PCB-4000

1+1 Phase Combiner
Installation and Operation Manual

Part Number MN/PCB4000.IOM
Revision 2

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.

Table of Contents

Tables

Figures

PREFACE

About this Manual

This manual provides installation and operation information for the Comtech EF Data PCB-4000 1+1 Phase Combiner. This is an informational document intended for the persons responsible for the operation and maintenance of the PCB-4000.

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.

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*A **WARNING** gives information about a possible hazard that MAY CAUSE DEATH or SERIOUS INJURY.*

*A **CAUTION** gives information about a possible hazard that MAY CAUSE INJURY or PROPERTY DAMAGE.*

*A **NOTE** gives important information about a task or the equipment.*

*A **REFERENCE** directs the user to additional information about a task or the equipment.*

Recommended Standard Designations

Electronic Industries Association (EIA) designations supersede Recommended Standard (RS) designations. Reference to the old RS designations (e.g., RS-232) may appear where it might concern actual text displayed on the unit's rear panel, Serial Interface, or Web Server Interface pages. All other references in the manual use the EIA designations.

Metric Conversion

Metric conversion information is provided on the inside back cover of this manual. Comtech EF Data provides this information to assist the user in cross-referencing non-Metric to Metric conversions.

Electrical Safety Notice

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

This equipment is designed to minimize exposure of personnel to hazards. For further information, contact the Comtech EF Data Customer Support Department. The persons responsible for the operation and maintenance of the PCB-4000 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.

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.

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Review the Warranty Policy before contacting Comtech EF Data Technical Support or Customer Service.

Contacting Comtech EF Data

Contact Comtech EF Data for:

- *Technical Support –* Product support or training.

- *Customer Service –* Information on returning an in-warranty or out-of-warranty product for upgrade or repair. **Be prepared to provide the product model number and its serial number.**

Contact Comtech EF Data Customer & Technical Support during normal business hours (Monday through Friday, 8 A.M. to 5 P.M Mountain Standard Time (MST)):

For:		Contact:
PCB-4000 Technical Support and Service	**Telephone**	**+1.480.333.4357**
	Email	**cdmipsupport@comtechefdata.com**
	Fax	**+1.480.333.2500**
Comtech EF Data Web Site	**Main Page**	**http://www.comtechefdata.com**
	Customer and Technical Support	**http://www.comtechefdata.com/support.asp**
	RMA (Return Material Authorization)	**http://www.comtechefdata.com/rmaform.asp**
Comtech EF Data Main Number		**+1.480.333.2200**
Mailing Address		**2114 West 7th Street Tempe, Arizona 85281 USA**

Returning a Product for Upgrade or Repair

Step	Task
1	Go to the Comtech EF Data **Home** page (http://www.comtechefdata.com). From the **SUPPORT** column at the bottom of the page, select the **Service** hyperlink, and read the **Return Material Authorization** section in its entirety.
2	Request a Return Material Authorization Number: • *On the Comtech EF Data **Home** page:* From the **SUPPORT** column at the bottom of the page, select the **RMA Request** hyperlink; *OR* • *On the Comtech EF Data **Support** page:* Click **[Send RMA Request]**; *OR* • *On the Comtech EF Data **Service** page*: Select the **Return Material Authorizaion** hyperlink; • Fill out the RMA form completely; • Click **[Send Email]**. *Alternately:* • Send an e-mail providing this same detailed information to Comtech EF Data Customer Service (**service@comtechefdata.com**). • Contact Comtech EF Data Customer & Technical Support by phone or fax.
3	Pack the product in its original shipping carton and protective packaging.
4	Ship the product back to Comtech EF Data. **Shipping charges should be prepaid.**

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-4000 1+1 Phase Combiner (**Figure 1-1**), together with two **S**olid **S**tate **P**ower **A**mplifiers (SSPAs), form a complete 1+1 phase combined system that doubles the available output power. The PCB-4000 also features a "soft fail" configuration; i.e., if one SSPA experiences a failure, the total output power will be reduced by only 3 dB, rather than 6 dB.

Figure 1-1. Comtech EF Data PCB-4000 1+1 Phase Combiner Control Box (PCCB)

1.2   Functional Description

The PCB-4000 is available in an X-Band version (CEFD P/N PL/11285-1), a C-Band version (CEFD P/N PL-0000330), or a Ku-Band version (CEFD P/N PL-0021051). The box may be included in a top-level system assembly or as a subassembly kit item. For application examples, see **Appendix A. ASSEMBLY KITS**.
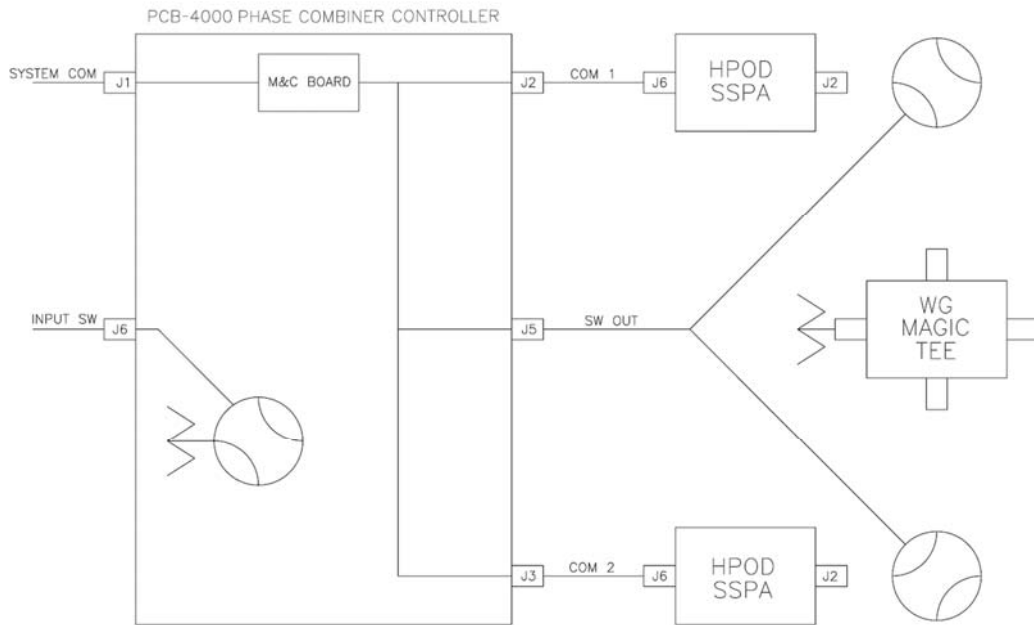
Monitor & Control (M&C) System Interconnect
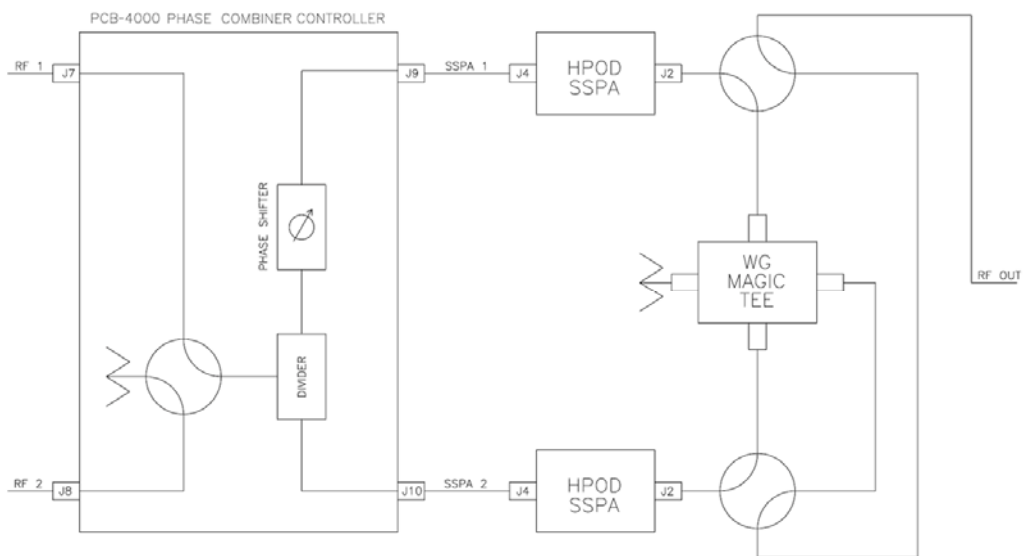
RF System Interconnect

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

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

The PCB-4000 1+1 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 "**SSPA COM 1 | J2**" and "**SSPA COM 2 | J3**" connectors to each SSPA.

- It is also through this connection that the PCCB receives it prime power to operate. A +24V signal from each SSPA is diode OR'ed to provide redundant operating power for the PCCB.

- A "Y" cable connects to the "**SSPA SW OUT | J5**" connector for control of the waveguide switches. Monitor and Control (M&C) communication with the PCCB is accomplished via the "**SYSTEM COM | J1**" connector.

Note: In order to avoid ambiguities, all communication to each SSPA is also accomplished via the PCCB 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 1 OUT | J9**" and "**SSPA 2 OUT | J10**" output connectors.

  o The RF path to the "**SSPA 1 OUT | J9**" output connector contains a manually adjustable phase shifter; this phase shifter is used to equalize the phase difference of each SSPA signal path to achieve maximum system output power. It is accessible via a small cover panel. This critical component is factory set and should only be adjusted, if needs arise, by carefully following an appropriate alignment procedure – see **Chapter 3. INSTALLATION, STARTUP, AND TROUBLESHOOTING PROCEDURES** for further information.

  o The RF path to the "**SSPA 2 OUT | 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 **V**oltage **S**tanding **W**ave **R**atio (VSWR). You should not alter any RF cable inside (or outside) of the 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.
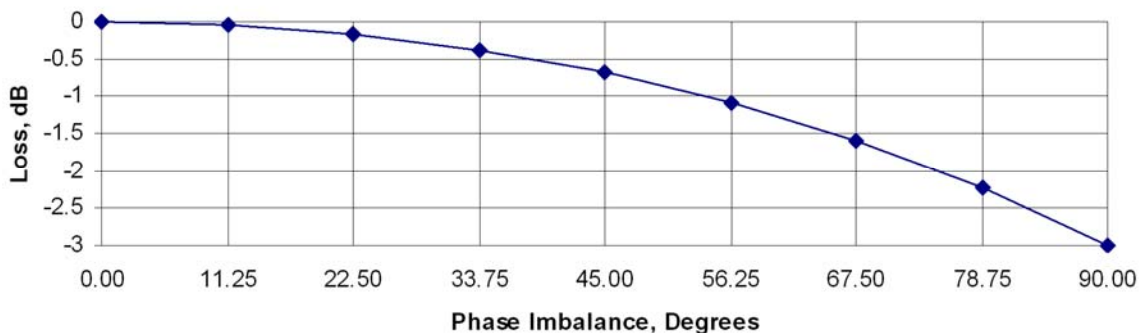
Figure 1-3. Combining Loss vs. Phase Imbalance Summary of Specifications

1.3.1   Phase and Gain Equalization

Naturally, two separate amplifiers are likely to have different phase and gain characteristics. The PCB-4000 1+1 system is designed such that the phase difference between the two 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. (See alignment procedure).

The amplifier gain difference is automatically compensated for by the PCCB Monitor and Control System. Upon power up, the M&C reads the gain of each individual amplifier as calibrated at the factory, and automatically attenuates the amplifier with the most gain so as to be equal with the lower gain unit.

For example, if SSPA #1 had a factory-calibrated gain setting of 76 dB, and SSPA #2 had a factory-calibrated gain setting of 73 dB, the M&C system would automatically set the attenuation setting of SSPA#1 to 3 dB to equalize the system gain. Although not generally needed or recommended, a user input gain offset setting is also provided for system fine-tuning. For operation and alignment information, see **Chapter 3. INSTALLATION, STARTUP, AND TROUBLESHOOTING PROCEDURES**.

Note that, due to the power divider and cable losses, the overall gain of the system will be less than the individual gain of each amplifier. Please refer to the system test data sheet for actual system gain.

1.3.2   System Attenuation

The PCB-4000 makes it easy to adjust the overall system gain. Upon input of the requested attenuation setting, the PCB-4000 automatically adjusts the gain of each SSPA 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, the maximum allowable attenuation in a 1+1 system is software limited to 24 dB, but still exceeds system specifications.

1.3.3   Soft Fail Protection

In the event of a failure of one of the SSPAs, the PCB-4000 controls the waveguide switches such that the good unit's power is routed around the "Magic-Tee" combiner directly to the output port. This results in only a 3 dB power loss, or "soft failure". Without the waveguide switches, a failure in one unit would result in a 6 dB power loss.

1.4   Dimensional Envelope

Note: All dimensions are in English units; metric units are shown in parentheses. This figure is typical for the PL-0000330 C-Band, PL/11285-1 X-Band, PL-0021051 Ku-Band versions of the PCB-4000.
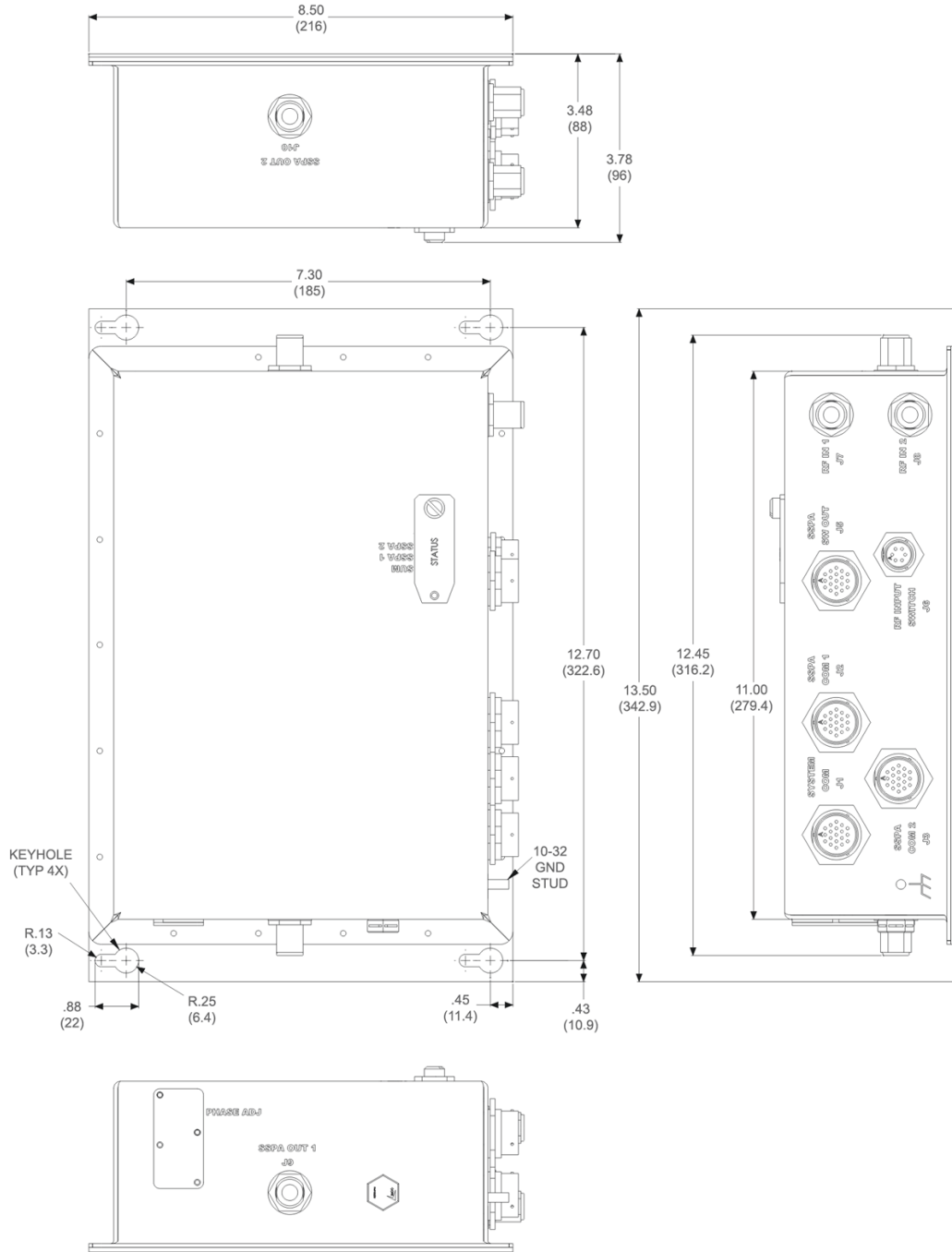
Figure 1-4. PCB-4000 Dimensional Envelope

Chapter 2. EXTERNAL CONNECTORS

2.1   Overview

This chapter summarizes the connectors provided for all necessary external connections between the PCB-4000 1+1 Phase Combiner Control Box (PCCB) and other equipment. **Table 2-1** on the next page lists the connectors provided on the PCB-4000 grouped according to service function.

PCCB Front View

PCCB Left Side View   **PCCB Right Side View**
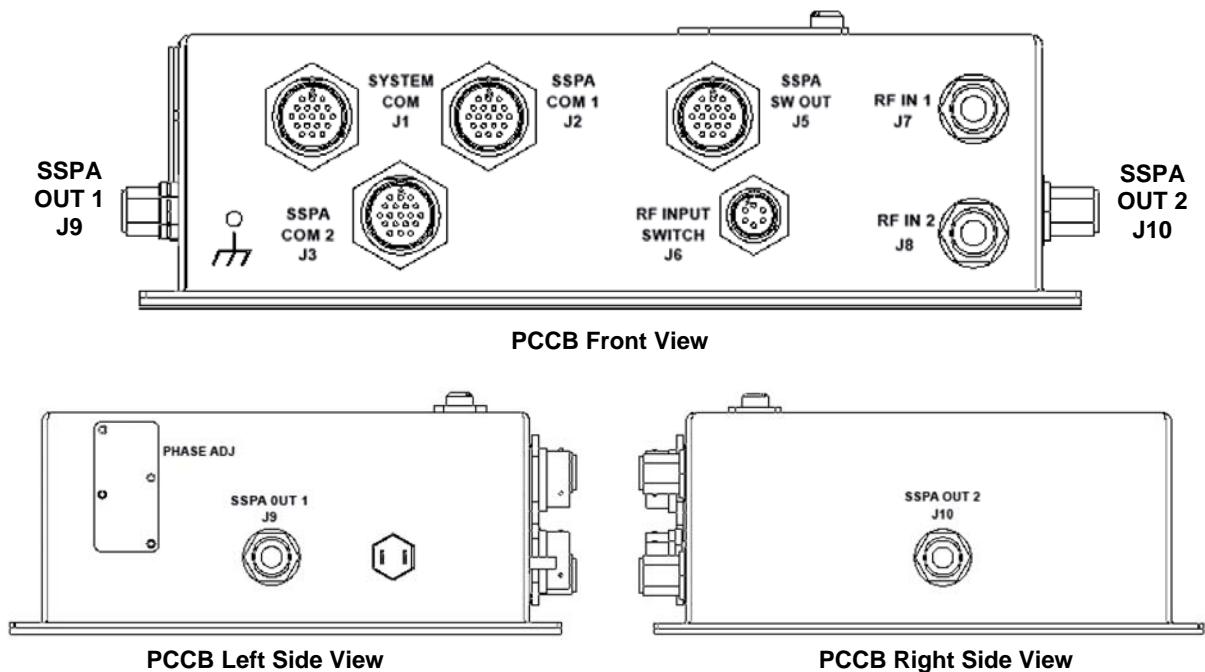
Figure 2-1. PCB-4000 External Connectors

See **Chapter 3. INSTALLATION, STARTUP, and TROUBLESHOOTING PROCEDURES** and **Appendix A. ASSEMBLY KITS** for basic installation and operational examples.

For information about remote monitor and control (M&C) of the PCB-4000, see **Chapter 5. SERIAL REMOTE CONTROL**.

Table 2-1. PCB-4000 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 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		
Power/Ground (Sect 2.4)	AC	Pin 'R' on SSPA COM 1 J1, SSPA COM 2 J3	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

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

2.2.1   "SYSTEM COM | J1" Connector

The 19-pin circular "**SYSTEM COM | J1**" connector, type MS3112E14-19S, serves as the primary input between the user and the PCCB for controlling and monitoring both SSPAs.

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

Table 2-2. "SYSTEM COM | 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-4000, 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-4000, 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" Connectors

The 19-pin circular "**SSPA COM 1 | J2**" and "**SSPA COM 2 | J3**" connectors, type MS3112E14-19S, serve as the primary input/output interfaces between the PCCB and its specified SSPA.

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

Table 2-3. "SSPA COM 1 | J2" and "SSPA COM 2 | J3" 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 19-pin circular "**SSPA SW OUT | J5**" connector, type MS3112E14-19S, connects via a "Y" cable to the SSPA #1 and SSPA #2 waveguide switches.

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

Table 2-4. "SSPA SW OUT | 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

RF INPUT
SWITCH
J6

The PCCB contains a built-in selector switch – a latching 28 VDC coaxial unit. The switch position is selected by the 6-pin circular "**RF INPUT SWITCH | J6**" connector (CEFD P/N CN/MS-PT07M6PC).

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

Table 2-5. "RF INPUT | 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

RF IN 1
J7

RF IN 2
J8

The Type 'N' "**RF IN 1 | J7**" and "**RF IN 2 | J8**" connectors serve as RF signal input interfaces to the PCCB. Note that:

- The PCCB selects the "**RF IN 1 | J7**" input when the "**RF INPUT SWITCH | J6**" '**POS1**' Signal Function is activated.

- The PCCB selects the "**RF IN 2 | J8**" input when the "**RF INPUT SWITCH | J6**" '**POS2**' Signal Function is activated.

2.3.2   "SSPA OUT 1 | J9" Connector

SSPA 0UT 1
J9

The Type 'N' "**SSPA OUT | J9**" connector, located on the left side panel of the PCCB, provides the RF signal output from the PCCB to SSPA #1.

2.3.3   "SSPA OUT 2 | J10" Connector

SSPA OUT 2
J10

The Type 'N' "**SSPA OUT 2 | J10"** connector, located on the right side panel of the PCCB, provides the RF signal output from the PCCB to SSPA #2.

2.4   Power and Ground Interfaces

2.4.1   AC Power

The PCB-4000 derives its power from the SSPAs. Each SSPA provides a +24V signal line via cables interconnecting the SSPAs to the "**SSPA COM 1 | J2**" and "**SSPA COM 2 | J3**" connectors (Pin 'R' – see **Table 2-3** in **Sect. 2.2.2**). These two signals are "diode OR'ed" to provide redundancy.

Although the PCCB will turn on and function with only one SSPA powered on, the system does not provide optimum output power unless both 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. INSTALLATION, STARTUP, AND TROUBLESHOOTING PROCEDURES

> ⚠️ *Comtech EF Data recommends that only qualified personnel familiar with high-power amplifiers, test equipment, and phase-combined systems attempt the procedures provided in this appendix. Furthermore, before attempting any of these procedures, you are strongly advised to:*
>
> - *Read Chapter 1. INTRODUCTION to become familiar with system terminology and PCB-4000 1+1 Phase Combiner System Theory of Operation.*
>
> - *Read Chapter 2. EXTERNAL CONNECTORS to become familiar with the PCCB external connectors and their functionality.*
>
> - *Read Chapter 5. SERIAL REMOTE CONTROL to become familiar with the serial remote control commands and queries used in this chapter.*

3.1   Overview

As explained in **Chapter 1. INTRODUCTION**, the PCB-4000 1+1 Phase Combiner system is aligned at the factory using a network analyzer. All that should be required upon shipment is for you to unpack, inspect, and assemble the 1+1 phase-combined system – see **Figure 3-1** for an assembly example – and to complete all required cable connections (**Figure 3-2** and **Figure 3-3**).

Although the techniques featured in this appendix afford 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 you are strongly cautioned against making unneeded adjustments*. However, if you replace an amplifier or other critical system component (e.g., the PCB-4000 unit), the procedures provided in this appendix explain the steps necessary to restore proper system operation. This appendix also provides a verification procedure in the event that you just need to confirm proper system operation.

3.2   System Assembly, Cabling, and Installation

3.2.1   1+1 Phase Combiner System Assembly

Figure 3-1 shows an example of the PCB-4000 deployed in a typical 1+1 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 are referenced in the procedures provided in this appendix.
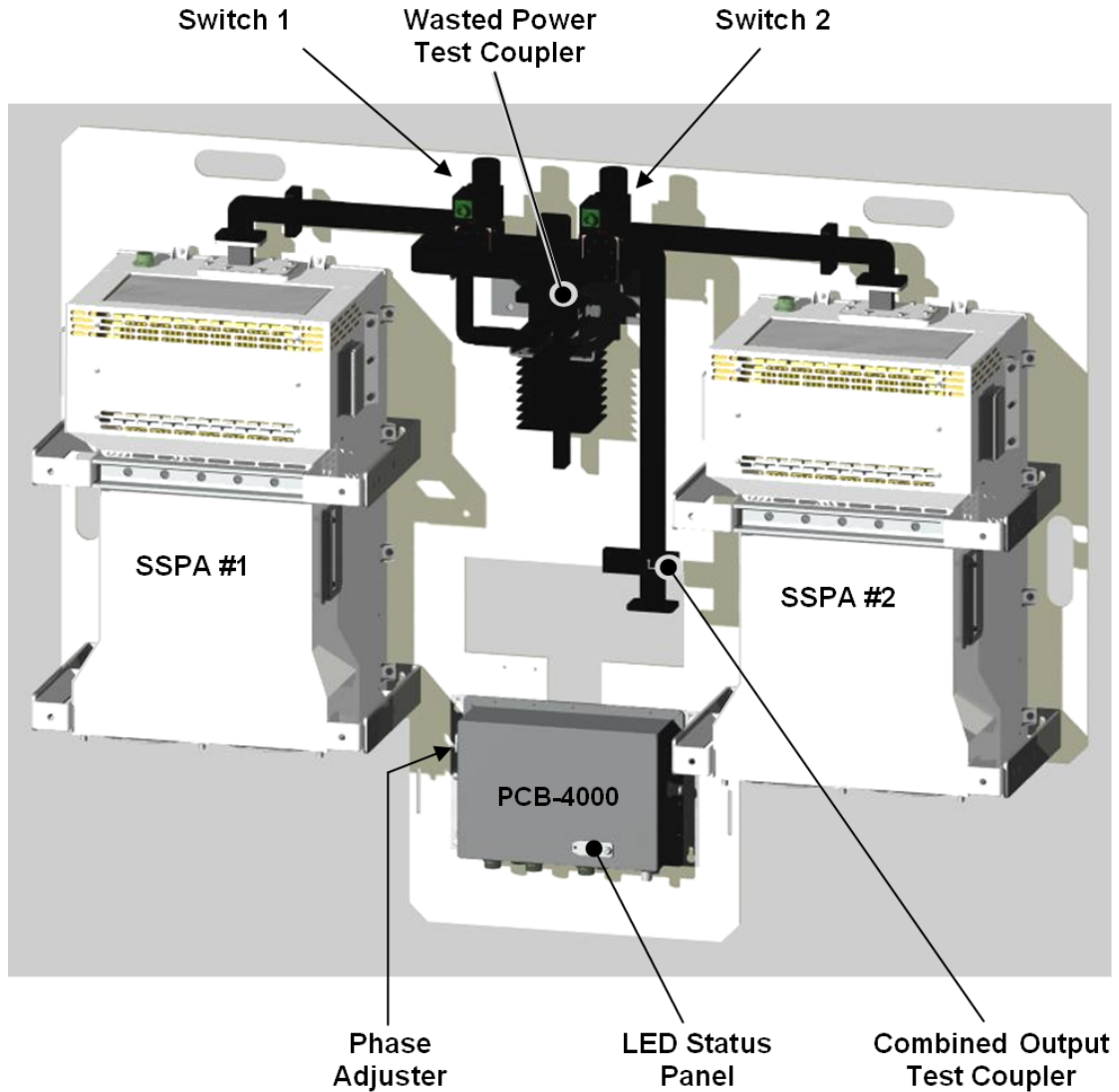
Figure 3-1. PCB-4000 1+1 Phase Combiner System Assembly Example

3.2.2   PCCB Cabling Connections

Figure 3-2 shows the PCCB external connectors. **Figure 3-3** summarizes the cables as routed from these connectors to other components of the 1+1 Phase Combiner System.
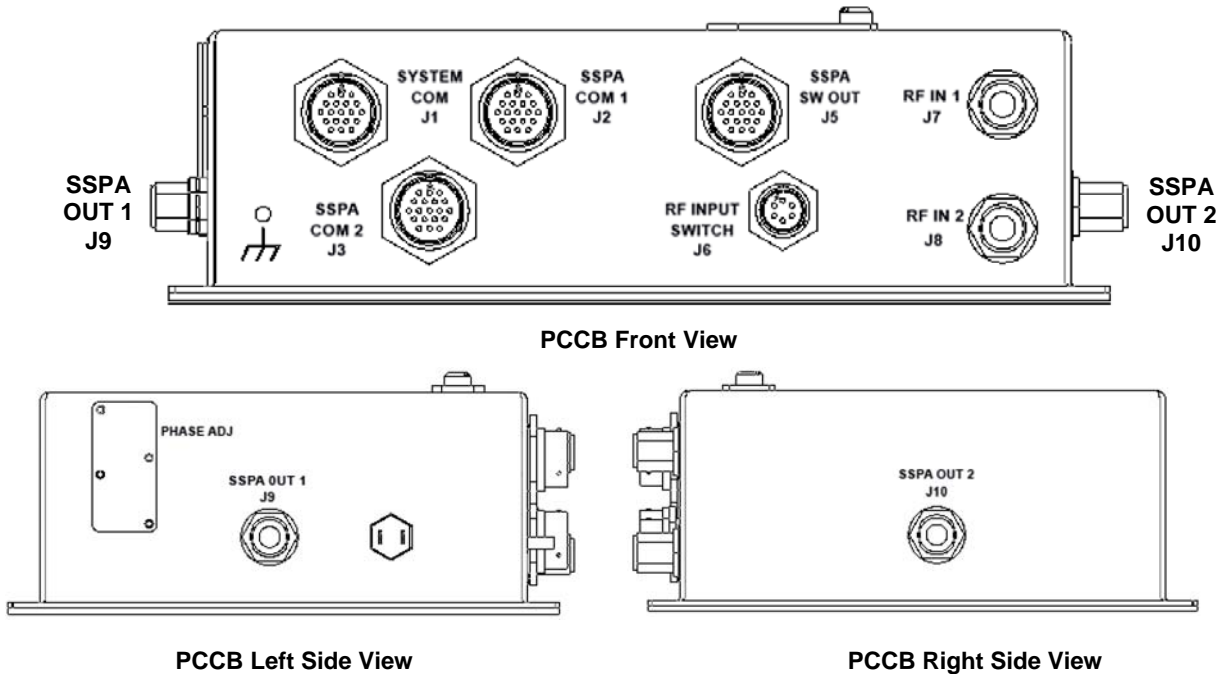
Figure 3-2. PCCB External Connectors
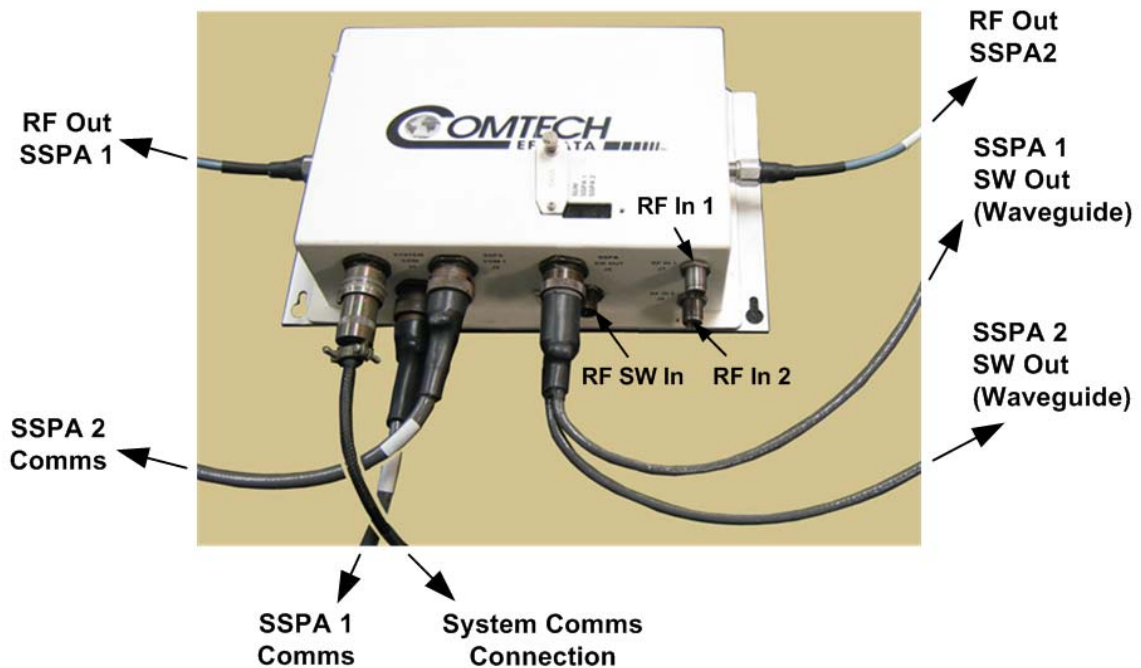
Figure 3-3. PCCB Cable Connections

3.2.3   System Component Installation and Interconnection

Refer to **Figure 3-1** through **Figure 3-3** to follow these steps:

Step	Task
1	Install the SSPAs in their respective positions as detailed in the factory datasheet 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 SSPA in Position 2. Refer to cable and component labeling to assure 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, see **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-4000 Phase Combiner Control Box (PCCB) to the mounting structure.
4	Install the Type 'N' RF Phase Matched Coaxial Cables (CEFD P/N CA/RF11872-1) as shown in **Figure 3-3**. Each cable is labeled according to its destination SSPA: o Connect the cable labeled "**SSPA1**" from the PCCB Type 'N' port labeled "**SSPA OUT 1 | J9**" to the RF Input port on **SSPA #1**. o Repeat this task for the cable labeled "**SSPA2**", connecting it between the PCCB Type 'N' port labeled "**SSPA OUT 1 | J10**" and the RF Input port on **SSPA #2**. ***Make sure to correctly install all RF cabling, as any "cross" connections will cause system malfunction.***
5	Install the "COM" Cable (CEFD P/N CA/WR11966-2) between each of the following PCCB connectors and their corresponding SSPA "**COM**" ports: o (PCCB) "**SSPA COM 1 | J2**" to **SSPA #1**. o (PCCB) "**SSPA COM 2 | J3**" to **SSPA #2**.
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 3-3**) and the two waveguide switches as shown in **Figure 3-1**. Pay particular attention to ensure that the ends labeled "**SW1**" and "**SW2**" are connected, respectively, to Waveguide Switch #1 and Waveguide Switch #2.
7	Install the user-provided RF Input Switch control cable (if applicable) to the PCCB connector labeled "**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.

3.3   Initial System Setup and Verification

This section assumes that the system has been assembled, that all cables have been connected, and that the output port is terminated in a broadband high power load as depicted in the **Figure 1-2** block diagram in **Chapter 1. INTRODUCTION**. If the system is "live" and you desire only to verify operation, see **Section 3.5**.

You may verfiy overall system performance by measuring the ratio of the transmitted power to that of the power being dissipated by the "dummy" load. Adjust the gain and amplitude balance if necessary.

Follow these steps:

Step	Task
1	In the normal 1+1 phase combiner mode, the **RED=X** remote command setting should be set to "**1**". You can verify this by querying the system (see **Chapter 5. SERIAL REMOTE CONTROL**).
2	**A.** Attach a power meter to the Combined Output Power Test Coupler (**Figure 3-1**). **B.** Apply a low-level signal at center frequency; making sure the output signal (at the system output port –not the coupled port) will be at least 10 dB below Prated. **C.** Measure the output power and include the coupler correction factor.
3	**A.** Attach a power meter to the Wasted ("Load") Power Test Coupler (**Figure 3-1**). **B.** Measure the power and include coupler correction factor.
4	If the Wasted ("Load") power level is 15-20 dB below the transmitted power, the system is operating correctly. ⓘ *If the ratio is below 10 dB, proceed to the gain and phase alignment procedures that follow in this chapter.*
5	**A.** Slowly increase the input power until the desired operating output power is achieved. **B.** Again, verify the appropriate ratio of the transmitted to dissipated power.
6	If desired, repeat **Steps 1** through **5** at different frequencies to verify proper full bandwidth operation.

3.3.1   LED Status Operation

The PCB-4000 1+1 Phase Combiner features four Light-Emitting Diode (LED) indicators – three are operational, with the fourth reserved for future applications. Each LED provides visual cues to the operational, online, and offline status of the system.

Figure 3-4 illustrates the location of the LED indicators. Located on the top of the PCB-4000 enclosure under a pivoting protective plate, you may view the LEDs by first loosening the captive screw that keeps the plate in place, and then swiveling the plate to reveal the LED display window.
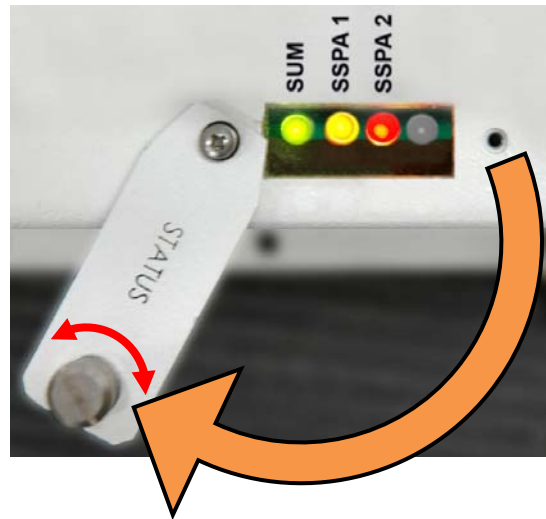
Figure 3-4. PCCB LED Display Window

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) -or- SSPA 2 (LED 3)	Phase-Combine mode (RED=1)	Green (constant)	SSPA is unfaulted, unmuted and online.
		Orange (constant)	SSPA is unfaulted but muted, and online.
		Red (blinking)	SSPA is faulted and has gone offline.
		Red (constant)	SSPA is faulted but online.
	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.
(LED 4)	*Inoperable* (always dark), reserved for future use		

3.4   Gain or Amplitude Balance Verification and Alignment

This procedure is generally not necessary if all parameters of Section 3.3 have been met.

As a result of the configuration of the waveguide switches in a 1+1 system, it is possible to measure the individual gain of each SSPA path by switching each SSPA individually to the output load.

This procedure assumes that the output port is terminated and that data will be taken using the Combined Output Power and Wasted Power Test Couplers (Figure 3-1).

Follow these steps:

Step	Task
1	A. Attach a power meter to the Combined Output Power Test Coupler (**Figure 3-1**). B. Apply a low-level signal at center frequency, making sure the output signal will be at least 10 dB below Prated.
2	To measure only the individual gain of SSPA#1, SSPA#2 must by *bypassed* by changing the state of the waveguide switches via remote control (for detailed remote command and query information, see **Chapter 5. SERIAL REMOTE CONTROL**): A. Execute remote command **RED=0**; B. Execute remote command **BYP=2**. The output of SSPA#1 will be sent to the system output, while SSPA#2 will be muted and directed to the "wasted" port.
3	Record the amplitude or gain level of SSPA#1.
4	Execute remote command **BYP=1** to measure the individual gain of SSPA#2. This time, the output of SSPA#2 will be sent to the system output, while SSPA#1 will be muted and directed to the "wasted" port.
5	Record the amplitude or gain level of SSPA#2.
6	Compare the levels of the two paths. Typically, the gains of each SSPA will be within ± 1 dB at center frequency. If the above test is performed at other frequencies, it is reasonable to assume that the gain difference may be greater.

3.5   Amplitude Alignment *(as necessary)*

Even if the difference of each individual SSPA path is greater than ±1 dB, amplitude adjustment may not be necessary to meet all parameters of **Section 3.3**. However, if these parameters have *not* been met, then fine tuning adjustment is advisable.

> *If the system is to be used in a narrow frequency range, you may also wish to optimize the gain balance over this narrow range.*

Follow these steps:

Step	Task
1	If Steps **1** through **6** in **Section 3.4** have not been completed, perform them *now*.
2	Again, insure the input signal is at center frequency and that the output power level is approximately Prated -10 dB.
3	Alternately toggle between remote commands **BYP=1** and **BYP=2** to measure the gains of each SSPA path. Note which path has the greater amount of gain.
4	Use the **AOF** (user amplitude offset) remote command/query to equalize the gain between the 2 paths. For example, if SSPA 1 has 2 dB excess gain: A. Query the offset of SSPA 1 using remote query **AOF?1**. The unit should respond with a gain offset ranging between 0 and 6. Record this value, then add 2 dB. For this example, assume SSPA 1 responded with 1 dB. Adding 2 dB of required additional offset to the existing 1 dB of offset results in 3 dB of required offset. B. Now send remote command **AOF=1,3.00**.
5	Proceed to the Phase Alignment procedure (**Section 3.6**) if anything has been changed or altered that may affect the phase alignment. Otherwise, verify proper operation via the LED Indicators as detailed in **Section 3.3.1**.

3.6   Phase Alignment

As the system is aligned at the factory, this step should generally not be necessary unless it has been required to replace one of the SSPAs or other critical path components. Make sure to meet all parameters of Section 3.3 before performing this adjustment.

This procedure assumes that the system installation is complete and that the output port terminates in a broadband high power load.

Verify the overall system performance by measuring the ratio of the transmitted power to that of the power being dissipated by the "dummy" load. If necessary, adjust the phase balance by trimming the phase shifter, which is located inside the PCCB box and accessible via a secured cover labeled **PHASE ADJ** on the left side of the box.
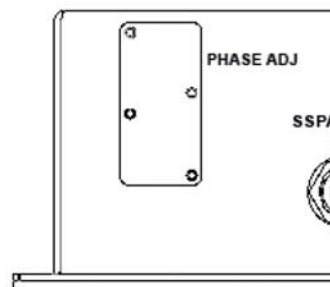
Figure 3-5. PCCB PHASE ADJ Panel

Follow these steps:

Step	Task
1	Ensure the system is set to 1+1 phase combined mode by issuing remote command **RED=1** (see **Chapter 5. SERIAL REMOTE CONTROL**).
2	A. Attach a power meter to the Combined Output Power Test Coupler (**Figure 3-1**). B. Apply a low level signal at center frequency, making sure the output signal (at the system output port – not the coupled port) will be at least 10 dB below Prated. C. Measure the output power and include the coupler correction factor.
3	A. Attach a power meter to the Wasted ("Load") Power Test Coupler (**Figure 3-1**). B. Measure the power and include coupler correction factor.
4	If the Wasted ("Load") power level is 15-20 dB below the transmitted power, the system is operating correctly. However, if the ratio is below 10-15 dB, proceed to the align the phase shifter: A. Remove the **PHASE ADJ** cover panel (**Figure 3-5**) located on the left side of the PCCB box. B. Utilizing the supplied socket and screwdriver, first loosen the phase shifter lock nut. C. Slowly adjust the phase shifter by turning the screwdriver. The system is aligned at the operating frequency when the transmitted to "wasted" power ratio is maximized. If it is not possible to view the transmitted and "wasted" power simultaneously, it is recommended to minimize the "wasted" power. Generally, the "wasted" power reading will be more sensitive to phase shifter adjustments.
5	A. Achieve the desired operating output power by slowly increasing the input power. B. Verify the appropriate ratio of the transmitted to dissipated power once more.
6	Verify that the system works over the full bandwidth by injecting a signal at the start and stop frequencies as well. The ratio of the transmitted to "wasted" power should be 15-20 dB, but is not likely to be as good as it was at the adjustment (center) frequency. If acceptable full bandwidth performance is not measured, it may be necessary to repeat **Steps 2** through **5** for the start, stop, and center frequencies – realizing that optimum performance at any one particular frequency must be sacrificed slightly to achieve full bandwidth operation.

Step	Task
7	Make sure the lock nut on the phase shifter is tightly secured by using the supplied socket, then replace the cover panel.

3.7   System Online and Transmitting

This procedure assumes that the system installation is complete and that access to the system output port is unavailable due to current system traffic.

To check for proper operation, measure and compare the difference in power transmitted *versus* the power dissipated in the load termination.

Follow these steps:

Step	Task
1	**A.** Attach a power meter to the Combined System Output Power Test Coupler (**Figure 3-1**). **B.** Measure the output power and include the coupler correction factor.
2	**A.** Attach a power meter to the Wasted ("Load") Power Test Coupler (**Figure3-1**). **B.** Measure the power and include the coupler correction factor.
3	The Wasted ("Load") power level should be 15-20 dB below the power being transmitted to the antenna.

Chapter 4. UPDATING FIRMWARE

4.1　Updating Firmware via the Internet

TO ENSURE OPTIMAL PERFORMANCE, IT IS IMPORTANT TO OPERATE THE PCB-4000 WITH ITS LATEST AVAILABLE FIRMWARE.

The PCB-4000 1+1 Phase Combiner is factory-shipped with the latest version of operating firmware. If a firmware update is needed, it can be acquired by download from the Comtech EF Data Web site (www.comtechefdata.com) or from Comtech EF Data Customer Support, during normal business hours, via e-mail or on CD by standard mail delivery.

The PCB-4000 Firmware Update process is as follows:

- Transfer the new firmware update for upgrading the PCB-4000 to a user-provided PC intended for Monitor and Control (M&C) of the PCB-4000 system.

- Connect the PCB-4000 to an available serial port on the user-provided PC.

- Once extracted from the downloaded archive file, execute the firmware update – without having to open the PCB-4000 – via use of the provided **FLSHCSAT.exe** utility program.

4.2   Getting Started: Preparing for the Firmware Download

1. Locate and identify the PCB-4000 1+1 Phase Combiner Control Box (PCCB). The illustration at right identifies the key cable connections between the PCCB to the other components in and a typical 1+1 Phase Combined System.
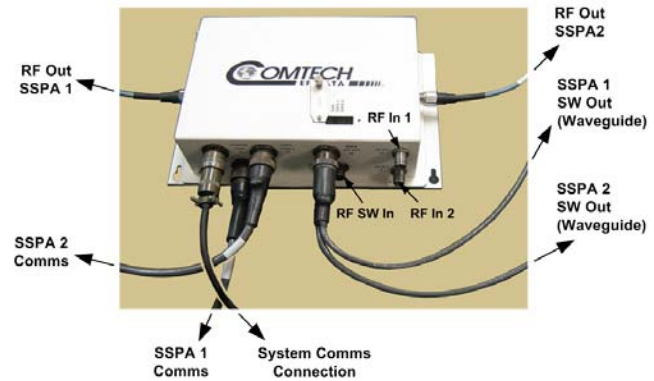
2. Connect the PCB-4000 to a user-supplied PC.

    User-supplied items needed:

    - A Microsoft Windows-based PC, equipped with an available serial port, and running a terminal emulator program (e.g., Tera Term or HyperTerminal).

    - A serial adapter cable for connecting the PC to the PCB-4000. If needed, the CA/ WR12243-1 System Programming Cable is available from Comtech EF Data. Contact CEFD Customer Support for ordering information.

    A. Connect the user PC serial port to the PCB-4000 "**SYSTEM COM | J1**" port.
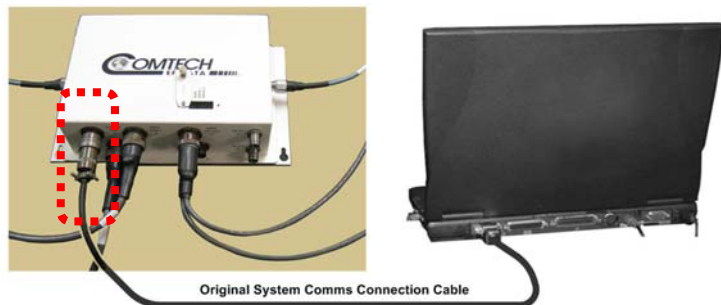
    B. **On the PC:** Open the terminal emulator program.

Refer to your terminal emulator program HELP feature or user guide for operating and configuration instructions.

Configure the utility program serial port communication and terminal display operation:

- 9600 or 19200 bps (Baud Rate)
- Parity = NO
- Local Echo = ON
- 8 Data Bits
- Port Flow Control = NONE
- 1 Stop Bit
- Display New line Rx/Tx: CR

C. **Energize the PCB-4000 1+1 Phase Combiner System** (the PCB-4000 derives its power from the SSPAs).

3. **Obtain the firmware number for the PCB-4000.**

   On the PC: Via serial remote control, obtain the firmware number by using the **<0/FRW?** query.

   > *See* **Chapter 5. SERIAL REMOTE CONTROL** *for information and instructions on using remote commands and queries via the PCB-4000 Serial Interface.*

4. **Create a temporary folder (subdirectory) on the user PC for the firmware archive download.**

   > - *Drive letter "c:" is used in these examples. Any valid, writable drive letter can be used.*
   >
   > - *Typical for all tasks: Type the command <u>without quotes</u>, and then press Enter to execute.*

   There are several ways you may use create a temporary folder on a Windows-based PC:

   A. **Use the Windows Desktop to create and rename the temporary folder.**

      - Right-click anywhere on the desktop to open the popup submenu, and then select **New > Folder** to create the temporary folder. The new folder will be created on the desktop.

      - Right-click on the new folder and then select "**Rename**" from the popup submenu. Rename this folder to "**temp**" or some other convenient, unused name.
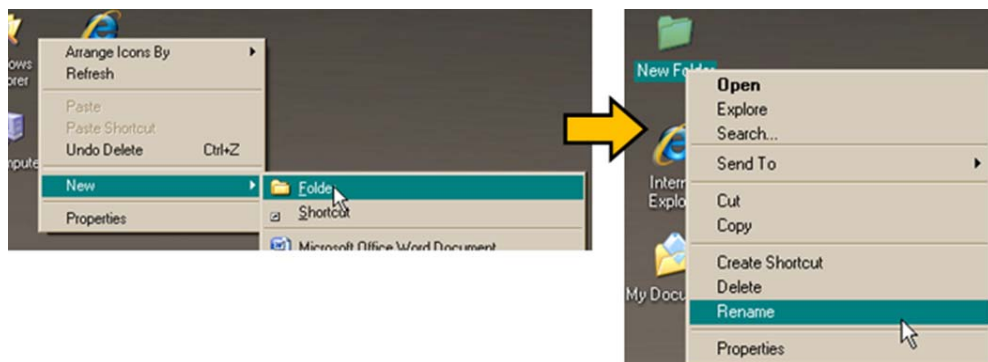
   B. **Use Windows Explorer to create and rename the temporary folder.**

      - Select **File > New > Folder** to create the temporary folder. The new folder will be created in the active folder.

- Right-click the "**New Folder**" folder name, and then rename this folder to "**temp**" or some other convenient, unused name.
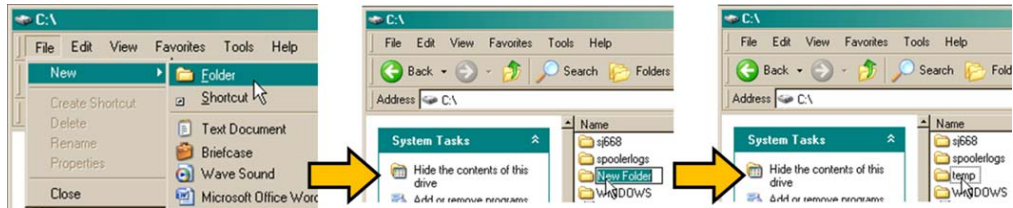
C. **Use the 'Run' and 'Browse' windows to create and rename the temporary folder.**

- Select **[Start]** on the Windows taskbar, and then click the **Run...** icon. The '**Run**' window will open.

- Click **[Browse]** in the '**Run**' window. The '**Browse**' window will open.

- Click the **Create New Folder** icon in the '**Browse**' window. The new folder will be created.

- Right-click the "**New Folder**" folder name, and then rename this folder to "**temp**" or some other convenient, unused name.
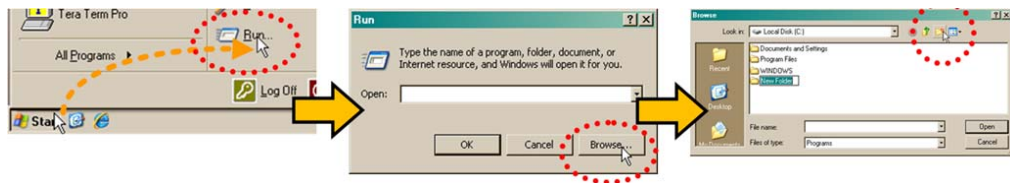
D. **Use Windows Command-line to create the temporary folder.**

- **First,** click **[Start]** on the Windows taskbar, and then click the '**Run...**' icon (or, depending on Windows OS versions *prior* to Windows 95, click the '**MS-DOS Prompt**' icon from the Main Menu).

- **Next,** open a **Command-line** window…

  o For Windows 95 or Windows 98 – Type "**command**".

  o For any Windows OS versions later than Windows 98 – Type "**cmd**" or "**command**".
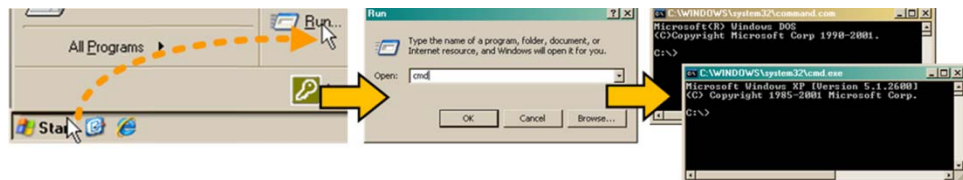
  o Alternately, from **[Start]**, select **All Programs > Accessories > Command Prompt**.

o Finally, from the Command-line '**c:\>'** prompt, type "**mkdir temp**" or "**md temp**" (*mkdir* and *md* stand for *make directory*), and then click **[OK]**.
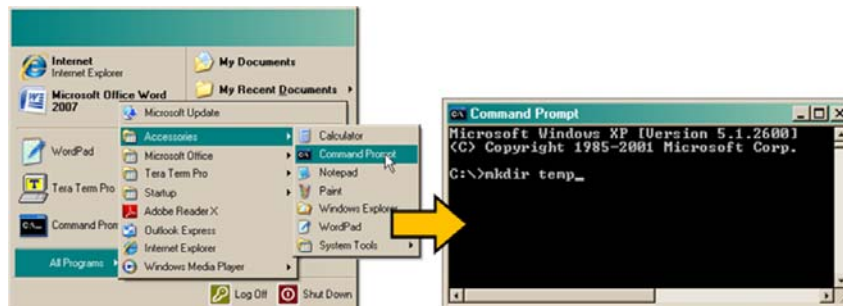
There should now be a "temp" folder created and available for placement of the firmware file download.

4.3 Downloading and Extracting the Firmware Update

1. **First, download the firmware update file from the Comtech EF Data Web site:**

   A. Go online to www.comtechefdata.com.

   B. On the *Main* page – under *Support Information* or the *Support* tab, select the *Software Downloads* hyperlink.

   C. On the *Software Downloads* page – click **Download Flash and Software Update Files**.

   D. On the *Flash Updates Index* page – select the **(Select a Product Line) Transceivers** hyperlink.

   E. Under the **MBT-4000/B** heading, select the **PCB4000 (1+1 Phase Combiner)** product hyperlink.

   F. Select the appropriate firmware archive EXE or ZIP file download hyperlink.

   - **About Firmware Numbers, File Versions, and Formats:** The Comtech EF Data Web site catalogues its firmware update files by product type (e.g., router, modem, etc.), the specific model, and optional hardware configurations.

     The download hyperlink for the PCB-4000 base unit firmware appears as **FW11411-1x.CCC**, where '**x**' denotes the revision letter.

   - **About File Archive Formats:** Comtech EF Data provides its downloadable files in two compressed archive formats: ***.exe** (self-extracting) and ***.zip** (compressed).

     The ***.exe** file does not require a file archiver and compression utility

program such as *PKZIP for Windows, WinZip, ZipCentral,* etc. (*PKZIP for DOS* is not supported due to file naming conventions). **Comtech EF Data does not provide this utility program.**

Some firewalls do not allow the download of *.exe files. Download the *.zip file instead, and extract the firmware files from the archive download with a user-supplied utility program. For detailed information on handling archived files, refer to the utility program Help documentation.

G. **Download the archive file to the temporary folder.**

- Once the **EXE** or **ZIP** hyperlink is selected the '**File Download'** window opens and prompts selection of **[Open]** or **[Save]**:

  o Click **[Open]** to turn over file extraction to the user-supplied utility program. Be sure to extract the firmware files to the "**temp**" folder created earlier.
  o Click **[Save]** to open the '**Save As'** window. Be sure to select and **[Save]** the archive ***.exe** or ***.zip** file to the "**temp**" folder created earlier.

  o Otherwise, click **[Cancel]** to quit and exit the file download process.
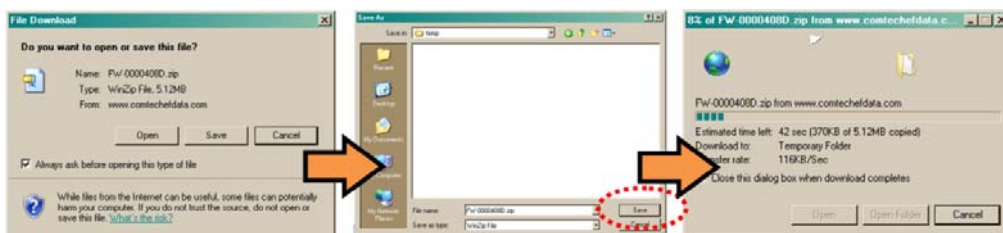
2. **Next, extract the firmware files from the archive file.**

- (If not already done with **File Download > [Open]**) Extract the firmware files from the downloaded ***.exe** or ***.zip** archive file with the user-supplied utility program:

  o Double-click on the archive file name, and then follow the prompts provided by the user-supplied utility program. Extract, at a minimum, four files:

     - **ReleaseNotes_vX-X-X.pdf** – Where "X-X-X" denotes the firmware version number.

     - **fw11411x.CCC** – Firmware file, where "x" denotes the firmware revision letter.

     - **FLSHCSAT.EXE** – CEFD Flash Upload Utility Program.

     - **CCCflash.hlp:** FLSHCSAT Help File.

3. **Confirm availability of the firmware files in the temporary folder.**

There are several ways you may view the contents of the temporary folder on a Windows-based PC.

A. **From the Windows Desktop:**

- Double-left-click the "**temp"** folder saved to the Windows Desktop.

- Use **Windows Explorer** to locate, and then double-left-click the "**temp**" folder.

- Use the '**Browse'** window (**[Start] > ...Run > [Browse]**) to locate, and then double-click the "**c:\temp**" folder.

B. **Using Command-line:**

- Type "**cd c:\temp**" at the Command-line prompt to change to the temporary directory created earlier using Command-line.

- Type "**dir**" to list the files extracted to the temporary directory from the downloaded archive file.

The firmware files have been successfully downloaded and are now available for transfer to the PCB-4000.

4.4 Performing the Automated FTP Upload Procedure

To proceed with the firmware update procedure, assumptions are made that:

- *The PCB-4000 is connected to a user-supplied, Windows-based PC, and:*

   o *The PC serial port is connected to the 'J1 | System COM' port.*

   o *The PC is running a terminal emulation program (for operation of the PCB-4000 serial remote interface).*

- *The latest firmware files have been downloaded or otherwise received from Comtech EF Data and are available on the user PC in an accessible temporary folder.*

1. Double-click **FLSHCAT.EXE** (filename or icon) on the PC desktop to execute the FLASH UPLOAD utility program.

2. From the FLSHCAT dialogue box, select the pertinent serial port used for communication between the PC and the PCCB (this example selects COM1, as noted at '**A**'.)

3. Do **not** select a Baud Rate ('**B**') other than the default selection of 38400, unless otherwise instructed by Comtech EF Data Technical Support.

4. Click '**Software Upload**' ('**C**').
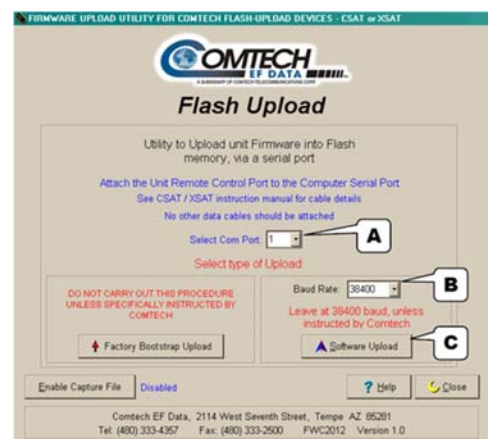
Select the firmware file for upload. Click '**Choose File'** then, once the *Select a File Name* dialogue box opens, use the window on the right to navigate to the desired folder. Finally, double-click on the firmware file from the window on the left.
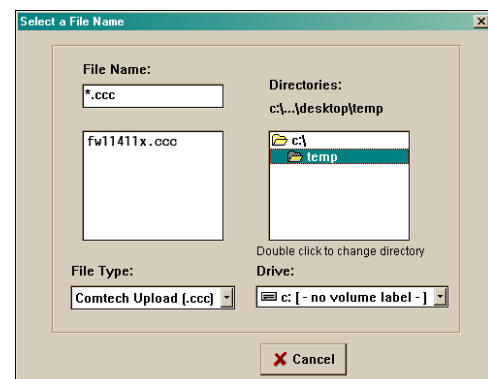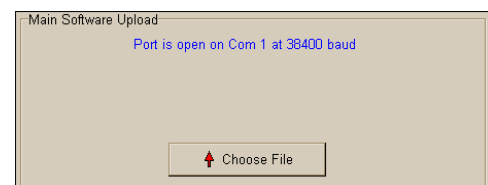
5. Prior to continuing the upload process, power off the PCB-4000 system by disconnecting the "**SSPA COM 1 | J2**" and "**SSPA COM 2 | J3**" connector cables.

After disconnecting these cables, click '**Start Upload**'.
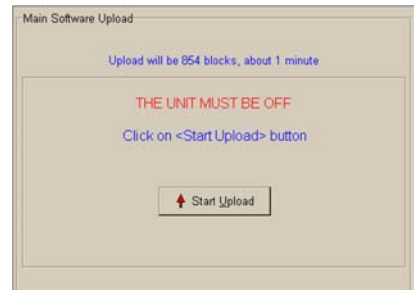
6. When prompted, reconnect the "**SSPA COM 1 | J2**" and "**SSPA COM 2 | J3**" connector cables.
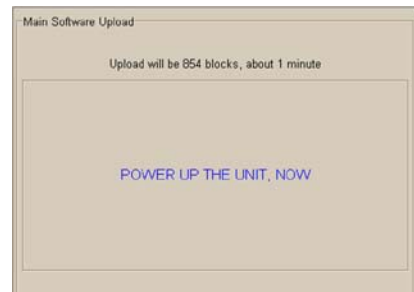
7. Once communications have been re-established between the PC and PCCB, the upload will take place – *do not interrupt this upload process*.

> *If the upload is not successful for any reason (e.g., the comms cable is not physically connected, the wrong COM port is specified, the user inadvertently interrupted the upload, etc.), troubleshoot the setup as needed, and then click on 'Repeat Upload' or 'Go Back to Start' to resume or retry the upload process.*
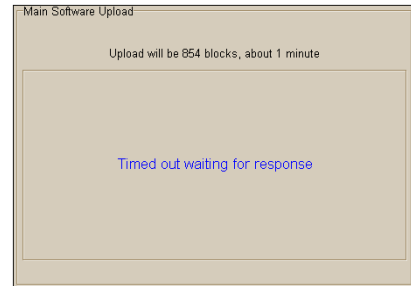
8. Upon successful completion of the upload, you may click on '**Go Back to Start**' (if, for example, more than one PCB-4000 1+1 Phase Combined System requires upgrade) or '**Close**' (to exit the FLSHCAT program).

9. If needed, disconnect the System Programming Cable (CEFD P/N CA/WR12243-1) and reconnect the original System Communications connection cable.

10. 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, and SSPA2 operations. See **Chapter 3. INSTALLATION, STARTUP, and TROUBLESHOOTING PROCEDURES** for more information on these operational states.
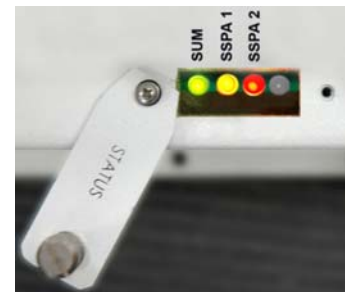
The PCB-4000 Firmware Update Process is now complete.

Chapter 5. SERIAL REMOTE CONTROL

5.1   Overview

Remote monitor and control of the PCB-4000 1+1 Phase Combiner is available either through 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.

5.1.1   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.

5.1.2   EIA-232

This is a much simpler configuration in which the Controller device connects 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.

5.2   Remote Commands and Queries Overview

5.2.1   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 to be a user PC running a terminal emulator program or an 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.

5.2.2   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)	 (4 characters)	 / ASCII code 47 (1 character)	 (3 characters)	 = or ? ASCII codes 61 or 63 (1 character)	 (n characters)	 Carriage Return ASCII code 13 (1 character)

Example: <0412/MUT=1{CR}

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

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

5.2.2.1 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.

5.2.2.2 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.*

5.2.2.3 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 aupported 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 PCCB.

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=
   - ART=

5.2.2.4 Address Delimiter

This is the "forward slash" character '**/**' (ASCII code 47).

5.2.2.5 Instruction Code

This three-character alphabetic sequence 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.

5.2.2.6 Instruction Code Qualifier

This single character 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.

Symbol	Definition
! (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, but then 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).
# ASCI 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).

5.2.2.7 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).

5.2.2.8 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.

5.3   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	CODE	C	Q	PAGE	CODE	C	Q	PAGE	CODE	C	Q	PAGE
A				**D**				**R**				**T**			
AMP	X	X	5-8	DAT	X	X	5-10	RAS		X	5-11	TIM	X	X	5-13
AOF	X	X	5-8					RCS		X	5-11	TNA		X	5-13
ATT	X	X	5-8					RED	X	X	5-11				
AUX		X	5-8	**F**				RET		X	5-12				
				FRW		X	5-10	RMS		X	5-12				
B								RSN		X	5-12				
BYP	X	X	5-8					RUS		X	5-12				
				L											
C				LNA		X	5-10								
CAA	X		5-8					**S**							
CAS		X	5-9					SBR	X	X	5-12				
CCS		X	5-9	**M**				SFS		X	5-12				
CID	X	X	5-9	MUT	X	X	5-10	SPA	X	X	5-12				
CMS		X	5-9												
CUS		X	5-9												

Unless otherwise noted – In the tables that follow, these codes are used in the 'Response to Command' column (per Sect. 5.2.2.6)

= 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)
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 *Command:* AOF=x,yy.yy where: x=0 or 1 (SSPA number) yy.yy=Attenuation offset *Query:* AOF? **Example:** AOF=1,01.50 **Note:** AOF command will not take values greater than 6 dB)	AOF= AOF? AOF*	AOF?	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)
AUX Input Enable	AUX=	N/A	1 byte, value of 0, 1	Query only. Enables AUX input for SSPA mute <0001V1/AUX? **Where:** x is 0 (AUX Mute disabled) 1 (AUX Mute enabled)	AUX= AUX? AUX*	AUX?	SSPA	AUX=x (see Description of Arguments for details)
Bypass SSPA	BYP=	PCB	1 byte value of 0, 1 or 2	Command or Query. *Command:* BYP=a, *where:* a = 0 (No SSPA is bypassed) 1 (SSPA #1 is bypassed) 2 (SSPA #2 is bypassed) • Command bypasses the SSPA specified by argument. • Command works only in RED=0 mode. *Query:* BYP? • Query returns the number of the SSPA that is currently bypassed or offline. • Query works in any RED mode.	BYP= BYP? BYP* (received ok but in the wrong RED mode)	BYP?	PCB	BYP=a (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

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 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 = reserved
				    f = SW1 Absent FLT
				    g = SW2 Absent FLT
					N/A	CAS?	ALL (Check SSPA manual for arguments returned from SSPA)	CAS=x….x (see Description of Arguments for details)

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 = redundancy/phase combine mode
				    e,f,g,x = SSPAs fault status (g is reserved (X))
					N/A	CCS?	SSPA (per MBT manual)	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. First line is limited to 24 characters. Second line is also limited to 24 characters. No carriage return between first line and second line.	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 (Check SSPA manual for arguments returned from SSPA)	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 (Check SSPA manual for arguments returned from SSPA)	CUS=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)
Set RTC(Real-Time-Clock) Date	DAT=	ALL	6 bytes, numerical	Command or Query. A command in the form **mmddyy**, where; dd = day of the month, between 01 and 31, mm = month of the year, between 01 and 12 and yy = year, between 00 and 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)
Retreive 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=FWxxxxx

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, where Sub-body= YYYYYYYYYY ZZ mmddyy hhmmss,** *where:*
				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?	SSPA	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, *where:* 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)

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	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' XXXXX=OK'cr' SW1FT=OK'cr' SW2FT=OK''cr''lf' **Note:** XXXXX = reserved	N/A	RAS?	ALL (Check SSPA manual for arguments returned from SSPA)	RAS=x....x (see Description of Arguments for details)
Retrieve Configuration Status	N/A	N/A	33 bytes alphanumeric	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' *where:* ATT= attenuation in dB AMP= RF power amplifier state, 0=OFF, 1=ON MUT=RF mute state, 0=unmuted, 1=muted PCM=Redundancy/Phase Combined mode, 0 = off 1 = 1:1 phase combine 2 = 1:2 phase combine (future) 3 = reserved 4 = reserved FLT=X,Y,Z -> SSPAs fault state X = SSPA#1 (1=faulted, 0=unfaulted) Y = SSPA#2 (1=faulted, 0=unfaulted) Z = reserved (X)	N/A	RCS?	SSPA (per MBT manual)	RCS=x....x (see Description of Arguments for details)
Redundancy /Phase Combine Mode	RED=	PCB	1 byte, value of 0, 1,2,3	Command or Query. Set the redundancy/phase combine mode. 0 = Off 1 = 1:1 Phase combined 2 = reserved 3 = reserved 4 = reserved	RED= RED?	RED?	PCB	RED=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 Equipment Type	N/A	N/A	20 bytes, alphanumeric	Query only. The unit returns a string indicating the Model Number and the value of internal software revision installed. **Example:** Phase –Combine Ver. 1.1.16I	N/A	RET?	ALL	RET=x….x (see Description of Arguments for details)

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 (Check SSPA manual for arguments returned from SSPA)	RMS=*x….x* (see Description of Arguments for details)

Serial Number	N/A	PCB	9 bytes, numerical 000000000 to 999999999	Query only. Used to Query the units 9 digit serial number. Slave returns its S/N, in the form **xxxxxxxxx**. **Example:** RSN=000000165	N/A	RSN?	ALL	RSN=xxxxxxxxx (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 (Check SSPA manual for arguments returned from SSPA)	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?	SSPA	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?	PCB	SPA=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)
Set RTC Time	TIM=	ALL	6 bytes, numerical	Command or Query. A command in the form **hhmmss**, indicating the time from midnight, where hh = hours, between 00 and 23; mm = minutes, between 00 and 59, and ss = seconds, between 00 and 59 **Example:** TIM=231259 would be 23 hours, 12 minutes and 59 seconds past midnight.	TIM = TIM? TIM *	TIM?	ALL	TIM=xx (see Description of Arguments for details)
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?	SSPA	TNA=**xx** (see Description of Arguments for details)

Notes:

Appendix A. ASSEMBLY KITS

A.1 Overview

This appendix provides a reference to the Comtech EF Data accessory and assembly kits that satisfy installation requirements for a PCB-4000 1+1 Phase Combined System – an example is shown at right:
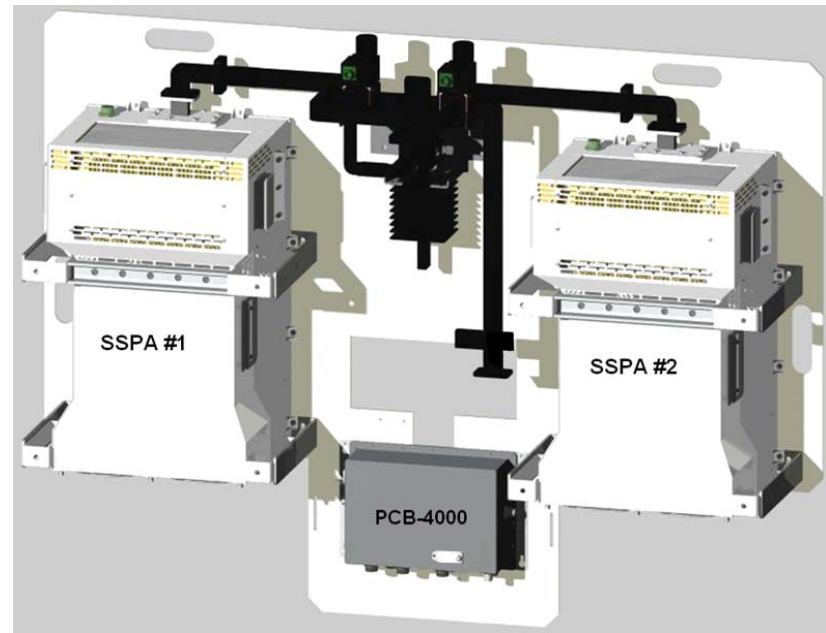
A.1.1   Summary of Available Assemblies

Table A-1 outlines availability of assembly kits for the PCB-4000. This includes common subassemblies that may be shared amongst the available configurations. Note that the model of the SSPA pair deployed within a PCB-4000 1+1 Phase Combined System may vary and, as such, the illustrations provided herein may or may not intentionally omit the depiction of any installed SSPA pair.

Table A-1. Appendix Figure Quick Reference

Assembly Type	Sect.	Figure	Table (BOM)	CEFD Part No.	Description
Common	A.2.1	A-1	A-2	PL/12319-1	Universal Pole Mounting Kit
	A.2.2	A-2	A-3	KT-0000017	Unistrut Mounting Kit
	A.2.3	A-3	A-4	KT/12300-1	HPOD Mooting Kit
PCCB	A.3	A-4	A-5	PL/11285-1 (p/o KT/11344-1)	1+1 Phase Combiner Box, X-Band
				PL-0000030 (p/o KT-0000056)	1+1 Phase Combiner Box, C-Band
				PL-0021051(p/o KT-0020623)	1+1 Phase Combiner Box, Ku-Band
X-Band	A.3.1.1	A-5	A-6	KT/11344-1	X-Band Top Assembly Kit
	A.3.1.2	A-6	A-7	KT/11387	X-Band Waveguide and Switch Assembly Kit
C-Band	A.3.2.1	A-7	A-8	KT-0000055	C-Band Top Assembly Kit
	A.3.2.2	A-8	A-9	KT-0000054	C-Band Waveguide and Switch Assembly Kit
Ku-Band	A.3.3.1	A-9	A-10	KT-0020621	Ku-Band Top Assembly Kit
	A.3.3.2	A-10	A-11	KT-0020623	Ku-Band Waveguide and Switch Assembly Kit

Notes:

A.2   Common Kit Subassemblies

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

Table A-2. Kit PL/12319-1 BOM

Item No.	QTY	CEFD Part No.	Description
colspan			
1	N/A	(FP-0000134)	Unistrut, Dual Channel (SHOWN FOR CLARITY 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

PL/12319-1 Universal Pole Mounting Kit (as per Figure A-1 on next page)
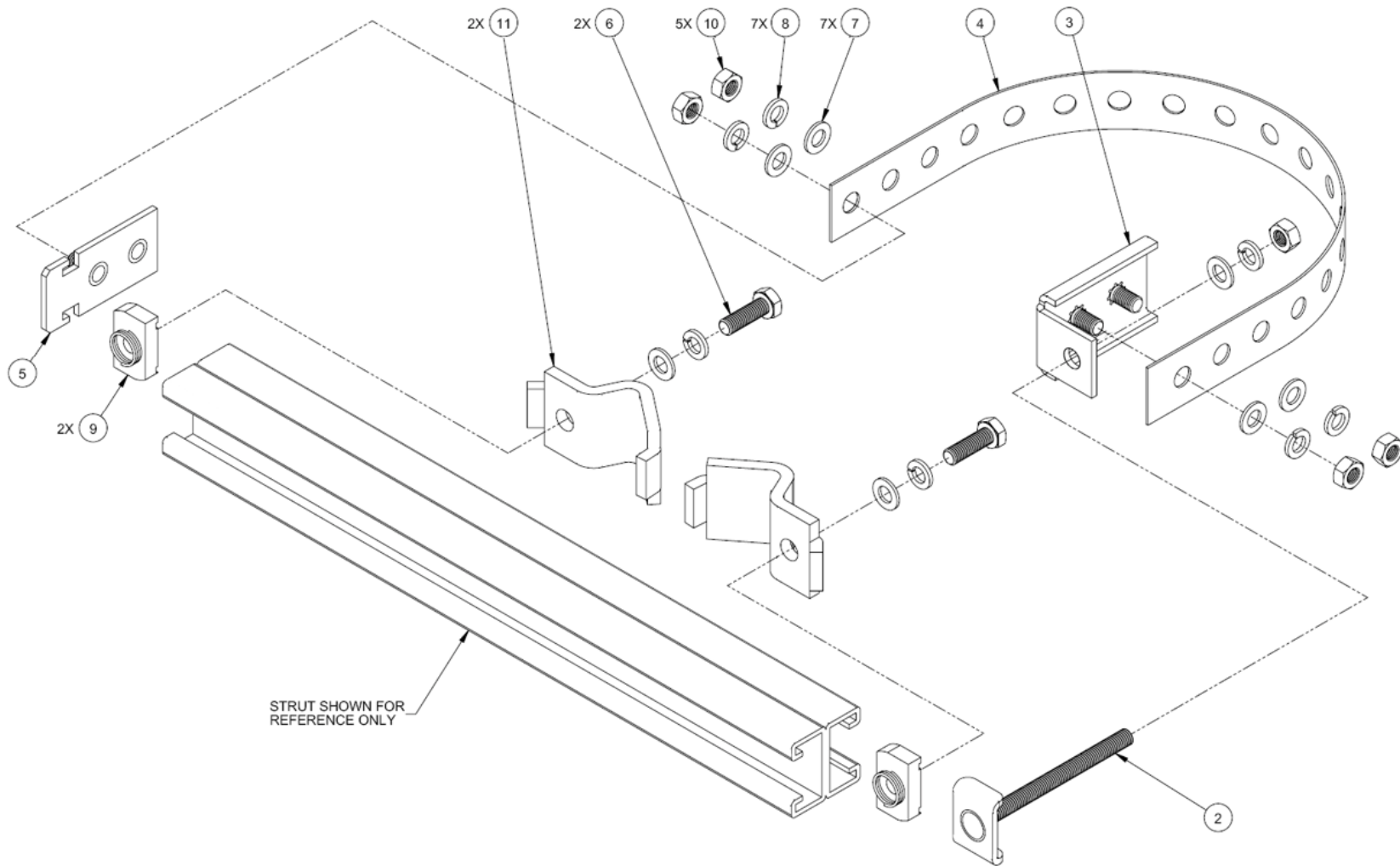
Figure A-1. Universal Pole Mounting Kit PL/12319-1

A.2.2   Unistrut Mounting Kit (KT-0000017)

Table A-3. Kit KT-0000017 BOM

Item No.	QTY	CEFD Part No.	Description
Unistrut Mounting Kit KT-0000017 (as per Figure A-2 on next page)			
1	3	FP-0000134	Unistrut, Dual Channel, 74.13″ LG
2	4	FP/BR11932-1	Bracket, Unistrut, SS, 26.25″ LG
4	12	HW/3/8SPRINGNUT	Spring Nut, 3/8-16, Short Spring, SS (P3300)
5	12	HW-0000069	Washer, Flat, Thick, 3/8, SS
6	12	HW/3/8-SPLIT	Washer, Lock, Split, 3/8, SS
7	12	HW./3/8-16X1BLT	Bolt, Hex Head, 3/8 x 1″ LG, SS
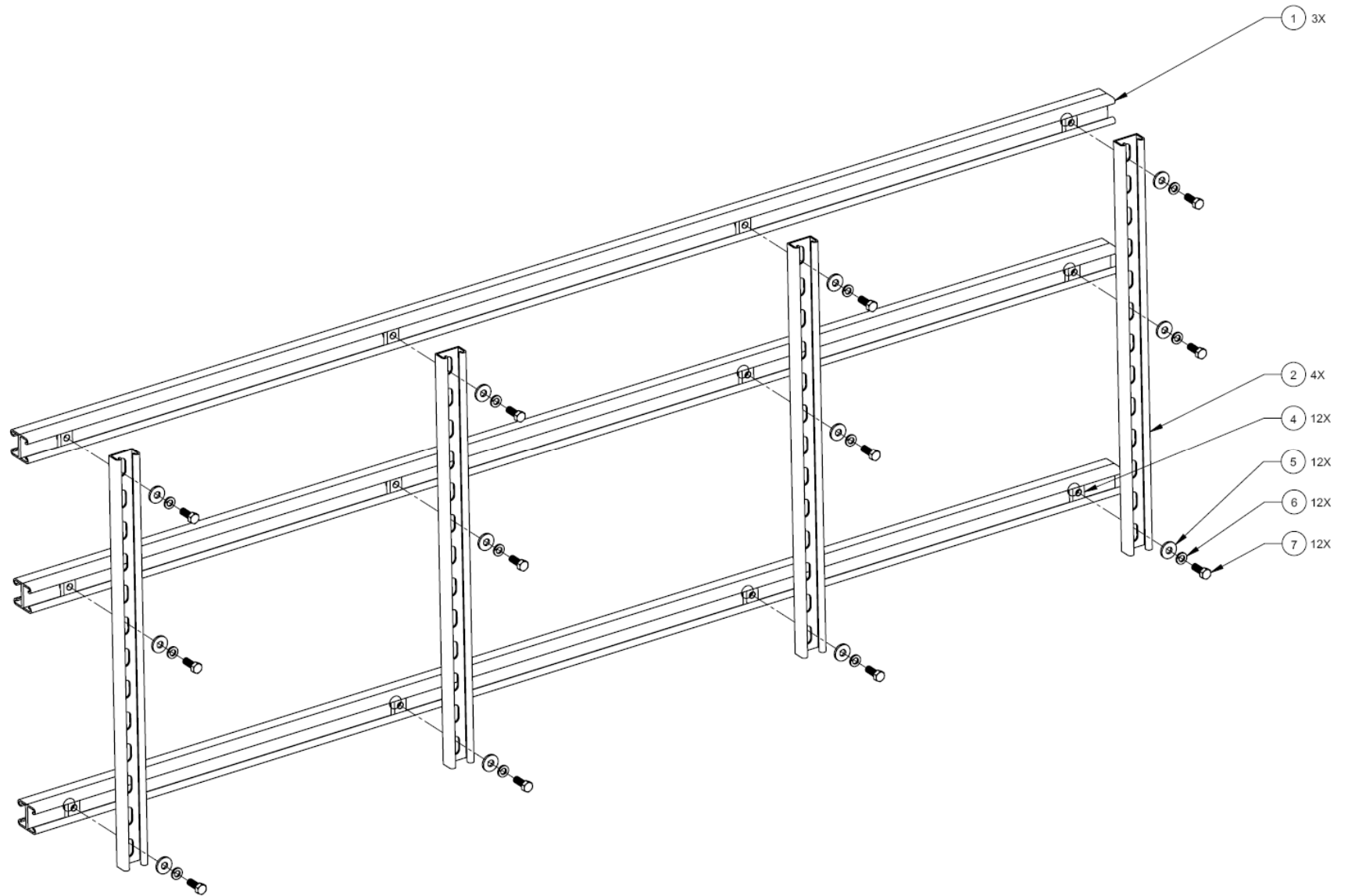
Figure A-2. Unistrut Mounting Kit (CEFD P/N KT-0000017)

A.2.3 HPOD Mounting Bracket Kit (KT/12300-1)

Table A-4. Kit KT/12300-1 BOM

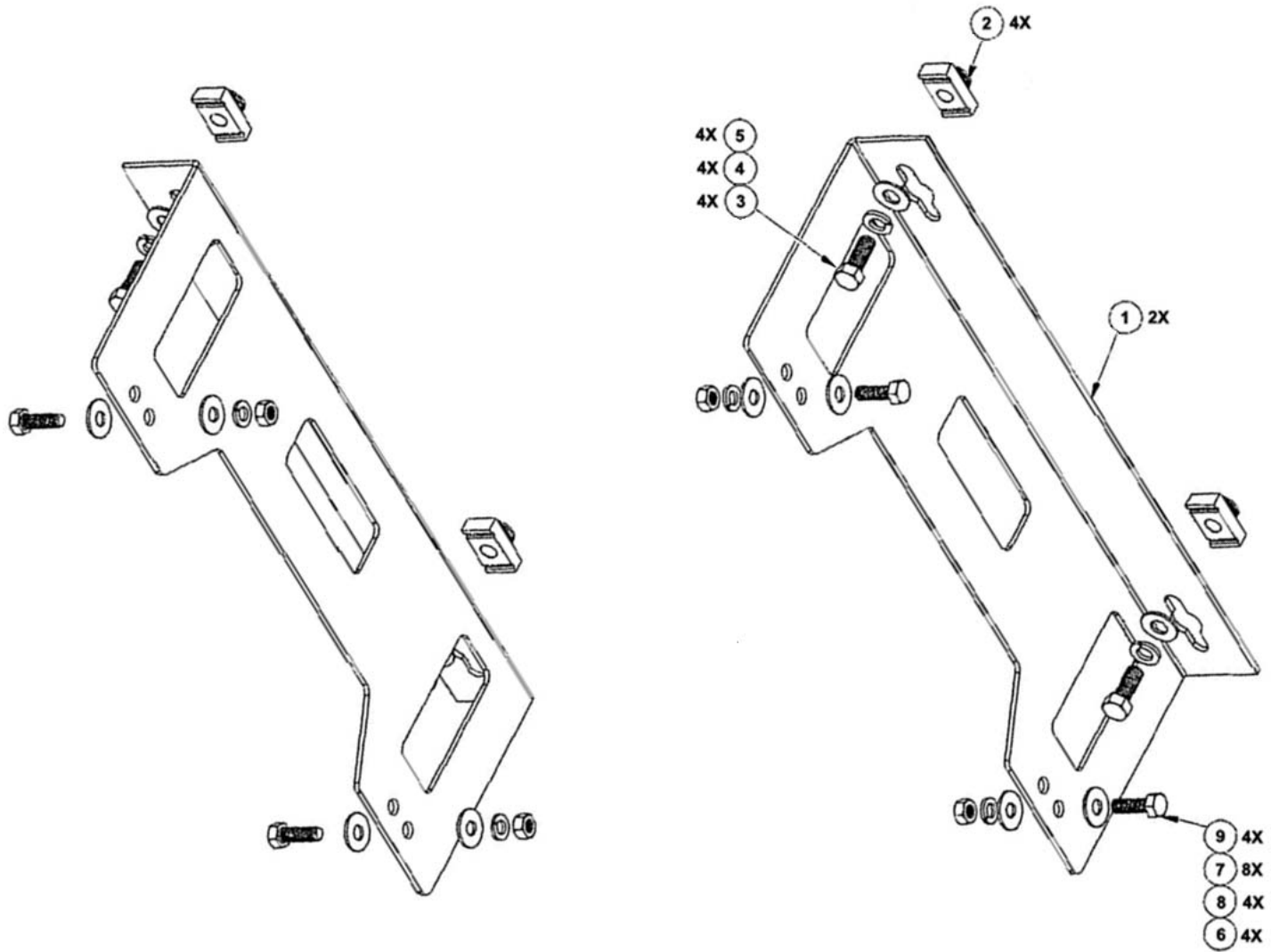| HPOD Mounting Bracket Kit KT/12300-1 (as per Figure A-3 on next page)			
Item No.	QTY	CEFD Part No.	Description
1	2	FP/BR12239-1	Bracket, Unistrut
2	4	HW/3/8SPRINGNUT	Spring Nut, 3/8-16, Short Spring, SS (P3300)
3	4	HW/3/8-FLT	Washer, Flat, 3/8
4	4	HW/3/8-SPLIT	Washer, Lock, Split, 3/8, SS
5	4	HW/3/8-16X1BLT	Bolt, Hex Head, 3/8-16 x 1" LG, SS
6	4	HW/5/16-18HEXNT	Nut, Hex, 5/16-18, SS
7	8	HW/5/16-Flat	Washer, Flat, 5/16, SS
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-4000 1+1 Phase Combiner Box Assemblies

The PCB-4000 1+1 Phase Combiner standalone unit is available in an X-Band, C-Band, or Ku-Band version. The PCCB may be available as a top assembly line item or as a kit subassembly item (**Figure A-4**).

For example, the standalone PL/11285-1 X-Band unit is provided as part of the top-level KT/11344-1 X-Band system assembly kit. It is also provided as a subassembly item in a box and bracket kit which is, in turn, a line item provided in the top-level KT-0000055 C-Band or KT-0020623 Ku-Band system assembly kits.

Table A-5. PCB-4000 1+1 Phase Combiner Box Kit BOM

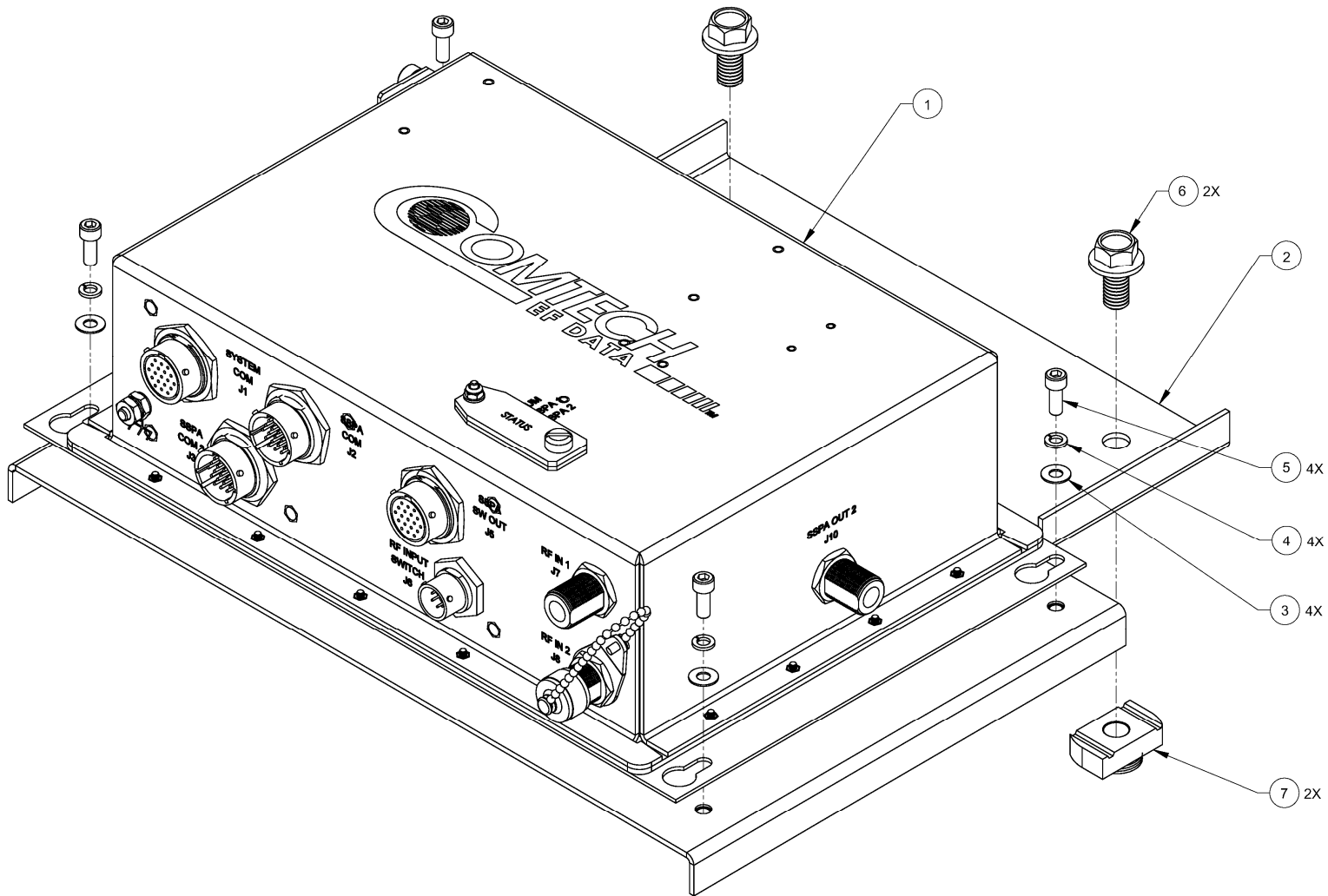| Item No.	Box and Bracket Kit / QTY		CEFD Part No.	Description
	KT-0000056	KT-0020622		
1	N/A	N/A	PL/11285-1	1+1 Phase Combiner Box, X-Band
	1	–	PL-0000030	1+1 Phase Combiner Box, C-Band
	–	1	PL-0021051	1+1 Phase Combiner Box, Ku-Band
2	1	1	FP-0020874	Bracket, Mounting, Phase Combiner Box
3	4	4	HW/10-FLT	Washer, Flat, 3/8, SS
4	4	4	HW/10-SPLIT	Washer, Lock, Split, 3/8, SS
5	4	4	HW10-32x1/2SH	Bolt, Socket Head, SS
6	2	2	HW-0000070	Screw, Hex, Serrated Flange Head, SS
7	2	2	HW3/8SPRINGNUT	Spring Nut, 3/8-16, Short Spring, SS (P3300)

Figure A-4. PCB-4000 Phase Combiner Box and Bracket Kit (See Table for CEFD P/N)

A.3.1   PCB-4000 X-Band Unit (PL/11285-1) Assemblies

A.3.1.1   X-Band 1:1 Combined Assembly Kit – HPOD (KT/11344-01)

Table A-6. Kit KT/11344-1 BOM

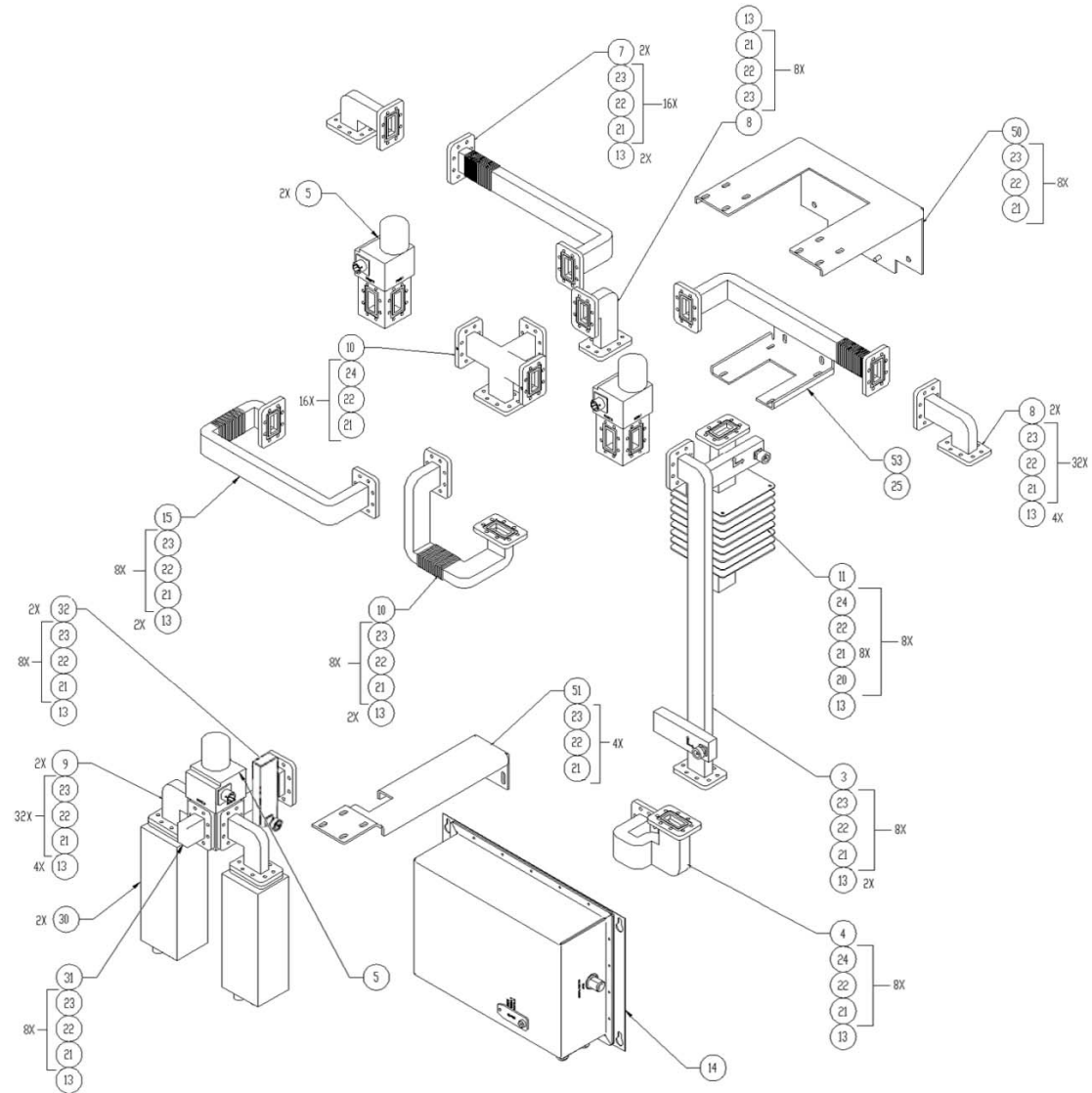| Item No.	QTY	CEFD Part No.	Description
			Kit KT/11344-1 (see Figure A-5)
3	1	FP/WG11306-1	Waveguide, 90 Degrees Bend with Coupler
4	4	FP/WG11307-1	Waveguide, Transition CPRG-112 to CPRG-137
5	3	SW/WG-HAGS	Switch, WR112G, +24V
6	1	RF/ADAP-112-N	RF, Magic Tee, Coupler, 7.9 – 8.4 GHz
7	2	FP/WG11300-1	Waveguide, 90 Degrees E Bend CPRG-112
8	3	FP/WG11301-1	Waveguide, 90 Degrees CPRG –112
9	2	FP/WG11308-1	Waveguide, 90 Degrees, H Bend, CPRG-112
10	1	FP/WG11310-1	Waveguide, Combiner, CPRG-112
11	1	RF/X-TERM850W	PNQ, RF, Termination. Load 850W
13	15	GA/CPR112-R-F-C	Gasket, Round, Full-Thickness
14	1	PL/11285-1	Top Assembly, Combiner Box
15	1	FP/WG1309-1	Waveguide, E Bend SW-to-SW, CPRG-112
20	A/R	HW/8-32HEXNUT	Nut, Hex, SS
21	A/R	HW/8-FLT	Washer, Flat, SS
22	A/R	HW/8-SPLIT	Washer, Lock, Split, SS
23	A/R	HW/8-32X1/2SHCS	Screw, Socket Head Cap
24	A/R	HW/8-32X7/8SHCS	Screw, Socket Head Cap
25	A/R	HW/SEM6 32X3/8PH	Screw, Phil Pan Head
31	1	RF/ADAP-112-N	Adapter, RF, CPRG112 to "N"
32	1	RF/CG-112/137INN	Cross guide Coupler, 40 dB
50	1	FP/BR11311-1	Mounting Bracket, Switch and Load
51	1	FP/BR11670-1	Bracket, LNA's 1:1 and Combiner Sys
53	1	FP/BR11375-1	Bracket, Load, XSAT
54	4	RF/N-TERM50M1	50 Ω, 1W DC-8GHz

Note: A/R = As Required

Figure A-5. X-Band 1:1 Combined Assembly Kit – HPOD (CEFD P/N KT/11344-1)

A.3.1.2   X-Band 1:1 Waveguide and Switch Redundant Assembly Kit – ODPA (KT/11387-1)

Table A-7. Kit KT/11387-1 BOM

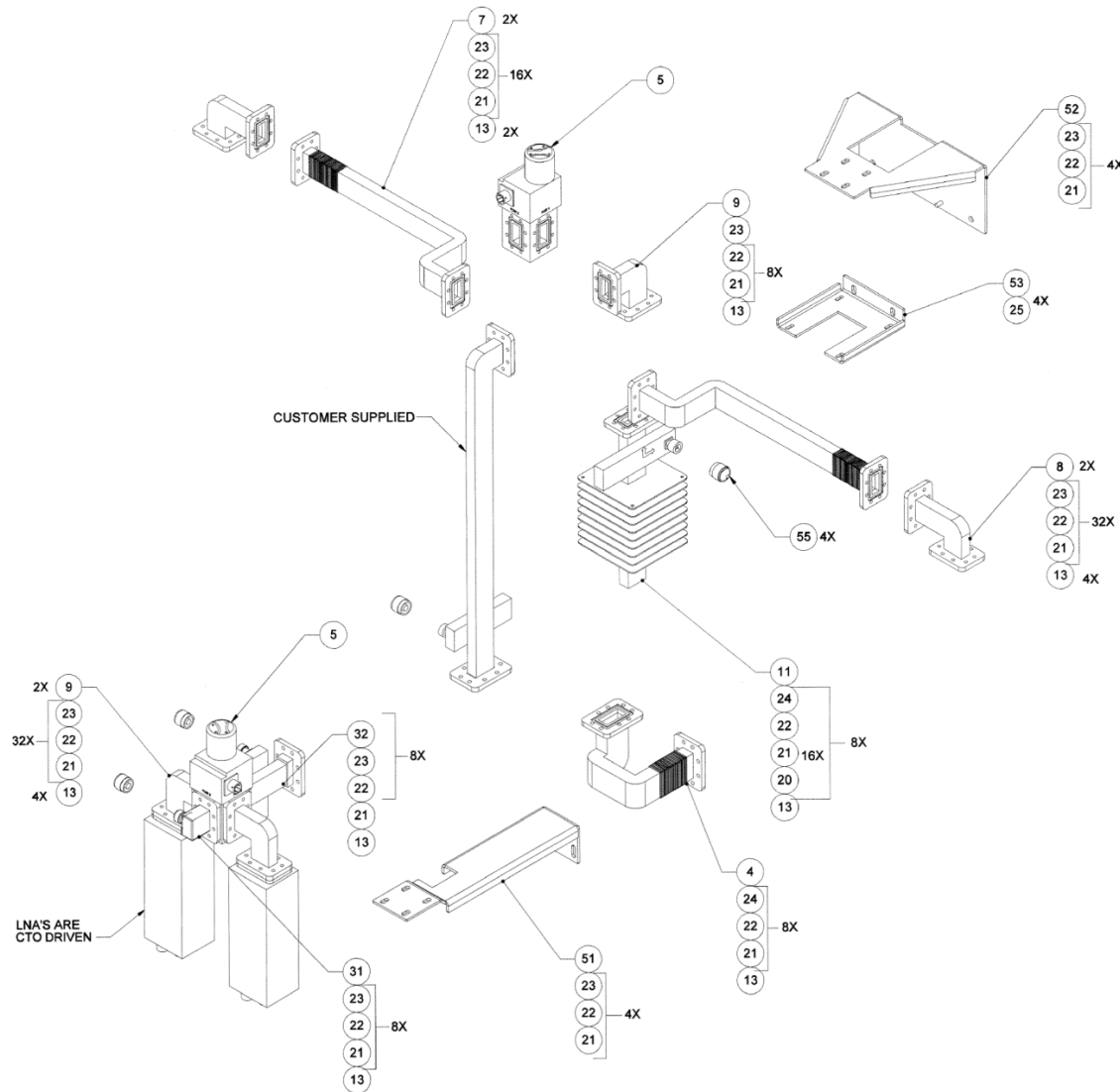| Kit KT/11387-1 (see Figure A-6)			
Item No.	QTY	CEFD Part No.	Description
3	1	RF/CG-112/137INN	Cross guide Coupler, 40 dB, Type N Connector, 137-112
4	1	FP/WG11671-1	Waveguide, 1:1 Filter to TX
5	2	SW/WG-HAGS	Switch, WR112G, +24V, Sealed, Standard Thread, Cold Temperature Rating
7	2	FP/WG11305-1	Waveguide, 90 Degree H-Bend Transition
8	2	FP/WG11301-1	Waveguide, 90 Degree, CPRG-112
9	3	FP/WG11308-1	Waveguide, 90 Degree, H-Bend, CPRG-112
11	1	RF/X-TERM850W	Termination, Load, 850 Watt, CPRG112, with Cross guide Coupler, 40 dB
13	14	GA/CPR112-R-F-C	Gasket, Round, CPR112, Full Thickness,
20	A/R	HW/8-32HEXNUT	Nut, Hex 8-32
21	A/R	HW/8-FLT	Washer, Flat SS
22	A/R	HW/8-SPLIT	Washer, Split SS
23	A/R	HW/8-32X1/2SHCS	Screw, Socket Cap
24	A/R	HW/8-32X7/8SHCS	Screw, Socket Head Cap, SS
25	A/R	HW/SEM632X3/8PH	Screw, Square Cone Pan Head Phillips SS
31	1	RF/ADAP-112-N	Adapter, CPRG112 to "N"
32	1	RF/CG-112/137INN	Coupler, Cross guide 40 dB N Type Connector
55	4	RF/N-TERM50M1	RF, 50Ω 1Watt, DC-8 GHz, Type N Male

Note: A/R = As Required

Figure A-6. X-Band 1:1 Waveguide and Switch Redundant Assembly Kit – ODPA (CEFD P/N KT/11387)

A.3.2   PCB-4000 C-Band Unit (PL-0000330) Assemblies

A.3.2.1   C-Band 1+1 Phase Combined Top Assembly Kit – HPOD (KT-0000055)

Table A-8. Kit KT-0000055 BOM

Kit KT-0000055 (see Figure A-7)			
Item No.	QTY	CEFD Part No.	Description
1	1	KT-0000017	1:2 Unistrut Mounting Kit
2	2	KT/12300-1	HPOD Mounting Bracket Kit
3	1	KT-0000056	C-Band Phase Combiner Box and Bracket Kit
4	1	KT-0000054	C-Band 1:1 HPOD Waveguide and Switch Kit
N/A	2	CA/RF11872-1*	Cable Assembly, Ku-Band RF IN
N/A	2	CA/WR11966-1*	Cable Assembly, SSPA to Combiner Box
N/A	1	CA/WR12013-1*	Cable Assembly, Switches, Combined System
N/A	A/R	HW/TW14.5HDBLK	Cable Ties

Notes:

1.   A/R = As Required

2.   *See **Chapter 3. INSTALLATION, STARTUP, and TROUBLESHOOTING PROCEDURES** for information on making cable connections in a 1+1 Phase Combiner System.
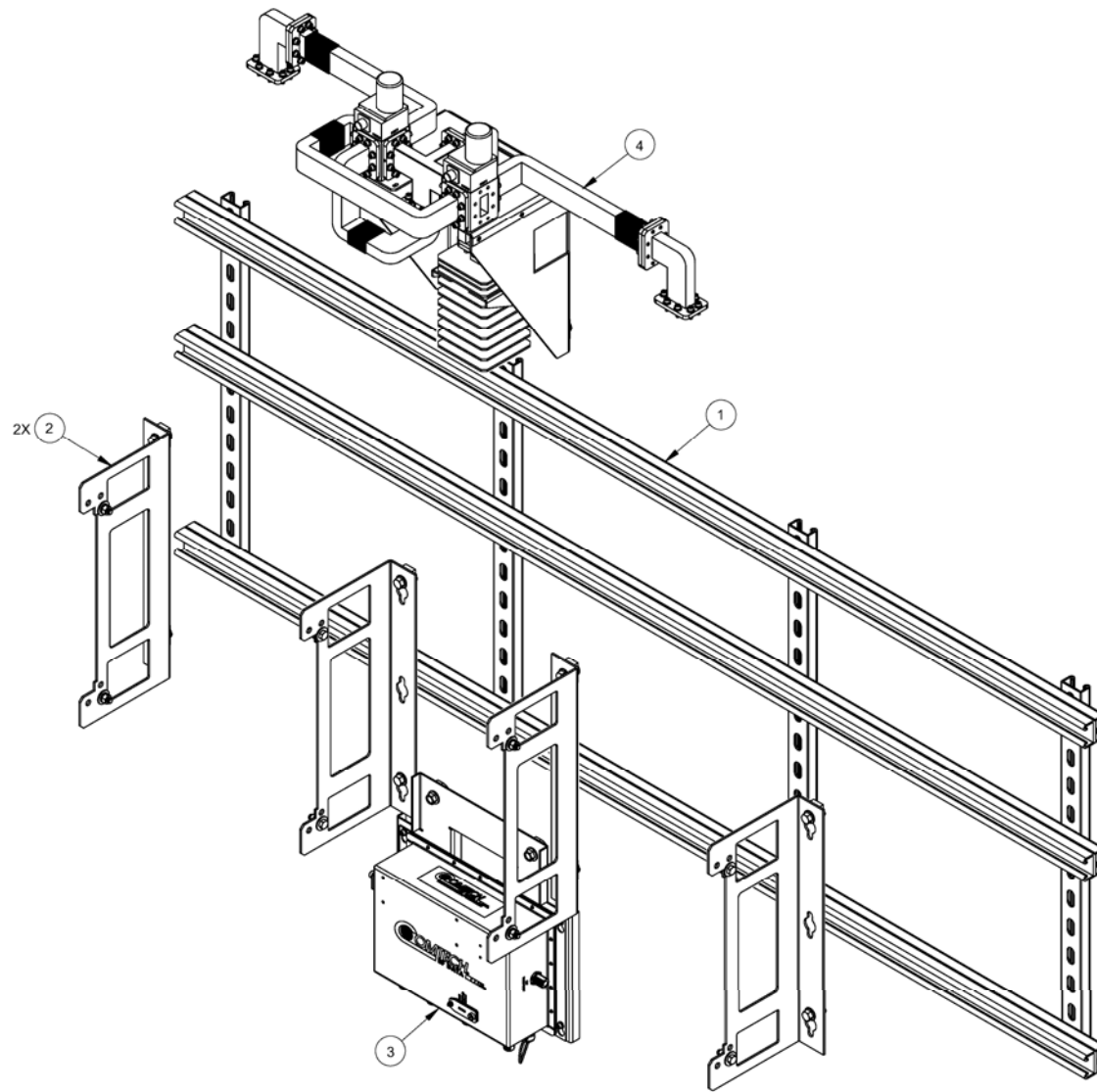
Figure A-7. C-Band 1+1 Phase Combined Top Assembly Kit – HPOD (CEFD P/N KT-0000055)

A.3.2.2   C-Band 1+1 Phase Combined Waveguide and Switch Kit – HPOD (KT-0000054)

Table A-9. Kit KT-0000054 BOM

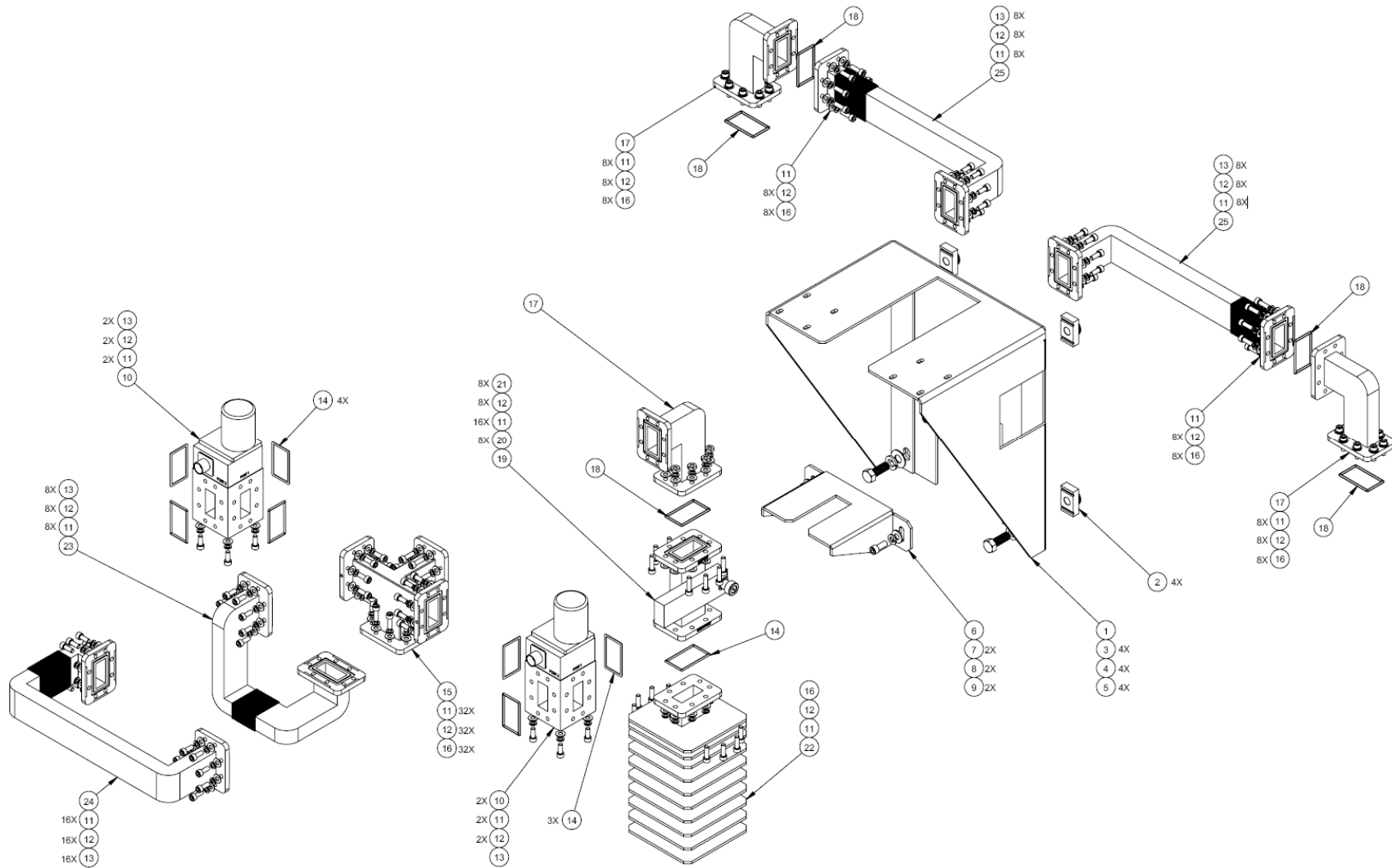| Kit KT-0000054 (see Figure A-8)			
Item No.	QTY	CEFD Part No.	Description
1	1	FP-0000414	MOUNTING BRACKET, DUAL VERTICAL SWITCHES, CPR-137
2	4	HW/3/8SPRINGNUT	SPRINGNUT, 3/8-16, SHORT SPRING, SS (P3300)
3	4	HW/3/8-FLT	3/8 FLAT WASHER, SS
4	4	HW/3/8-SPLIT	3/8 SPLIT LOCK WASHER SS
5	4	HW/3/8-16X1BLT	3/8 - 16 HEX HEAD BOLT, 1.0 LONG, SS
6	1	FP-0000416	SUPPORT BRACKET, CPR-137 TERMINATION
7	2	HW/1/4-FLT	1/4 FLAT WASHER
8	2	HW/1/4-SPLIT	1/4 SPLIT WASHER
9	2	HW/1/4-20X5/8SHCS	SCREW, 1/4-20 X 5/8 SHCS, SCREW, 1/4-20 X 5/8 SHCS, SS
10	2	SW/WGS28V-137S	SW WAVEGUIDE, CPR137, +28V SEALED
11	136	HW/10-FLT	#10 FLAT WASHER SS
12	128	HW/10-SPLIT	#10 SPLIT LOCK WASHER SS
13	64	HW/10-32X1/2SH	#10-32X1/2 SOCKET HEAD CAP SCREW, SS
14	9	GA/CPR-137-R-H-C	GASKET, D SHAPE, CPR-137, HALF THICKNESS, CONDUCTIVE
15	1	HW-0000131	RF MAGIC TEE, COUPLER, 5.85-6.425 GHz, WR-137G, C-BAND, 4 WAY
16	56	HW/10-32X5/8SHC	#10-32 X 5/8 SOCKET HEAD CAP SCREW, SS
17	3	FP-0000410	WAVEGUIDE, CPRG-137, H-BEND ELBOW
18	9	GA/CPR137-R-F-C	GASKET, ROUND, CPR137, FULL THICKNESS, CONDUCTIVE
19	1	RF/CG-137-40-N	RF CROSSGUIDE, WR137, 40DB, N FEMALE, GROOVED
20	8	HW/10-32X3/4SH	#10-32X3/4 SOCKET HEAD CAP SCREW, SS
21	8	HW/10-32HEXNUT	#10-32 HEX NUT, SS
22	1	RF/C-TERM1000W	RF TERMINATION, LOAD, 1000 WATT, CPRG-137
23	1	FP-0000411	WAVEGUIDE, CPRG-137, SWITCH TO MAGIC TEE
24	1	FP-0000408	WAVEGUIDE, CPRG-137, SWITCH TO SWITCH
25	2	FP-0000409	WAVEGUIDE, CPRG-137, E-BEND ELBOW

Figure A-8. C-Band 1+1 Phase Combined Waveguide and Switch Kit – HPOD (CEFD P/N KT-0000054)

A.3.3   PCB-4000 Ku-Band Unit (PL-0021051) Assemblies

A.3.3.1   Ku-Band 1+1 Phase Combined System – HPOD (KT-0020621)

Table A-10. Kit KT-0020621 BOM

Kit KT-0020621 (see Figure A-9)			
Item No.	QTY	CEFD Part No.	Description
1	1	KT-0000017	1:2 Unistrut Mounting Kit
2	1	KT-0020623	Ku-Band 1:1 HPOD Waveguide and Switch Kit
3	1	KT-0020622	Ku-Band Phase Combiner Box and Bracket Kit
4	2	KT/12300-1	HPOD Mounting Bracket Kit
N/A	2	CA/RF11872-1*	Cable Assembly, Ku-Band RF IN
N/A	2	CA/WR11966-1*	Cable Assembly, SSPA to Combiner Box
N/A	1	CA/WR12013-1*	Cable Assembly, Switches, Combined System
N/A	A/R	HW/TW14.5HDBLK	Cable Ties

Notes:

1. A/R = As Required

2. *See **Chapter 3. INSTALLATION, STARTUP, and TROUBLESHOOTING PROCEDURES**for information on making cable connections in a 1+1 Phase Combiner System.
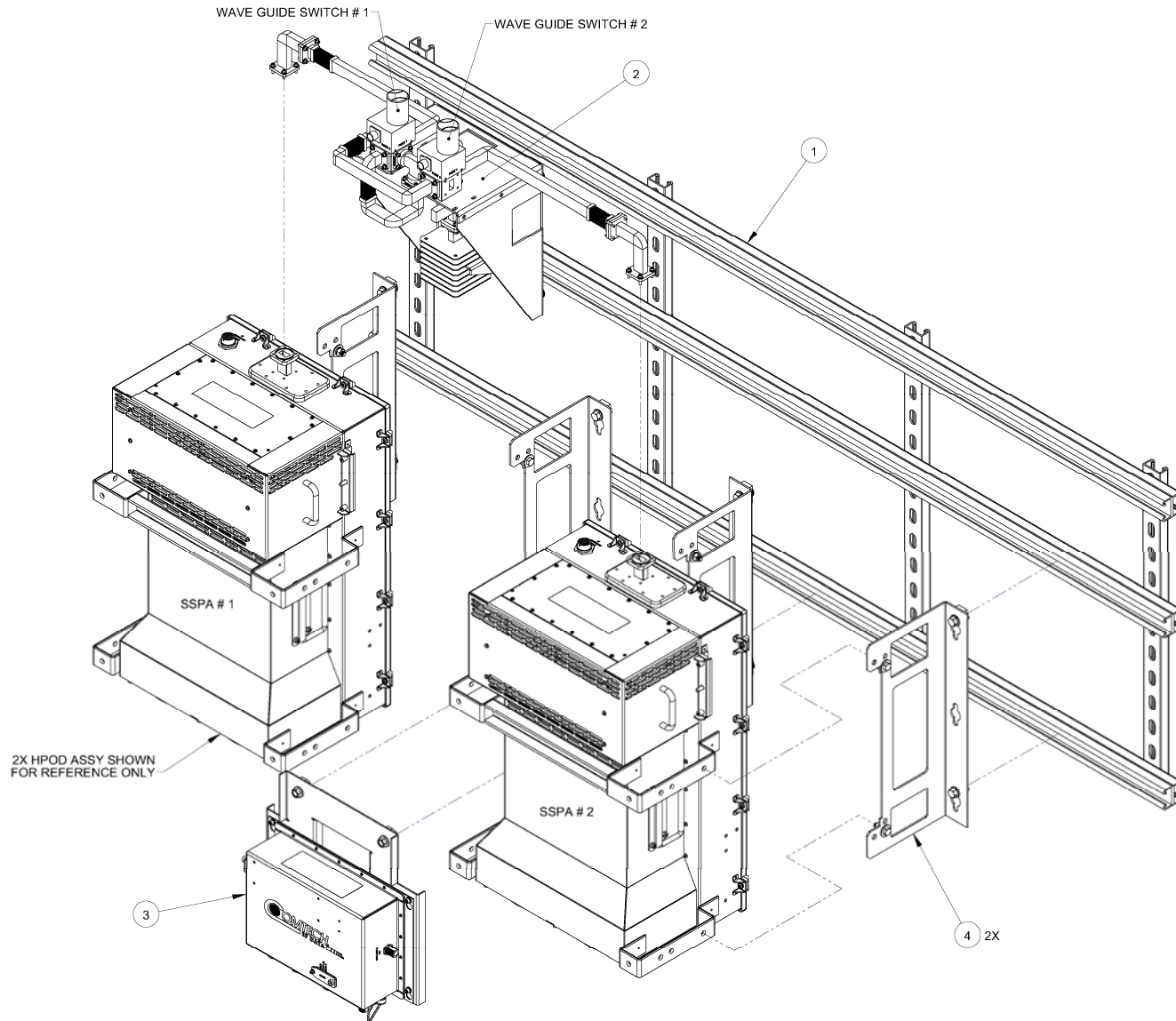
Figure A-9. Ku-Band 1+1 Phase Combined System – HPOD (CEFD P/N KT-0020621)

A.3.3.2   Ku-Band 1+1 Phase Combined Waveguide and Components Kit – HPOD (KT-0020623)

Table A-11. Kit KT-0020623 BOM

| Kit KT-0020623 (see Figure A-10)			
Item No.	QTY	CEFD Part No.	Description
1	1	FP-0000414	MOUNTING BRACKET, DUAL VERTICAL SWITCHES, WR75
2	4	HW/3/8SPRINGNUT	SPRINGNUT, 3/8-16, SHORT SPRING, SS (P3300)
3	4	HW/3/8-FLT	3/8 WASHER, FLAT, SS
4	4	HW/3/8-SPLIT	3/8 WASHER, SPLIT LOCK, SS
5	4	HW/3/8-16X1BLT	3/8-16 X 1.00 HEX HEAD BOLT, SS
6	1	FP-0000416	SUPPORT BRACKET, TERMINATION
7	2	HW/1/4-FLT	1/4 WASHER, FLAT, SS
8	2	HW/1/4-SPLIT	1/4 WASHER, SPLIT LOCK, SS
9	2	HW/1/4-20X5/8SHCS	1/4-20 X 5/8 SOCKET HEAD CAP SCREW, SS
10	2	SW/WGS28V-75SB	SW WAVEGUIDE, WR75, +28V SEALED
11	1	RF-0000024	RF MAGIC TEE, COUPLER, WR-75G, Ku-BAND, 4 WAY
12	3	FP-0020812	WAVEGUIDE, WR-75G, H-BEND ELBOW
13	1	RF/CG-75-40-N	RF CROSSGUIDE, WR-75G, 40DB, N FEMALE, GROOVED
14	1	RF/TERM75/350W	RF TERMINATION, LOAD, 350 WATT, WR-75G
15	1	FP-0020877	WAVEGUIDE, WR-75, SWITCH TO MAGIC TEE
16	1	FP-0020878	WAVEGUIDE, WR-75, SWITCH TO SWITCH
17	2	FP-0020876	WAVEGUIDE, WR-75, FLEX, E-BEND ELBOW
18	20	HW/6-FLT-ROD	#6 WASHER, FLAT, SS
19	48	HW/6-FLT	#6 WASHER, FLAT, SS
20	60	HW/6-SPLIT	#6 WASHER, SPLIT LOCK, SS
21	28	HW/6-32X1/2SHCS	#6-32 X 1/2 SOCKET HEAD CAP SCREW, SS
22	24	HW/6-32X5/8SHCS	#6-32 X 5/8 SOCKET HEAD CAP SCREW, SS
23	8	HW/6-32X3/4SHCS	#6-32 X 3/4 SOCKET HEAD CAP SCREW, SS
24	8	HW/6-32HEXNUT	#6-32 HEX NUT, SS
25	8	HW/8-FLT	#8 WASHER, FLAT, SS
26	8	HW/8-SPLIT	#8 WASHER, SPLIT LOCK, SS
27	8	HW/8-32X3/8SHCS	#8-32 X 3/8 SOCKET HEAD CAP SCREW, SS
28	15	GA/GSKTWR75HALF	GASKET, WR-75, HALF THICKNESS, CONDUCTIVE
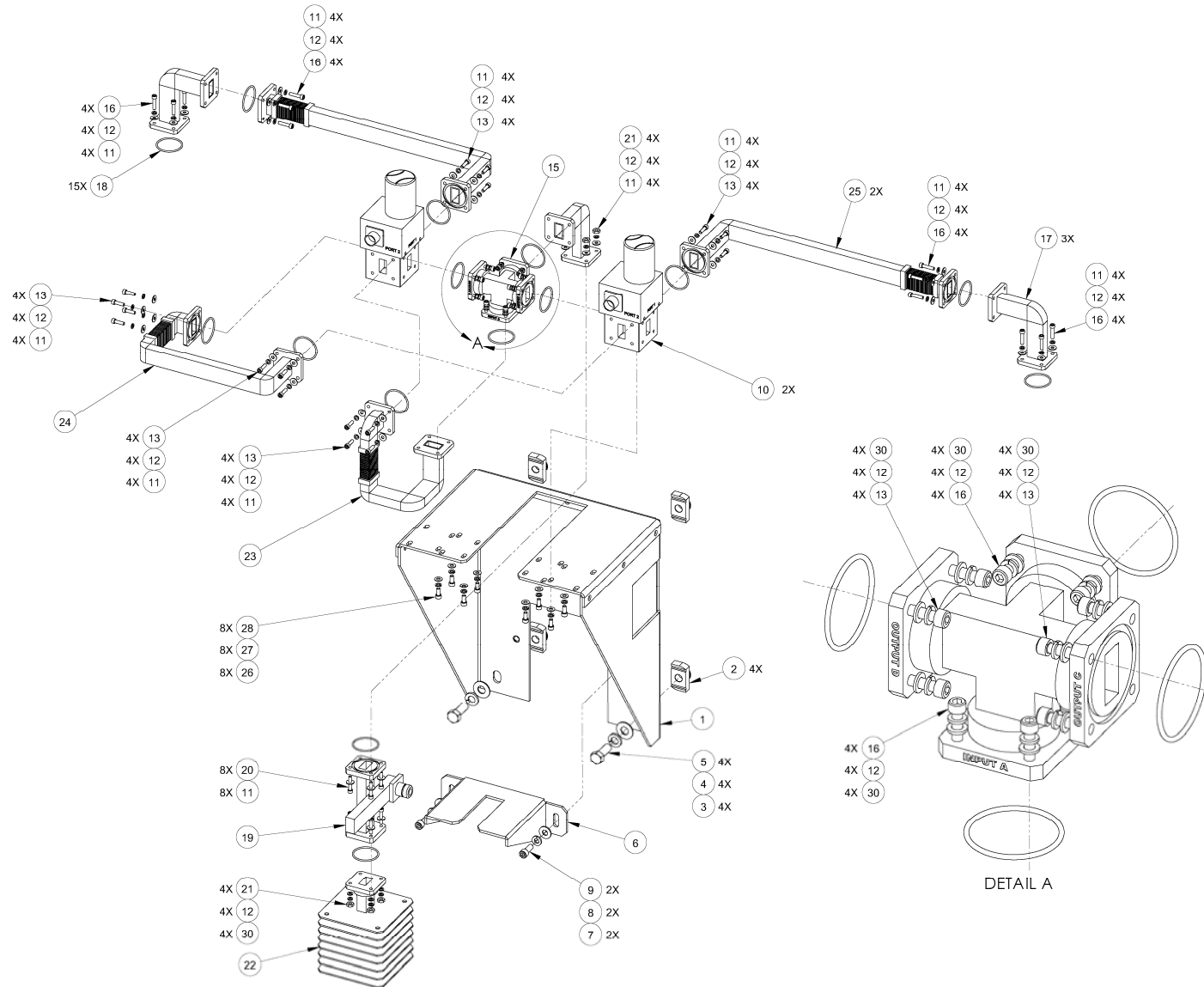
Figure A-10. Ku-Band 1+1 Phase Combined Waveguide and Components Kit – HPOD (CEFD P/N KT-0020623)

Notes:

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
° C = (F - 32) * 0.555
° F = (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. avoir.	28.35	—	0.9115	0.0625	0.07595	0.02835
1 oz. troy	31.10	1.097	—	0.06857	0.08333	0.03110
1 lb. avoir.	453.6	16.0	14.58	—	1.215	0.4536
1 lb. Troy	373.2	13.17	12.0	0.8229	—	0.3732
1 kilogram	1.0×10^3	35.27	32.15	2.205	2.679	—

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