



PCB-4300

1:2 Phase Combiner Installation and Operation Manual

Part Number MN/PCB4300.IOM

Revision 2

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IMPORTANT NOTE: The information contained in this document supersedes all previously published information regarding this product. Product specifications are subject to change without prior notice.

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PREFACE

About this Manual

This manual provides installation and operation information for the Comtech EF Data PCB-4300 1:2 Phase Combiner. This is a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the PCB-4300.

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.

Revision 2 of this manual represents a complete rewrite in which all content has been updated in its entirety and re-ordered to conform to current Comtech EF Data Technical Publications standards and practices.

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

Reporting Comments or Suggestions Concerning this Manual

Comments and suggestions regarding the content and design of this manual are appreciated. To submit comments, please contact the Comtech EF Data Technical Publications Department:

TechnicalPublications@comtechedata.com

Conventions and References

Cautions and Warnings



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



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.



IMPORTANT or NOTE indicates information critical for proper equipment function, or a statement that is associated with the task being performed.

Recommended Standard Designations

Recommended Standard (RS) Designations have been superseded by the new designation of the Electronic Industries Association (EIA). References to the old designations are shown only when depicting actual text displayed on the screen of the unit (RS-232, RS-485, etc.). All other references in the manual will be shown with the EIA designations.

Trademarks

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

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 non-metric to metric conversions.

Electrical Safety Notice

This equipment has been designed to minimize exposure of personnel to hazards. For further information, contact the Comtech EF Data Customer Support Department.

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.



Double pole / neutral fusing is used on the prime power supply input.

Warranty Policy

Comtech EF Data products are warranted against defects in material and workmanship for a specific period from the date of shipment, and this period varies by product. In most cases, the warranty period is two years. During the warranty period, Comtech EF Data will, at its option, repair or replace products that prove to be defective. Repairs are warranted for the remainder of the original warranty or a 90 day extended warranty, whichever is longer. Contact Comtech EF Data for the warranty period specific to the product purchased.

For equipment under warranty, the owner is responsible for freight to Comtech EF Data and all related customs, taxes, tariffs, insurance, etc. Comtech EF Data is responsible for the freight charges only for return of the equipment from the factory to the owner. 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.

All equipment returned for warranty repair must have a valid RMA number issued prior to return and be marked clearly on the return packaging. Comtech EF Data strongly recommends all equipment be returned in its original packaging.

Comtech EF Data Corporation's obligations under this warranty are limited to repair or replacement of failed parts, and the return shipment to the buyer of the repaired or replaced parts.

Limitations of Warranty

The warranty does not apply to any part of a product that has been installed, altered, repaired, or misused in any way that, in the opinion of Comtech EF Data Corporation, would affect the reliability or detracts from the performance of any part of the product, or is damaged as the result of use in a way or with equipment that had not been previously approved by Comtech EF Data Corporation.

The warranty does not apply to any product or parts thereof where the serial number or the serial number of any of its parts has been altered, defaced, or removed.

The warranty does not cover damage or loss incurred in transportation of the product.

The warranty does not cover replacement or repair necessitated by loss or damage from any cause beyond the control of Comtech EF Data Corporation, such as lightning or other natural and weather related events or wartime environments.

The warranty does not cover any labor involved in the removal and or reinstallation of warranted equipment or parts on site, or any labor required to diagnose the necessity for repair or replacement.

The warranty excludes any responsibility by Comtech EF Data Corporation for incidental or consequential damages arising from the use of the equipment or products, or for any inability to use them either separate from or in combination with any other equipment or products.

A fixed charge established for each product will be imposed for all equipment returned for warranty repair where Comtech EF Data Corporation cannot identify the cause of the reported failure.

Exclusive Remedies

Comtech EF Data Corporation's warranty, as stated is in lieu of all other warranties, expressed, implied, or statutory, including those of merchantability and fitness for a particular purpose. The buyer shall pass on to any purchaser, lessee, or other user of Comtech EF Data Corporation's products, the aforementioned warranty, and shall indemnify and hold harmless Comtech EF Data Corporation from any claims or liability of such purchaser, lessee, or user based upon allegations that the buyer, its agents, or employees have made additional warranties or representations as to product preference or use.

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.

Customer Support



Refer to p.ix in this Preface for information regarding this product's Warranty Policy.

Contact the Comtech EF Data Customer Support Department for:

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

A Customer Support representative may be reached at:

Comtech EF Data
Attention: Customer Support Department
2114 West 7th Street
Tempe, Arizona 85281 USA
480.333.2200 (Main Comtech EF Data number)
480.333.4357 (Customer Support Desk)
480.333.2161 FAX

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

- **Contact** the Comtech EF Data Customer Support Department. Be prepared to supply the Customer Support representative with the model number, serial number, and a description of the problem.
- **Request** a Return Material Authorization (RMA) number from the Comtech EF Data Customer Support representative.
- **Pack** the product in its original shipping carton/packaging to ensure that the product is not damaged during shipping.
- **Ship** the product back to Comtech EF Data. (Shipping charges should be prepaid.)

Online Customer Support

An **RMA number request** can be requested electronically by contacting the Customer Support Department through the online support page at www.comtechefdata.com/support.asp:

- **Click** on the “Service” hyperlink, then read the “Return Material Authorization” section for detailed instructions on our return procedures.
- **Click** on the “RMA Request Form” hyperlink, then fill out the form completely before sending.
- **Send e-mail** to the Customer Support Department at service@comtechefdata.com.

Chapter 1. INTRODUCTION

1.1 Overview

Phase combining is a traditional technique that cost effectively increases the available output power of an amplifier system. The PCB-4300 1:2 Phase Combiner (**Figure 1-1**), together with three Solid State Power Amplifiers (SSPAs) and associated waveguide and cabling, form a complete 1:2 phase combined system.



Figure 1-1. Comtech EF Data PCB-4300 1:2 Phase Combiner Control Box (PCCB)

In a 1:2 phase combined system, two of the three SSPAs are normally online and their outputs are summed in the waveguide combiner, effectively doubling the system output power. The third SSPA remains offline and, in the event of a failure of either of the two online units, its “standby” output is automatically switched in place of the failed unit – thereby maintaining full system output power.

1.2 Functional Description

The PCB-4300 is available in either a Ku-Band version (CEFD P/N PL/11285-2) or C-Band version (CEFD P/N PL-0000582). For application examples, see **Appendix A. ASSEMBLY KITS**.

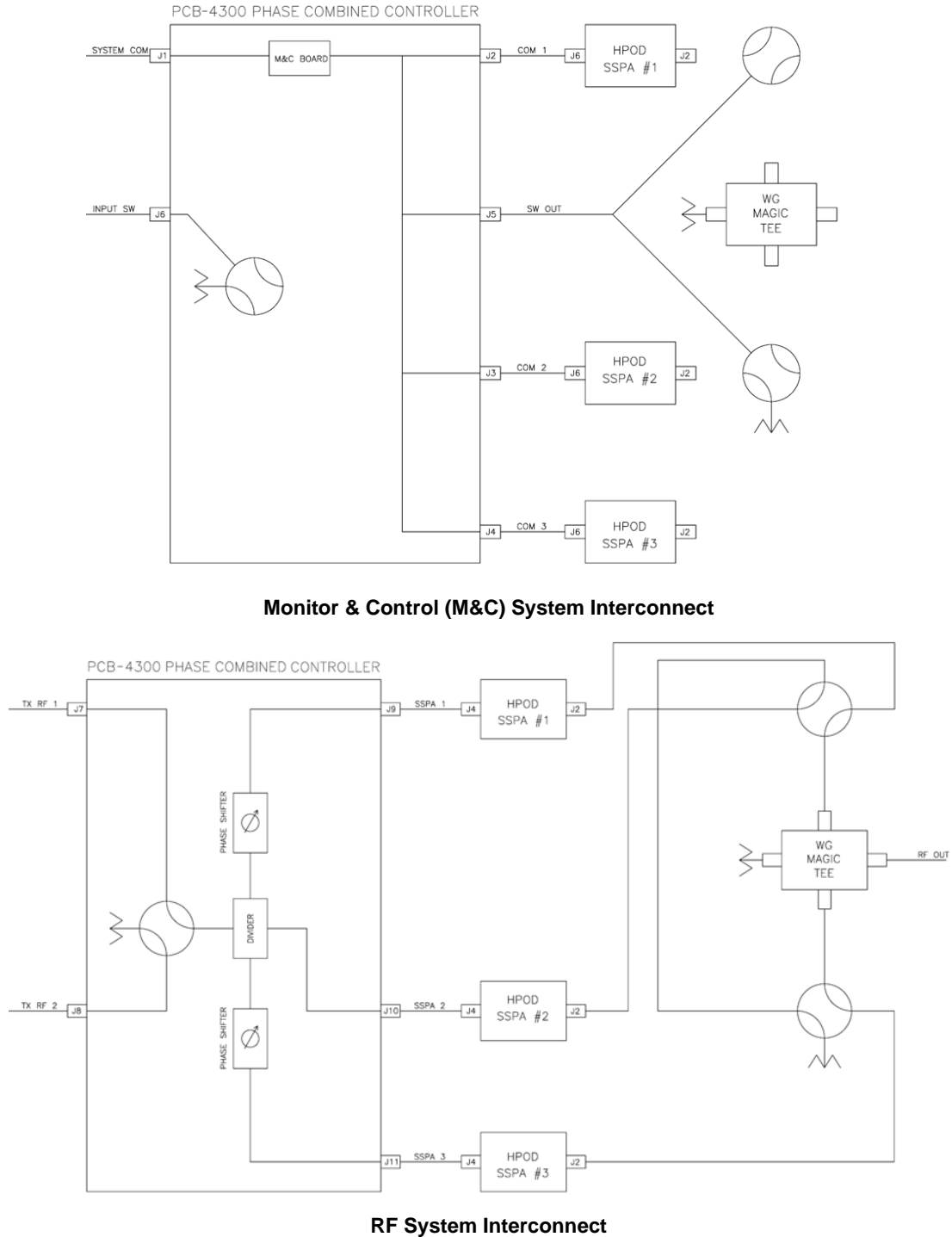


Figure 1-2. Comtech EF Data 1:2 Phase Combined System Block Diagrams

Figure 1-2 provides block diagrams depicting the major components of the 1:2 phase combined system. (These diagrams employ Comtech EF Data HPODs – High Powered Outdoor Amplifiers – as the designated SSPAs.)

The PCB-4300 1:2 Phase Combiner Control Box (PCCB) contains a microprocessor-based M&C circuit board to control the system. Interconnection is as follows:

- The PCCB communicates with each SSPA via control cables that are attached from the PCCB J2, J3, and J4 connectors to each SSPA.
- It is also through this connection that the PCCB receives its prime power to operate. A +24V signal from each SSPA is diode OR'ed to provide redundant operating power for the PCCB.
- Control of the waveguide switches is accomplished via a “Y” cable at the J5 connector. The user communicates with the control box via the J1 System Comm connector.

Note: In order to avoid ambiguities, all communication to each SSPA is also accomplished via the control box M&C.

The PCCB provides a weatherized housing for the necessary input RF components. System interconnection is as follows:

- An input RF redundancy switch, controlled via the **RF INPUT SWITCH J6** connector, selects which RF path is directed to the output.
- The output RF signal is fed into an in-phase divider, which equally splits the signal in phase and amplitude to the **SSPA OUT 1 J9**, **SSPA OUT 2 J10**, and **SSPA OUT 3 J11** output connectors.
 - The RF paths to the **SSPA OUT 1 J9** and **SSPA OUT 3 J11** output connectors each contain a manually adjustable phase shifter; these phase shifters are used to equalize the phase difference of each SSPA signal path to achieve maximum system output power. They are accessible via a small cover panel. These critical components are factory set and should only be adjusted, if needs arise, by carefully following an appropriate alignment procedure – refer to **Chapter 3. OPERATION AND ADJUSTMENT PROCEDURES** for further information.

It is also important for the user to install the individual SSPAs in the correct position (as aligned at the factory). For installation examples, see **Appendix A. ASSEMBLY KITS**.

- The path to **SSPA OUT 2 J10** output connector contains a length of coaxial cable that is factory manufactured to provide equal phase length paths from the RF input to each PCCB output when the adjustable phase shifter is set to its midpoint. This provides a maximum adjustable phase range.

There are also several isolators inside the PCCB that maintain good system Voltage Standing Wave Ratio (VSWR). The user should not alter any RF cable inside (or outside) this box that is part of the RF signal path.

- The RF signals from the PCCB are fed to the RF input of the respective SSPA via a set of phase matched cables. Again, the phase length (and matching) of these cables is essential to system operation and no substitutes should be used. The routing should not be such to cause extreme bends.

- The output waveguide combining system consists of balanced waveguide lengths, two waveguide transfer switches, a “Magic-Tee” combiner with termination, and couplers for test and alignment.

1.3 Theory of Operation

As mentioned previously, phase combining is a common technique to increase the available output power of an amplifier system. Referring back to the **Figure 1-2** system block diagrams, when two signals of equal phase and amplitude are fed into the “Magic-Tee” combiner, the individual power of each SSPA is summed at the output port and cancelled in the termination port.

In real systems, the phase and amplitude of the two signals are never exactly equal, so there is a small amount of power that is absorbed by the load termination. This terminated port is sometimes referred to as the “wasted” power port. In practice, however, it is possible to keep phase and amplitude imbalances at low enough levels such that overall combining losses are only in the 0.2 to 0.5 dB range.

Figure 1-3 shows the effects of phase imbalance on the power combining efficiency.

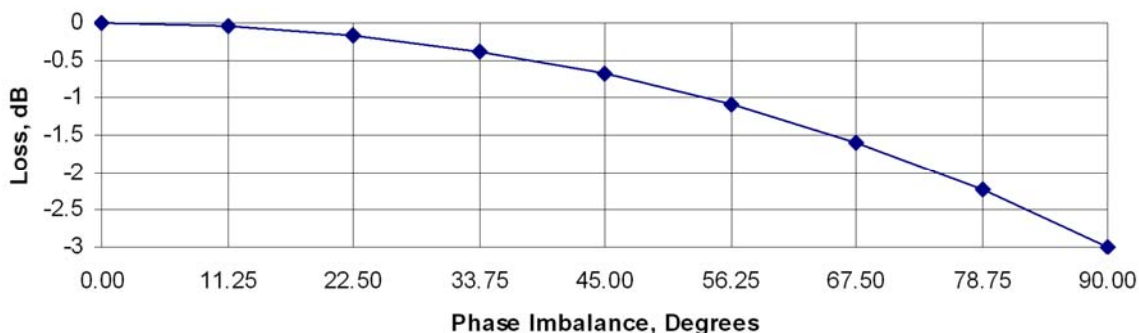


Figure 1-3. Combining Loss vs. Phase Imbalance Summary of Specifications

1.3.1 Phase and Gain Equalization

Note: Phase and gain equalization are performed at the factory, and no user intervention is required unless an amplifier or other critical system component, such as the phase combiner box, needs replaced. The following paragraphs are provided for informational purposes; for operational and alignment information, refer to **Chapter 3. OPERATION AND ADJUSTMENT PROCEDURES**.

Naturally, three separate amplifiers are likely to have different phase and gain characteristics. The PCB-4300 1:2 system is designed such that the phase difference between the three amplifier paths is compensated by adjusting the phase shifter in the Phase Combiner Control Box. This is done at the factory for the full amplifier bandwidth and should not normally require further adjustment in the field unless an amplifier has been replaced.

The gains of the three amplifiers are also equalized at the factory to provide optimum system performance. The PCB-4300 software has a command that reads the stored factory gain of each SSPA and adjusts “offsets” to equalize the gains between the three SSPAs. These Amplitude Offsets – AOF1, AOF2, and AOF3 – are often further fine-tuned at the factory to provide optimum system performance (see test datasheet for specific system offsets).

It is important to reiterate that these offsets, adjusted at the factory and stored in non-volatile memory, are transparent to the user; they should not need further adjustment in end user applications unless an amplifier has been replaced.

1.3.2 System Switching

The possible combinations of which two SSPAs are “online” and directed to the system waveguide combiner output, versus which SSPA is offline, are as follows:

- 1+2 online (SSPA #3 offline);
- 1+3 online (SSPA#2 offline);
- 2+3 online (SSPA #1 offline).

There are two software modes that control which two SSPAs are online versus which SSPA is offline: “automatic” and “manual”. Either mode is invoked by the state of the FoRCe (FRC=) command (see **Appendix B. REMOTE CONTROL**). Note the following:

- **FRC=00** – This command is the factory default and executes “automatic” mode, whereby the two SSPAs that are online and combined will generally be the first two that “clear” their faults; i.e., the first two SSPAs that are powered on. (Refer also to the PRF setting description below.) Should a fault occur in an online unit while FRC=00, the offline unit will automatically switch in place of the faulted unit, maintaining full system output power.
- **FRC=XX** – Where FRC=00 is the *automatic* mode, when it is desired to force two *specific* SSPAs online, executing this command puts the system in “manual” mode and combines the output of the two selected SSPAs. This is accomplished by sending this command, where *XX* = **12** (1+2), **13** (1+3), or **23** (2+3).

Manual mode also implies that, if one of the online units fail, a switchover to replace the faulted unit with the offline unit will NOT occur automatically.

(Note that the FRC command is also useful, should system re-alignment be needed – i.e. the command indirectly directs one SSPA to the offline port for easy characterization and measurement.)

The recommended and default setting is FRC=00.

PRF=XX – The PReferred command, where *XX* = **00**, **12**, **13**, or **23**, affects the possible online/offline states. Note the following:

- If the setting is PRF=00, there is no “preferred” condition, and the first two SSPAs without faults detected by the PCB-4300 will be directed online.
- If PRF is something *other* than 00 – e.g., PRF=13 – then, if at any time both units 1 and 3 have no faults, they will be switched online.

The recommended and default setting is PRF=00.

1.3.3 System Gain

Note that, due to the power divider and cable losses, the overall gain of the system will be approximately 5-10 dB less than the individual gain of each amplifier. Refer to the system test data sheet for actual system gain.

1.3.4 System Attenuation

The PCB-4300 makes it easy to adjust the overall system gain. In a standard 1:2 phase combined system, there is no common attenuator to adjust the overall system gain; the gains of each of the individual SSPAs must be changed appropriately. The PCB-4300 eases this process: The user need only input a single desired attenuation value via the ATT attenuation command (see **Appendix B. REMOTE CONTROL**), and the PCB-4300 automatically communicates with each SSPA and adjusts the individual gains accordingly, resulting in the desired attenuation value while maintaining optimum power combining conditions.

The SSPAs included in the system are calibrated over a range 10 dB beyond specification (30 dB vs. 20 dB). As explained above, a portion of the 30 dB range is required for gain equalization; therefore, while the maximum allowable attenuation in a 1:2 system is software-limited to 24 dB, it still exceeds system specifications.

1.4 Dimensional Envelope

Note: All dimensions are in English units; metric units are shown in parentheses. This figure is typical for the PL/11285-2 Ku-Band and PL-0000582 C-Band versions of the PCB-4300.

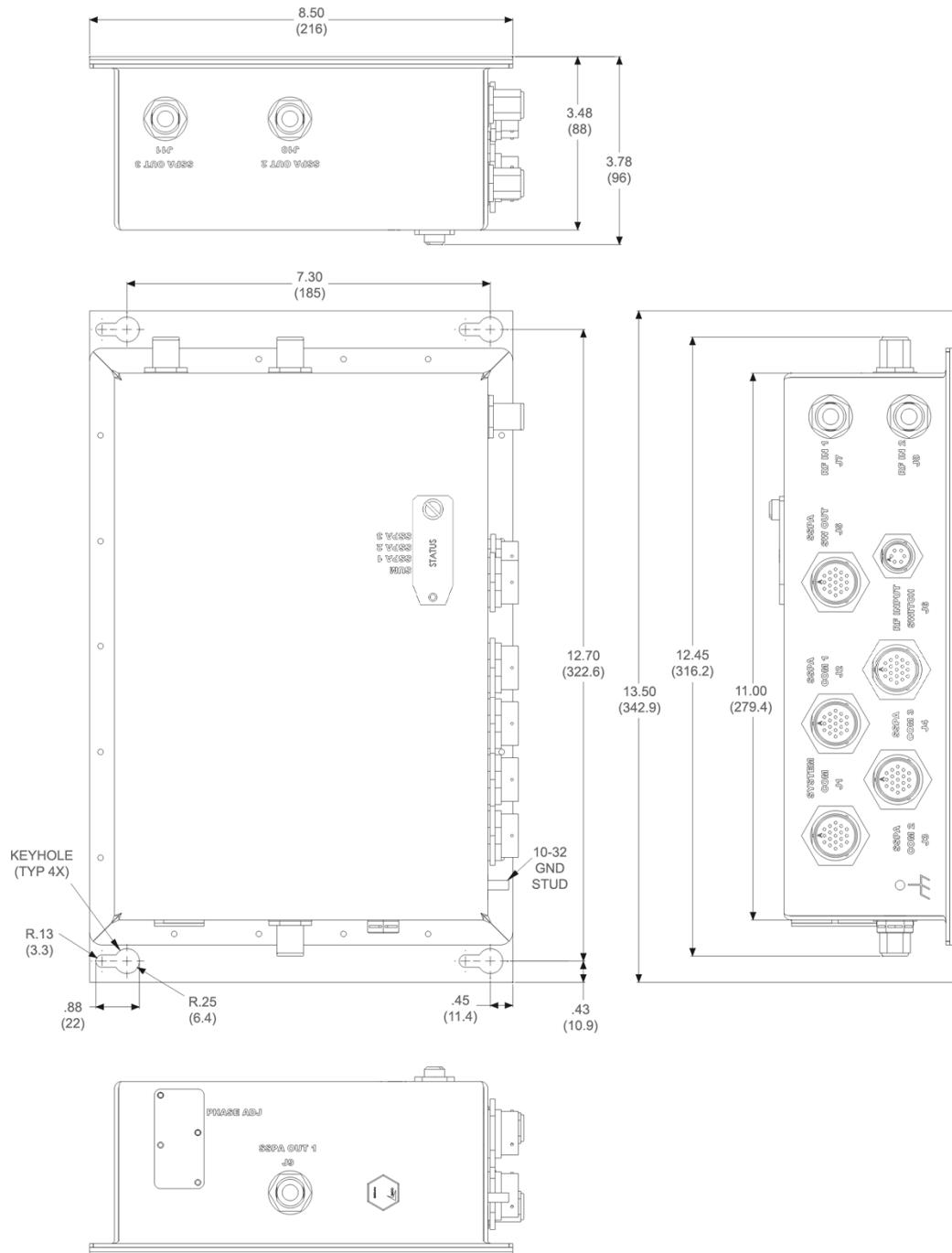


Figure 1-4. PCB-4300 Dimensional Envelope

Notes:

Chapter 2. EXTERNAL CONNECTORS

2.1 Overview

This chapter summarizes the connectors provided for all necessary external connections between the PCB-4300 1:2 Phase Combiner and other equipment. **Table 2-1** on the next page summarizes the connectors provided on the PCB-4300, grouped according to service function.

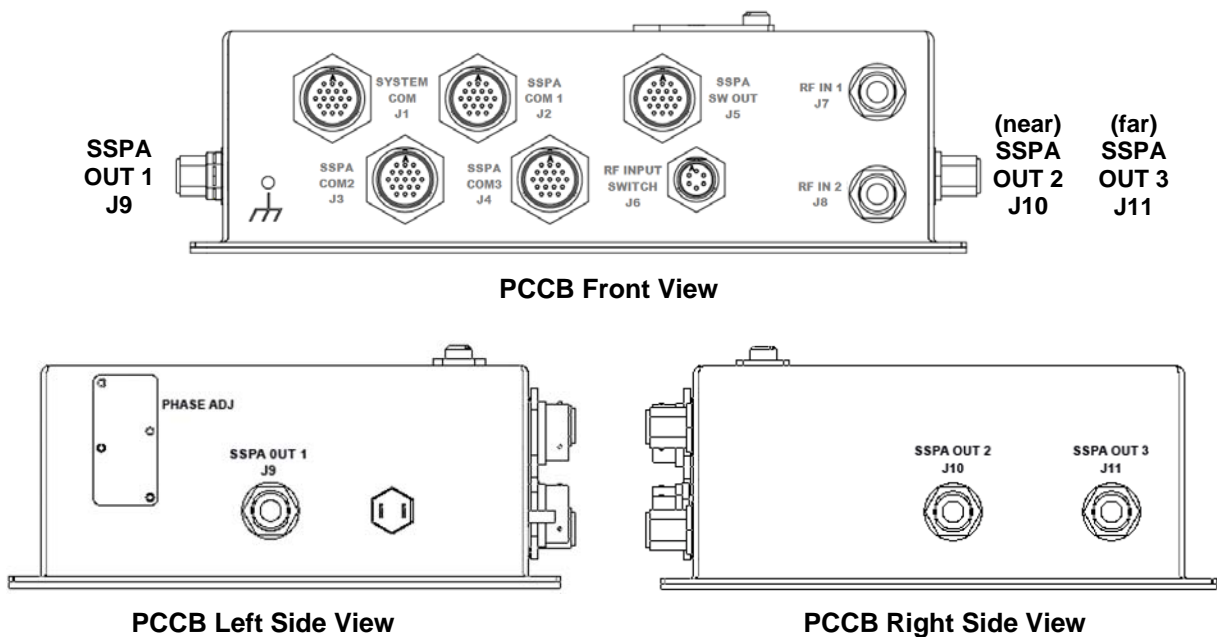


Figure 2-1. PCB-4300 External Connectors

Basic installation and operational information is provided in **Chapter 3. OPERATION AND ADJUSTMENT PROCEDURES** and **Appendix A. ASSEMBLY KITS**. For a detailed overview on the PCB-4300's operability (via remote M&C commands and queries), refer to **Appendix B. REMOTE CONTROL**.

Table 2-1. PCB-4300 External Connectors

Connector Group (Chapter Sect.)	Name / Ref Des	Connector Type	Function
M&C (Sect. 2.2)	SYSTEM COM J1	19-pin Circular Connector	Customer EIA-232/485 and discrete interface
	SSPA COM 1 J2	19-pin Circular Connector	Connects to SSPAs
	SSPA COM 2 J3		
	SSPA COM 3 J4		
	SSPA SW OUT J5	19-pin Circular Connector	Connects to both waveguide switches
RF INPUT SWITCH J6	6-pin Circular Connector	Drive input, selects either RF IN 1 or RF IN 2	
RF (Sect. 2.3)	RF IN 1 J7	Type 'N'	RF Inputs to PCCB
	RF IN 2 J8		
	SSPA OUT 1 J9	Type 'N'	RF Outputs to SSPAs
	SSPA OUT 2 J10		
	SSPA OUT 3 J11		
Power/Ground (Sect 2.4)	AC	Pin 'R' on SSPA COM 1 J1, SSPA COM 2 J3, SSPA COM 3 J4	See Sect. 2.4.1 for AC power provision note
	Ground	#10-32 stud	Common Chassis Ground



To maintain compliance with the European EMC Directive (EN55022, EN50082-1) properly shielded cables are required for data I/O.

2.2 Monitor and Control (M&C) Interface Connectors

Note: All M&C connectors are found on the front panel of the PCCB box.

2.2.1 SYSTEM COM J1 Connector



The **SYSTEM COM J1** connector is a 19-pin circular connector, type MS3112E14-19S. It serves as the primary input between the user and the PCCB for controlling and monitoring both SSPAs. Its pinout specification is provided in **Table 2-2**.

Mating connector: ITT Cannon MS3116J14-19P
(CEFD P/N CN/MS3116J14-19P).

Table 2-2. Connector J1 Pinouts

Pin #	Signal Function	Signal Name / Description
A	RS485_+RX	Customer communications interface
B	RS485_-RX	Customer communications interface
C	RS485_+TX	Customer communications interface
D	RS485_-TX	Customer communications interface
E	RS232_RD	Customer communications interface
F	Spare	Reserved for future use
G	RS232_TD	Customer communications interface
H	System Fault NO	When there is a summary fault in the PCB-4300, this pin (NO) will be tied to the Fault Common pin.
J	System Fault NC	When there is not a summary fault in the PCB-4300, this pin (NC) will be tied to the Fault Common pin.
K	Fault Common	
L	SSPA 1 Fault NO	When there is a fault with SSPA 1, this pin (NO) will be tied to the Fault Common pin.
M	SSPA 1 Fault NC	When there is not a fault with SSPA 1, this pin (NC) will be tied to the Fault Common pin.
N	Ground	
P	SSPA 2 Fault NO	When there is a fault with SSPA 2, this pin (NO) will be tied to the Fault Common pin.
R	SSPA 2 Fault NC	When there is not a fault with SSPA 2, this pin (NC) will be tied to the Fault Common pin.
S	System Mute	SSPA will be muted if this pin is grounded
T	SSPA 3 Fault NO	(NOTE: This pin is reserved for use with 1:2 systems only.)
U	SSPA 3 Fault NC	(NOTE: This pin is reserved for use with 1:2 systems only.)
V	Ground	GND

2.2.2 SSPA COM 1 J2, SSPA COM 2 J3, SSPA COM 3 J4 Connectors



The **SSPA COM 1 J2**, **SSPA COM 2 J3**, and **SSPA COM 3 J4** connectors are 19-pin circular connectors, type MS3112E14-19S. Each serves as the primary input/output interface between the PCCB and its specified SSPA. The typical pinout specification is provided in **Table 2-3**.

Typical mating connector: ITT Cannon MS3116J14-19P
(CEFD P/N CN/MS3116J14-19P).

Table 2-3. Connector J2, J3, J4 Pinouts

Pin #	Signal Function	Signal Name / Description	Direction
A	NC		
B	NC		
C	NC		
D	NC		
E	RS232_RD	Provides for Comm between PCB and SSPA	Input
F	NC		
G	RS232_TD	Provides for Comm between PCB and SSPA	Output
H	Switch Inhibit Output	Provides a hardware mute input to SSPA with switch fault	Output
J	NC		
K	Ground	GND	
L	SUMFLT_NO	Monitors SSPA summary fault relay	Input
M	NC		
N	Ground	GND	
P	ONLINE_STATUS	Used by PCB for online status indication	Input
R	+24V	Bias voltage from SSPA	Input
S	Mute Control	Allow for customer inhibit. Tied to Pin S of System Comm (J1) connector	
T	NC		
U	NC		
V	NC		

2.2.3 SSPA SW OUT J5 Connector



The **SSPA SW OUT J5** connector is a 19-pin circular connector, type MS3112E14-19S. It connects, via a “Y” cable, to the SSPA #1 and SSPA #2 waveguide switches. Its pinout specification is provided in **Mating connector:** ITT Cannon MS3116J14-19P

(CEFD P/N CN/MS3116J14-19P).

Table 2-4.

Mating connector: ITT Cannon MS3116J14-19P
(CEFD P/N CN/MS3116J14-19P).

Table 2-4. Connector J5 Pinouts

Pin #	Signal Function	Signal Name / Description	Direction
A	Pos1, SW1 Drive		Output
B	Ground	GND	
C	POS2, SW1, Drive		Output
D	POS1, SW1, Indicator		Input
E	Ground	GND	
F	POS2, SW1, Indicator		Input
G	NC		
H	POS1, SW2, Drive		Output
J	Ground	GND	
K	POS2, SW2, Drive		Output
L	POS1, SW2, Indicator		Input
M	Ground	GND	
N	POS2, SW2, Indicator		Input
P	NC		
R	NC		
S	NC		
T	NC		
U	NC		
V	NC		

2.2.4 RF INPUT SWITCH J6 Connector



The PCCB contains a built-in selector switch, a latching 28 VDC coaxial unit. The position of this switch is selected by the **RF INPUT SWITCH J6** – a 6-pin circular connector (CEFD P/N CN/MS-PT07M6PC). Its pinout specification is provided in **Table 2-5**.

Mating connector: ITT Cannon MS3116J10-6S
(CEFD P/N CN/MS3116J10-6S).

Table 2-5. Connector J6 Pinouts

Pin #	Signal Function	Signal Name / Description	Direction
A	POS1, Drive		Input
B	Ground	GND	
C	POS2, Drive		Input
D	POS1, Indicator		Output
E	Ground	GND	
F	POS2, Indicator		Output

2.3 RF Interface Connectors

2.3.1 RF IN 1 J7, RF IN 2 J8 Connectors



The **RF IN 1 J7** and **RF IN 2 J8** connectors are Type ‘N’ female connectors, each serving as an RF signal input interface to the PCCB. Note the following:

- The **RF IN 1 J7** input is selected when the RF INPUT SWITCH J6’s “**POS1**” Signal Function is activated.
- The **RF IN 2 J8** input is selected when the RF INPUT SWITCH J6’s “**POS2**” Signal Function is activated.

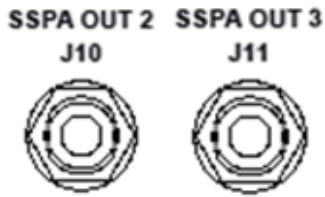
2.3.2 SSPA OUT 1 J9 Connector

**SSPA OUT 1
J9**



The **SSPA OUT J10** connector, located on the left side panel of the PCCB, is a Type ‘N’ female connector. It provides the RF signal output from the PCCB to SSPA #1.

2.3.3 SSPA OUT 2 J10, SSPA OUT 3 J11 Connectors



The **SSPA OUT 2 J10** and **SSPA OUT 3 J11** connectors, located on the right side panel of the PCCB, are Type 'N' female connectors. They provide the RF signal outputs from the PCCB to SSPA #2 and SSPA #3.

2.4 Power and Ground Interfaces

2.4.1 AC Power

The PCB-4300 derives its power from the SSPAs. Each SSPA provides a +24V signal line via cables interconnecting the SSPAs to the SSPA COM 1 J2, SSPA COM 2 J3, and SSPA COM 3 J4 connectors (Pin 'R' – see **Table 2-3** in **Sect. 2.2.2**). These three signals are “diode OR’ed” to provide redundancy.

Note: Although the PCB-4300 box will turn on and function when only one SSPA is powered, the system will not provide optimum output power unless at least two of the three SSPAs are powered on.

2.4.2 Ground Connector



A #10-32 stud is provided on the front panel of the PCCB for connecting a common chassis ground among equipment.

Notes:

Chapter 3. OPERATION AND ADJUSTMENT PROCEDURES



Before attempting any of the procedures featured in this chapter, the user is strongly advised to read Chapter 1. INTRODUCTION to become familiar with system terminology and Theory of Operation, and Chapter 2. EXTERNAL CONNECTORS to become familiar with the PCCB's connectors and their functionality.

3.1 Overview

As indicated in **Chapter 1. INTRODUCTION**, the PCB-4300 1:2 Phase Combiner system has adjustments made, using a network analyzer in the factory, to the amplifier gains and phase shifters. As these in-factory adjustments are based on the specific arrangement of the SSPAs within the system, in order to ensure proper system operation and performance it is mandatory that the components are installed in the same positions as was done in the factory. See **Section 3.2** in this chapter for the steps needed for the proper assembly and installation of a typical 1:2 Phase Combiner System.

As the factory alignment/adjustment of the system facilitates easy adjustment and setting of the phase shifter for optimum output power combining over the full amplifier bandwidth, *alignment in the field is generally not required and the user is strongly cautioned against making unneeded adjustments.*

However, if an amplifier or other critical system component (e.g., the PCB-4300 unit) is replaced, the procedures provided in this chapter explain the steps necessary to restore proper system operation. Procedures for both single frequency and full bandwidth operation are provided in this chapter, as well as a verification procedure that is furnished for the user who simply wants to confirm that the system is working properly.



It is recommended that only qualified personnel familiar with high-power amplifiers, test equipment, and phase combined systems attempt these procedures.

3.2 System Assembly Example and Cable Connections

Figure 3-1 shows an example of the PCB-4300 deployed in a typical 1:2 phase combined system (see **Appendix A. ASSEMBLY KITS** for details on band-specific system applications). Take note of the callouts in this figure, as they will be referenced in the procedures that follow in this chapter. **Figure 3-2** summarizes the cabling required from the PCCB to other components of the system.

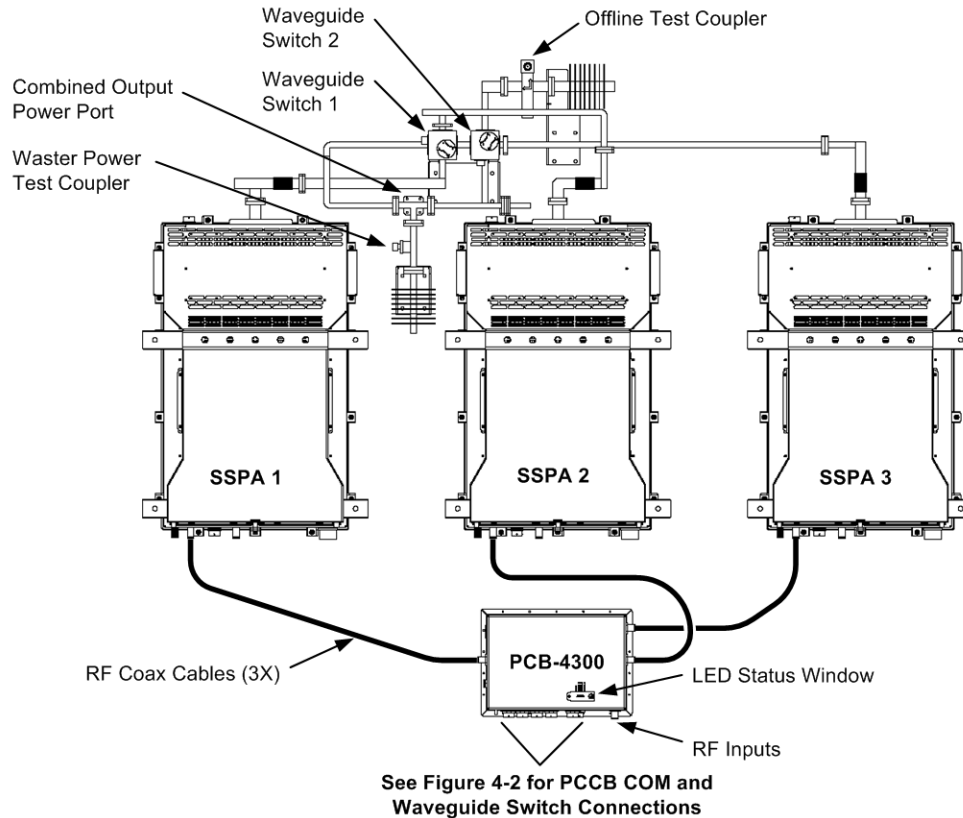


Figure 3-1. PCB-4300 1:2 Phase Combined System Assembly Example

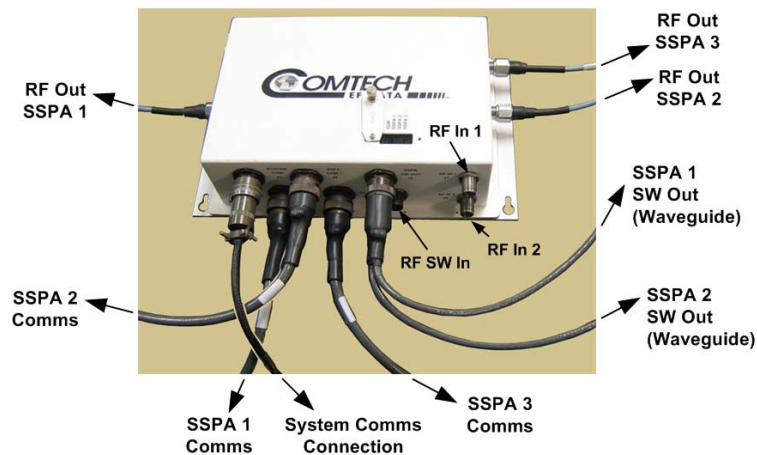



Figure 3-2. PCB-4300 1:2 Phase Combined System Cable Connections

3.2.1 Installation

Referring to **Figure 3-1** and **Figure 3-2**, observe the following:

Step	Procedure
1	Install the SSPAs in their respective positions as detailed in the factory data sheet and in accordance with Figure 3-1 . This means that the specific serial numbered SSPA that was aligned in Position 1 at the factory must also now be installed in position 1; the same applies to the SSPAs in positions 2 and 3. Labels are provided to help ensure correct installation. It is suggested that any mounting hardware used in the installation process not be fully tightened until the entire system is installed.
2	Attach the Waveguide (WG) combining network to the mounting structure and to each SSPA. For assembly details, refer to Appendix A. ASSEMBLY KITS . Take care to install the provided waveguide gaskets at each SSPA output. It may be necessary to slightly adjust each SSPA to prevent undue stress on the waveguide structure. Tighten all hardware when proper alignment is achieved.
3	Assemble the PCB-4300 Phase Combiner Control Box (PCCB) to the mounting structure.
4	<p>Install the Type 'N' RF Phase Matched Coaxial Cables (CEFD P/N CA/RF11872-1) as shown in Figure 3-1. Each cable is labeled according to its destination SSPA:</p> <ul style="list-style-type: none"> ○ Connect the cable labeled 'SSPA1' from the PCCB Type 'N' port labeled 'SSPA OUT 1 J9' to the RF Input port on SSPA #1. ○ Repeat this task for the cables labeled 'SSPA2' and 'SSPA3', connecting them between PCCB Type 'N' ports labeled 'SSPA OUT 1 J10' and 'SSPA OUT 3 J11' and their corresponding RF Input ports on SSPAs #2 and #3. <p> IMPORTANT <i>Ensure the RF cabling is installed correctly, as any "cross" connections will cause system malfunction.</i></p>
5	<p>Install the "COM" Cables (CEFD P/N CA/WR11966-2) between each of the following PCCB connectors and their corresponding SSPA "COM" ports:</p> <ul style="list-style-type: none"> ○ (PCCB) SSPA COM 1 J2 to SSPA #1. ○ (PCCB) SSPA COM 2 J3 to SSPA #2. ○ (PCCB) SSPA COM 3 J4 to SSPA #3.
6	Install a Waveguide (WG) Switch Control "Y" Cable (CEFD P/N CA/WR12013-1) between the PCCB connector labeled ' SSPA SW Out J5 ' (Figure 3-2), and the two waveguide switches as shown in Figure 3-1 . Pay particular attention to ensure that the ends labeled ' SW1 ' and ' SW2 ' are respectively connected to Waveguide Switch #1 and Waveguide Switch #2.
7	Install the user-provided RF Input Switch control cable (if applicable) to the PCCB ' RF INPUT SWITCH J6 '.
8	Properly terminate the waveguide system output port, review all cables for proper connections, and ensure that all mounting hardware is tightened.

3.2.2 LED Status Operation

The PCB-4300 1:2 Phase Combiner features four Light-Emitting Diode (LED) indicators. Each LED provides the user with visual cues to the operational, online, and offline status of the system.

Figure 3-3 illustrates the location of the LED indicators. Located on the top of the PCB-4300 enclosure under a pivoting protective plate, the LEDs may be viewed by loosening the captive screw that keeps the plate in place; the user can then swing the plate away to reveal the LED display window.

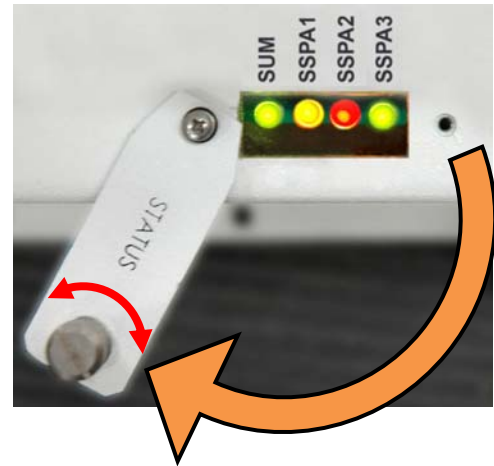


Figure 3-3. PCB-4300 LED Status Panel

The behavior of the LEDs, as they appear under varying operational conditions, is as follows:

LED	Color / Behavior		Description
SUM (LED 1)	Green		Phase Combiner has no summary fault.
	Red (blinking)		A switch fault has occurred.
	Red (constant)		A Summary Fault has occurred.
SSPA 1 (LED 2)	Phase-Combine mode (RED=1)	Green (constant)	SSPA is unfaulted, unmuted and online.
		Orange (constant)	SSPA is unfaulted but muted, and online.
-or-		Red (blinking)	SSPA is faulted and has gone offline.
SSPA 2 (LED 3)		Red (constant)	SSPA is faulted but online.
SSPA 3 (LED 4)	Non Phase-Combine mode (RED=0)	Green (constant)	SSPA is unfaulted, unmuted and online.
		Green (blinking)	SSPA is unfaulted, unmuted and offline.
		Orange (constant)	SSPA is unfaulted but muted, and online.
		Orange (blinking)	SSPA is unfaulted but muted, and offline.
		Red (constant)	SSPA is faulted but online.
		Red (blinking)	SSPA is faulted and has gone offline.

3.3 System Verification

For this section, it is assumed that the system has been assembled and all cables have been connected per the previous section, and that the output port is terminated in a high power load as depicted in the block diagram in **Figure 1-2**.

The following test equipment is required

- Dual Channel Power Meter, or two single channel Power Meters. (If only one power meter is available, attachment to the Combined Output Power Test Port Coupler is generally preferred.)
- CW Input Signal Source.
- Calibration data of system test couplers, i.e., the Combined Output Power Coupler and the “Wasted” Power Coupler.
- PC for serial control and communication.
- Test Datasheet (shipped from by factory).

Overall system performance may essentially be verified by repeating the factory-performed tests, and then comparing these new results to the findings on the provided Test Datasheet. Take care to review and become familiar with this datasheet before attempting these tests.

Observe the following:

Step	Procedure
1	Verify that the amplitude offsets reported by the PCB-4300 agree with those set at the factory (see provided Test Datasheet). The offsets for SSPAs #1, #2 and #3 can be queried by sending remote query <X/AOF=?Y via the serial port (where X=PCB-4300 address, and Y=1, 2, or 3 – the individual SSPA offset in question). Make sure the system attenuation is set to zero (ATT=0.00).

After the amplitude offsets have been verified in **Step 1**, the procedure is then basically continued in two parts – **System Gain Verification** and **System P1dB Verification**. To continue:

3.3.1 System Gain Verification

Step	Procedure
2	Set the CW Input Signal Source to the start, center, and end frequencies of the amplifier range and to a level that will give a system output power of approximately 10 dB below the combined P1dB. For example, for a 14-14.5 GHz system with a combined Prated of 53dBm (individual SSPA= 50dBm) and a system gain of 65 dB, the input source would be set to a level of 53 dBm – 65 – 10 = -22 dBm. Measure, verify, and record this level at the input to the phase combiner system for each of the three frequencies.
3	Attach one channel of the power meter to the Combined Output Power Test Coupler (refer to Figure 3-1); attach the second channel of the power meter to the “Wasted” Power Test Coupler. Make sure the power meter has been appropriately calibrated to include the respective correction factors of the test port couplers.

4	<ul style="list-style-type: none"> • Execute remote command FRC=13 to force SSPAs #1 and #3 <i>online</i>. If necessary, query the PCB-4300 via remote query FRC?. • Apply the CW signal from the source to the input of the phase combiner system. • Measure the output power by reading the power meter channel attached to the Combined Output Power Test Coupler; add the input signal level, and compute the gain. <p>For example, if :</p> <ul style="list-style-type: none"> A. The input frequency was 14.0 GHz; B. The corrected power meter reading at the Combined Output Power Test Coupler was 42.1 dBm; C. The measured input signal level for 14.0GHz was -22.2 dBm (as per Step 2); <p>Then the computed gain at 14.0 GHz would be 42.1 + 22.2 = 64.3 dB for the two SSPAs currently online.</p>
5	Repeat Step 4 for the other two frequencies with the current SSPAs online, e.g., FRC=13 .
6	Repeat Steps 4 and 5 for the other possible SSPA combinations, e.g., FRC=12 , and FRC=23 .
7	Compare the data taken to that under the “Gain” section on the factory’s Test Datasheet. Note that small errors or differences – probably within the range of ±1 dB – are to be expected due to different power meters, calibration issues, etc. The factory maintains a stringent Calibration and Test Procedure to ensure correct and accurate data is shipped with every system. Before contacting the factory to report any notable discrepancies, double check all connections and the calibration factors involved.

3.3.2 System P1dB Verification

Step	Procedure
8	<p>The 1 dB compression point can also be measured for each of the possible online combinations and frequencies. Use the commands listed above to test the various SSPA online pairs. Again, small differences between customer data and factory data are expected due to the factors listed previously in Step 7.</p> <p>The “wasted” power readings are given in the datasheet for reference purposes only. The user should not be concerned with discrepancies in the “Wasted” power readings if the corresponding P1dB level is satisfactory.</p>

3.4 Single Frequency Alignment (as necessary)



This alignment procedure should be attempted only if there has been a replacement of one of the SSPAs or other critical component (such as the PCB-4300) since the time that the system was aligned at the factory.

This particular procedure is for an application that requires operation only over a small fraction of the possible amplifier bandwidth. The alignment procedure for narrow band operation is less complex than alignment for full bandwidth – see **Section 3.5** for the Full Bandwidth Alignment procedure.

The equipment required for this procedure is identical to that as described in **Section 3.3**; the exception being that this procedure also requires use of the Phase Shifter Adjustment Tool Kit (screwdriver and socket) provided with the system.

The procedure is basically divided into two parts: **Gain Equalization** and **Phase Equalization**. It is recommended that the user first review **Section 3.3** for details of the test methods and remote control commands and queries that will be utilized in this procedure.

3.4.1 Gain Equalization

The gains of the individual SSPAs will be equalized by use of the “offline” or “standby” test coupler and AOF settings. The offline port is used because it will give a reading of the output of an individual amplifier.

Observe the following:

Step	Procedure
1	Select the frequency at which it is desired to align the system. Apply a CW signal to the input of the PCB-4300 at a level that will give a system output power of approximately 10 dB below the combined P1dB. For example , for a 14-14.5 GHz system with a combined Prated of 53dBm (individual SSPA=50 dBm) and a system gain of 65 dB, the input source would be set to a level of 53dBm – 65 – 10 = -22 dBm.
2	Attach one channel of the power meter to the Offline Power Test Coupler (refer to Figure 3-1). Make sure the power meter has been appropriately calibrated.
3	Execute remote serial command ATT=0.00 to the PCB-4300. This ensures the system attenuation is set to 0 dB.
4	Execute serial remote command AGI= to the PCB-4300. This command performs a coarse equalization of the gains according to a factory calibration value stored in each individual SSPA; reads this value from each of the three SSPAs; then adjusts the Amplitude Offset (AOF1, AOF2, and AOF3) levels of the two SSPAs with the higher gain to match the unit with the lowest gain. For example , if the factory calibrated gains were SSPA#1=75 dB, SSPA#2=73dB, and SSPA#3=76dB, the AGI= command would result in the following offsets: AOF1=2.00, AOF2=0.00, and AOF3=3.00 .
5	Measure the gain (or output level) of each individual SSPA at the desired frequency by using serial remote command FRC= to alternately send the output of each SSPA to the Offline Test Port Coupler. The table that follows is intended as a worksheet to help equalize the gains. (Note that the AOF level can be queried via serial remote command <X/AOF=?Y (where X =PCB-4300 address, and Y =1, 2, or 3 – the individual SSPA offset in question.)

5 (cont)	Offline SSPA	'FRC=' Setting	AOF Value	Measured Output Level (dBm) @Fre=_____
	1	23	AOF#1=_____	#1=_____
	2	13	AOF#2=_____	#2=_____
	3	12	AOF#3=_____	#3=_____
6	If necessary, fine-tune the offsets of one or more of the SSPAs to achieve equalization. Record the final offsets and output levels in the above table. (The offsets are adjusted by the serial remote command <X/AOF=Y,Z.ZZ (where X =PCB-4300 address; Y =1, 2, or 3 – individual SSPA offset in question; and Z.ZZ =desired offset level). For example , if it is desired to set the offset level of AOF#3 to 3.75 dB, and the PCB-4300 address is 1, then serial remote command <1/AOF=3,3.75 should be sent.			

3.4.2 Phase Equalization

Once the amplitudes have been equalized at the selected frequency, the phase paths can be aligned. This is accomplished by adjusting the two phase shifters inside the PCB-4300 box (see **Figure 3-4**), using the Phase Shifter Adjustment Tool Kit, such that the Combined Output Power Level is maximized and the “Wasted” Output Power Level is minimized.

Referring to the block diagram in **Figure 1-2**, there are two phase shifters:

- The phase shifter in the path to SSPA#1 are used to equalize the phase between SSPAs #1 and #2;
- The phase shifter in the path to SSPA#3 is used to equalize the phase between SSPAs #3 and #2.

Since they were equalized to a “reference” (i.e., #2), by default SSPAs #1 and #3 will be equalized to each other.

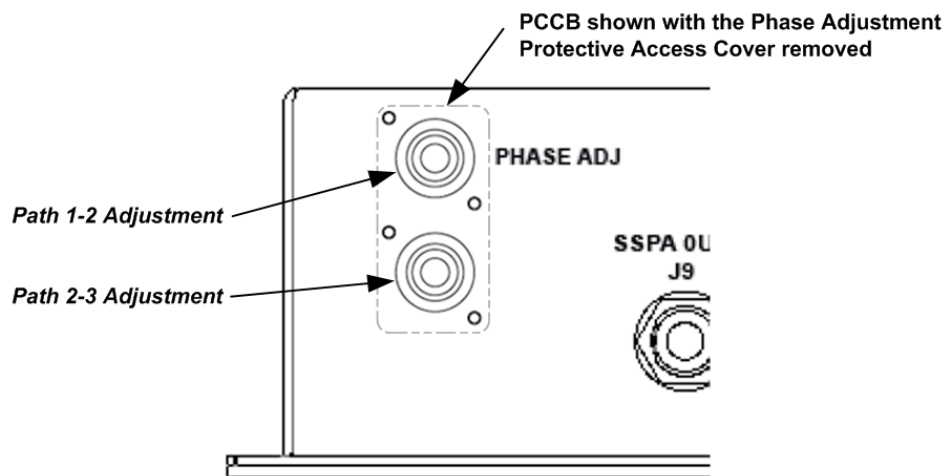


Figure 3-4. Phase Shifter Adjustment Locations

Observe the following:

Step	Procedure
7	<p>Attach one channel of the power meter to the Combined Output Power Test Coupler (refer to Figure 3-1). Attach the second channel of the power meter to the “Wasted” Power Test Coupler. Make sure the power meter has been appropriately calibrated to include the respective correction factors of the test port couplers.</p> <p>Note: If only one power meter is available, it may be alternately switched between the Combined Output Test Coupler and the Wasted Test Coupler. It is suggested to start with it at the Wasted Test Port as the power level at this port will be more sensitive to adjustment.</p>
8	<p>Align the phase between SSPA#1 and #2:</p> <ul style="list-style-type: none"> • First, execute serial remote command FRC=12. • Referring to Figure 3-4, use the provided tool to loosen the locknut on the phase shifter for path 1-2. Slowly turn the phase shifter with the screwdriver while viewing the Combined and Wasted Power readings. For single frequency alignment, the optimum setting is when the Combined level is maximized and the Wasted level is minimized. <p>Note: For single frequency operation, (a) the difference between Combined and Wasted Power levels will be 15-25 dB or more, and (b) there may be two different positions of the phase shifter which give good results.</p>
9	<p>Align the phase between SSPA#3 and #2:</p> <ul style="list-style-type: none"> • First, execute serial remote command FRC=23. • Referring to Figure 3-4, adjust the phase shifter for path 2-3 as was done for path 1-2 in Step 8.
10	<p>After aligning paths 1-2 and 2-3 per Steps 8 and 9, execute serial remote command FRC=13 to combine SSPAs #1 and #3. The Combined and Wasted level ratios should be similar to those for the other paths mentioned above. Then:</p> <ul style="list-style-type: none"> • Perform any necessary fine adjustments, toggling between all three paths until satisfactory performance is achieved. • Tighten all phase shifter adjustment nuts with the provided socket. • Replace the cover over the access hole. <p>Note: The Wasted Power Level is more sensitive, but optimizing it beyond <i>reasonable</i> values has a diminishing effect on the desired Combined Output Power.</p>

3.5 Full Bandwidth Alignment (as necessary)



This alignment procedure should be attempted only if there has been a replacement of one of the SSPAs or other critical component (such as the PCB-4300) since the time that the system was aligned at the factory.

The alignment procedure for full bandwidth operation is obviously more complex than alignment for narrow band operation – see **Section 3.4** for the Single Frequency Alignment procedure. At the factory, a multi-channel network analyzer is utilized to accomplish the phase matching, which facilitates adjustments to be made while viewing system performance over the full amplifier bandwidth.

The test procedure provided here facilitates aligning the system with a CW input source and power meters. The equipment required for this procedure is identical to that as described in **Sections 3.3 and 3.4**. The system will have to be aligned by toggling back and forth between start, middle and stop frequencies. While very similar to the Single Frequency Alignment procedure described in the previous section, the alignments and adjustments must now be made and “balanced” over the full amplifier bandwidth.

The procedure is basically divided into two parts: **Gain Equalization** and **Phase Equalization**. It is recommended that the user first review **Section 3.4** for details of the test methods and remote control commands and queries that will be utilized in this procedure.

3.5.1 Gain Equalization

The gains of the individual SSPAs will be equalized by use of the “offline” or “standby” test coupler and AOF settings. The offline port is used because it will give a reading of the output of an individual amplifier.

Observe the following:

Step	Procedure
1	Apply a CW signal to the input of the PCB-4300 at a level that will give a system output power of approximately 10 dB below the combined P1dB. For example , for a 14-14.5 GHz system with a combined Prated of 53dBm (individual SSPA=50 dBm) and a system gain of 65 dB, the input source would be set to a level of 53dBm – 65 – 10 = -22 dBm.
2	Attach one channel of the power meter to the Offline Power Test Coupler (refer to Figure 3-1). Make sure the power meter has been appropriately calibrated to include the respective correction factors of the Offline Test Port Coupler.
3	Execute remote serial command ATT=0.00 to the PCB-4300. This ensures the system attenuation is set to 0 dB.
4	Execute serial remote command AGI= to the PCB-4300. This command performs a coarse equalization of the gains according to a factory calibration value stored in each individual SSPA; reads this value from each of the three SSPAs; then adjusts the Amplitude Offset (AOF1, AOF2, and AOF3) levels of the two SSPAs with the higher gain to match the unit with the lowest gain. For example , if the factory calibrated gains were SSPA#1=75 dB, SSPA#2=73dB, and SSPA#3=76dB, the AGI= command would result in the following offsets: AOF1=2.00, AOF2=0.00, and AOF3=3.00 .

5	Measure the gain (or output level) of each individual SSPA at the start, middle, and stop frequencies of the amplifier band by using serial remote command FRC= to alternately send the output of each SSPA to the Offline Test Port Coupler. The table that follows is intended as a worksheet to help equalize the gains. (Note that the AOF level can be queried via serial remote command <X/AOF=?Y (where X =PCB-4300 address, and Y =1, 2, or 3 – the individual SSPA offset in question.)					
	Offline SSPA	'FRC=' Setting	AOF Value	Measured Output Level (dBm)		
				F_{strt}=	F_{mid}=	F_{end}=
	1	23	AOF#1=_____	_____	_____	_____
	2	13	AOF#2=_____	_____	_____	_____
3	12	AOF#3=_____	_____	_____	_____	
6	If necessary, fine-tune the offsets of one or more of the SSPAs to achieve equalization. Record the final offsets and output levels in the above table. (The offsets are adjusted by the serial remote command <X/AOF=Y,Z.ZZ (where X =PCB-4300 address; Y =1, 2, or 3 – individual SSPA offset in question; and Z.ZZ =desired offset level). For example , if it is desired to set the offset level of AOF#3 to 3.75 dB, and the PCB-4300 address is 1, then serial remote command <1/AOF=3,3.75 should be sent.					

3.5.2 Phase Equalization

Once the amplitudes have been equalized across the frequency band, the phase paths can be aligned. This is accomplished by adjusting the two phase shifters inside the PCB-4300 box (see **Figure 3-4**), using the Phase Shifter Adjustment Tool Kit, such that the Combined Output Power Level is maximized and the “Wasted” Output Power Level is minimized.

Referring to the block diagram in **Figure 1-2**, there are two phase shifters:

- The phase shifter in the path to SSPA#1 are used to equalize the phase between SSPAs #1 and #2;
- The phase shifter in the path to SSPA#3 is used to equalize the phase between SSPAs #3 and #2.

Since they were equalized to a “reference” (i.e., #2), by default SSPAs #1 and #3 will be equalized to each other.

Observe the following:

Step	Procedure
7	Attach one channel of the power meter to the Combined Output Power Test Coupler (refer to Figure 3-1). Attach the second channel of the power meter to the “Wasted” Power Test Coupler. Make sure the power meter has been appropriately calibrated to include the respective correction factors of the test port couplers. Note: If only one power meter is available, it may be alternately switched between the Combined Output Test Coupler and the Wasted Test Coupler. It is suggested to start with it at the Wasted Test Port as the power level at this port will be more sensitive to adjustment.

8	<p>Align the phase between SSPA#1 and #2:</p> <ul style="list-style-type: none">• First, execute serial remote command FRC=12.• Referring to Figure 3-4, use the provided tool to loosen the locknut on the phase shifter for path 1-2. Slowly turn the phase shifter with the screwdriver while viewing the Combined and Wasted Power readings. Toggle back and forth between the Start, Middle, and Stop frequencies to maximize the difference (ratio) between the Combined Power and the Wasted Power. The ratio generally needs to be balanced at the endpoints, and will usually be greater at the center frequency. <p>Note: For broadband operation, (a) the difference between Combined and Wasted Power levels will be 10-20 dB or more, and (b) there may be two different positions of the phase shifter which give good results at the center frequency, but there is only one position which will give the broadest band operation – i.e., which gives the best difference between the combined and wasted power levels at all frequencies.</p>
9	<p>Align the phase between SSPA#3 and #2:</p> <ul style="list-style-type: none">• First, execute serial remote command FRC=23.• Referring to Figure 3-4, adjust the phase shifter for path 2-3 as was done for path 1-2 in Step 8.
10	<p>After aligning paths 1-2 and 2-3 per Steps 8 and 9, execute serial remote command FRC=13 to combine SSPAs #1 and #3. The Combined and Wasted level ratios should be similar to those for the other paths mentioned above. Then:</p> <ul style="list-style-type: none">• Perform any necessary fine adjustments, toggling between all three paths until satisfactory performance is achieved. It may be necessary to slightly “skew” the combined/wasted power ratio over frequency to achieve best system performance at a band edge.• Tighten all phase shifter adjustment nuts with the provided socket.• Replace the cover over the access hole. <p>Note: The Wasted Power Level is more sensitive, but optimizing it beyond <i>reasonable</i> values has a diminishing effect on the desired Combined Output Power.</p>

Chapter 4. FLASH UPGRADING

4.1 Overview

This chapter provides procedural information for upgrading the firmware for the Comtech EF Data PCB-4300 1:2 Phase Combiner. This chapter assumes that the user has familiarity with Microsoft Windows-based operating systems.

4.2 Flash Updating via Internet













The PCB-4300 uses 'Flash memory' technology internally; this makes firmware upgrading very simple, and updates can now be sent via the Internet (**Figure 4-1**), via E-mail, or on CD. The complete upgrading process is summarized as follows:

- New firmware update for upgrading the PCB-4300 is transferred to a user provided PC intended for Monitor and Control (M&C) of the PCB-4300 system.
- By simply connecting the PCB-4300 to an available serial port on the user-provided PC, the upgrade can then be performed without opening the PCB-4300.
- Once the firmware update is extracted from the transferred archive file, the upgrade process is executed via use of a utility program, **FLSHCSAT.exe**.

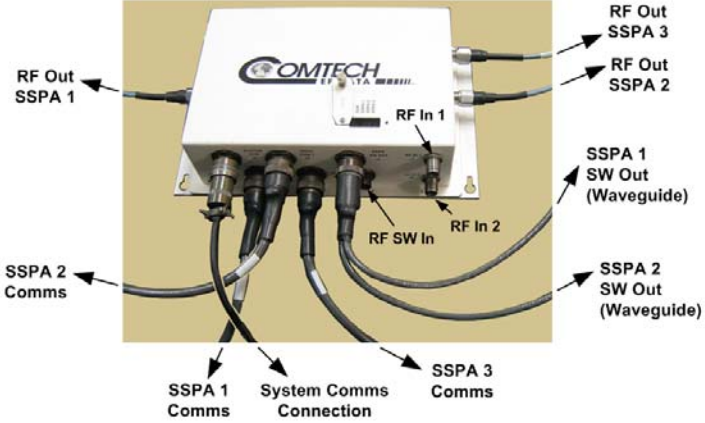
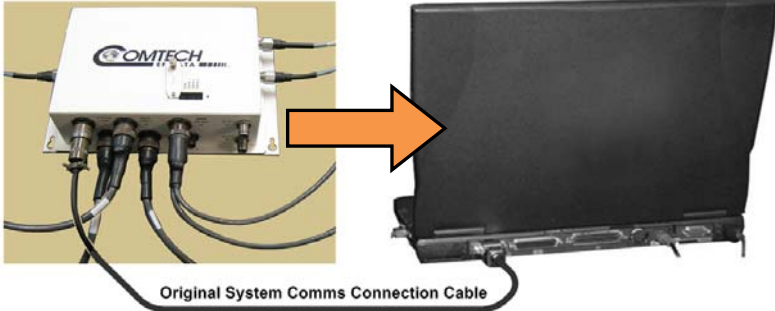





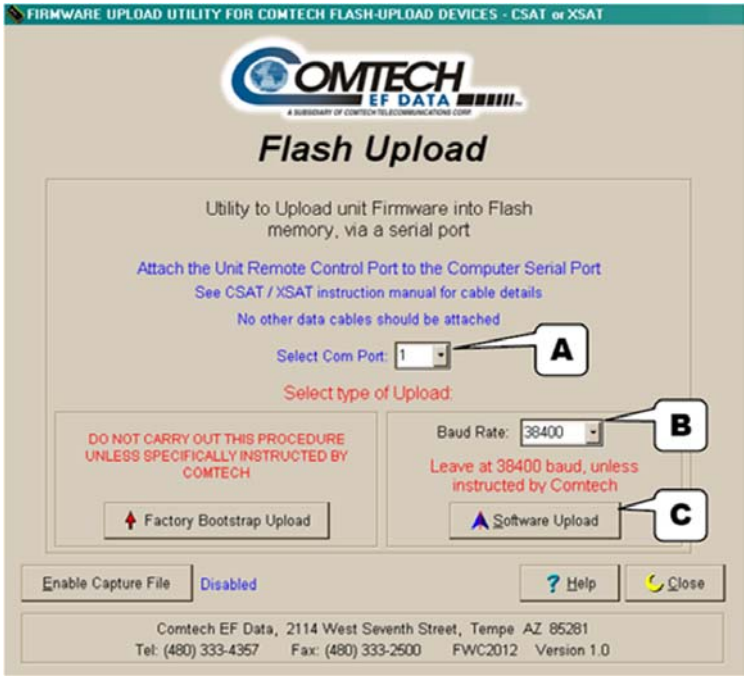
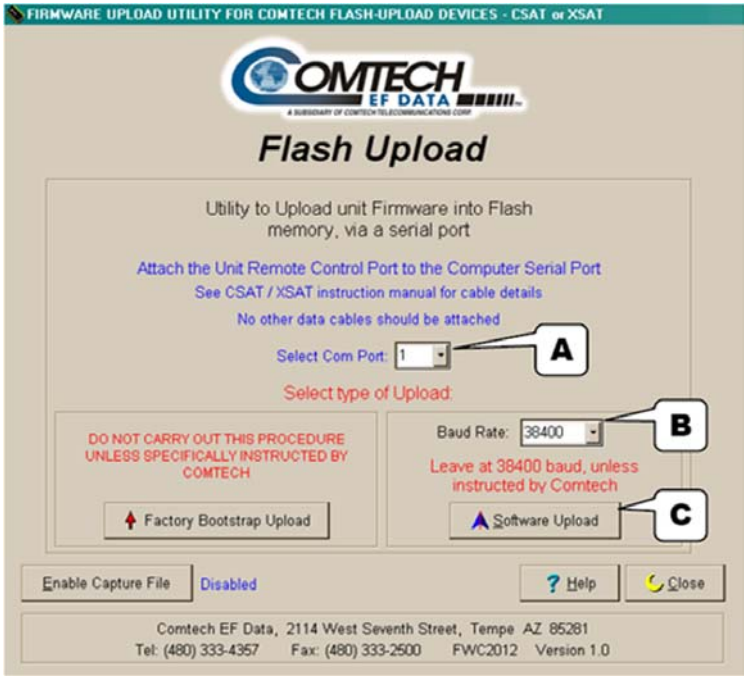
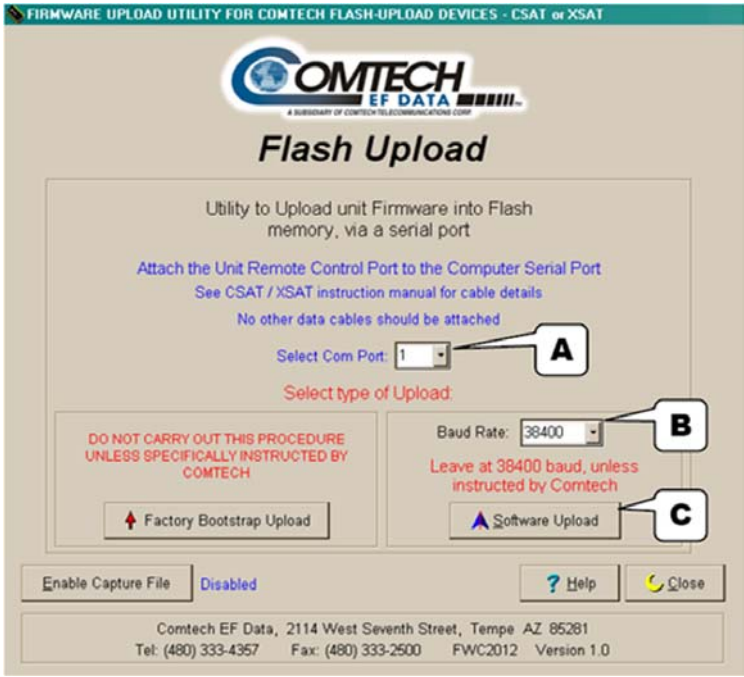
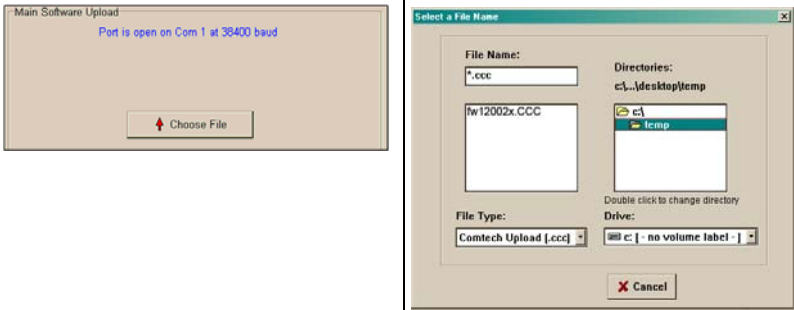

Figure 4-1. Flash Update via Internet

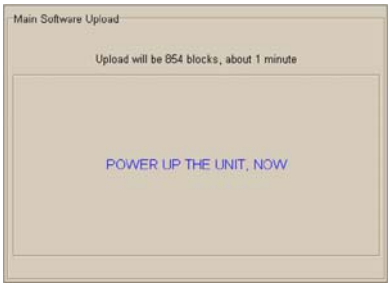
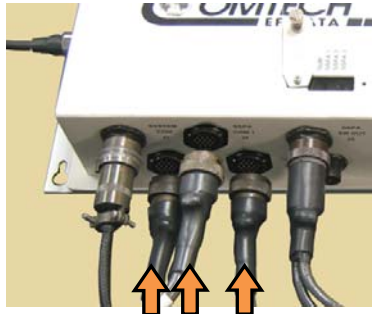
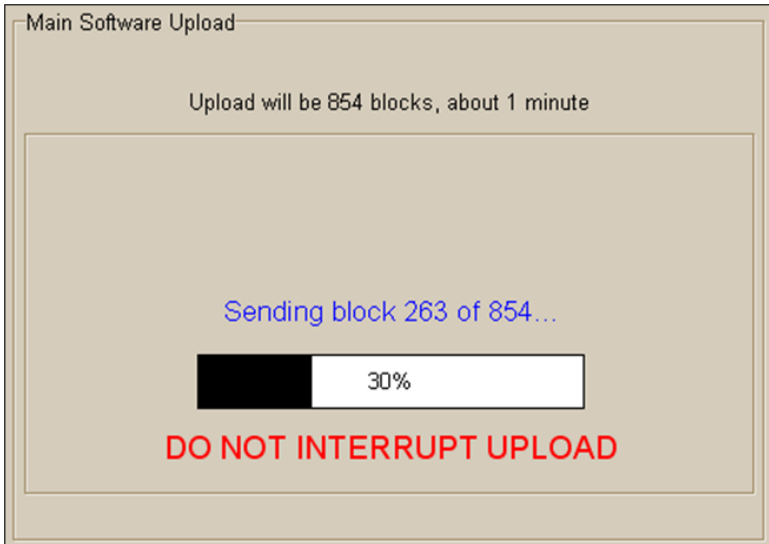
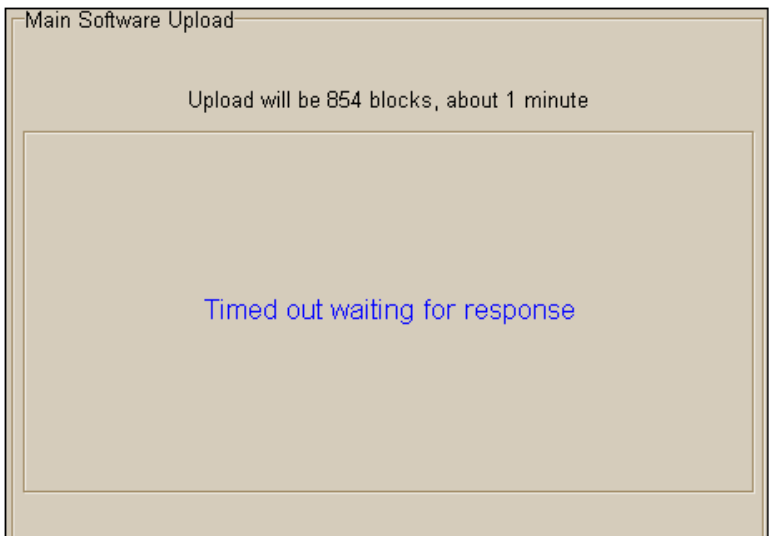
4.2.1 Firmware File Transfer Procedure

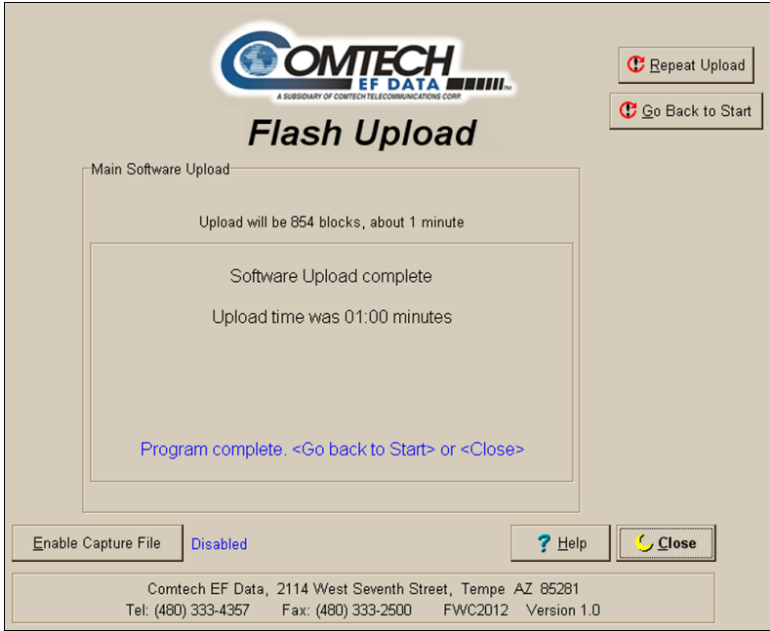


Step	Procedure					
1	<p>Identify the reflashable product, firmware number, and version for download. Via serial remote control, the firmware number, versions, and revision level can be queried as follows: <0/FRW?</p>					
2	<p>Create a temporary directory (folder) on the PC:</p> <p>Windows: Select File → New → Folder and rename the "New Folder" to "temp" or another unused name. A "<i>c:\temp</i>" folder should now exist.</p> <p>Note: The c: is the drive letter used in this example. Any valid, writable drive letter can be used.</p> <p>CMD prompt: At the command prompt (c:\>) type "MD temp" or "mkdir temp" without quotes (MD and mkdir stand for <i>make directory</i>). A "<i>c:\temp</i>" subdirectory should now exist, where c: is the drive letter used in the example.</p>					
3	<p>Download the correct firmware file to this temporary folder. As shown in Figure 4-1:</p> <ol style="list-style-type: none"> Go online to: www.comtechefdata.com; Click on: Support tab; Click on: Software Downloads drop-down or hyperlink from Support page; Click on: Download Flash and Software Update Files icon; Click on: Flash and Software Update Files / Select a Product Line: Transceivers hyperlink; Under the MBT-4000/B heading, select the PCB4300 (1:2 Phase Combiner) product hyperlink; Select the appropriate firmware hyperlink for download. <p>About Firmware Numbers, File Versions, and Formats: The flashable files on the download server are organized by product prefix; Depending on the product for which it is intended, the file name may designate the firmware number (verify that the correct firmware number is known – see Step 1); revision letter, if applicable; release version; and release date.</p> <p>The naming convention for the PCB-4300 Base Unit firmware is FW12002x.CCC (where 'x' denotes the firmware revision letter).</p> <p>Note: The current version firmware release is provided. If applicable, a minimum of one version prior to the current release is also available. <i>Be sure to identify and download the desired version.</i></p> <p>The downloadable files are stored in two formats: *.exe (self-extracting) and *.zip (compressed). Some firewalls will not allow the downloading of *.exe files. In this case, download the *.zip file instead.</p> <p>For additional help with "zipped" file types, refer to <i>PKZIP for Windows</i>, <i>WinZip</i>, or <i>ZipCentral</i> help files. <i>PKZIP for DOS</i> is not supported due to file naming conventions.</p>					
4	<p>Extract the files to the temporary folder on the PC, PC, then verify the success of the file extraction using the dir command. At least four files should be extracted:</p> <div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Name</th> </tr> </thead> <tbody> <tr> <td> PCB4300_ReleaseNotes_v1_1_1.pdf</td> </tr> <tr> <td> FLSHCSAT.EXE</td> </tr> <tr> <td> fw12002-CCC</td> </tr> <tr> <td> CCCflash.hlp</td> </tr> </tbody> </table> </div> <div> <ul style="list-style-type: none"> • PCB4300_ReleaseNotes_vX-X-X.pdf: Where "X-X-X" denotes the firmware version number. • fw12002x.CCC: Firmware file, where "x" denotes the firmware revision letter. • FLSHCSAT.EXE: CEFD Flash Upload Utility Program. • CCCflash.hlp: FLSHCSAT Help File. </div> </div> <p>If these four files are available as indicated here, proceed to the next section to perform the flash upgrade.</p>	Name	 PCB4300_ReleaseNotes_v1_1_1.pdf	 FLSHCSAT.EXE	 fw12002-CCC	 CCCflash.hlp
Name						
 PCB4300_ReleaseNotes_v1_1_1.pdf						
 FLSHCSAT.EXE						
 fw12002-CCC						
 CCCflash.hlp						

4.3 Flash Upgrade Procedure

Step	Procedure	
1	<p>Locate and identify the PCB-4300 1:2 Phase Combiner System.</p> <p>The illustration to the right serves to identify the key cable connections at the PCCB for a typical system.</p>	 <p>The diagram shows a white rectangular device with the 'COMTECH' logo. It has several ports on its front panel. Labels with arrows point to the following connections: 'RF Out SSPA 1' (top left), 'RF Out SSPA 3' (top right), 'RF Out SSPA 2' (top right), 'RF In 1' (top center), 'RF In 2' (top right), 'SSPA 1 SW Out (Waveguide)' (middle right), 'SSPA 2 SW Out (Waveguide)' (middle right), 'RF SW In' (middle center), 'SSPA 2 Comms' (bottom left), 'SSPA 1 Comms' (bottom center), 'System Comms Connection' (bottom center), and 'SSPA 3 Comms' (bottom right).</p>
2	<p>Ensure that the PCCB is connected to a user-provided Windows-based PC.</p>	 <p>The diagram shows the PCCB on the left and a black PC on the right. An orange arrow points from the PCCB to the PC. A cable labeled 'Original System Comms Connection Cable' connects the two. Below the PC, there is a note: 'NOTE: If needed, the CA/WR12243-1 System Programming Cable is available from Comtech EF Data. Contact CEFD Customer Support for ordering information.'</p>  <p>The image shows a coiled cable with a connector on one end and a standard RJ45 Ethernet connector on the other.</p>
3	<p>Double-click FLSHCAT.EXE (filename or icon) to execute the flash upload utility.</p>	 <p>The icon shows a small black and yellow component with the text 'FLSHCSAT.EXE' below it.</p>

Step	Procedure	
3	Double-click FLSHCAT.EXE (filename or icon) to execute the flash upload utility.	
4	Front the FLSHCAT dialogue box, select the pertinent serial port used for communication between the PC and the PCCB.. (In this example, as noted at 'A', COM1 has been selected.)	
5	Do not select a Baud Rate (noted at 'B') other than the default selection of 38400, unless otherwise instructed by Comtech EF Data Technical Support.	
6	Click on ' Software Upload ' as noted at 'C'.	
7	Select the firmware file for upload. Click ' Choose File ' then, once the <i>Select a File Name</i> dialogue box opens, use the window on the right to navigate to the desired folder. Finally, double-click on the firmware file from the window on the left.	
8	Prior to continuing the upload process, the PCB-4300 system must be powered off by disconnecting the SSPA COM 1 J2 , SSPA COM 2 J3 , and SSPA COM 3 J4 connector cables. Once this is done, click ' Start Upload '.	

Step	Procedure	
9	<p>When prompted, reconnect the SSPA COM 1 J2, SSPA COM 2 J3, and SSPA COM 3 J4 connector cables.</p>	<div style="display: flex; justify-content: space-around;">   </div>
10	<p>Once communications have been established between the PC and PCCB, the upload will take place – <i>do not interrupt this upload process.</i></p>	
	<p>Note: If the upload is not successful for any reason – e.g., the communications cable is not physically connected, the wrong COM port is specified, the user inadvertently interrupted the upload, etc. – the user may troubleshoot the setup as needed, then click on 'Repeat Upload' or 'Go Back to Start' to resume or retry the upload process.</p>	

Step	Procedure	
11	<p>Upon successful completion of the upload, the user may click on 'Go Back to Start' (if, for example, more than one PCB-4300 1:2 Phase Combined System requires upgrade) or 'Close' (to exit the FLSHCAT program).</p>	
12	<p>If needed, disconnect the CAWR12243-1 System Programming Cable and reconnect the original System Communications connection cable.</p>	
13	<p>The LEDs on the top of the PCCB may illuminate GREEN (unmuted), ORANGE (muted), or RED (faulted) to indicate the current status of the PCCB, SSPA1, SSPA2, and SSPA3 operations.</p> <p>Refer to Chapter 3. OPERATION AND ADJUSTMENT PROCEDURES for more information on these operational states of the PCB-4300.</p>	
<p>The upgrade process has been successfully completed.</p>		

Appendix A. ASSEMBLY KITS

A.1 Overview

This appendix outlines the Comtech EF Data accessory and assembly kits that satisfy installation requirements for a PCB-4300 1:2 Phase Combined System – an example is shown to the right:

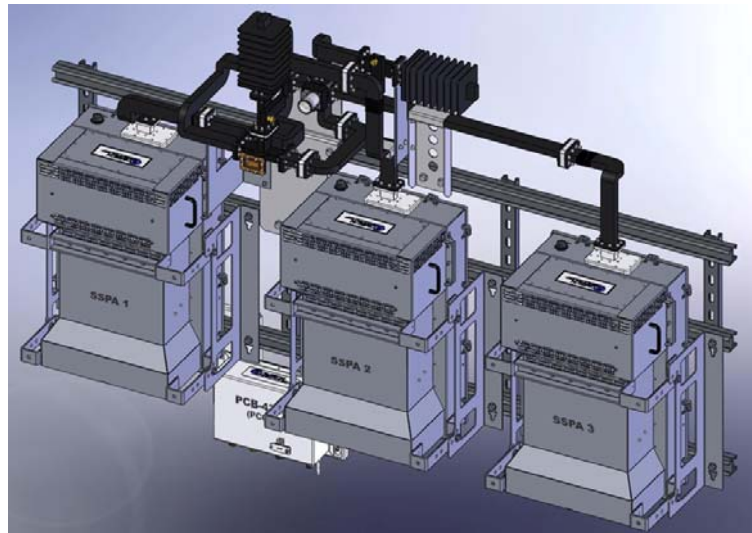
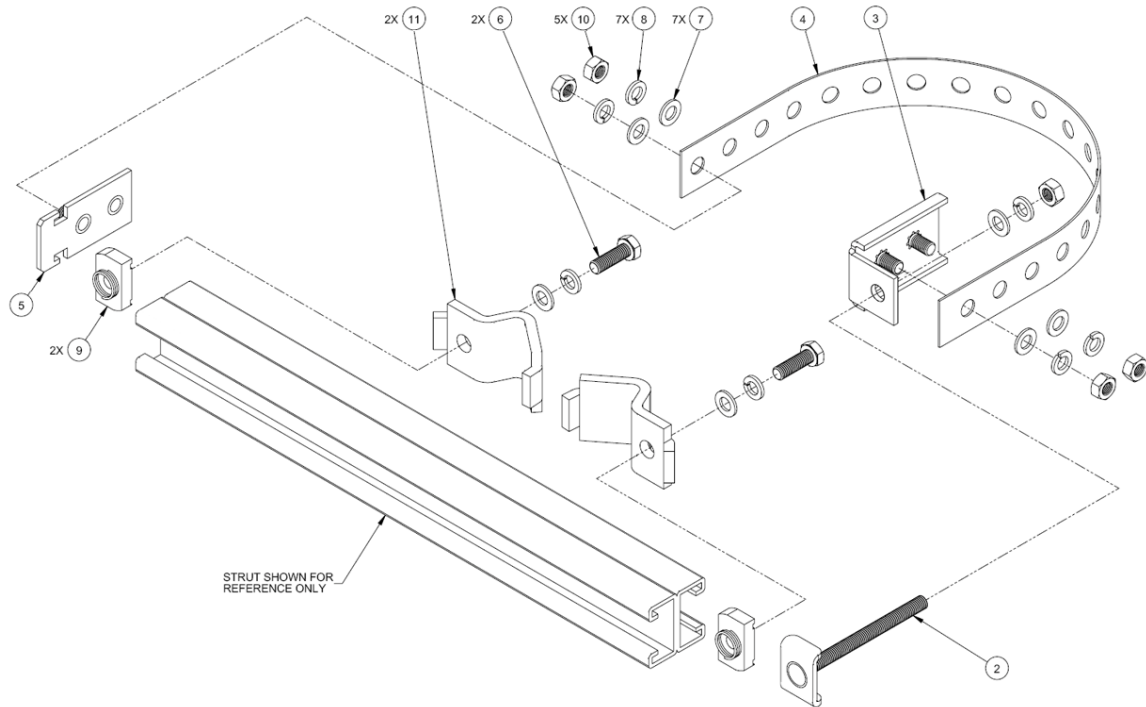


FIGURE	TABLE (BOM)	CEFD Part No.	Description
A-1	N/A	PL/12319-1	Universal Pole Mounting Kit
A-2	N/A	KT-0000017	Dual-Channel Unistrut Mounting Kit, 1:2
A-3	N/A	KT/12300-1	HPOD Mounting Bracket Kit
A-4	N/A	KT-0000028	(PL/11285-2) 1:2 Phase Combiner Box, Ku-Band
		KT-0000108	(PL-0000582) 1:2 Phase Combiner Box, C-Band
A-5, A-6	A-1	KT-0000317	1:2 Phase Combined System Assembly, Ku-Band, HPOD
A-7, A-8	A-2	KT-0000026	Waveguide/Components Kit, 1:2 Phase Combined System Assembly
A-9 thru A-13	A-3	KT/11830-1	1:2 Phase Combined System Kit, Ku-Band (<i>Legacy Item</i>)
A-14, A-15	A-4	KT-0000109	1:2 Phase Combined System Assembly, C-Band, 350w HPOD
A-16, A-17	A-5	KT-0000107	1:2 Phase Combined C-Band WaveguideKit – HPOD

Note: As the model of the SSPA group deployed within a 1:2 Phase Combined System may vary, the illustrations provided herein either show installed SSPAs for reference purposes only, or otherwise intentionally omit the depiction of any installed SSPA group.

A.2 Common Assembly Items

A.2.1 Universal Pole Mounting Kit PL/12319-1

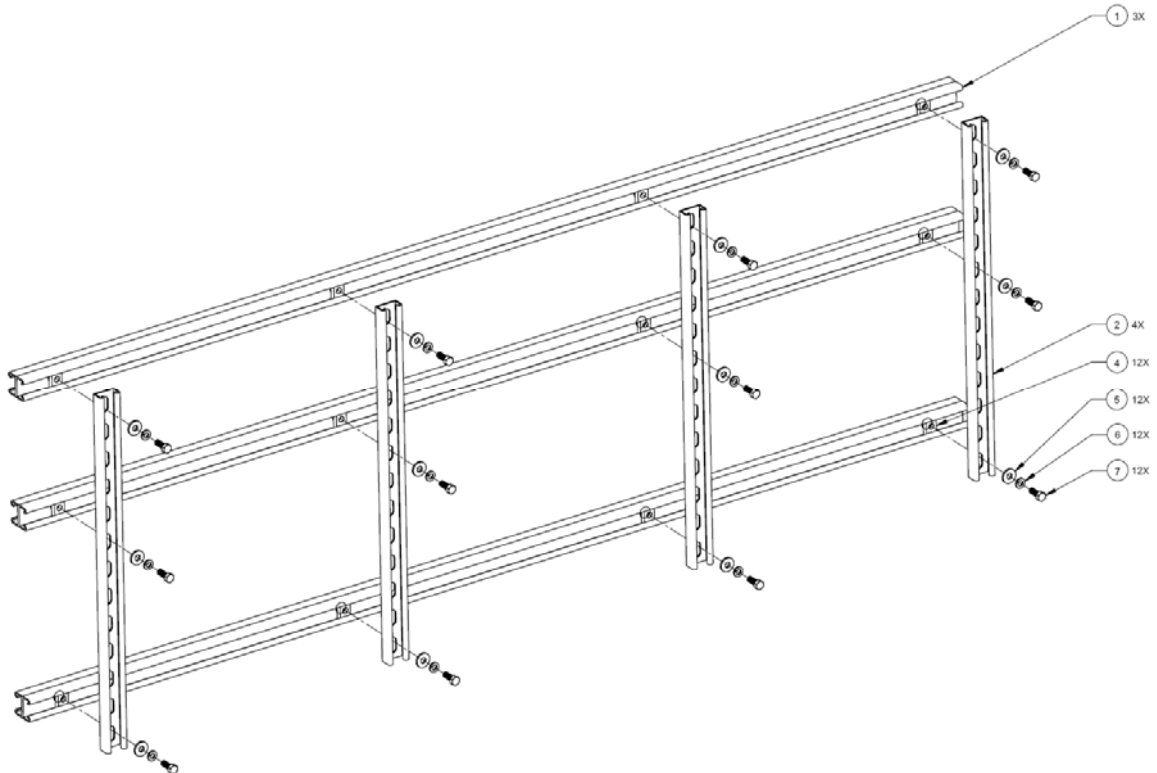


PL/12319-1 Universal Pole Mounting Kit			
Item No.	QTY	CEFD Part No.	Description
1	N/A	(FP-0000134)	Unistrut, Dual Channel (SHOWN FOR REFERENCE ONLY, P/O CEFD KT-0000017 MOUNTING KIT)
2	1	FP/BR0072	Bracket, Strap Tensioner
3	1	FP/BR0070	Bracket, Strap Termination
4	1	FP/BR0071	Bracket, 1-1/4 Strap (TRIM TO REQUIRED LENGTH)
5	1	FP/BR0069	Bracket, Strap, Fixed
6	2	HW/M8X1.25X25HEXSS	Bolt, Hex head, M8X1.25X25, SS
7	7	HW/M8FLATSS	Washer, Flat, M8 SS, METRIC
8	7	HW/M8LOCKSS	Washer, Split Lock, M8, SS, METRIC
9	2	HW/M8SPRINGNUT	Spring Nut, M8X1.25
10	5	HW/M8X1.25MMHEXNUTSS	Nut, Hex M8X1.25X16MM, SS
11	2	HW/PIPEBLOCK	Pipe Block

Figure A-1. Universal Pole Mounting Kit, PL/12319-1

A.2.2 Dual-Channel Unistrut Mounting Kit KT-000017

The CEFD P/N KT-000017 Dual-channel Unistrut kit is a line item for both the PCB-4300 1:2 Ku-Band Phase Combined Assembly **PL-0000317** (see Sect. A.4.1) and the PCB-4300 1:2 C-Band Phase Combined Assembly **KT-0000109** (see Sect. A.5.1).

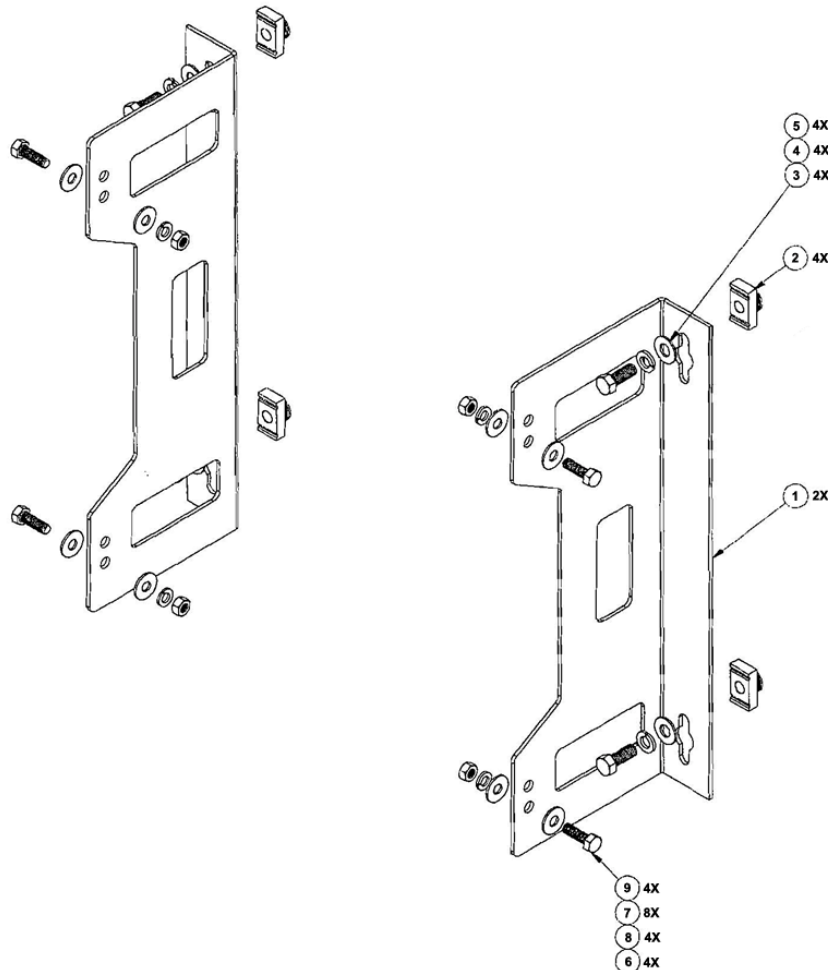


Phase Combiner Box and Bracket Kit KT-0000XXX				
Item No.	QTY		CEFD Part No.	Description
	KT-0000028	KT-0000108		
1	1	–	PL/11285-2	1:2 Phase Combiner Box, Ku-Band
1	–	1	PL-0000582	1:2 Phase Combiner Box, C-Band
2	1	1	FP-0000237	Bracket, Mounting, Phase Combiner Box
3	4	4	HW/10-FLT	Washer, Flat, SS
4	4	4	HW/10-SPLIT	Washer, Split Lock, SS
5	4	4	HW10-32x1/2SH	Bolt, Socket Head, SS
6	2	2	HW-0000070	Screw, Hex, Serrated Flange Head, SS

Figure A-2. PCB-4300 Phase Combiner Box and Bracket Kits

A.2.3 HPOD Unistrut Mounting Kit KT/12300-1

The CEFD P/N KT/12300-1 HPOD Unistrut Mounting Kit is a line item for both the PCB-4300 1:2 Ku-Band Phase Combined Assembly **PL-0000317** (see **Sect. A.4.1**) and the PCB-4300 1:2 C-Band Phase Combined Assembly **KT-0000109** (see **Sect. A.5.1**).

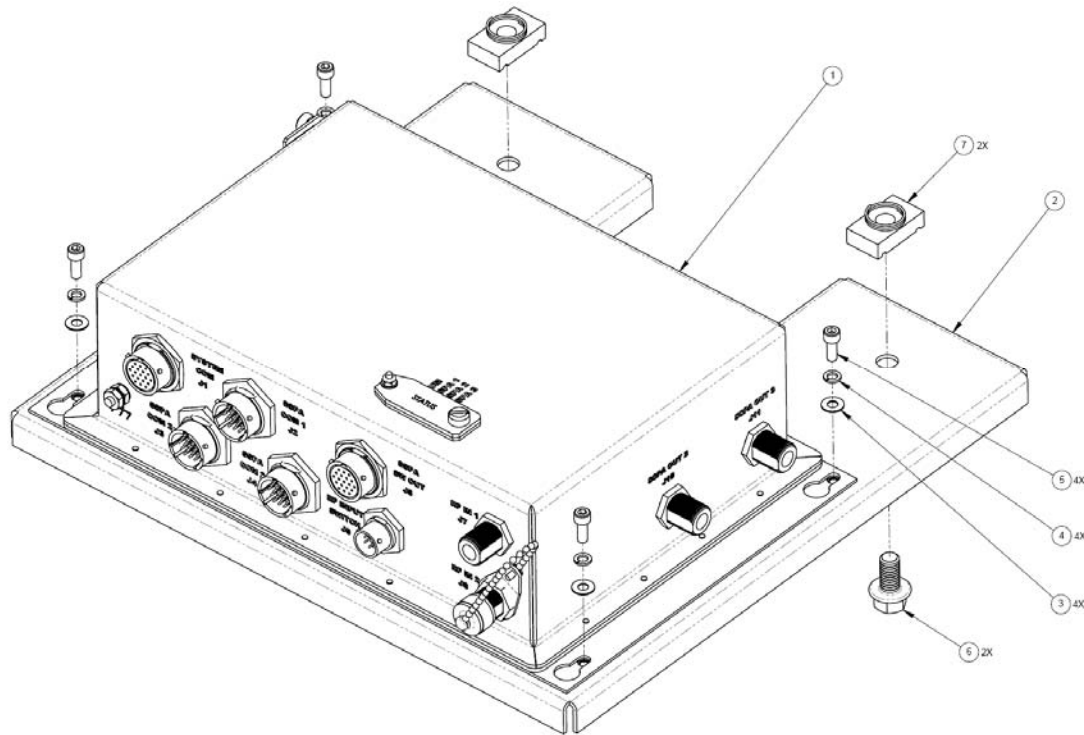


HPOD Mounting Bracket Kit KT/12300-1			
Item No.	QTY	CEFD Part No.	Description
1	2	FP/BR12239-1	Bracket, Unistrut
2	4	HW/3/8SPRINGNUT	Spring Nut, 3/8-16, Short Spring, SS
3	4	HW/3/8-FLT	Washer, Flat, 3/8
4	4	HW/3/8-SPLIT	Washer, Lock, Split, 3/8, SS
5	4	HW/3/8-16X1BLT	Bolt, Hex Head, 3/8-16 x 1" LG, SS
6	4	HW/5/16-18HEXNT	Nut, Hex, 5/16-18
7	8	HW/5/16-Flat	Washer, Flat, 5/16
8	4	HW/5/16-SPLIT	Washer, Lock, Split, 5/16, SS
9	4	HW/5/16-18X1BLT	Bolt, Hex Head, 5/16-18 x 1" LG, SS

Figure A-3. HPOD Mounting Bracket Kit (CEFD P/N KT/12300-1)

A.3 PCB-4300 Phase Combiner in Assemblies

The PCB-4300 1:2 Phase Combiner is available in either a Ku-Band version (CEFD P/N PL/11285-2) or C-Band version (CEFD P/N PL-0000582). The box is provided as a subassembly item (as shown here in **Figure A-4**) either in Ku-Band Box/Bracket Kit **KT-0000028**, which in turn is a line item for PCB-4300 1:2 Ku-Band Phase Combined Assembly **PL-0000317** (see **Sect. A.4.1**), *or* as part of C-Band Box/Bracket Kit **KT-0000108**, which in turn is a line item for PCB-4300 1:2 C-Band Phase Combined Assembly **KT-0000109** (see **Sect. A.5.1**).



Phase Combiner Box and Bracket Kit KT-0000XXX				
Item No.	QTY		CEFD Part No.	Description
	KT-0000028	KT-0000108		
1	1	–	PL/11285-2	1:2 Phase Combiner Box, Ku-Band
	–	1	PL-0000582	1:2 Phase Combiner Box, C-Band
2	1	1	FP-0000237	Bracket, Mounting, Phase Combiner Box
3	4	4	HW/10-FLT	Washer, Flat, SS
4	4	4	HW/10-SPLIT	Washer, Split Lock, SS
5	4	4	HW10-32x1/2SH	Bolt, Socket Head, SS
6	2	2	HW-0000070	Screw, Hex, Serrated Flange Head, SS

Figure A-4. PCB-4300 Phase Combiner Box and Bracket Kits

A.4 PCB-4300 Ku-Band Unit (PL/11285-2) Assemblies

A.4.1 Ku-Band 1:2 Phase Combined System Assembly – HPOD PL-0000317

Table A-1. PL-0000317 Assembly BOM

PL-0000317 (as per Figures A-6 and A-7 on pages that follow)			
Item No.	QTY	CEFD Part No.	Description
1	1	KT-0000017	Dual-Channel Unistrut Mounting Kit, 1:2
2	1	KT-0000026	1:2 Phase Combined System Waveguide and Components Kit
3	1	KT-0000028	Phase Combiner Box and Bracket Kit
4	3	KT/12300-1	HPOD-to-Unistrut Mounting Kit
5	2	CA/WR11966-1	Cable Assembly, SSPA-to-Combiner Box
6	1	CA-0000101	Cable Assembly, SSPA3-to-Combiner Box
7	3	CA/RF11872-1	Cable Assembly, RF In, 1:2 Ku-Band Matched Set
8	1	CA/WR12013-1	'Y' Cable Assembly, WG Switches-to-Combiner Box
9	16	HW/TW14.5HDBLK	Cable Tie, 14.5", Heavy Duty, Black
10	A/R	LB/BLK1.0X0.5SMP	Brady Label w/Silver Matte Finish, 1" x .50"
11	6	LB/BLK/2RPDL2	Blank Cabel Label, White, 1" x .50"

Note: A/R = As Required

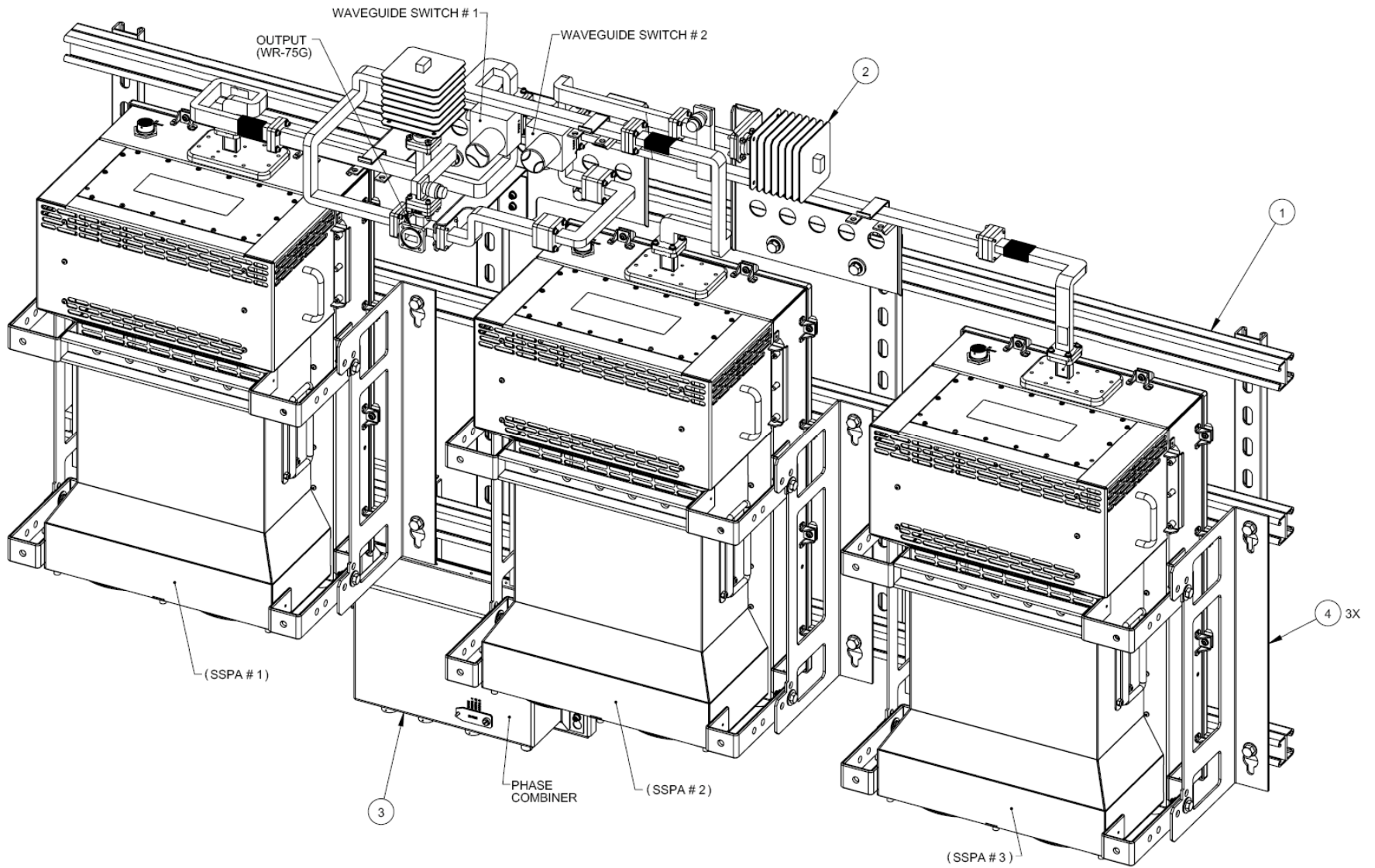


Figure A-5. Ku-Band 1:2 Phase Combined Assembly – HPOD (CEFD P/N PL-0000317)

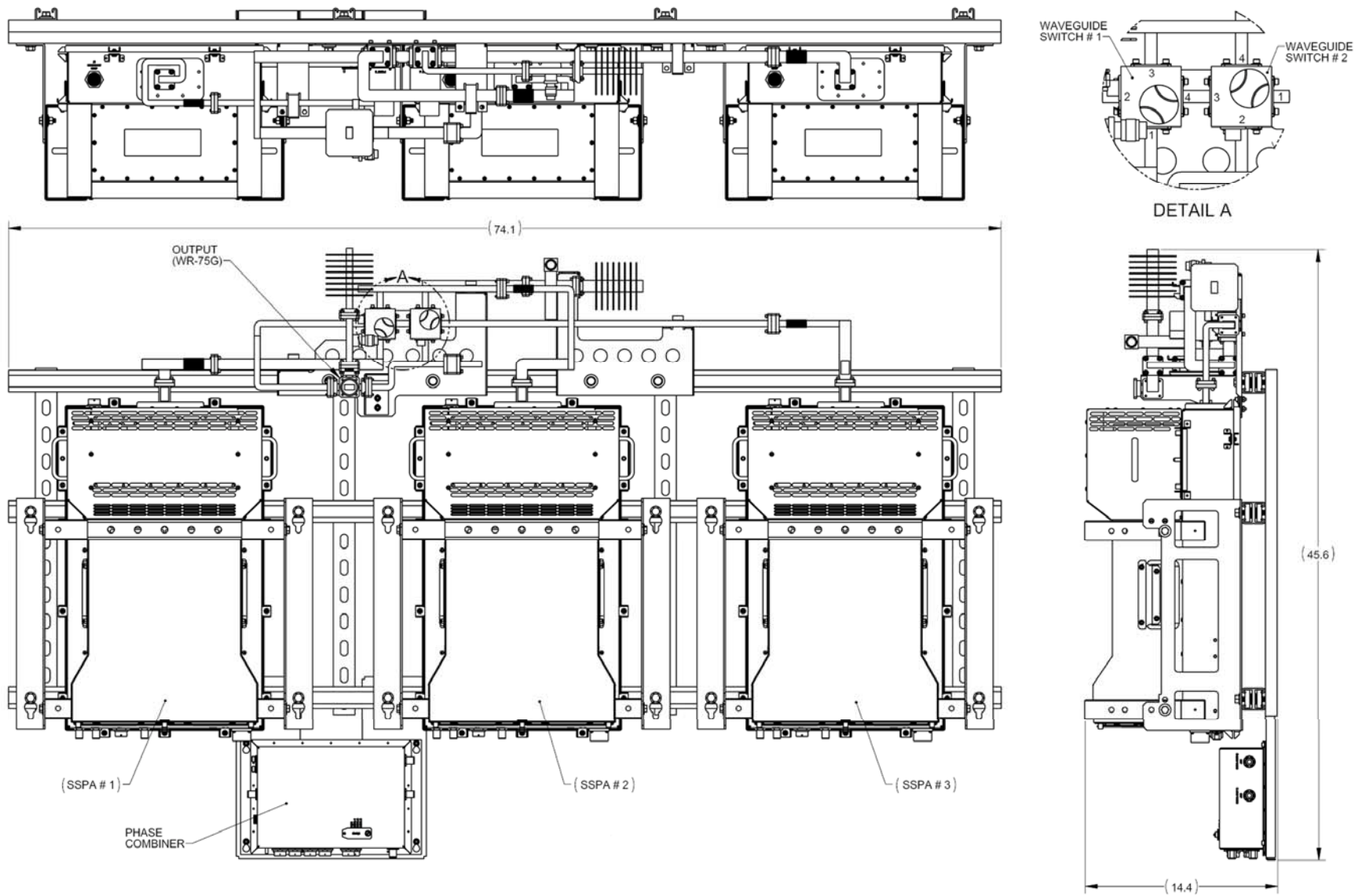


Figure A-6. Ku-Band 1:2 Phase Combined Assembly – HPOD (CEFD P/N PL-0000317)

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A.4.1.1 Ku-Band 1:2 Phase Combined System – Waveguides and Components Kit KT-000026

Table A-2. KT-000026 Kit BOM

KT-000026 (as per Figures A-7 and A-8)			
Item No.	Qty	Item Number	Item Description
1	1	FP-0000201	WAVEGUIDE, SW TO U-BEND, WR-75, KU-BAND
2	1	FP-0000202	WAVEGUIDE, U-BEND TO MAGIC TEE, WR-75, KU-BAND
3	1	FP-0000203	WAVEGUIDE, RIGHT, SSPA 1, WR-75, KU-BAND
4	1	FP-0000205	WAVEGUIDE, LEFT, SSPA 3, WR-75, KU-BAND
5	1	FP-0000206	WAVEGUIDE, RIGHT, SSPA 3, WR-75, KU-BAND
6	1	FP-0000207	WAVEGUIDE, RIGHT, SSPA 2, WR-75, KU-BAND
7	1	FP-0000208	WAVEGUIDE, LEFT, SSPA 2, WR-75, KU-BAND
8	1	FP-0000209	WAVEGUIDE, SWITCH TO LOAD, WR-75, KU-BAND
9	1	FP/WG11823-1	WAVEGUIDE, LEFT, WR-75G
10	1	FP/WG11825-1	WAVEGUIDE, STRAIGHT, WR-75G
11	1	FP/WG11827-1	WAVEGUIDE, OUTPUT LEFT, WR-75G
12	1	FP-0000218	WAVEGUIDE, U-BEND, WR-75, KU-BAND
13	2	FP-0000215	SPACER, THICK, WAVEGUIDE, WR-75, KU-BAND
14	1	FP-0000216	SPACER, MEDIUM, WAVEGUIDE, WR-75, KU-BAND
15	1	FP-0000217	SPACER, WAVEGUIDE, WR-75, KU-BAND
16	2	FP-0000222	ADAPTER, FLAT, WAVEGUIDE, WR-75, KU-BAND
17	1	FP-0000240	BRACKET, MOUNTING, MAGIC TEE
18	1	FP-0000241	BRACKET, MOUNTING, WAVEGUIDE SWITCHES
19	1	FP-0000242	BRACKET, MOUNTING, TERMINATION
20	2	SW/WGS28V-75SB	SW WAVEGUIDE, WR75, +28VDC, SEALED, SIDE & BOT MNT
21	2	RF/TERM75/350W	RF WAVEGUIDE, TERMINATION, WR75, KU, 10.0-15.0 GHZ, 350 WATT 6061 AL
22	1	RF-0000024	MAGIC TEE, WR-75G SQ FLANGES, KU-BAND
23	2	RF/CG-75-40-N	RF CROSSGUIDE COUPLER, 40 DB, WR-75 GROOVED, "N" TYPE FEMALE, 13.75
24	2	RF/N-TERM50M1	RF 50 OHM, 1W, DC-8 GHZ, N MALE

25	30	GA/WR75-R-H-C	GASKET, O RING, WR-75, HALF THICKNESS, CONDUCTIVE
40	76	HW/6-FLT	#6 FLAT WASHER S.S.
41	44	HW/6-FLT-ROD	#6 FLAT WASHER, REDUCED O.D.,.267 DIA, S.S.
42	96	HW/6-SPLIT	#6 SPLIT LOCK WASHER S.S.
43	20	HW/6-32HEXNUT	6-32 HEX NUT
44	36	HW/6-32X1/2SHCS	6-32X1/2 SOCKET HD CAP SCREW SS
45	32	HW/6-32X5/8SHCS	6-32X5/8 SOCKET HD CAP SCREW SS
46	12	HW/6-32X3/4SHCS	6-32X3/4 SOCKET HD CAP SCREW SS
47	16	HW/6-32X7/8SHCS	6-32 X 7/8 SOCKET HEAD CAP SCREW S.S.
48	8	HW/6-32X1.0SHCS	6-32 X 1.0 SOCKET HEAD CAP SCREW S.S.
49	8	HW/6-32X1.12SHCS	6-32 X 1.125 SOCKET HEAD CAP SCREW S.S
50	12	HW/6-32X1.25SHC	6-32 X 1.25 SOCKET HEAD CAP SCREW, SS
51	7	HW/8-FLT	#8 FLAT WASHER S.S.
52	7	HW/8-SPLIT	#8 SPLIT LOCK WASHER S.S.
53	7	HW/8-32X3/8SHCS	8-32 X 3/8 SOCKET HD CAP SCRW SS
54	5	HW/10-FLT	#10 FLAT WASHER S.S.
55	3	HW/10-SPLIT	#10 SPLIT LOCK WASHER S.S.
56	3	HW/10-32HEXNUT	10-32 HEX NUT S.S.
57	3	HW/10-32X5/8SHC	10-32 X 5/8 SOCKET HEAD CAP SCREW S.S.
58	4	HW-0000069	WASHER, FLAT, THICK, 3/8, SST
59	4	HW/3/8-SPLIT	3/8 SPLIT LOCK WASHER S.S.
60	4	HW/3/8-16X1BLT	3/8 - 16 HEX HEAD BOLT, 1.0 LONG, S.S.
61	4	HW/3/8SPRINGNUT	SPRINGNUT, 3/8-16, SHORT SPRING, SST (P3300)

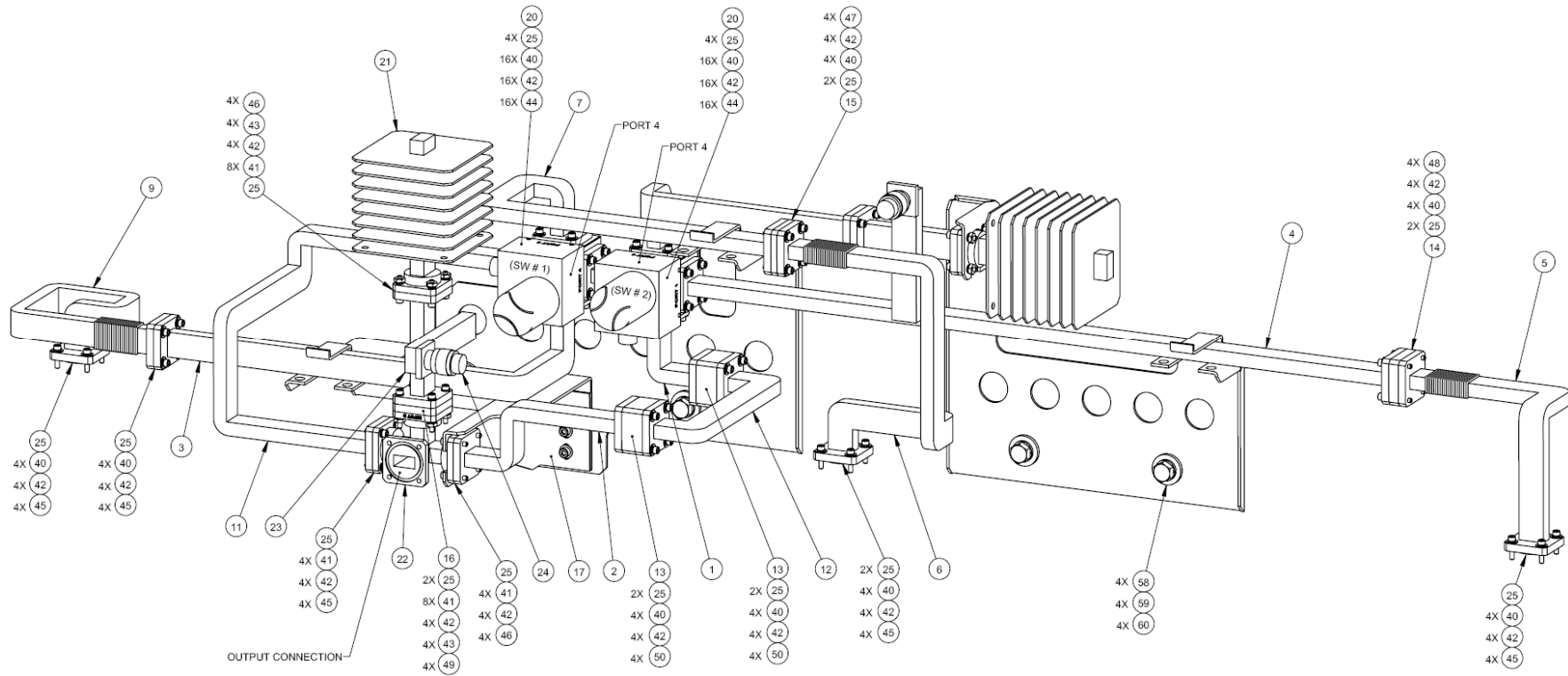


Figure A-7. Ku-Band 1:2 Waveguides and Components Kit (CEFD P/N KT-000026) – Front View

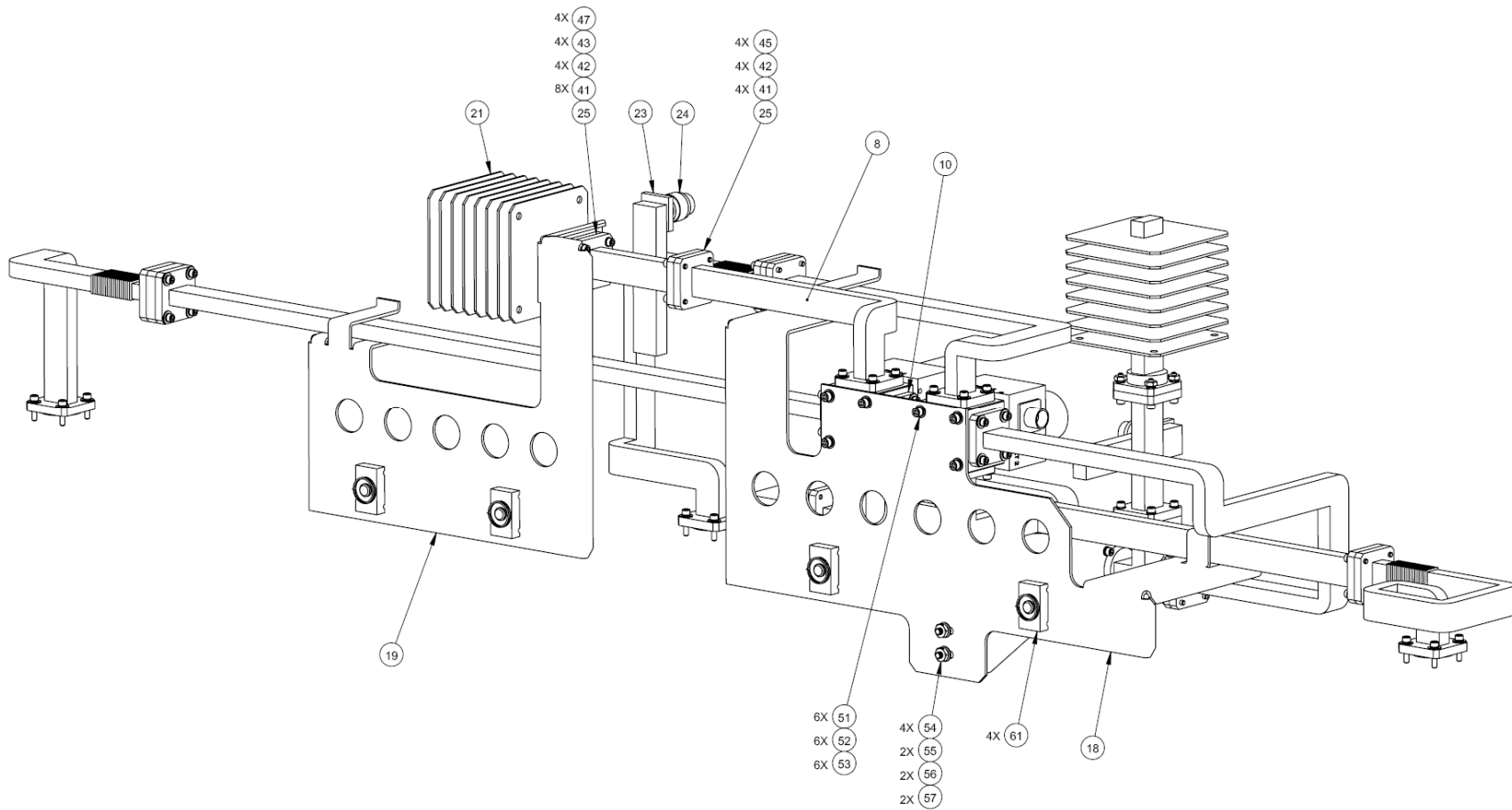


Figure A-8. Ku-Band 1:2 Waveguides and Components Kit (CEFD P/N KT-000026) – Back View

A.4.2 Ku-Band 1:2 Phase Combined System Kit KT/11830-1 (Legacy Item)



The Ku-Band 1:2 Phase Combined System Kit KT/11830-1 is a legacy item that has been superseded by the KT-0000026 Ku-Band 1:2 Waveguides and Components Kit detailed in Sect. A.4.1.1. The information provided in this section and the subsection that follows is intended for reference purposes only.

Table A-3. Kit KT/11830-1 BOM

KT/11830-1 (as per Figure A-9)			
Item No.	Qty	Item Number	Item Description
1	2	SW/WGS28V-75SB	SW WAVEGUIDE, WR75, +28VDC, SEALED, SIDE & BOT MNT
2	1	FP/WG11823-1	WAVEGUIDE, LEFT, WR-75G
3	1	FP/WG11824-1	WAVEGUIDE, RIGHT, WR-75G
4	1	FP/WG11825-1	WAVEGUIDE, STRAIGHT, WR-75G
5	1	FP/WG11826-1	WAVEGUIDE, CENTER, WR-75G
6	1	FP/WG11827-1	WAVEGUIDE, OUTPUT LEFT, WR-75G
7	1	FP/WG12082-1	WAVEGUIDE, SWITCH TO U-BEND, WR75
8	1	FP/WG11831-1	WAVEGUIDE, 90 DEGREE, E-BEND, 1.50 X 1.50, WR-75G
9	1	FP/WG12084-1	WAVEGUIDE, U-BEND TO MAGIC TEE, WR75
10	1	FP/WG11839-1	WAVEGUIDE SSPA TO SWITCH, CENTER, WR-75G
11	1	FP/WG11837-1	WAVEGUIDE STRAIGHT, RIGHT, WR-75G
12	1	FP/WG11838-1	WAVEGUIDE SSPA TO SWITCH, LEFT, WR-75G
13	2	RF/TERM75/350W	RF WAVEGUIDE, TERMINATION, WR75, KU, 10.0-15.0 GHZ, 350 WATT 6061 AL
14	1	RF/2259-0000G2	RF MAGIC TEE, COUPLER, 12.75-14.5 GHZ, WR-75G, KU-BAND, 4 WAY
15	1	FP/BR11835-1	BRACKET SWITCH MOUNTING, 1:2 KU-BAND, COMBINED
16	1	FP/BR12086-1	BRACKET, LOAD, MTG, MAGIC TEE
17	1	FP/WG11850-1	WAVEGUIDE SWITCH TO MAGIC TEE, STRAIGHT, WR-75G
20	32	HW/6-32X5/8SHCS	6-32X5/8 SOCKET HD CAP SCREW SS
21	32	HW/6-32HEXNUT	6-32 HEX NUT
22	64	HW/6-32X1/2SHCS	6-32X1/2 SOCKET HD CAP SCREW S.S.

23	160	HW/6-FLT	#6 FLAT WASHER S.S.
24	128	HW/6-SPLIT	#6 SPLIT LOCK WASHER S.S.
25	32	HW/6-32X1.0SHCS	6-32 X 1.0 SOCKET HEAD CAP//SCREW S.S.
30	12	GA/WR75-R-F-C	GASKET, O RING, WR-75, FULL THICKNESS, CONDUCTIVE
31	8	GA/WR75-R-H-C	GASKET, O RING, WR-75, HALF THICKNESS, CONDUCTIVE
40	1	FP/BR12085-1	BRACKET, MTG, OFFLINE LOAD
41	2	FP/SP11971-1	SPACER, .550, WR-75G
42	1	FP/SP11972-1	SPACER, .340, WR-75G
43	1	FP/SP11973-1	SPACER, .200, WR-75G
45	2	RF/CG-75-40-N	RF CROSSGUIDE COUPLER, 40 DB, WR-75 GROOVED, "N" TYPE FEMALE, 13.75
0	3	CA/RF11872-1	CABLE ASSY RF IN, MATCHED SET, 1:2 KU-BAND
0	3	CA/WR11966-1	CABLE ASSY, SSPA TO COMBINER BOX
0	1	CA/WR12013-1	'Y' CABLE ASSY, SWITCHES, COMBINED SYSTEM
0	1	LB/CABLE-1RFIN	LABEL, CABLE, RF INPUT, SSPA #1 (ROHS)
0	1	LB/CABLE-2RFIN	LABEL, CABLE, RF INPUT, SSPA #2 (ROHS)
0	1	LB/CABLE-3RFIN	LABEL, CABLE, RF INPUT, SSPA #3 (ROHS)
0	1	LB/HPODSSPA-1	LABEL, HPOD, SSPA #1 ID LABEL
0	1	LB/HPODSSPA-2	LABEL, HPOD, SSPA #2 (ROHS)
0	1	LB/HPODSSPA-3	LABEL, HPOD, SSPA #3 (ROHS)
0	1	LB/WG-SW1	LABEL, SWITCH, WAVEGUIDE, #1 (ROHS)
0	1	LB/WG-SW2	LABEL, SWITCH, WAVEGUIDE, #2 (ROHS)
0	1	MS/11-314	MS SOCKET, 12 POINT, 2.4 OAL, .065 DIA., 3/8 DRIVE
0	1	MS/S3161	MS SCREWDRIVER, STUBBY FLAT BIT, 3/16 BLADE, 1 1/4 BLADE LENGTH
0	1	PL/11285-2	ASSY, TOP COMBINER BOX - 1:2

Note: Items in 'Item No.' column marked '0' indicate an item not shown in Figure A-10.

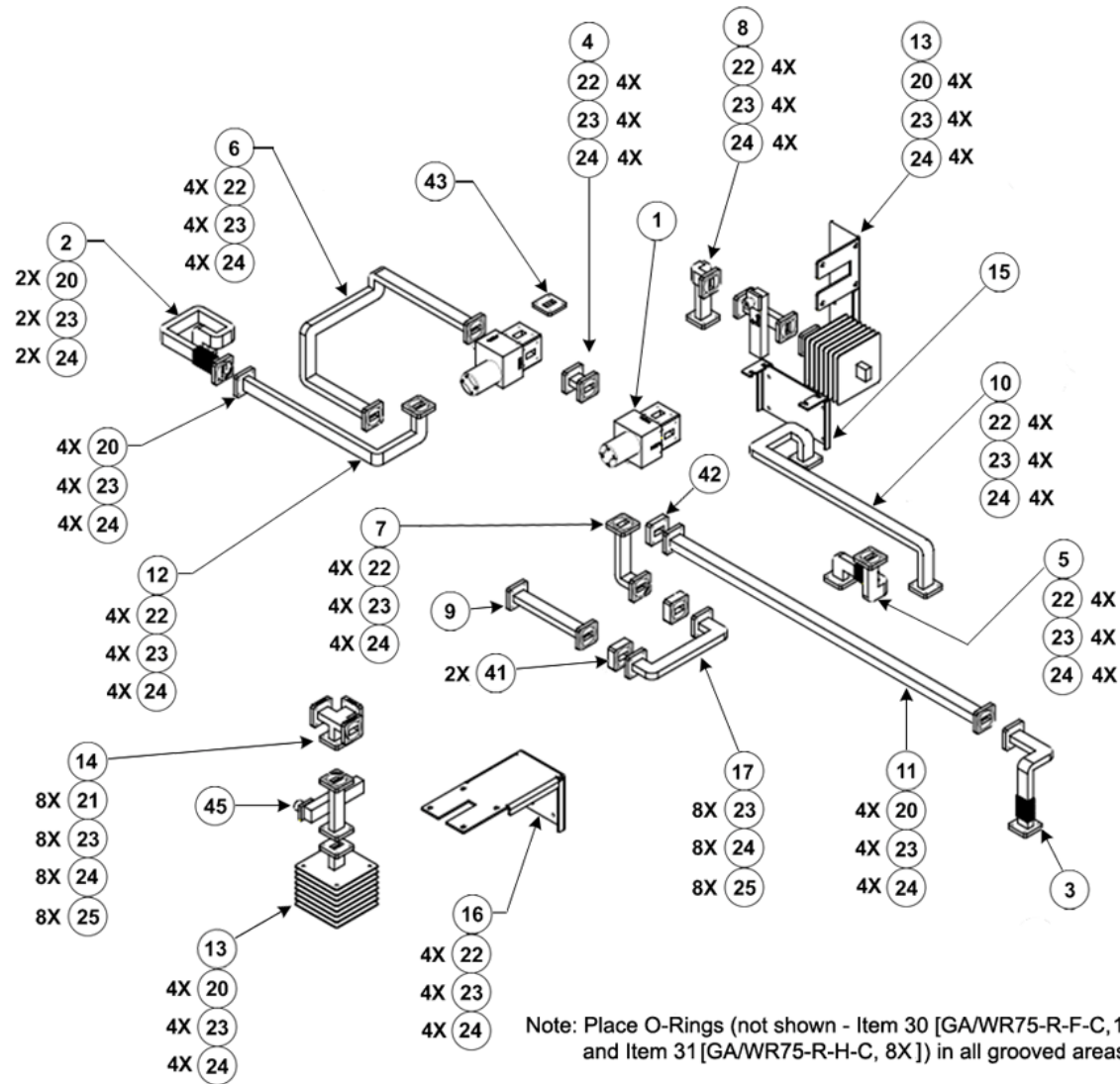


Figure A-9. Ku-Band 1:2 Phase Combined System Kit KT/11830-1 (Legacy Item)

A.4.2.1 Ku-Band 1:2 Phase Combined System Kit KT/11830-1 – Assembly Examples

This subsection provides examples of the Ku-Band 1:2 Phase Combined System Kit KT/11830-1 cable connections and assembled waveguides. Specifically, cabling between the PCCB and SSPAs for Comms, RF, and Waveguide Switches, and the waveguide assemblies between SSPAs #1, #2, and #3 are shown. Note that, as the model of the SSPA group deployed within a 1:2 Phase Combined System may vary, the figures provided here show installed SSPAs for reference purposes only.

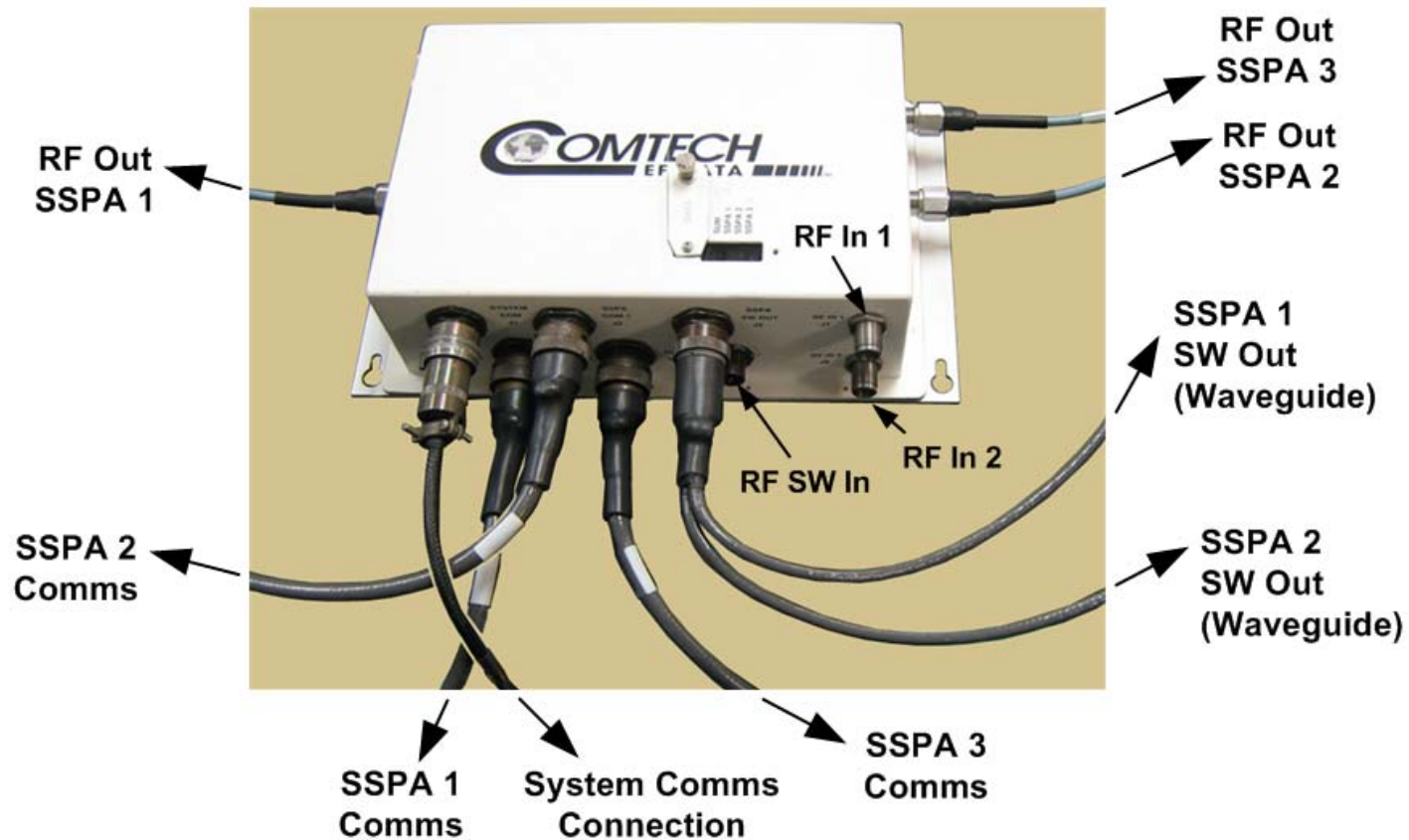


Figure A-10. Ku-Band 1:2 Phase Combined System Kit KT/11830-1 – PCCB Cabling Connections

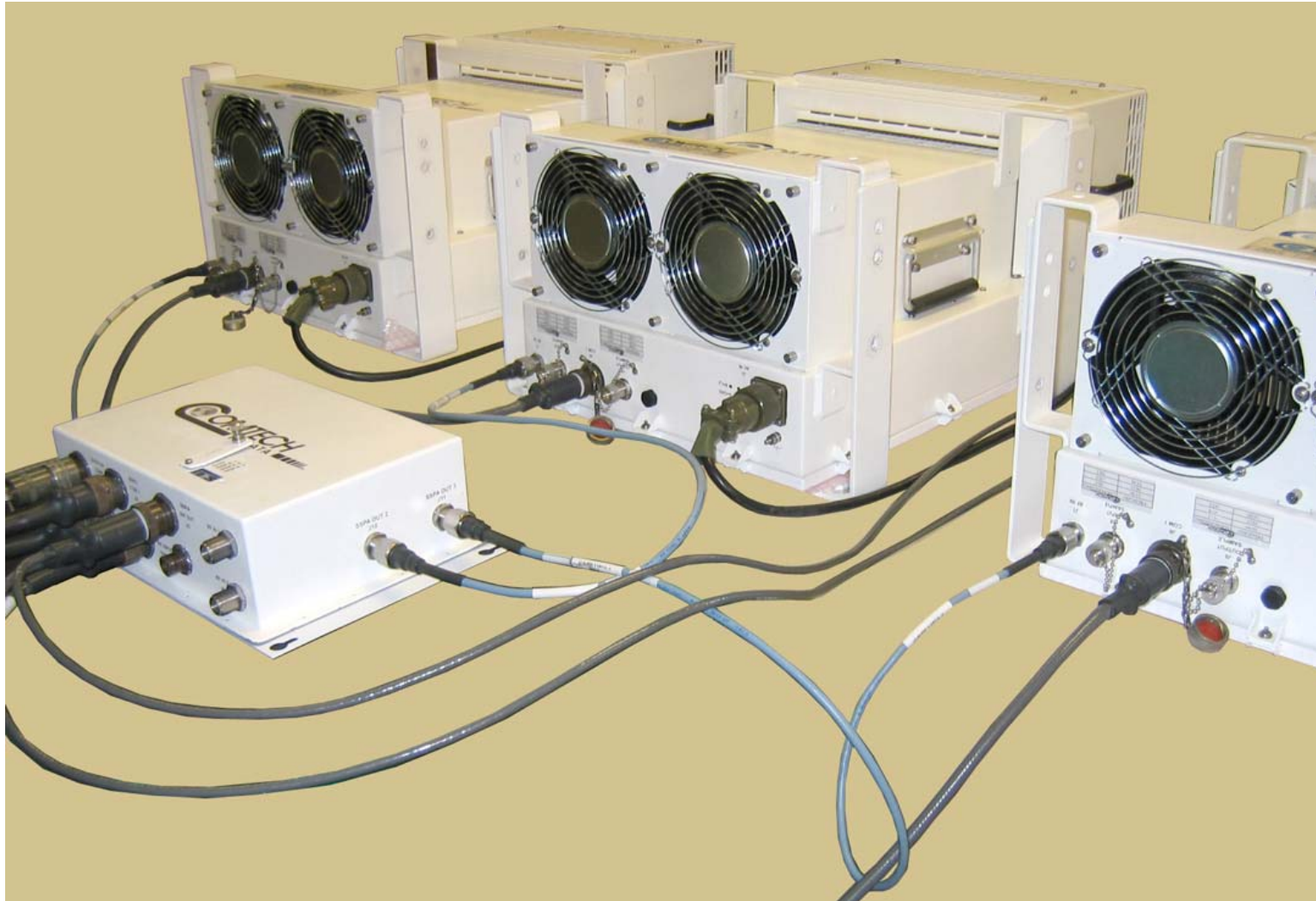


Figure A-11. Ku-Band 1:2 Phase Combined System Kit KT/11830-1 – SSPA Comms and RF Cable Connection

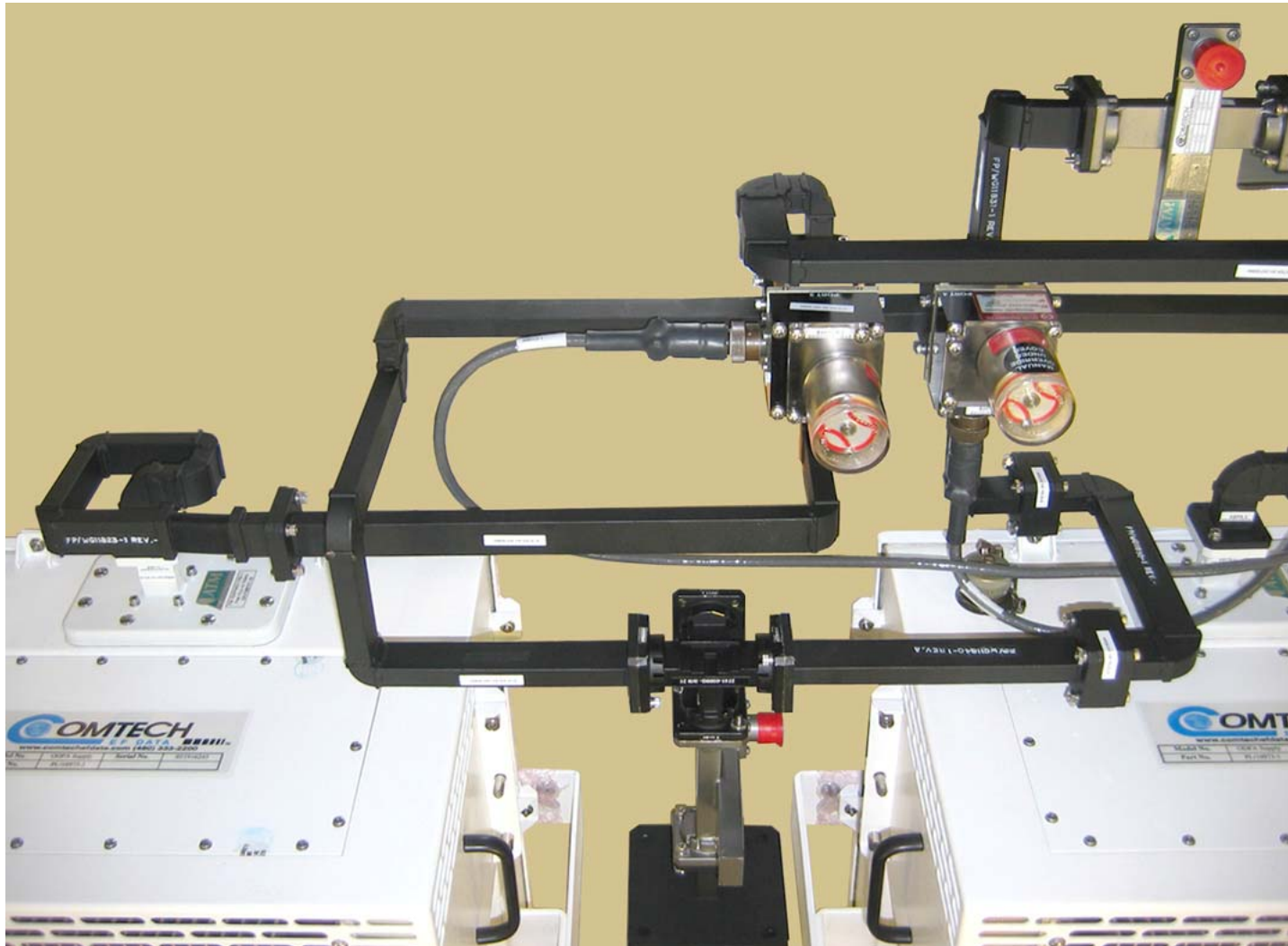


Figure A-12. Ku-Band 1:2 Phase Combined System Kit KT/11830-1 – SSPA1 → SSPA2 Waveguide Assembly



Figure A-13. Ku-Band 1:2 Phase Combined System Kit KT/11830-1 – SSPA2 → SSPA3 Waveguide Assembly

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A.5 PCB-4300 C-Band Unit (PL-0000582) Assemblies

A.5.1 C-Band 1:2 Phase Combined Top Assembly Kit – 350W HPOD (CEFD P/N KT-0000109)

Table A-4. Kit KT-0000109 BOM

KT-0000109 (as per Figure A-14)			
Item No.	Qty	Item Number	Item Description
1	1	KT-0000017	DUAL-CHANNEL UNISTRUT MOUNTING KIT, 1:2
2	3	KT/12300-1	MOUNTING BRACKET KIT, HPOD → UNISTRUT
3	1	KT-0000107	WAVEGUIDE KIT, 1:2 PHASE COMBINED C-BAND HPOD
4	1	KT-0000108	PHASE COMBINER BOX AND BRACKET KIT, 1:2 C-BAND
0	3	CA/RF11872-1	ASSY, CABLE RF IN, MATCHED SET, 1:2 KU-BAND
0	3	CA/WR11966-1	ASSY, CABLE SSPA TO COMBINER BOX
0	1	CA/WR12013-1	ASSY, CABLE CABLE ASSY, SWITCHES, COMBINED SYSTEM
0	A/R	LB/CABLE-1RFIN	ID LABEL, CABLE, RF INPUT, SSPA #1
0	A/R	LB/CABLE-2RFIN	ID LABEL, CABLE, RF INPUT, SSPA #2
0	A/R	LB/CABLE-3RFIN	ID LABEL, CABLE, RF INPUT, SSPA #3
0	A/R	LB/HPODSSPA-1	ID LABEL, HPOD, SSPA #1
0	A/R	LB/HPODSSPA-2	ID LABEL, HPOD, SSPA #2
0	A/R	LB/HPODSSPA-3	ID LABEL, HPOD, SSPA #3
0	A/R	LB/WG-SW1	ID LABEL, SWITCH, WAVEGUIDE, #1
0	A/R	LB/WG-SW2	ID LABEL, SWITCH, WAVEGUIDE, #2
0	1	MS/11-314	MS SOCKET, 12 POINT, 2.4 OAL, .065 DIA., 3/8 DRIVE
0	1	MS/S3161	MS SCREWDRIVER, STUBBY FLAT BIT, 3/16 BLADE, 1 1/4 BLADE LENGTH

Notes:

1. Items in 'Item No.' column marked '0' indicate an item not shown in **Figure A-14**.
2. In 'Qty' column, A/R = As Required

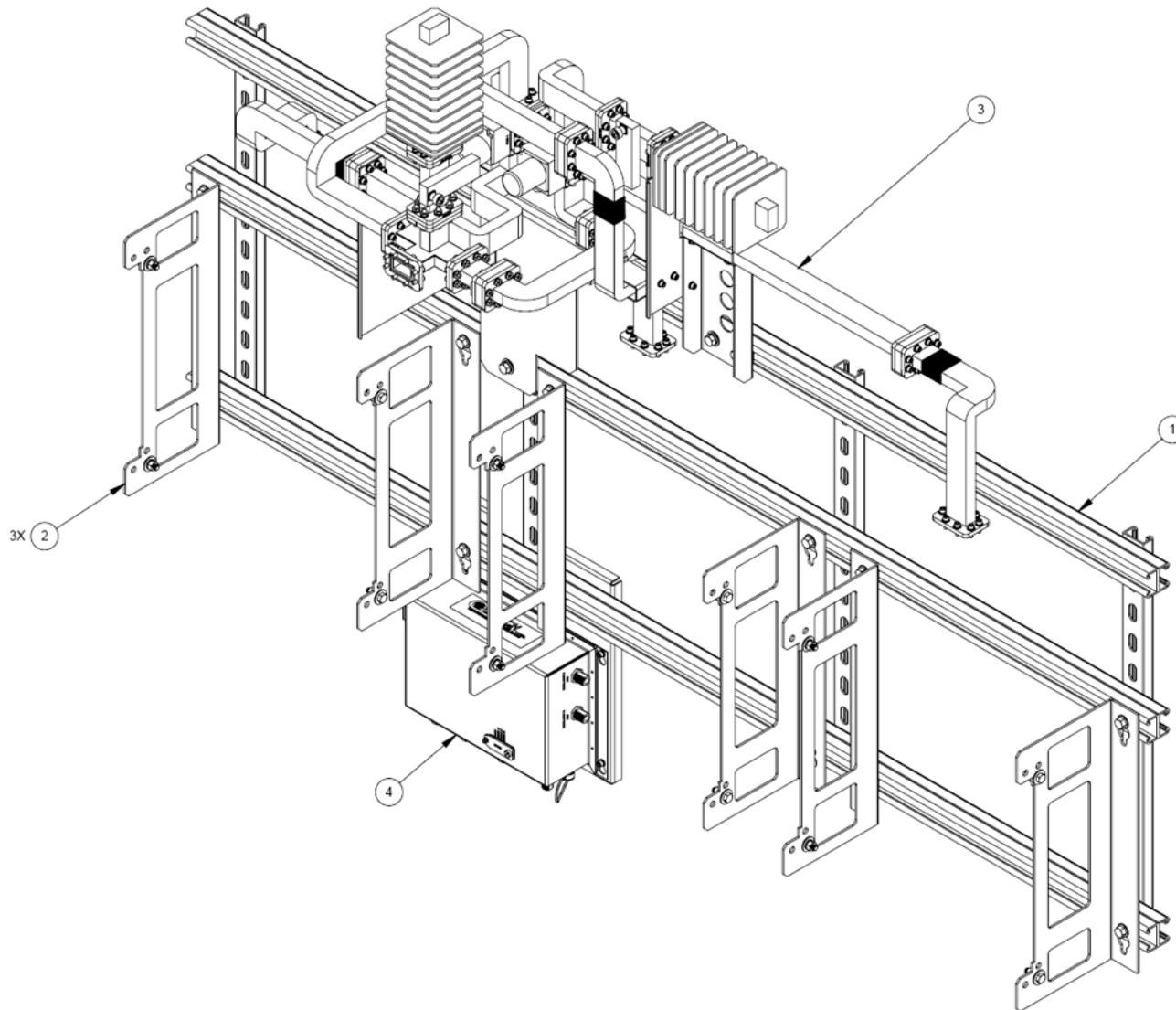


Figure A-14. Combined 1:2 C-Band Top Assembly Kit – HPOD (CEFD P/N KT-0000109)

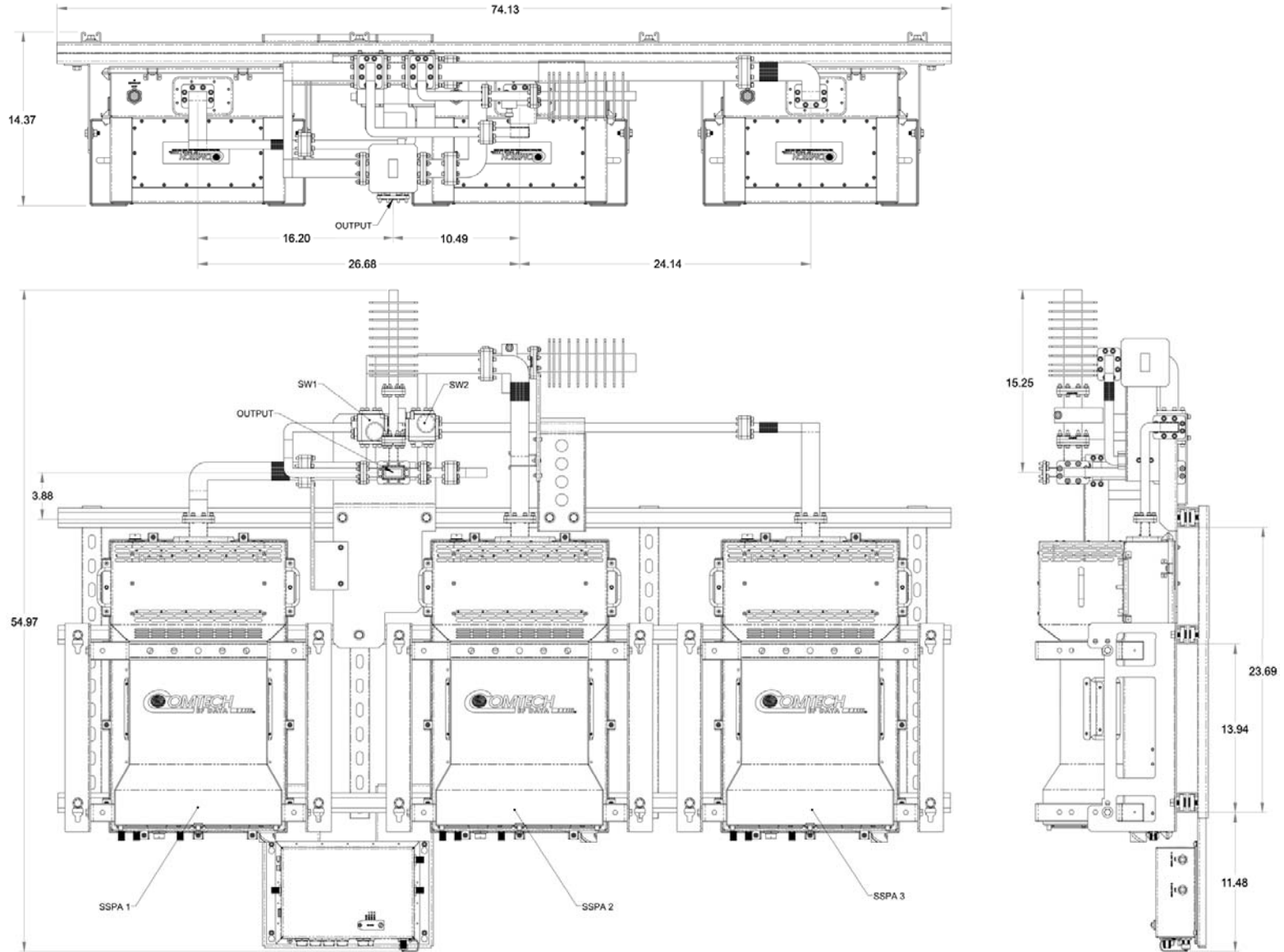


Figure A-15. Combined 1:2 C-Band Top Assembly Kit – HPOD (CEFD P/N KT-0000109)

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A.5.1.1 C-Band 1:2 Phase Combined System Waveguide Kit – HPOD (CEFD P/N KT-0000107)

Table A-5. Kit KT-0000107 BOM

KT-0000107 (as per Figure A-16)			
Item No.	QTY	CEFD Part No.	Description
1	1	FP-0000589	MOUNTING BRACKET, DUAL SWITCH, C-BAND
2	2	SW/WGS28V-137S	SW WAVEGUIDE, CPR137, +28V SEALED
3	1	FP-0000586	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, SW1_P4 TO SW2_P3
4	1	FP-0000587	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, A3
5	1	FP-0000597	MOUNTING BRACKET, WAVEGUIDE SUPPORT, A3
6	1	FP-0000606	BRACKET, WAVEGUIDE SUPPORT
7	1	FP-0000600	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, SW2 TERMINATION
8	2	RF/CG-137-40-N	RF CROSSGUIDE, WR137, 40DB, N FEMALE, GROOVED
9	2	RF/C-TERM1000W	RF TERMINATION, LOAD, 1000 WATT, CPRG-137
10	1	FP-0000593	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, SW2_P3_TB TO TB-1
11	5	FP-0000594	WAVEGUIDE SPACER, CPR-137 X .500
12	1	FP-0000595	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, TB-1 TO TB-2
13	1	FP-0000608	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, TB-TEE_D TO TB-2
14	1	HW-0000131	RF MAGIC TEE, COUPLER, 5.85-6.425 GHz, WR-137G, C-BAND, 4 WAY
15	1	FP-0000592	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, L3-TEE_C TO L3-SW1_P2
16	1	FP-0000605	BRACKET, WAVEGUIDE SUPPORT, 1:2 PHASE COMBINED C-BAND HPOD, AMP2
17	1	FP-0000598	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, A2-1 TO IN-AMP2
18	1	FP-0000599	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, A2
19	1	FP-0000596	WAVEGUIDE ADAPTER, 1:2 PHASE COMBINED C-BAND HPOD
20	1	FP-0000607	BRACKET, WAVEGUIDE SUPPORT
21	1	FP-0000590	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, A1
22	1	FP-0000591	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, IN-AMP1 TO A1-1
23	1	FP-0000588	WAVEGUIDE, 1:2 PHASE COMBINED C-BAND HPOD, IN-AMP3 TO A3-1
24	29	GA/CPR-137-R-H-C	GASKET, D SHAPE, CPR-137, HALF THICKNESS, CONDUCTIVE
25	1	GA/CPR137-R-F-C	GASKET, ROUND, CPR137, FULL THICKNESS, CONDUCTIVE
26	5	HW/3/8SPRINGNUT	SPRINGNUT, 3/8-16, SHORT SPRING, SST (P3300)
27	5	HW/3/8-FLT	3/8 FLAT WASHER, S.S.
28	5	HW/3/8-SPLIT	3/8 SPLIT LOCK WASHER S.S.

29	5	HW/3/8-16X1BLT	3/8 - 16 HEX HEAD BOLT, 1.0 LONG, S.S.
30	254	HW/10-FLT	#10 FLAT WASHER S.S.
31	198	HW/10-SPLIT	#10 SPLIT LOCK WASHER S.S.
32	78	HW/10-32X1/2SH	10-32X1/2 SOCKET HEAD CAP SCREW S.S.
33	8	HW/10-32X7/8SHCS	SCREW, 10-32 X 7/8 SOCKET HEAD CAP SCREW S.S.
34	56	HW/10-32HEXNUT	HW 10-32 HEX NUT S.S.
35	40	HW/10-32X5/8SHC	HW 10-32 X 5/8 SOCKET HEAD CAP SCREW S.S.
36	32	HW/1032X1-1/4SHCS	SCREW, 10-32 X 1 1/4 SOCKET HEAD CAP SCREW S.S.
37	24	HW/10-32X3/4SH	10-32X3/4 SOCKET HEAD CAP SCREW S.S.
38	8	HW/10-32X1SHCS	10-32X1.0 SOCKET HEAD CAP SCREW S.S.
39	8	HW/10-32X1.75SH	10-32 X 1.75 SOCKET HEAD CAP SCREW S.S.

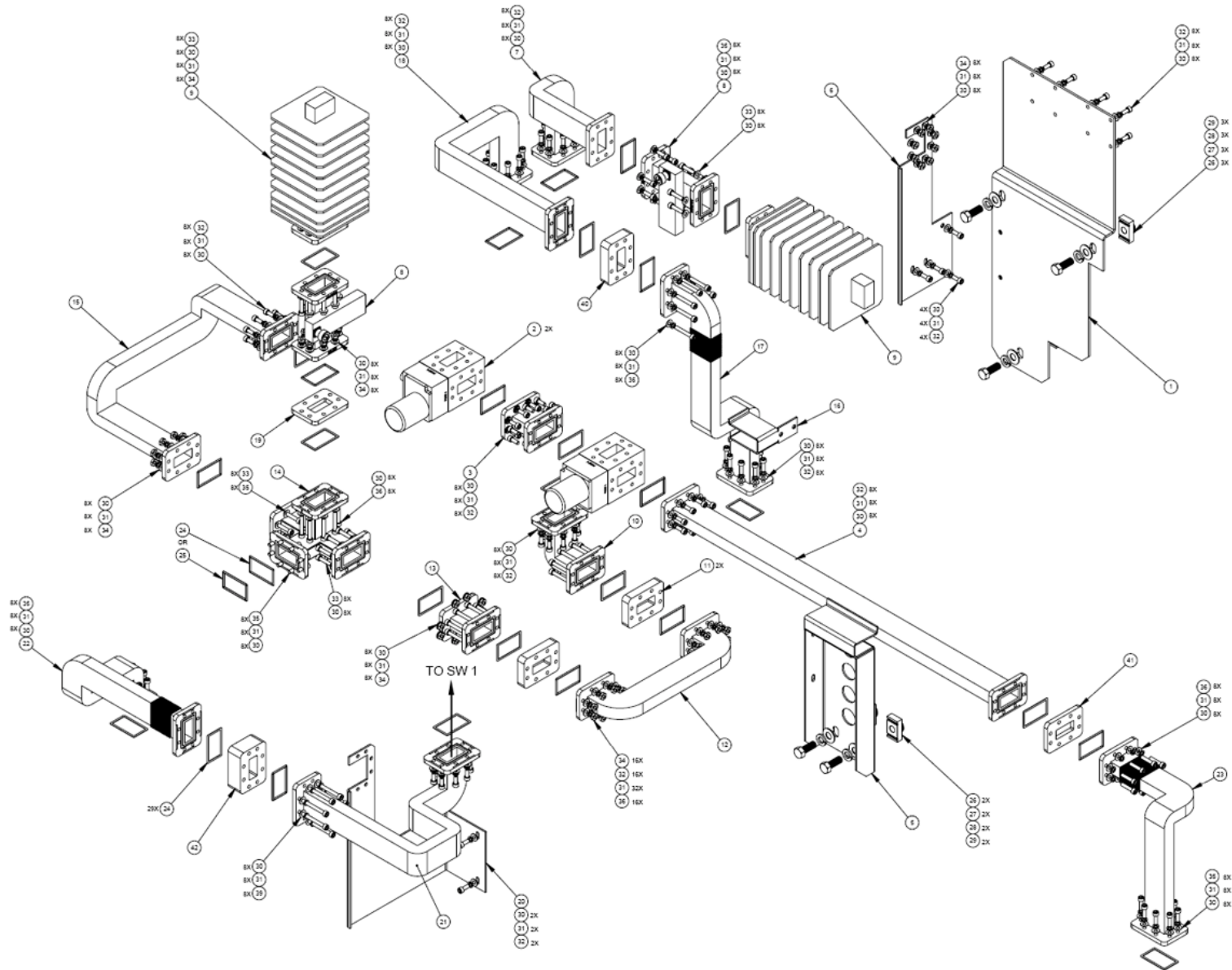


Figure A-16. C-Band 1:2 Phase Combined System Waveguide Kit (Exploded) – HPOD (CEFD P/N KT-0000107)

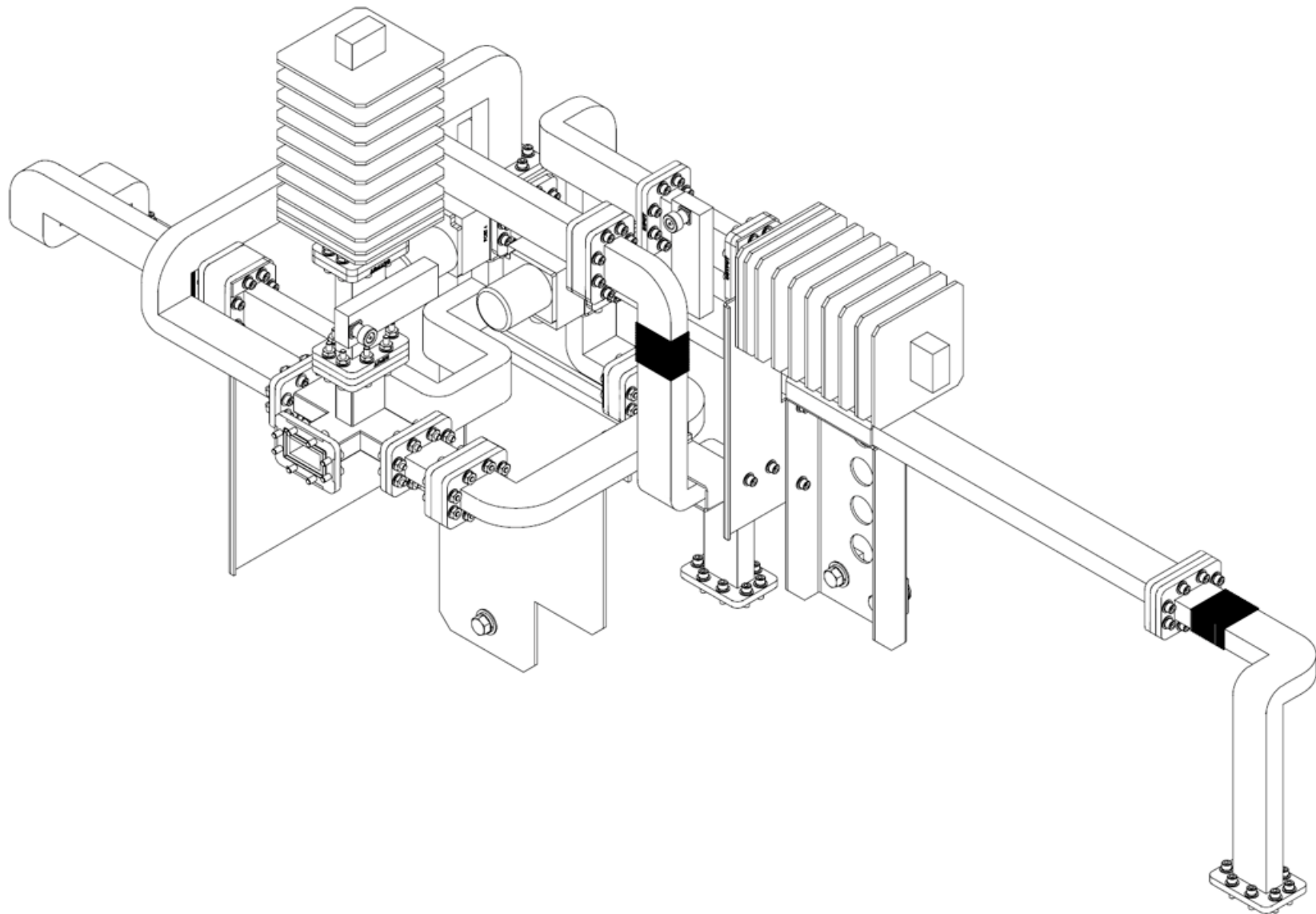


Figure A-17. C-Band 1:2 Phase Combined System Waveguide Kit (Assembled) – HPOD (CEFD P/N KT-0000107)

Appendix B. REMOTE CONTROL

B.1 Overview

This appendix describes the protocol and message command set for remote monitor and control of the PCB-4300 1:2 Phase Combiner.

The electrical interface is either an EIA-485 multi-drop bus (for the control of many devices) or an EIA-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.

B.2 EIA-485

For applications where multiple devices are to be monitored and controlled, a full-duplex (or 4-wire plus ground) EIA-485 is preferred. Half-duplex (2-wire plus ground) EIA-485 is possible, but is not preferred. In full-duplex EIA-485 communications, there are two separate, isolated, independent, differential-mode twisted pairs, each handling serial data in different directions.

It is assumed that a 'Controller' device (a PC or dumb terminal) transmits data in a broadcast mode via one of the pairs. Many 'Target' devices are connected to this pair, and all simultaneously receive data from the Controller. The Controller is the only device with a line-driver connected to this pair – the Target devices have only 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, the address of the intended recipient Target is included in a framed 'packet' of data. 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.

EIA-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.

B.3 EIA-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 EIA-232 electrical levels, on one conductor, and Target-to-Controller data is carried in the other direction on the other conductor.

B.4 Basic Protocol

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

All data is transmitted in framed packets. The host Controller is assumed a PC or ASCII dumb terminal that 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 EIA-485 mode.

B.5 Packet Structure

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

Example: <0412/MUT=1{CR}

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

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

B.5.1 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.

B.5.2 Target (Base) Address

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



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.

B.5.2.1 Virtual Address

Virtual Address is a method that allows the user to access the SSPA via the PCCB using any communications software. Virtual Address is supported in both EIA-232 and EIA-485 applications.

The following example depicts use of the virtual addressing scheme:

<123V1/MUT? *where:*

Base address = 123;

'V' = virtual address delimiter;

1 = virtual address of SSPA automatically set by the phase combiner box.

Notes:

1. Only three virtual commands can be used to program the individual SSPAs when in Phase Combined mode (RED=1):
 - CAA=
 - DAT=
 - TIM=
2. All virtual queries can be directed to the individual SSPAs in any mode.
3. The following virtual commands can NEVER be used to program the individual SSPAs:
 - MUT=
 - ATT=

B.5.3 Address Delimiter

This is the “forward slash” character '/' (ASCII code 47).

B.5.4 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 if seen in its raw ASCII form. Upper and lower case alphabetic characters (i.e., A-Z [ASCII codes 65-90], and a-z [ASCII codes 97-122]) may be used.

B.5.5 Instruction Code Qualifier

This is a single character, which further qualifies the preceding instruction code. Code Qualifiers obey the following rules:

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

Symbol	Definition
= (ASCII code 61)	'=' 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) that follow it. For example: MUT=1 would mean 'enable the Mute function.'
? (ASCII code 63)	'?' 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: MUT? Would mean 'return the current state of the Mute function.'

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

Symbol	Definition
= (ASCII code 61)	The = code is used in two ways: First, if the Controller has sent a query code to a Target (for example: MUT? would mean 'return the current state of the Mute function'), the Target would then respond with MUT=x , where 'x' represents the state in question (1 being 'enabled', 2 being 'disabled'). Second, if the Controller sends an instruction to set a parameter to a particular value, then, providing the value sent in the argument is valid, the Target will acknowledge the message by replying with MUT= (with no message arguments).
? (ASCII code 63)	The ? code is only used as follows: If the Controller sends an instruction to set a parameter to a particular value, then, if the value sent in the argument is not valid, 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 argument of the message sent by the Controller.
! (ASCII code 33)	The ! code is only used as follows: If the Controller sends an instruction code that the Target does not recognize, the Target will acknowledge the message by echoing the invalid instruction, followed by the ! character; for example, XYZ!
* (ASCII code 42)	The * code is only used as follows: If the Controller sends an instruction to set a parameter to a particular value, then, if the value sent in the argument is valid, but the target is in the wrong mode (e.g., Standby mode in Redundancy configuration) such that it will not permit that particular parameter to be changed at that time, the Target will acknowledge the message by replying (for example) with MUT* (with no message arguments).
# ASCII code 35)	The # code is only used as follows: If the controller sends an instruction code that 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; for example, MUT# (with no message arguments).

B.5.6 Optional Message Arguments

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

B.5.7 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 codes 13 and 10).

Both indicate the valid termination of a packet.

B.6 Remote Commands / Queries

Index Notes: Column ‘C’ = Command; Column ‘Q’ = Query; columns marked ‘X’ designate instruction code as *Command only*, *Query only*, or *Command/Query*.

CODE	C	Q	PAGE
A			
AGI	X		B-7
AMP	X	X	B-7
AOF	X	X	B-7
ATT	X	X	B-7
C			
CAA	X		B-7
CAS		X	B-7
CCS		X	B-8
CID	X	X	B-8
CMS		X	B-8
CUS		X	B-8

CODE	C	Q	PAGE
D			
DAT	X	X	B-8
F			
FRC	X	X	B-8
FRW		X	B-9
L			
LNA		X	B-9
M			
MUT	X	X	B-9

CODE	C	Q	PAGE
P			
PRF	X	X	B-9
R			
RAS		X	B-10
RCS		X	B-10
RET		X	B-10
RMS		X	B-11
RSN		X	B-11
RUS		X	B-11

CODE	C	Q	PAGE
S			
SBR	X	X	B-11
SFS		X	B-11
SPA	X	X	B-11
T			
TIM	X	X	B-11
TNA		X	B-12

Unless otherwise noted – In the tables that follow, these codes are used in the ‘Response to Command’ column (per Sect. B.5.6)

= Message ok

? Received ok, but invalid arguments were found

* Message ok, but not permitted in current mode

Parameter Type	Command (Instruction Code and qualifier)	Command Valid for PCB or SSPA	Arguments for Command or Response to Query	Description of Arguments (Note that all arguments are ASCII numeric codes – i.e., ASCII codes between 48 and 57)	Response to Command (Target to Controller)	Query (Instruction Code and qualifier)	Query Valid for PCB or SSPA	Response to Query (Target to Controller)
Automatic Gain Initialize	AGI=	PCB	0 bytes, alphanumeric	Command only. Initializes all gains for the attenuation offset. This command takes no arguments.	AGI= AGI? AGI*	N/A	N/A	N/A
RF Power Amplifier State	AMP=	PCB	1 byte, value of 0, 1	Command or Query Turns ON or OFF the SSPAs in the form AMP=x, where: 0 = Off 1 = On	AMP= AMP? AMP*	AMP?	ALL	AMP=x (see Description of Arguments for details)
Attenuation Offset	AOF=	PCB	7 bytes, alphanumeric	Command or Query Sets attenuation offset for specified SSPA <i>Command:</i> AOF=x.yy.yy <i>Query:</i> AOF?x where: x=1, 2, or 3 (SSPA number) yy.yy=Attenuation offset Example: AOF=1,01.50 Note: AOF command will not take values greater than 6 dB)	AOF= AOF? AOF*	AOF?x where x=1,2, or 3	PCB	AOF=x.yy.yy (see Description of Arguments for details)
Attenuation	ATT=	PCB	5 bytes, numerical	Command or Query. Valid attenuation level, in dB, at 0.25-dB step size as factory default. Example: ATT=12.25 Note: The attenuation range is limited to a maximum of 24 dB.	ATT= ATT? ATT*	ATT?	ALL	ATT=xx.xx (see Description of Arguments for details)
Clear All Stored Alarms	CAA=	ALL	None	Command only Instructs the slave to clear all Stored Events. This command takes no arguments.	CAA=	N/A	N/A	N/A
Concise Alarm Status	N/A	N/A	11 bytes numerical 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'cr'lf' where: a thru k = 0 or 1, 0 = OK 1 = FT a = +24V Power Supply b = +5V Power Supply c = SSPA1 d = SSPA2 e = SSPA3 f = SW1 Absent FLT g = SW2 Absent FLT	N/A	CAS?	ALL	CAS=x...x (see Description of Arguments for details)

Parameter Type	Command (Instruction Code and qualifier)	Command Valid for PCB or SSPA	Arguments for Command or Response to Query	Description of Arguments (Note that all arguments are ASCII numeric codes – i.e., ASCII codes between 48 and 57)	Response to Command (Target to Controller)	Query (Instruction Code and qualifier)	Query Valid for PCB or SSPA	Response to Query (Target to Controller)
Concise Configuration Status	N/A	N/A	24 bytes numerical	Query only. Used to query the summarized version of RCS. Example: CCS=aa.aa,b,c,d,e,f,g,x'cr'lf' where: aa.aa = attenuation in dB b = RF power amplifier state c = mute state d = reserved e,f,g,x = SSPAs fault status	N/A	CCS?	ALL	CCS=x...x (see Description of Arguments for details)
Circuit Identification	CID=	PCB	24 bytes, alphanumeric	Command or Query Used to identify or name the unit or station.	CID= CID?	CID?	ALL	CID=x...x (see Description of Arguments for details)
Concise Maintenance Status	N/A	N/A	23 bytes numerical	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'cr'lf' where: aaa.a = +24V Power Supply bbb.b = +5V Power Supply ccc.c = reserved (XXX.X) ddd.d = reserved (XXX.X)	N/A	CMS?	ALL	CMS=x...x (see Description of Arguments for details)
Concise Utility Status	N/A	N/A	11 bytes, alphanumeric	Query only. Used to Query the Maintenance status of the unit, response is comma delimited. Example: CUS=aaaa,bbbb'cr'lf' where: aaaa = Remote Unit Address bbbb = Remote Baud Rate	N/A	CUS?	ALL	CUS=x...x (see Description of Arguments for details)
Set RTC(Real-Time-Clock) Date	DAT=	ALL	6 bytes, numerical	Command or Query. A command in the form mmddy , 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 99 (2000 to 2099) Example: DAT=042503 would be April 24, 2003	DAT= DAT? DAT*	DAT?	ALL	DAT=xx (see Description of Arguments for details)
Force Unit Online	FRC=	PCB	2 bytes	Command or Query. Force two SSPA's to be online, in the form FRC=xy where: xy = 12 (SSPAs 1 and 2) 23 (SSPAs 2 and 3) 13 (SSPAs 1 and 3) 00 (Automatic mode)	FRC= FRC?	FRC?	PCB	FRC=xy (see Description of Arguments for details)

Parameter Type	Command (Instruction Code and qualifier)	Command Valid for PCB or SSPA	Arguments for Command or Response to Query	Description of Arguments (Note that all arguments are ASCII numeric codes – i.e., ASCII codes between 48 and 57)	Response to Command (Target to Controller)	Query (Instruction Code and qualifier)	Query Valid for PCB or SSPA	Response to Query (Target to Controller)
Retrieve Firmware Number	N/A	N/A		Query only Gets the Firmware Number of the unit. Bulk = FW/XXXXX M&C = FW/XXXXX FPGA = FW/XXXXX Example: FRW=FW12001'cr'lf	N/A	FRW?	ALL	FRW=FWxxxx
Retrieve next 5 unread Stored Alarms	N/A	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(CR)Sub-body , where Sub-body= YYYYYYYYYY ZZ mmddy hhmss, <i>where:</i> 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?	ALL	LNA=YY..ss (see Description of Arguments for details)
Mute State	MUT=	PCB	1 byte, value of 0,1	Command or Query. Mute the SSPAs, <i>where:</i> 0 = Disabled, 1 = Enabled 2 = Inhibit asserted (Query only) Example: MUT=1	MUT= MUT? MUT*	MUT?	ALL	MUT=x (see Description of Arguments for details)
Preferred	PRF=	PCB	2 bytes	Command or Query. Allows the user to choose two preferred SSPAs that will be switched to, if available, in the form PRF=xy, where: xy = 12 (SSPAs 1 and 2) 23 (SSPAs 2 and 3) 13 (SSPAs 1 and 3) 00 (Automatic mode)	PRF= PRF?	PRF?	PCB	PRF=xy (see Description of Arguments for details)

Parameter Type	Command (Instruction Code and qualifier)	Command Valid for PCB or SSPA	Arguments for Command or Response to Query	Description of Arguments (Note that all arguments are ASCII numeric codes – i.e., ASCII codes between 48 and 57)	Response to Command (Target to Controller)	Query (Instruction Code and qualifier)	Query Valid for PCB or SSPA	Response to Query (Target to Controller)
Retrieve Alarm Status	N/A	N/A	53 bytes alphanumeric	<p>Query only. Used to Query the Alarm status of the unit. Example: RAS='cr' P24VT=OK'cr' P5VLT=OK'cr' SSPA1=OK'cr' SSPA2=OK'cr' SSPA3=OK'cr' SW1FT=OK'cr' SW2FT=OK'cr'lf'</p> <p>Note: XXXXX = reserved</p>	N/A	RAS?	ALL	RAS=x...x (see Description of Arguments for details)
Retrieve Configuration Status	N/A	N/A	33 bytes alphanumeric	<p>Query only. Used to Query the configuration status. Example: RCS='cr' ATT=12.75'cr' AMP=1'cr' MUT=1'cr' PCM=1,0'cr' FLT=0,0,X'cr'lf'</p> <p><i>where:</i></p> <p>ATT= attenuation in dB AMP= RF power amplifier state, 0=OFF, 1=ON MUT=RF mute state, 0=unmuted, 1=muted PCM=reserved FLT=X,Y,Z (SSPA fault states) X = SSPA#1 (1=faulted, 0=unfaulted) Y = SSPA#2 (1=faulted, 0=unfaulted) Z = SSPA#3 (1=faulted, 0=unfaulted)</p>	N/A	RCS?	ALL	RCS=x...x (see Description of Arguments for details)
Retrieve Equipment Type	N/A	N/A	20 bytes, alphanumeric	<p>Query only. The unit returns a string indicating the Model Number and the value of internal software revision installed. Example: Phase –Combine Ver. 1.1.16l or KPA-100-1415 VER:1.1.3</p>	N/A	RET?	ALL	RET=x...x (see Description of Arguments for details)

Parameter Type	Command (Instruction Code and qualifier)	Command Valid for PCB or SSPA	Arguments for Command or Response to Query	Description of Arguments (Note that all arguments are ASCII numeric codes – i.e., ASCII codes between 48 and 57)	Response to Command (Target to Controller)	Query (Instruction Code and qualifier)	Query Valid for PCB or SSPA	Response to Query (Target to Controller)
Retrieve Maintenance Status	N/A	N/A	47 bytes, alphanumeric	Query only. Used to Query the maintenance status of the unit. P24VT=024.1'cr' P05VT=015.2'cr' XXXXX=XXX.X'cr' XXXXX=XXX.X'cr''lf' Note: XXXXX = reserved	N/A	RMS?	ALL	RMS=x...x (see Description of Arguments for details)
Serial Number	N/A	PCB	9 bytes, numerical 00000000 to 99999999	Query only. Used to Query the units 9 digit serial number. Slave returns its S/N, in the form xxxxxxxx. Example: RSN=00000165	N/A	RSN?	ALL	RSN=xxxxxxxx (see Description of Arguments for details)
Retrieve Utility Status	N/A	N/A	17 bytes, alphanumeric	Query only. Used to Query the utility status of the unit Example: RUS='cr' ADR=0001'cr' BDR=9600'cr''lf'	N/A	RUS?	ALL	RUS=x...x (see Description of Arguments for details)
Remote Baud Rate	SBR=	PCB	4 bytes,	Command or Query. Set remote baud rate as follows: 9600 = 9600 baud 19K2 = 19200 baud	SBR= SBR?	SBR?	PCB	SBR=xx (see Description of Arguments for details)
Summary Fault Status	N/A	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?	ALL	SFS=x (see Description of Arguments for details)
Remote Address	SPA=	PCB	4 byte, numerical	Command or Query. Set Physical Address-between 0001 to 9999. Resolution 0001 Example: SPA=0412	SPA= SPA?	SPA?	ALL	SPA=x (see Description of Arguments for details)
Set RTC Time	TIM=	ALL	6 bytes, numerical	Command or Query. A command in the form hhhmss, 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 past midnight.	TIM = TIM? TIM *	TIM?	ALL	TIM=xx (see Description of Arguments for details)

Parameter Type	Command (Instruction Code and qualifier)	Command Valid for PCB or SSPA	Arguments for Command or Response to Query	Description of Arguments (Note that all arguments are ASCII numeric codes – i.e., ASCII codes between 48 and 57)	Response to Command (Target to Controller)	Query (Instruction Code and qualifier)	Query Valid for PCB or SSPA	Response to Query (Target to Controller)
Retrieve Number of unread Stored Alarms	N/A	N/A	2 bytes, numerical	Query only. Returns the number of Stored Events which remain unread, in the form xx . Example reply: TNA=18	N/A	TNA?	ALL	TNA=xx (see Description of Arguments for details)

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

Temperature	° Fahrenheit	° Centigrade
Water freezes	32	0
Water boils	212	100
Absolute 0	-459.69	-273.16

Formulas
$^{\circ}\text{C} = (\text{F} - 32) * 0.555$
$^{\circ}\text{F} = (\text{C} * 1.8) + 32$

Units of Weight

Unit	Gram	Ounce Avoirdupois	Ounce Troy	Pound Avoirdupois	Pound Troy	Kilogram
1 gram	—	0.03527	0.03215	0.002205	0.002679	0.001
1 oz. avoird.	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. avoird.	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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480 • 333 • 2200 PHONE
480 • 333 • 2161 FAX