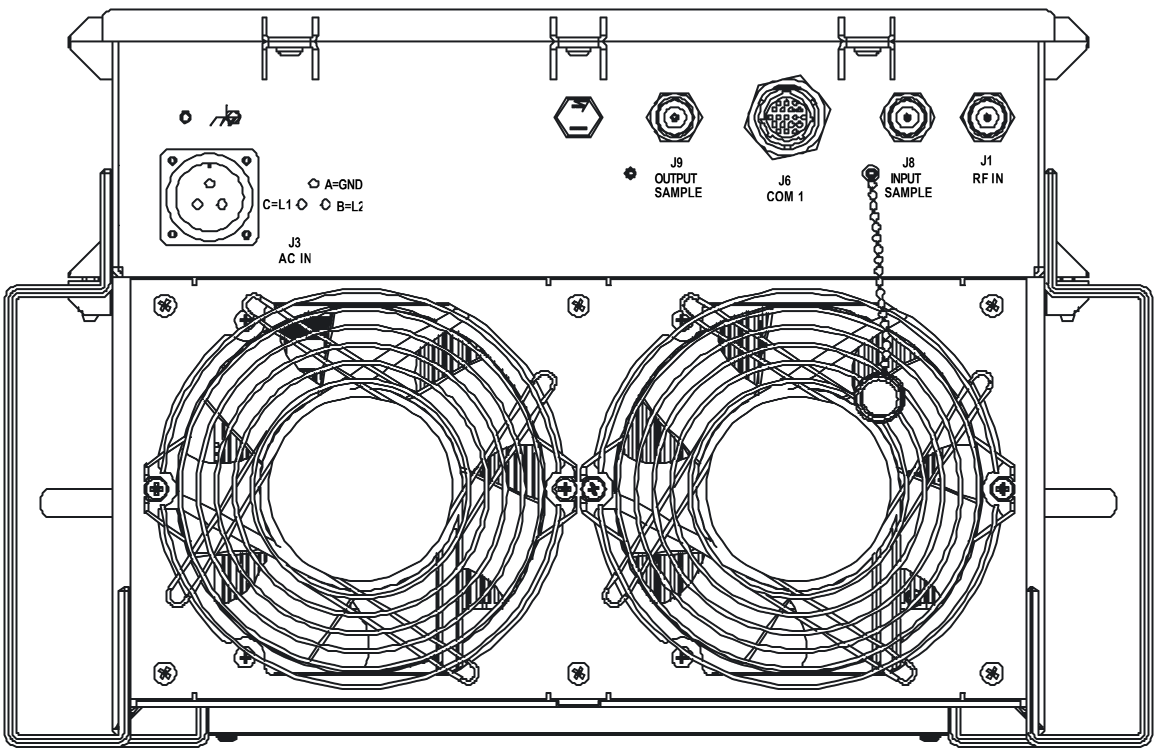

Figure 2-1

2.1.1 CONNECTOR J1: RF IN

The RF Input connector is a type N female. Typical input levels (-30dBm) depend on desired output power and unit attenuation. To prevent damage to the SSPA, RF input levels should not exceed +15 dBm.

2.1.2 CONNECTOR J2: RF OUT

The RF Output connector is a waveguide interface. The flange is described below according the the frequency range of the unit.

Table 2-1. Waveguide Output Flange

Unit Frequency Band	Waveguide Flange
C	CPR112G
X	CPR137G
Ku	WR75G

For safety reasons, never look directly into the waveguide output..

2.1.3 CONNECTOR J3: AC POWER MAINS

Before applying AC power to the unit, make sure the waveguide output of the amplifer is properly loaded or terminated. Failure to do so could lead to equipment damage and excessive RF radiation levels.

The prime power input requirements are

- 180-264 VAC
- 47 to 63 Hz
- The power supply is power factor corrected. The total power required from the prime power supply depends on the model used. Please refer to the respective data sheets.

The AC prime power input connector, J3, is a 3 pin circular connector, type CA3102E20-19PB FMLB A. The ground pin A, is of the first make, last break type. A mating connector (CA3106E20-19SB) is provided. The pin-out specifications for J3 and it's mate are contained in the table below.

Table 2-2. Connector J3 Pinout

Pin	Description
A	Ground
B	L2
C	L1

2.1.4 CONNECTOR J 4: REDUNDANT LOOP

The Redundant Loop Connector J4 is located near the waveguide output and is only utilized in configurations where the SSPA controls waveguide switching. In alternate configurations, such as "chain switching", another system block or external M&C controls the waveguide switching. In this case, the connector remains unused and the protective cap should be left attached. The pin-out specification is shown in Table 2-3.

Table 2-3. Connector J4 Pinout

Pin	Name	Description
A	SW_CMD_A1	
B	SW_CMD_COM	
C	SW_CMD_A2	
D	SW_IND_A1	
E	SW_IND_A2	
F	SW_CMD_B1	
G	SW_CMD_B2	
H	SW_IND_B1	
J	SW_IND_B2	
K	ADDR_1	
L	ADDR_2	
M	COM	
N	RED_1_1	
P	RED_1_2	
R	SMFLT_1_IN	
S	SMFLT_2_IN	
T	SMFLT_OUT	
U	RED_TXD	
V	RED_RXD	

2.1.5 CONNECTOR J6: COM 1, REMOTE COMMUNICATIONS AND DISCRETE CONTROL PORT.

The COM 1/ Discrete Control connector J6 is the primary input for controlling and monitoring the SSPA. It is a 19-pin circular connector, type MS3112E14-19S. The pin-out specification is contained in Table 2-4.

Mating connector: ITT: KPT06J14-19P or MS3116J14-19P.

Table 2-4. Connector J6 Pinout

Pin	Name	Description
A	RS485_+RX	
B	RS485_-RX	
C	RS485_+TX	
D	RS485_-TX	
E	RS232_RD	
F	Analog_Pwr_Mon	Reserved for future use
G	RS232_TD	
H	Aux_In	Auxiliary fault input, software enabled. When enabled, pin must be grounded to unmute SSPA
J	Aux_Out	Not for customer use
K	SumFLT_COM	
L	SumFLT_NO	Open when faulted, else tied to Pin K.
M	SumFLT_NC	When faulted, tied to Pin K, else open.
N	GND	
P	ONLINE_Status	Not for customer use
R	+24V	Not for customer use
S	Mute Control	SSPA will be muted if this pin is grounded
T	Minor_FLT_COM	Reserved for future use
U	Minor_FLT_NO	Reserved for future use
V	Minor_FLT_NC	Reserved for future use

2.1.6 CONNECTOR J 8: INPUT SAMPLE

The Input sample port connector is a type N female. It provides a nominal –20 dB sample of the input signal. A calibration label is provided near the connector that shows the actual coupling values vs. frequency.

2.1.7 CONNECTOR J 9: OUTPUT SAMPLE

The Output sample port connector is a type N female. It provides a nominal -40 dB sample of the output signal. A calibration label is provided near the connector that shows the actual coupling values vs. frequency.

2.2 TURNING ON THE SSPA

The SSPA does not contain a ‘Power On/Off’ switch. The SSPA is powered ON by connecting the J3 AC Power connector to the appropriate prime power source. The Mute or Transmit status of the SSPA will automatically come up in the last stored state (factory default = Transmit on, not muted).

WARNING

Never turn the unit ON without proper waveguide termination on the J2 “RF OUTPUT” port. Individuals can be exposed to dangerously high electromagnetic levels.

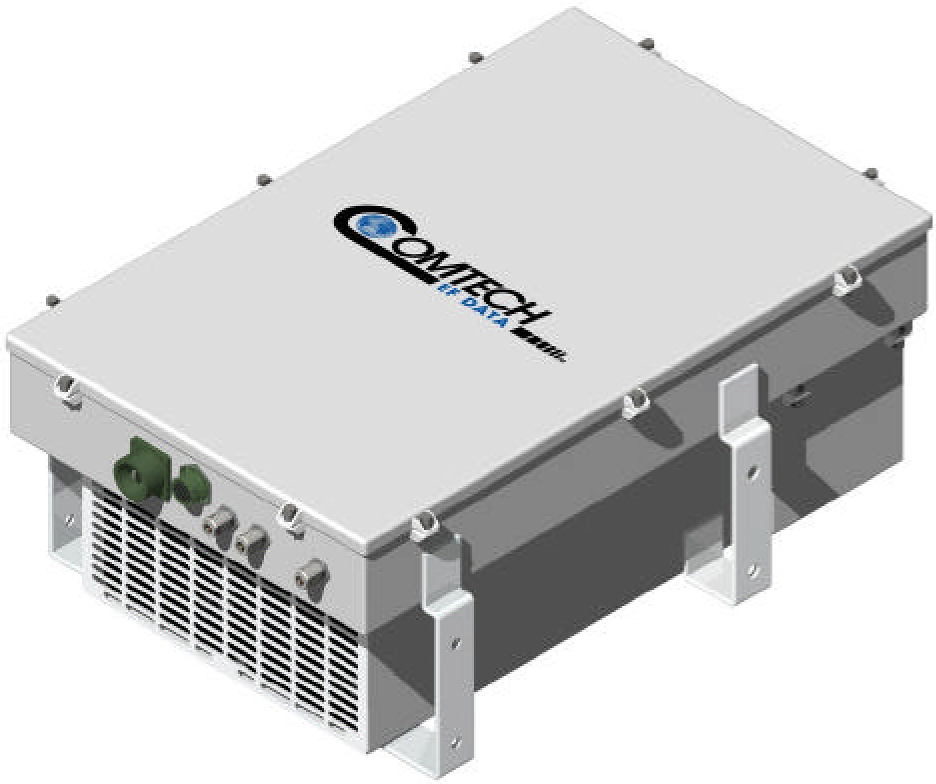

Figure 2-2. Outdoor Unit

Chapter 3. Theory of Operation

This section provides an overview of the Theory of Operation of the unit. Included are a basic block diagram and an explanation of the functions of each of the major systems within the

3.1 SSPA BLOCK DIAGRAM

A block diagram of the SSPA is shown on the following page in Figure 3-1. The major components of the unit are:

- SSPA Module
- Cooling System
- Monitor and Control (M&C)
- Power Supply (Power Factor Corrected and Removable/Field Replaceable)

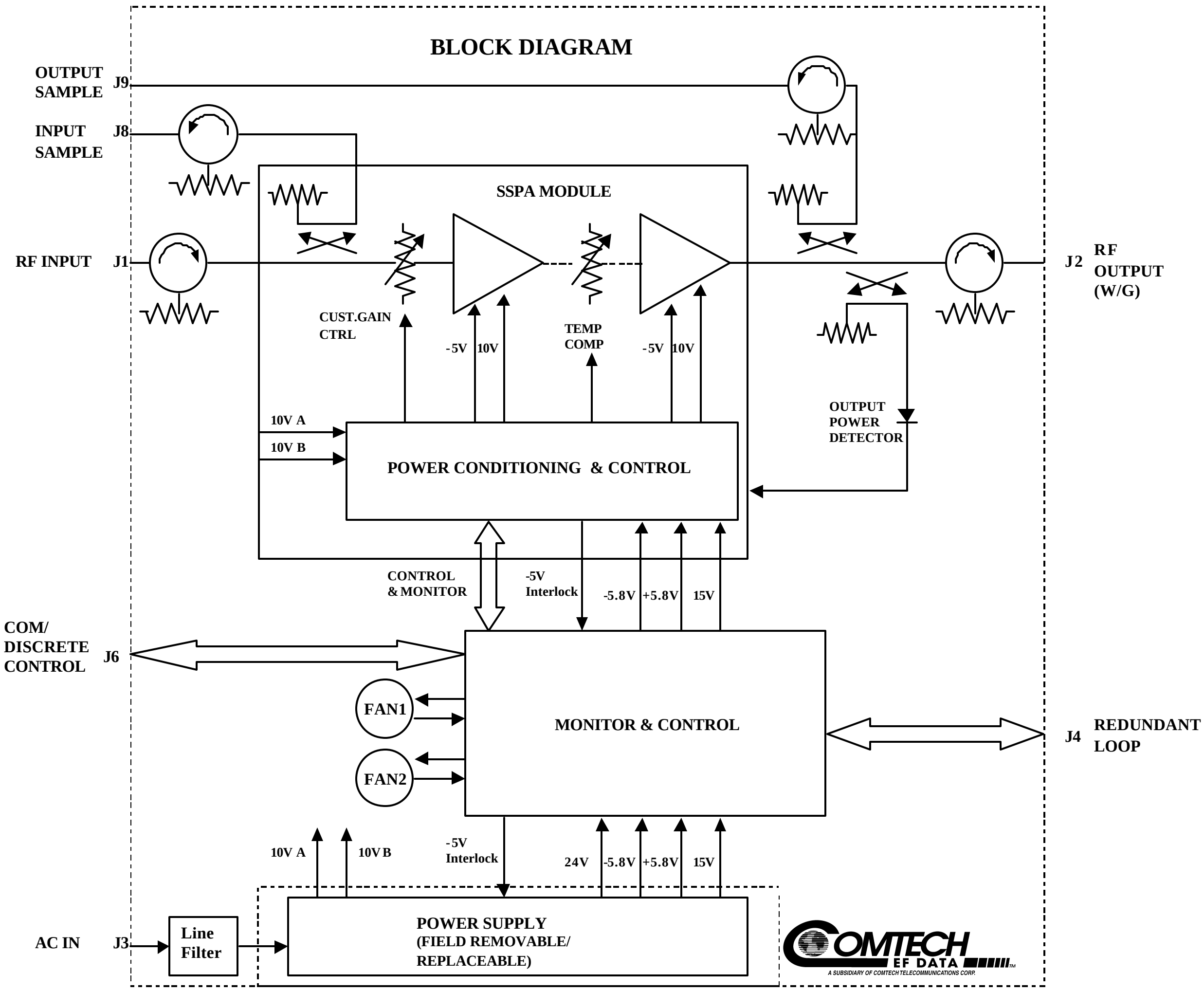

Figure 3-2. SSPA Block Diagram

3.2 SSPA Module

The amplifier module performs the core function of the unit. An isolator is at the RF input to ensure good VSWR. The RF signal then passes through an input sample port and on to an electronically controlled attenuator that adjusts the overall attenuation according to the user input. After some amplification, a second attenuator is automatically controlled via a look-up table to maintain the amplifier gain at a constant level over temperature variations.

The RF signal is then amplified by a multi-stage design that utilizes proprietary combining techniques to meet the rated power requirements. The output circuitry contains a coupler to provide a sampled signal for monitoring purposes. A power detector circuit also is included and the reading can be accessed via remote communication. A high power circulator and load is located at the output to provide good VSWR and protection from external mismatch.

3.3 Cooling System

The SSPA unit contains a robust heat sink and thermal design to maintain a low operating temperature. Two temperature controlled fans, which are monitored by the M&C board, draw cool outside air in across the power supply and specialized heat sink and exhaust the warmer air out the bottom of the unit. The amplifier module temperature is monitored, and if for any reason the amplifier temperature exceeds a safe preset limit, the amplifier module supply is shut down to protect the unit from thermal failure.

3.4 Monitor and Control (M&C)

The unit includes a microprocessor based system that provides monitoring and control of the essential parameters of the unit. The user interfaces with the unit through the M&C system via the remote control/discrete communications port. The unit is capable of either RS-232 or RS-485 remote communication. A discrete mute control and relay status output is also available. The M&C system monitors the fan speed, unit temperature, all power supply voltages, power transistor currents, output power, etc. Should a critical monitored parameter fail, the unit will mute the RF signal and report a fault. The details of the fault can be accessed via remote communication.

The M&C is also capable of acting as a controller in certain 1:1 or 1:2 redundant systems. When configured as the back-up SSPA in such a system, it communicates with the other SSPA(s) and toggles the waveguide switches as necessary.

3.5 POWER SUPPLY

The SSPA features a removable power supply which is also power factor corrected. It connects to the main chassis via a specialized connector capable of the required high current. It supplies several voltages necessary for the unit to operate. The 10V output is capable of 2000W and supplies current to the power transistors in the RF amplifier module via two paths, or cables (10V A and 10V B). The output status of this power supply is controlled by circuitry within the RF module. If the RF module does not have the –5V supply for any reason, it will not allow the 10V power supply to turn on. This protects the power transistors within the RF module from failure due to improper power supply sequencing. The +24V output powers the cooling fans and is the source of power for waveguide switching when the SSPA is used in redundant configurations. The +5 and +15 voltages are used to operate the M&C board and other overhead functions.

Chapter 4. CUSTOMER COMMANDS

4.1 INTRODUCTION

This section describes the operating features of the SSPA. A few key parameters and procedures are summarized, followed by detailed instructions of remote control communication commands.

4.2 RF INPUT LEVEL

The required RF input level to reach the full rated output power of the SSPA is determined by the individual amplifier maximum gain and power rating. For example, if the test data of an SSPA rated for 250W (54 dBm) indicated a gain of 75 dB, then a signal of :

54dBm – 75 dB = -21 dBm

would approximately give the rated output power. Increasing input power beyond this level would result in an output signal with increasingly higher levels of distortion. Of course, if the SSPA attenuation control is utilized, a higher level input signal level can be accommodated. The maximum input level should never exceed 15dBm, or permanent damage to the unit may occur.

4.3 ATTENUATOR CONTROL

The SSPA gain can be attenuated over a 30 dB range by excercising the “ATT” command. The details for the format of this command are found later in this section.

4.4 MUTE CONTROL

The amplifier may be muted via software or discrete control. Exercising the Mut=1 command will "software" mute the unit. The amplifier may also be "hardware" muted by pulling Pin S on the Com 1 / Discrete control connector (J6) to ground (see Chapter 1). The Mute command provides over 75 dB of RF on/off isolation.

However, the Mute command only turns off the first few low power stages of the amplifier, the high power stages remain on. By allowing the higher power transistors to stay on, the amplifier remains in more thermally stable state should the mute condition be removed. If the user desires to completely turn off the bias to the entire amplifier (perhaps to conserve energy in a redundant system), both the Mut=1 and Amp=0 commands should be executed.

For normal transmit operation, Mut=0 and Amp=1 are required.

4.5 FAULTS

The M&C system monitors certain key functions of the SSPA for proper operation. Should any of these parameters exceed predetermined limits, the M&C system will declare a fault and mute the unit. The conditions that will trigger a fault are:

- Any power supply more than ± 10% outside it's nominal value
- Either fan less than 25% of maximum speed
- I2C internal bus communications fault
- Thermal Shutdown - A temperature fault is indicated if the unit is ≥ +95°C. This creates a summary fault and will cause the unit to mute itself and switchover to the back-up unit (if in a redundant system). However, the 10V supply to the FET transistors will remain on until the unit reaches the thermal shutdown temperature of ≥ 100°C. For protection reasons, the unit will shutdown the 10V supply to the power transistors at temperatures ≥ 100°C.

4.6 POWER DETECTOR

A power detector is provided to monitor the output power. It has a useful range of over 20 dB and it's value can be read by excercising the "RMS" command. The test data supplied with each unit give the user an indication of the excellent accuracy and flatness of the power monitor over the frequency band of operation.

4.7 SOME COMMON COMMANDS

A few of the most common commands and queries are listed below. Full details for each of these are listed at the end of this section.

- RMS = Retrieve Maintainence Status. Displays voltages, fan speeds, Heatsink temperature, output power monitor reading, etc.

- RCS = Retrieve Configuration Status. Displays current attenuation, mute, amplifier, online, etc. status.

- RAS = Retrieve Alarm Status. Displays current alarm or fault status.

4.8 REMOTE CONTROL PROTOCOL AND STRUCTURE

This section describes the protocol and message command set for remote monitor and control of the SSPA product.

The electrical interface is either an RS-485 multi-drop bus (for the control of many devices) or an RS-232 connection (for the control of a single device), and data is transmitted in asynchronous serial form, using ASCII characters. Control and status information is transmitted in packets of variable length in accordance with the structure and protocol defined in later sections.

4.9 RS-485

For applications where multiple devices are to be monitored and controlled, a full-duplex (4-wire) RS-485 is preferred. Half-duplex (2-wire) RS-485 is possible, but is not preferred.

In full-duplex RS-485 communication there are two separate, isolated, independent, differential-mode twisted pairs, each handling serial data in different directions. It is assumed that there is a ‘controller’ device (a PC or dumb terminal), which transmits data, in a broadcast mode, via one of the pairs. Many ‘target’ devices are connected to this pair, which all simultaneously receive data from the controller. The controller is the only device with a line-driver connected to this pair; the target devices only have line-receivers connected.

In the other direction, on the other pair, each target has a tri-stateable line driver connected, and the controller has a line-receiver connected. All the line drivers are held in high-impedance mode until one (and only one) target transmits back to the controller.

Each target has a unique address, and each time the controller transmits, in a framed 'packet' of data, the address of the intended recipient target is included. All of the targets receive the packet, but only one (the intended) will reply. The target enables its output line driver, and transmits its return data packet back to the controller in the other direction on the physically separate pair.

4.10 RS-485 (FULL DUPLEX) SUMMARY:

- Two differential pairs - one pair for controller to target, one pair for target to controller.
- Controller-to-target pair has one line driver (controller), and all targets have line-receivers.
- Target-to-controller pair has one line receiver (controller), and all targets have tri-state drivers.

4.11 RS-232

This is a much simpler configuration in which the controller device is connected directly to the target via a two-wire-plus-ground connection. Controller-to-target data is carried, via RS-232 electrical levels on one conductor, and target-to-controller data is carried in the other direction on the other conductor.

4.12 BASIC PROTOCOL

Whether in RS-232 or RS-485 mode, all data is transmitted as asynchronous serial characters, suitable for transmission and reception by a UART. The asynchronous character format is fixed at 8 data bits, no parity, and 1 stop bit. Only two (2) baud rates are supported: 9600 baud and 19200 baud.

All data is transmitted in framed packets. The host controller is assumed to be a PC or ASCII dumb terminal, which is in charge of the process of monitor and control. The controller is the only device that is permitted to initiate, at will, the transmission of data. Targets are only permitted to transmit when they have been specifically instructed to do so by the controller.

All bytes within a packet are printable ASCII characters, less than ASCII code 127. In this context, the Carriage Return and Line Feed characters are considered printable.

All messages from controller to target require a response (with one exception). This will be either to return data that has been requested by the controller, or to acknowledge reception of an instruction to change the configuration of the target. The exception to this is when the controller broadcasts a message (such as Set time/date) using Address 0, when the target is set to RS-485 mode.

4.13 PACKET STRUCTURE

Controller-to-target:

Start of Packet	Target Address	Address De-limiter	Instruction Code	Code Qualifier	Optional Arguments	End of Packet
< ASCII code 60 (1 character)	(4 characters)	/ ASCII code 47 (1 character)	(3 characters)	= or ? ASCII code 61 or 63 (1 character)	(n characters)	Carriage Return ASCII code 13 (1 character)

Example: <0412/MUT=1{CR}

Target-to-controller:

Start of Packet	Target Address	Address De-limiter	Instruction Code	Code Qualifier	Optional Arguments	End of Packet
> ASCII code 62 (1 character)	(4 characters)	/ ASCII code 47 (1 character)	(3 characters)	=, ?, !, or * ASCII code 61, 63, 33 or 42 (1 character)	(From 0 to n characters)	Carriage Return, Line Feed ASCII code 13,10 (2 characters)

Example: >0412/MUT=1{CR}{LF}

Each of the components of the packet is now explained.

4.1 START OF PACKET

- Controller to Target: This is the character ‘<’ (ASCII code 60)
- Target to Controller: This is the character ‘>’ (ASCII code 62)

Because this is used to provide a reliable indication of the start of packet, these two characters may not appear anywhere else within the body of the message.

4.2 ADDRESS

Up to 9,999 devices can be uniquely addressed. In both RS-232 and RS-485 applications, the permissible range of values is 1 to 9999. It is programmed into a target unit using the remote control port.

IMPORTANT

The controller sends a packet with the address of a target - the destination of the packet. When the target responds, the address used is the same address, to indicate to the controller the source of the packet. The controller does not have its own address.

4.3 INSTRUCTION CODE

This is a three-character alphabetic sequence that identifies the subject of the message. Wherever possible, the instruction codes have been chosen to have some significance. This aids in the readability of the message, should it be displayed in its raw ASCII form. Upper case and lower case alphabetic characters may be used (A-Z, and a-z).

4.4 INSTRUCTION CODE QUALIFIER

This is a single character that further qualifies the preceding instruction code.

Code Qualifiers obey the following rules:

1. From Controller to Target, the only permitted values are:

   = (ASCII code 61)
   ? (ASCII code 63)

They have these meanings:

The '=' code (controller to target) is used as the assignment operator, and is used to indicate that the parameter defined by the preceding byte should be set to the value of the argument(s) which follow it.

For example, in a message from controller to target, MUT=1 would mean 'enable the mute function'.

The '?' code (controller to target) is used as the query operator, and is used to indicate that the target should return the current value of the parameter defined by the preceding byte.

For example, in a message from controller to target, MUT? denotes 'return the current state of the mute function'.

2. From Target to Controller, the only permitted values are:

   = (ASCII code 61)
   ? (ASCII code 63)
   ! (ASCII code 33)
   * (ASCII code 42)
   # (ASCII code 35)

They have these meanings:

The '=' code *(target to controller) is used in two ways:*

First, if the controller has sent a query code to a target (for example MUT?, meaning 'is mute enabled or disabled?'), the target would respond with MUT=x, where x represents the state in question, 1 being 'enable' and 0 being disable.

Second, if the controller sends an instruction to set a parameter to a particular value, and, providing the value sent in the argument is valid, then the target will acknowledge the message by replying with MUT= (with no message arguments).

The '?' code (target to controller) is only used as follows:

If the controller sends an instruction to set a parameter to a particular value, and, if the value sent in the argument is not valid, then the target will acknowledge the message by replying (for example) with MUT? (with no message arguments). This indicates that there was an error in the message sent by the controller.

The '*' code (target to controller) is only used as follows:

If the controller sends an instruction to set a parameter to a particular value, and, if the value sent in the argument is valid, however the target is in the wrong mode (e.g., standby mode in redundancy configuration) that it will not permit that particular parameter to be changed at that time, then the target will acknowledge the message by replying (for example) with MUT* (with no message arguments).

The '!' code (target to controller) is only used as follows:

If the controller sends an instruction code which the target does not recognize, then the target will acknowledge the message by echoing the invalid instruction, followed by the ! character with. Example: XYZ!

The '#' code (target to controller) is only used as follows:

If the controller sends an instruction code which the target cannot currently perform because of hardware resource issues, then the target will acknowledge the message by echoing the invalid instruction, followed by the # character. This response can only occur if the operator sends two or more 'hardware configuration' type commands without allowing adequate time between commands for the hardware to be configured. For example, if the operator issued commands to change both the frequency and the attenuation with less than 100 milliseconds between commands, and if this response is returned, then the command has not been accepted and the operator must resend the command.

4.5 MESSAGE ARGUMENTS

Arguments are not required for all messages. Arguments are ASCII codes for the characters 0 to 9 (ASCII 48 to 57), period (ASCII 46) and comma (ASCII 44).

4.6 END OF PACKET

Controller to Target: This is the 'Carriage Return' character (ASCII code 13)

Target to Controller: This is the two-character sequence 'Carriage Return', 'Line Feed'. (ASCII code 13, and code 10.)

Both indicate the valid termination of a packet.

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
Attenuation	ATT=	5 bytes, numerical	Command or Query. Valid attenuation level, in dB, at 0.25-dB step size as factory default. Example: ATT=12.25	ATT= (message ok) ATT? (Received ok, but invalid arguments found) ATT* (message ok, but not permitted in current mode)	ATT?	ATT=xx.xx (Same format as command arguments)
RF Power Amplifier State	AMP=	1 byte, value of 0, 1	Command or Query Turns ON or OFF the RF power amplifiers. 0 = Off 1 = On	AMP= (message ok) AMP? (received ok, but invalid arguments found) AMP* (message ok, but not permitted in current mode)	AMP?	AMP=x (same format as command arguments)
Mute State	MUT=	1 byte, value of 0,1	Command or Query. Mute the unit, where: 0 = Disabled 1 = Enabled Example: MUT=1	MUT= (message ok) MUT? (received ok, but invalid arguments found) MUT* (message ok, but not permitted in current mode)	MUT?	MUT=x (same format as command arguments)
Online Status	N/A	1 byte, value of 0,1	Command or Query. Online status (applies only to redundancy), where: 0 = Disabled 1 = Enabled Example: ONL=1	ONL= (message ok) ONL? (received ok, but invalid arguments found)	ONL?	ONL=x (same format as command arguments)
Redundancy Sate	RED=	1 byte, value of 0, 1	Command or Query Turns ON or OFF the redundancy state. 0 = OFF, 1 = ON	RED= (message ok) RED? (received ok, but invalid arguments found)	RED?	RED=x (same format as command arguments)

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
Redundancy Mode: Auto or Manual	RAM=	1 byte, value of 0, 1	Command or Query. Sets Auto or Manual mode for redundancy. 0 = Manual, 1 = Auto	RAM= (message ok) RAM? (received ok, but invalid arguments found)	RAM?	RAM= x (same format as command arguments)
Force Back-Up State	FBU=	1 byte, value of 0, 1, 2	Command or Query Force one of the online units to be a back up for maintenance and test purposes. 0 = Removed force back-up situation 1 = SSPA #1 is forced to be a back-up 2 = SSPA #2 is forced to be a back-up	FBU= (message ok) FBU? (received ok, but invalid arguments found)	FBU?	FBU=x (same format as command arguments)
Remote Address	SPA=	4 bytes, numeric	Command or Query. Set Physical Address-between 0001 to 9999. Resolution 0001 Example: SPA=0412	SPA= (message ok) SPA? (received ok, but invalid arguments found)	SPA?	SPA= x (same format as command arguments)
Remote Baud Rate	SBR=	4 bytes	Command or Query. Set remote baud rate as follows: 9600 = 9600 baud 19K2 = 19200 baud	SBR= (message ok) SBR? (received ok, but invalid arguments found)	SBR?	SBR=xx (same format as command arguments)
Set RTC(Real-Time-Clock) Date	DAT=	6 bytes, numeric	Command or Query. A command in the form **mmddyy**, where; dd = day of the month, between 01 and 31, mm = month of the year, between 01 and 12 and yy = year, between 00 and 96 (2000 to 2096) Example: DAT=042503 would be April 24, 2003	DAT= (message ok) DAT? (received ok, but invalid arguments found) DAT* (message ok, but not permitted in current mode)	DAT?	DAT=xx (same format as command arguments)
Set RTC Time	TIM=	6 bytes, numeric	Command or Query. A command in the form **hhmmss**, indicating the time from midnight, where hh = hours, between 00 and 23; mm = minutes, between 00 and 59, and ss = seconds, between 00 and 59 Example: TIM=231259 would be 23 hours, 12 minutes and 59 seconds from midnight.	TIM = (message ok) TIM? (received ok, but invalid arguments found) TIM * (message ok, but not permitted in current mode)	TIM?	TIM= xx (same format as command arguments)
Clear All Stored Alarms	CAA=	None	Command only Instructs the slave to clear all Stored Events This command takes no arguments.	CAA= (message ok)	N/A	N/A

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
Serial Number	N/A	9 bytes, numeric 000000000 to 999999999	Query only. Used to Query the units 9 digit serial number. Slave returns its S/N, in the form **xxxxxxxxx**. Example: RSN=000000165	N/A	RSN?	RSN=xxxxxxxxx (see description for details of arguments)
Retrieve Equipment Type	N/A	22 bytes, alpha-numeric	Query only. The unit returns a string indicating the Model Number and the value of internal software revision installed Example: RET=CPA-300 VER: 1.0.3	N/A	RET?	RET=x….x (see description for details of arguments)
Auto Fault Recovery	AFR=	1 byte, value of 0, 1	Command or Query. The SSPA output will automatically be muted in the event of detected fault. If auto fault recovery is enabled, it will cause the output to go active (unmute) if all faults are cleared. If disabled, the output will remain muted even if all faults are cleared.	AFR = (message ok) AFR? (received ok, but invalid arguments found) AFR* (message ok, but not permitted in current mode)	AFR?	AFR=x (same format as command arguments)
Retrieve next 5 unread Stored Alarms	N/A	145 bytes	Query only The unit returns the oldest 5 Stored Events, which have not yet been read over the remote control. Reply format: **Sub-body{CR}Sub-body{CR}Sub-body{CR}Sub-body{CR}Sub-body, where Sub-body=** **YYYYYYYYYY ZZ mmddyy hhmmss,** YYYYYYYYYY being the fault description. ZZ being the alarm type. FT = Fault OK = Clear IF = Information If there are no new events, the unit will reply with LNA*	N/A	LNA?	LNA=**YY..ss** (see description for details of arguments)
Retrieve Number of unread Stored Alarms	N/A	2 bytes, numeric	Query only. Returns the number of Stored Events which remain unread, in the form **xx**. Example reply: TNA=18	N/A	TNA?	TNA=**xx** (see description for details of arguments)

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
Summary Fault Status	N/A	1 byte, value of 0,1	Query only. Used to Query the status of the Summary Fault Relay. Example: SFS=0 where: 0 = OK 1 = FT	N/A	SFS?	SFS=**x** (see description for details of arguments)
Terminal Status change	N/A	1 byte, value of 0,1	Query only. Used to Query the status of the Terminal Status. Example: TSC=0 Where: 0 = no change in status, 1 = change in status	N/A	TSC?	TSC=**x** (see description for details of arguments)
Circuit Identification	CID=	24 bytes, alpha-numeric	Command or Query Used to identify or name the unit or station. First line is limited to 12 characters. Second line is also limited to 12 characters. No carriage return between first line and second line. Example: CID='cr' --Earth Station 0— ---SSPA #1----	CID= (message ok) CID? (received ok, but invalid arguments found)	CID?	CID=x…x (see description for details of arguments)
Retrieve Firmware Number	N/A		Query only Gets the Firmware Number of the unit. Example: <1/FRW= >0001/FRW/10786'cr' BULK=FW/10786'cr' MnC=FW/10787'cr' FPGA=FW/10788'cr''lf'	N/A	FRW?	FRW=FWxxxxx

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
Retrieve Maintenance Status	N/A	168 bytes, alpha- numeric	Query only. Used to Query the maintenance status of the unit P24VT=024.1’cr’ P15VT=015.2’cr’ P10V1=010.4’cr’ P10V2=010.4’cr’ P7V5T=007.8’cr’ P5VLT=005.8’cr’ N5VLT=-05.7’cr’ FANR1=100.0’cr’ FANR2=100.0’cr’ ATEMP=+40.0’cr’ A10V1=010.2’cr’ A10V2=010.2’cr’ FWPWR=+37.6’cr’ RVPWR=02.0’cr’’lf’ (optional) *Note: REFV will appear if REF OSC module is installed.	N/A	RMS?	RMS=***x….x*** (see description for details of arguments)

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
Concise Maintenance Status	N/A	84 bytes numeric	Query only. Used to Query the Maintenance status of the unit in concise format. Response is comma delimited. Example: CMS=aaa.a,bbb.b,ccc.c,ddd.d,eee.e, fff.f,ggg.g,hhh.h,iii.i,jjj.j,kkk.k,lll.l,mmm.m,nnn.n, 'cr''lf' where: aaa.a = +24V Power Supply bbb.b = +15V Power Supply ccc.c = +10V-1 Power Supply ddd.d = +10V-2 Power Supply eee.e = +7.5V Power Supply fff.f = +5V Power Supply ggg.g = -5V Power Supply hhh.h = Fan #1 speed (in percent) iii.i = Fan #2 speed (in percent) jjj.j = Amplifier temperature in deg. C kkk.k = Ampifier 10V1 lll.l = Amplifier 10V2 mmm.m=Forward RF output power, in dBm Note: nnn.n will appear for Ref Voltage if Reference Osc Module is installed.	N/A	CMS?	CMS=x….x (see description for details of arguments)
Retrieve Utility Status	N/A	27 bytes, alpha-numeric	Query only. Used to Query the utility status of the unit Example: RUS='cr' ADR=0001'cr' BDR=9600'cr'	N/A	RUS?	RUS=x….x (see description for details of arguments)
Concise Utility Status	N/A	11 bytes, alpha-numeric	Query only. Used to Query the Maintenance status of the unit, response is comma delimited. Example: CUS=aaaa,bbbb,ccc,'cr''lf' where: aaaa = Remote Unit Address bbbb = Remote Baud Rate	N/A	CUS?	CUS=x….x (see description for details of arguments)

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
Retrieve Alarm Status	N/A	117 bytes, alpha-numeric	Query only. Used to Query the Alarm status of the unit Example: RAS='cr' P24VT=OK'cr' P15VT=OK'cr' P10V1=OK'cr' P10V2=OK'cr' P7V5T=OK'cr' P5VLT=OK'cr' N5VLT=OK'cr' FAN#1=OK'cr' FAN#2=OK'cr' HSTMP=OK'cr' SHTDN=OK'cr' IICST=OK'cr' FPOUT=OK'cr''IF'	N/A	RAS?	RAS=x….x (see description for details of arguments)
Concise Alarm Status	N/A	25 bytes, numeric with commas	Query only. Used to Query the Alarm status of the unit, response is comma delimited. Example: CMS=a,b,c,d,e,f,g,h,I,j,k,I,m'cr''lf' where: a thru k = 0 or 1, 0 = OK 1 = FT a = +24V Power Supply b = +15V Power Supply c = +10V-A Power Supply d = +10V-B Power Supply e = +7.5V Power Supply f = +5V Power Supply g = -5V Power Supply h = Fan#1 State i = Fan#2 State j = Heatsink Temp k = Shutdown l = llC Status m=Forward Power Alarm	N/A	CAS?	CAS=x….x (see description for details of arguments)

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
Retrieve Configuration Status	N/A	45 bytes, alpha-numeric	Query only. Used to Query the configuration status of the unit Example: RCS='cr' ATT=12.75'cr' AMP=1'cr' MUT=1'cr' ONL=1'cr' RED=1-1'cr' GOF=00.00'cr' AFR=1'cr''lf' where: ATT= attenuation in dB AMP= RF power amplifier state, 0=OFF, 1=ON MUT=RF mute state, 0=unmuted, 1=muted ONL=Online status for redundancy RED=Redundancy state and mode, states: 0=OFF, 1=ON, modes: 0 = auto, 1 = manual GOF=Gain Offset in dB AFR= auto fault recovery, 0=manual, 1=auto	N/A	RCS?	RCS=x….x (see description for details of arguments)
Concise Configuration Status	N/A	24 bytes, numeric	Query only. Used to query the summarized version of RCS. Example: CCS=aaaaa,b,c,d,e-e,fffff,g,'cr' Where: aaaaa = attenuation in dB b = RF power amplifier state c = mute state, 0 = unmuted, 1 = muted d = online status e-e = redundancy state and mode fffff = gain offset in dB g = AFR	N/A	CCS?	CCS=x….x (see description for details of arguments)

	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of arguments (Note that all arguments are ASCII numeric codes, that is, ASCII codes between 48 and 57)	Response to Command (Target to controller)	Query (Instruction Code and qualifier)	Response to query (Target to controller)
RF Power FET Current status	N/A	variable length (Note: the number of FETs is determined on the information string [INF])	Query only Used to display all the FET currents. Example: RFS? Q01=xx'cr' Q02=xx'cr' Q03=xx.x'cr' Q04=xx.x'cr' Q05=xx.x'cr' Q06=xx.x'cr' Q07=xx.x'cr' Q08=xx.x'cr' Q09=xx.x'cr' Q10=xx.x'cr' Q11=xx.x'cr' Q12=xx.x'cr' Q13=xx.x'cr' Q14=xx.x'cr' Q15=xx.x'cr' Q16=xx.x'cr''lf'	N/A	RFS?	RFS=x….x (see description of arguments)
Concise RF Power FET Current Status	N/A	variable length	Query only Concise version of RFS. Example: CFS=xxx,xxx,x.x,x.x,……….,x.x,	N/A	CFS?	CFS=x…..x (see description of RFS. Note that each argument is separated by a comma)

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Chapter 5. Maintenance

5.1 POWER SUPPLY REMOVAL

CEFD's HPOD series of outdoor SSPAs feature field replaceable power supply modules.

To remove the supply:

1. Disconnect power from the SSPA
2. Loosen the four captive fasteners as indicated in Figure 5-1. Be certain to use an appropriate screwdriver, such as the one provided with the SSPA, to avoid damaging the fasteners.
3. The supply can now be pulled from the SSPA.

IMPORTANT

The SSPA/power supply interconnection is waterproof only when the supply and SSPA are mated. When exposed, the connection is only water resistant. Neither the SSPA nor the power supply should not be left exposed to the elements unless mated.

To install the supply:

1. Visually inspect the exposed SSPA heat sink for any debris/ blockage. Clean as required.
2. Visually inspect both the SSPA and power supply connector for damage/cleanliness. Correct/clean as required.
3. Inspect the gasket for damage. Replace as required
4. Place supply on SSPA, ensuring the guide pins and connection are properly aligned. Press gently to engage the connector.
5. Tighten the four captive fasteners as indicated in Figure 5-1. Be certain to use an appropriate screwdriver, such as the one provided with the SSPA, to avoid damaging the fasteners.

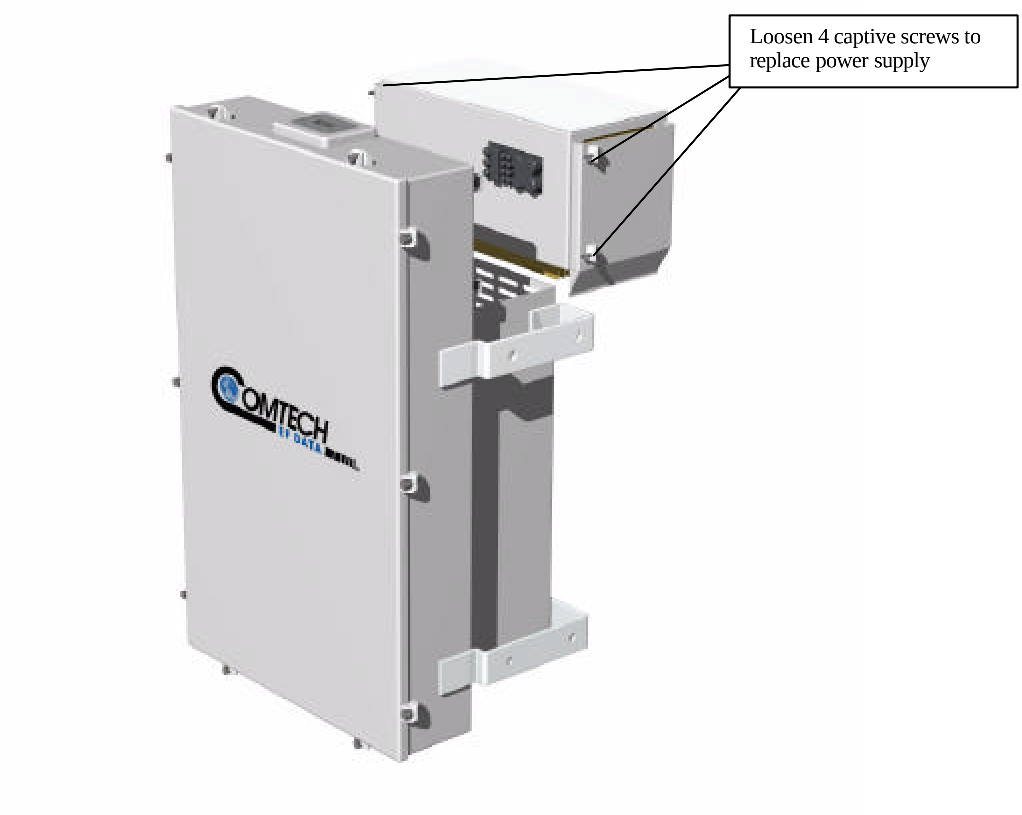

Figure 5-1. Power Supply Replacement

5.2 FAN REMOVAL

The fans utilized by the HPOD are designed for long life even in a harsh environment. They are still mechanical devices subject to wear and may need replacement after several years. In dusty environments, their removal facilitates clearing the heat sink of accumulated dust.

To remove the fan assembly:

1. Disconnect power from the SSPA
2. Loosen the six captive fasteners as indicated in Figure 5-2. Be certain to use an appropriate screwdriver, such as the one provided with the SSPA, to avoid damaging the fasteners.
3. Remove the fan assembly far enough to gain access to the two circular fan connectors.
4. Disconnect the circular fan connectors and remove the assembly.

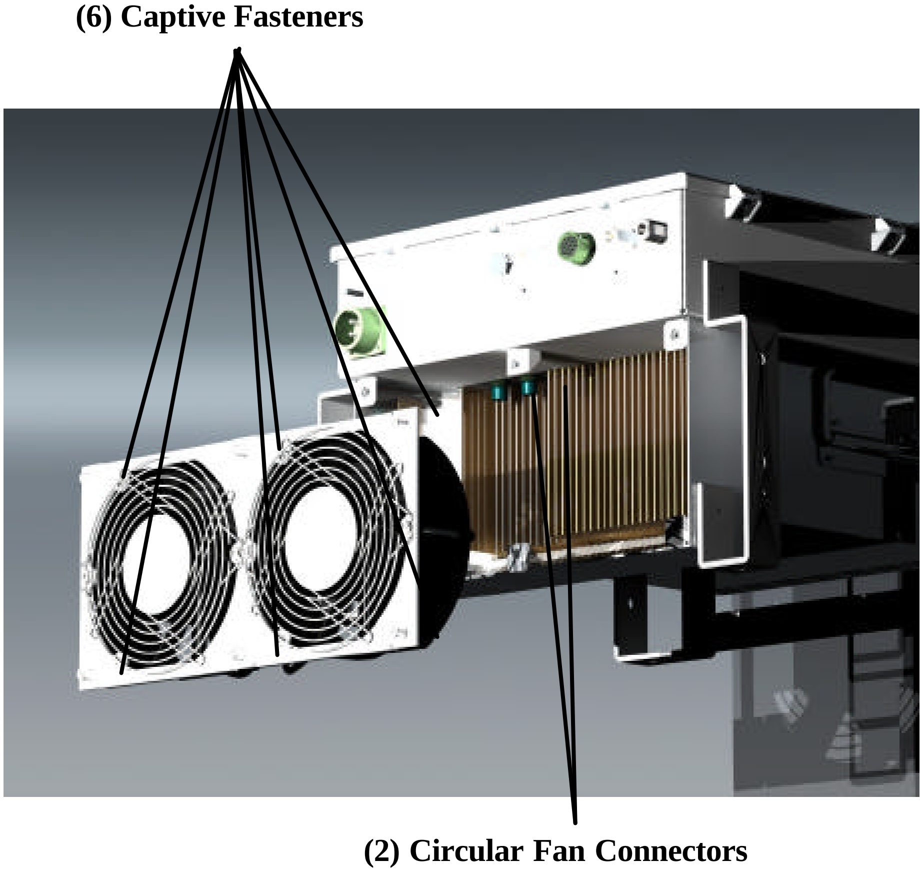

Figure 5-2. Fan Removal

To install the fan assembly:

1. Visually inspect the exposed SSPA heat sink for any debris/blockage. Clean as required
2. Connect the fan assembly's circular connectors to the SSPA
3. Place assembly on SSPA, ensuring proper alignment of the fasteners without any cable /fan interference.
4. Tighten the six captive fasteners as indicated in Figure 5-2. Be certain to use an appropriate screwdriver, such as the one provided with the SSPA, to avoid damaging the fasteners.

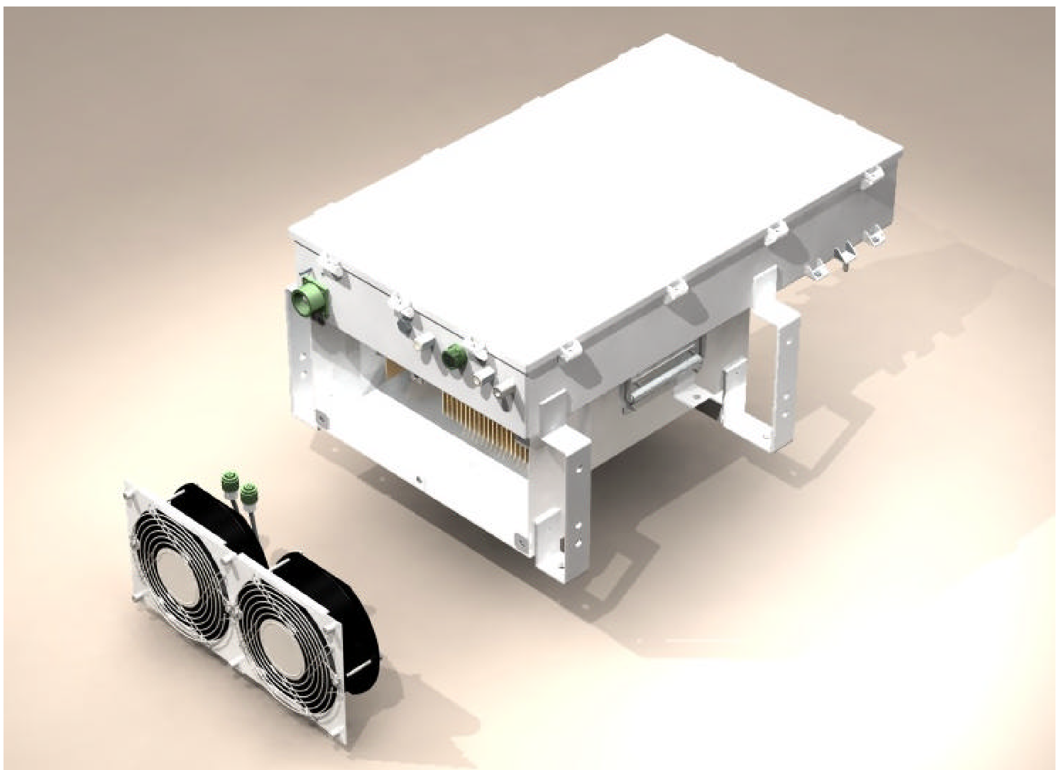

Figure 5-3. Fan Installation

5.3 SCHEDULED MAINTENANCE

Once a year (or sooner depending on environmental conditions), the SSPA heat sink should be cleaned.
To perform this maintenance:

1. Disconnect power from the SSPA
2. Remove the fan assembly as previously described
3. Remove the power supply as previously described
4. Using compressed air, blow through the SSPA heat sink to remove any foreign object accumulation that may be obstructing airflow.
5. Also using compressed air, clear the heat sink portions of the power supply.
6. Reinstall the supply and fan assembly.

5.4 DIMENSIONAL ENVELOPE

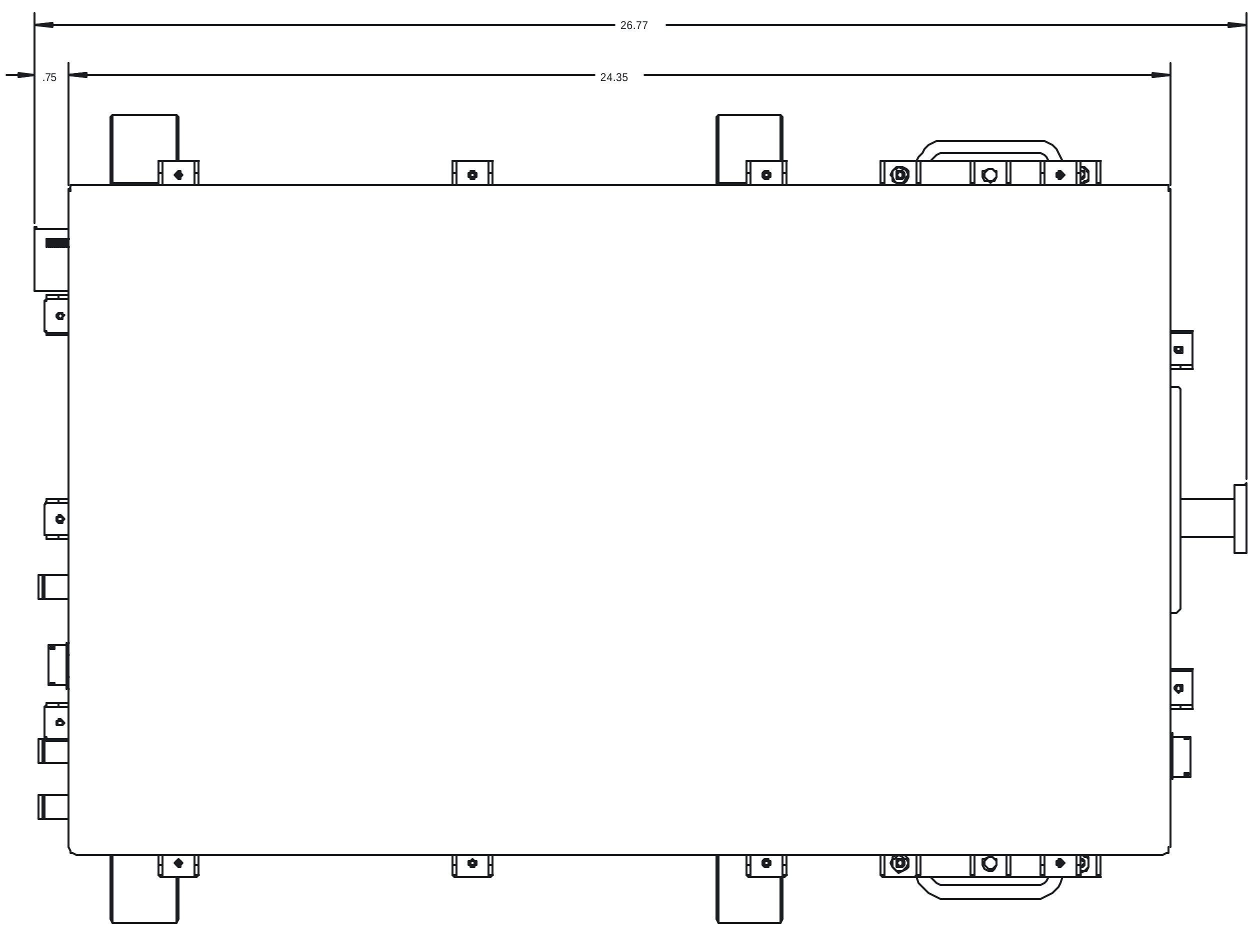

Figure 5-4a. Dimensional Envelope

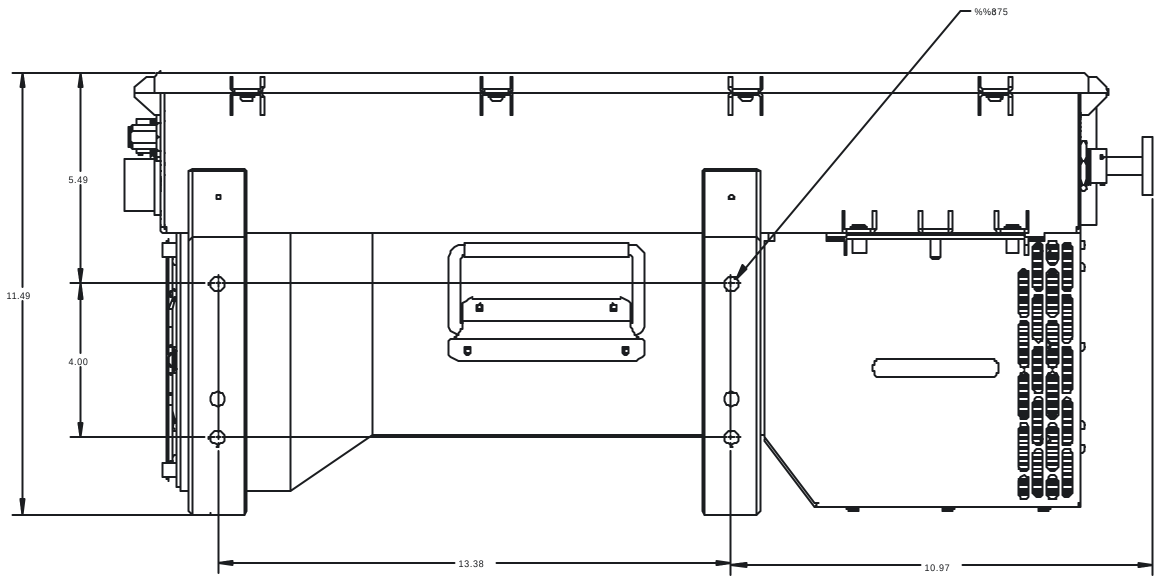

Figure 5-4b. Dimensional Envelope

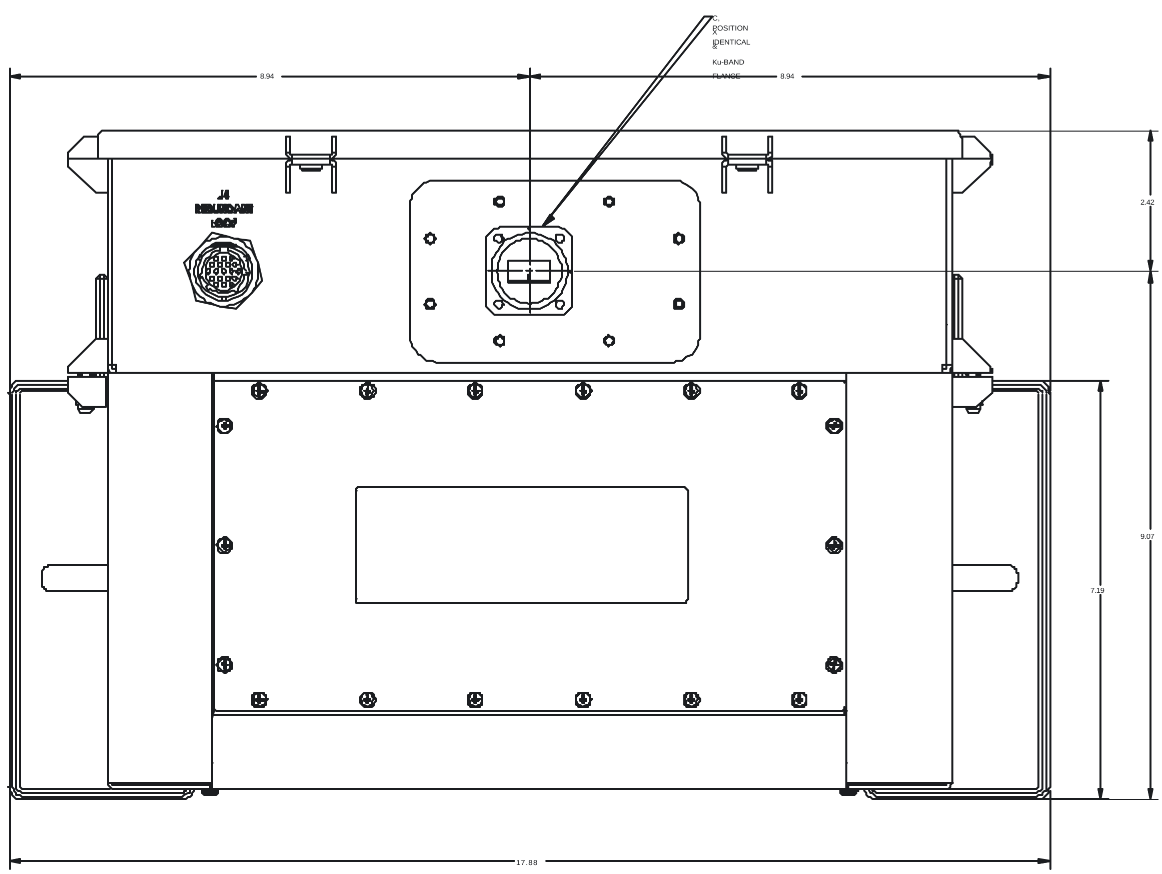

Figure 5-4c. Dimensional Envelope

Appendix A. ASSEMBLY KITS

A.1 REDUNDANT SWITCH KITS

The following figures and parts lists represent the phase combiner 1:1 redundant switch kits.

Table A-1. Parts List for Redundant 1:1 ODPA C-Band Assembly Kit P/N KT/11799(-1)

Item	Part No.	Description	Qty.
1	SW/WGS+28V137SC	Waveguide, CPR137, 28V, Sealed 3 Form C Relay	1
2	FP/BR11798-1	Bracket, Switch and Load Mounting	1
3	FP/WG11796-1	Waveguide, Left, CPRG-137, SSPA, C-Band	1
4	FP/WG11797-1	Waveguide, Right, CPRG-137, SSPA, C-Band	1
5		Not Used	
6	FP/WG11801-1	Waveguide, Straight, CPRG-137	2
7	RF/C-TERM1000W	Termination, Load, 1000 Watt, CPRG-137	1
8	RF/CG-137-40-N	Crossguide, WR137, 40 dB, Type N Female	1
N/S	FP/WG11800-1	Waveguide, 2.25X2.25 E Bend, CPRG-229	2
N/S	GA/CPR-137-R-H-C	Gasket, D Shape, CPR-137, Half Thickness, Conductive	2
N/S	GA/CPR137-R-F-C	Gasket, Round, CPR137, Full Thickness, Conductive	4
N/S	HW/1/4-20X5/8SHCS	Screw, 1/4-20 x 5/8 SHCS, S.S.	40
N/S	HW/1/4-FLT	1/4 Flat Washer	40
N/S	HW/1/4-SPLIT	1/4 Split Washer	40
N/S	HW/10-32X1/2SH	#10-32 x 1/2 Socket Head Cap Screw S.S.	32
N/S	HW/10-32X5/8SHC	#10-32 x 5/8 Socket Head Cap Screw S.S.	16
N/S	HW/10-FLT	#10 Flat Washer S.S.	48
N/S	HW/10-SPLIT	#10 Split Lock Washer S.S.	48
N/S	RF/CG-229-40-NRV	Crossguide, 40 dB, CPRG-229, Type N Female	1
N/S	RF/ADP-CPR229-N	Adapter, Waveguide, CPR229 Grooved to "N", 3.3 to 4.9 GHz	1
N/S	SW/WGS+28V-229	Waveguide, WR229 +28VDC, Seal -45 to 60°C	1

N/S = Not Shown
A/R = Use as Required

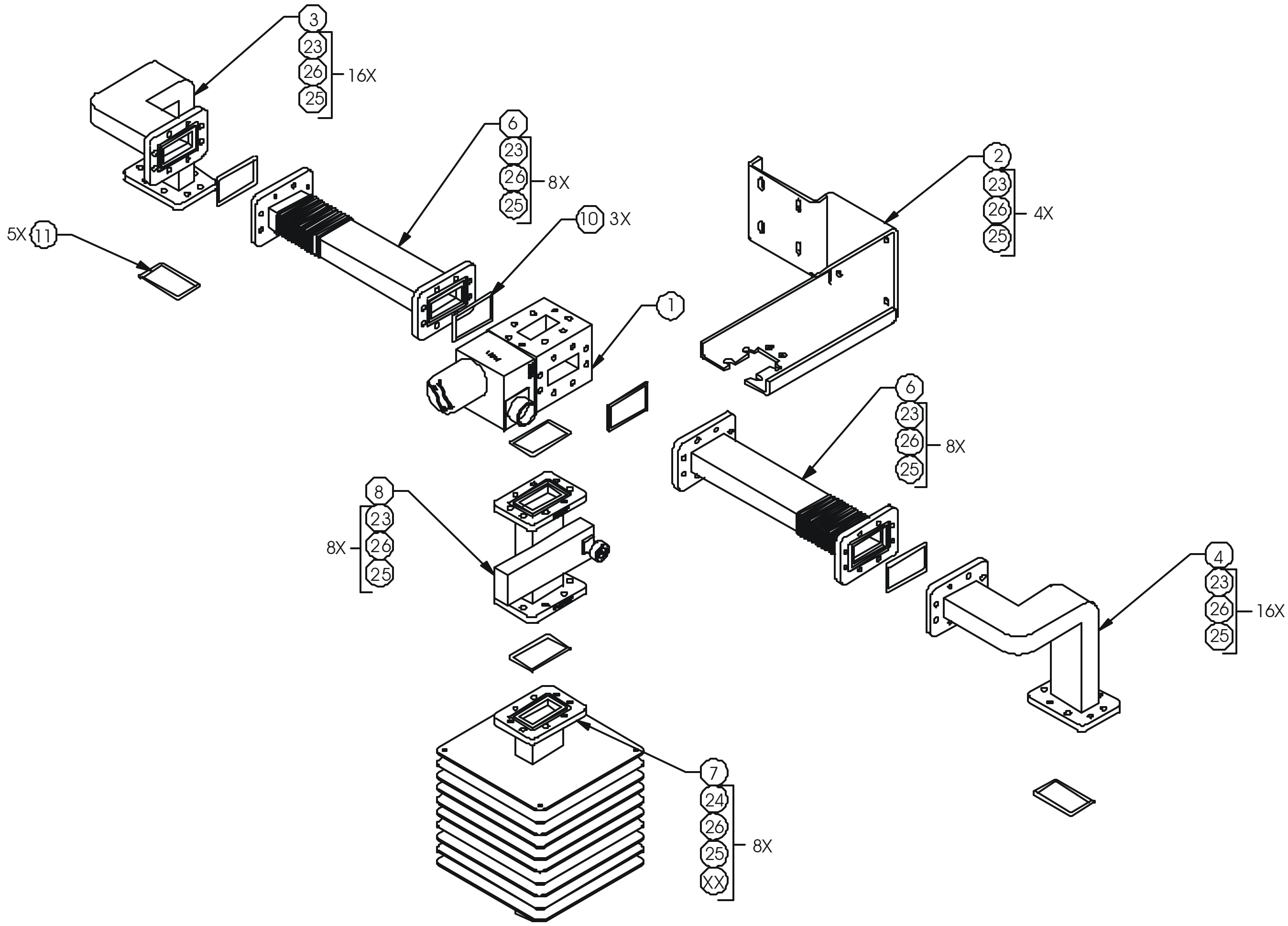

Figure A-1. Redundant 1:1 ODPA C-Band Assembly Kit, P/N KT/11799

Table A-2. Parts List for Redundant 1:1 ODPA X-Band Assembly Kit P/N KT/11387(-1)

Item	Part No.	Description	Qty.
1		Not Used	
2		Not Used	
3	RF/CG-112/137INN	Crossguide Coupler, 40 dB, Type N Connector, 137-112	1
4		Not Used	
5	SW/WG-HAGS	Switch, WR112G, +24V, Sealed, Standard Thread, Cold Temperature Rating	2
6		Not Used	
7	FP/WG11305-1	Waveguide, 90 Degree H-Bend Transition	2
8	FP/WG11301-1	Waveguide, 90 Degree, CPRG-112	2
9	FP/WG11308-1	Waveguide, 90 Degree, H-Bend, CPRG-112	3
10		Not Used	
11	RF/X-TERM850W	Termination, Load, 850 Watt, CPRG112, with Crossguide Coupler, 40 dB	1
12 thru 30		Not Used	
31	RF/ADAP-112-N	Adapter, CPRG112 to "N"	1
32 thru 50		Not Used	
51	FP/BR11670-1	Bracket, LNAs, 1:1 and Combiner Systems	1
52	FP/BR11377-1	Bracket, Switch, XSAT, 1:1	1
53	FP/BR11375-1	Bracket, Load, XSAT	1
N/S	GA/CPR112-R-F-C	Gasket, Round, CPR112, Full Thickness, Conductive	14
N/S	HW/8-32HEXNUT	#8-32 Hex Nut S.S.	A/R
N/S	HW/8-32X1/2SHCS	#8-32 x 1/2 Socket Head Cap Screw, S.S.	A/R
N/S	HW/8-32X7/8SHCS	#8-32 x 7/8 Socket Head Cap Screw, S.S.	A/R
N/S	HW/8-FLT	#8 Flat Washer S.S.	A/R
N/S	HW/8-SPLIT	#8 Split Lock Washer S.S.	A/R
N/S	HW/SEM632X3/8PH	#6-32 x 3/8 Square Cone Pan Head Phillips S.S.	A/R
N/S	RF/N-TERM50M1	50Ω, 1Watt, DC-8 GHz, Type N Male	4
	RF/TBD	TBD	0

N/S = Not Shown
A/R = Use as Required

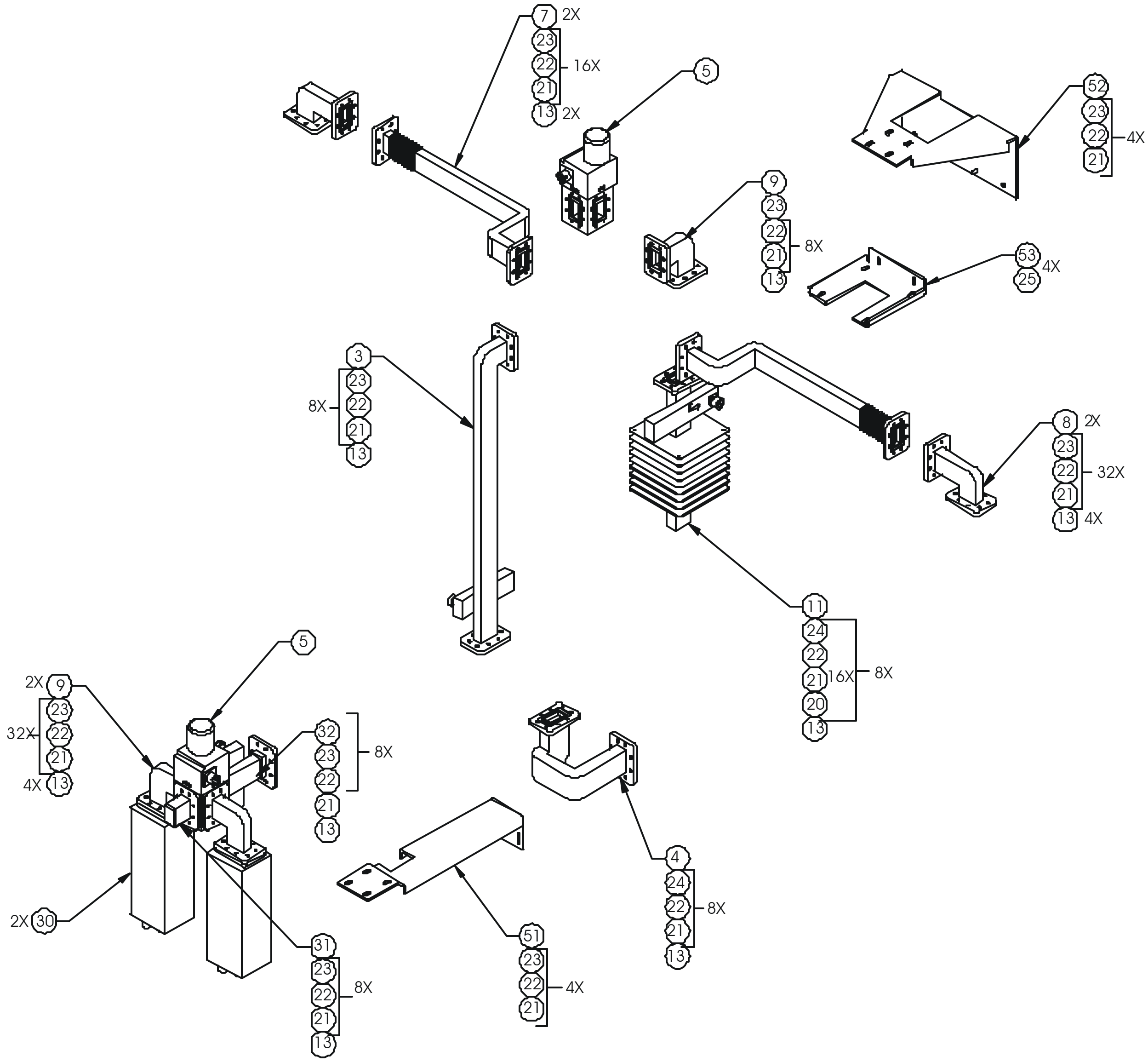

Figure A-2. Redundant 1:1 ODPA X-Band Assembly Kit, P/N KT/11387

METRIC CONVERSIONS

Units of Length

Unit	Centimeter	Inch	Foot	Yard	Mile	Meter	Kilometer	Millimeter
1 centimeter	—	0.3937	0.03281	0.01094	6.214×10^{-6}	0.01	—	—
1 inch	2.540	—	0.08333	0.2778	1.578×10^{-5}	0.254	—	25.4
1 foot	30.480	12.0	—	0.3333	1.893×10^{-4}	0.3048	—	—
1 yard	91.44	36.0	3.0	—	5.679×10^{-4}	0.9144	—	—
1 meter	100.0	39.37	3.281	1.094	6.214×10^{-4}	—	—	—
1 mile	1.609×10^{5}	6.336×10^{4}	5.280×10^{3}	1.760×10^{3}	—	1.609×10^{3}	1.609	—
1 mm	—	0.03937	—	—	—	—	—	—
1 kilometer	—	—	—	—	0.621	—	—	—

Temperature Conversions

Unit	° Fahrenheit	° Centigrade
32° Fahrenheit	—	0 (water freezes)
212° Fahrenheit	—	100 (water boils)
-459.6° Fahrenheit	—	273.1 (absolute 0)

Formulas
C = (F - 32) * 0.555
F = (C * 1.8) + 32

Units of Weight

Unit	Gram	Ounce Avoirdupois	Ounce Troy	Pound Avoir.	Pound Troy	Kilogram
1 gram	—	0.03527	0.03215	0.002205	0.002679	0.001
1 oz. avoir.	28.35	—	0.9115	0.0625	0.07595	0.02835
1 oz. troy	31.10	1.097	—	0.06857	0.08333	0.03110
1 lb. avoir.	453.6	16.0	14.58	—	1.215	0.4536
1 lb. Troy	373.2	13.17	12.0	0.8229	—	0.3732
1 kilogram	1.0×10^{3}	35.27	32.15	2.205	2.679	—

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