



LCS-4

L-Band Combiner Switch Installation and Operation Manual



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About this Manual

This manual provides installation and operation information for the Comtech EF Data LCS-4 L-Band Combiner Switch. This is a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the LCS-4.

Conventions and References

Cautions and Warnings



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



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



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

Metric Conversion

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

Trademarks

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

Reporting Comments or Suggestions Concerning this Manual

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

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

ELECTRICAL SAFETY

The LCS-4 has been shown to comply with the following safety standard:

- EN 60950: Safety of Information Technology Equipment, including electrical business machines.

The equipment is rated for operation over the range 100 - 240 volts AC. It has a maximum power consumption of 2.9 amps.

FUSES

The LCS-4 is fitted with two fuses, one each for line and neutral connections. These are contained within the body of the IEC power connector, behind a small plastic flap. For 115 and 130 volt AC operation, use T3, 15A, TO.75A, 20mm fuses.



For continued operator safety, always replace the fuses with the correct type and rating.

Environmental

The LCS-4 shall not be operated in an environment where the unit is exposed to extremes of temperature outside the ambient range 0 to 50°C (32 to 122°F), precipitation, condensation, or humid atmospheres above 95% RH, altitudes (un-pressurized) greater than 2000 meters, excessive dust or vibration, flammable gases, corrosive or explosive atmospheres.

Operation in vehicles or other transportable installations that are equipped to provide a stable environment is permitted. If such vehicles do not provide a stable environment, safety of the equipment to EN60950 may not be guaranteed.


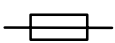
Installation



The installation and connection to the line supply must be made in compliance to local or national wiring codes and regulations.

The LCS-4 is designed for connection to a power system that has separate ground, line and neutral conductors. The equipment is not designed for connection to power system that has no direct connection to ground.

The LC-4 is shipped with a line inlet cable suitable for use in the country of operation. If it is necessary to replace this cable, ensure the replacement has an equivalent specification. Examples of acceptable ratings for the cable include HAR, BASEC and HOXXX-X. Examples of acceptable connector ratings include VDE, NF-USE, UL, CSA, OVE, CEBEC, NEMKO, DEMKO, BS1636A, BSI, SETI, IMQ, KEMA-KEUR and SEV.

International Symbols:

Symbol	Definition
	Alternating Current
	Fuse

Symbol	Definition
	Protective Earth
	Chassis Ground

Telecommunications Terminal Equipment Directive

In accordance with the Telecommunications Terminal Equipment Directive 91/263/EEC, this equipment should not be directly connected to the Public Telecommunications Network.

EMC (Electromagnetic Compatibility)

In accordance with European Directive 89/336/EEC, the LCS-4 has been shown, by independent testing, to comply with the following standards:

Emissions: EN 55022 Class B - Limits and methods of measurement of radio interference characteristics of Information Technology Equipment.

(Also tested to FCC Part 15 Class B)

Immunity: EN 50082 Part 1 - Generic immunity standard, Part 1: Domestic, commercial and light industrial environment.

Additionally, the LCS-4 has been shown to comply with the following standards:

EN 61000-3-2	Harmonic Currents Emission
EN 61000-3-3	Voltage Fluctuations and Flicker
EN 61000-4-2	ESD Immunity
EN 61000-4-4	EFT Burst Immunity
EN 61000-4-5	Surge Immunity
EN 61000-4-6	RF Conducted Immunity
EN 61000-4-8	Power frequency Magnetic Field Immunity
EN 61000-4-9	Pulse Magnetic Field Immunity
EN 61000-4-11	Voltage Dips, Interruptions, and Variations Immunity
EN 61000-4-13	Immunity to Harmonics



In order that the Modem continues to comply with these standards, observe the following instructions:

- Connections to the transmit and receive IF ports (Type N and Type F, female, connectors) should be made using a good quality coaxial cable - for example RG58/U (50Ω or RG59/U (75Ω).
- All 'D' type connectors attached to the rear panel must have back-shells that provide continuous metallic shielding. Cable with a continuous outer shield (either foil or braid, or both) must be used, and the shield must be bonded to the back shell.
- The equipment must be operated with its cover on at all times. If it becomes necessary to remove the cover, the user should ensure that the cover is correctly re-fitted before normal operation commences.

Warranty Policy

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

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

Limitations of Warranty

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

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

Exclusive Remedies

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

Disclaimer

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

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

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Chapter 1. INTRODUCTION

1.1 INTRODUCTION

The LCS-4 L-Band Combiner Switch (Figure 1-1) is available in the following configurations:

- Single Configuration (C-Band, Ku-Band, or L-Band)
- Redundant Configuration (C-Band, Ku-Band, or L-Band)



Procedures provided in this manual are based on utilizing Comtech EF Data equipment. If other user equipment is utilized, the customer shall obtain the documentation required to operate with the LCS-4 L-Band Combiner Switch.

The LCS-4 L-Band Combiner Switch has a 4-way transmit (TX) and Receive (RX) path combiner/splitter.

- Combines four TX L-Band signals from L-Band modulators for delivery to an Outdoor Unit (ODU) or Block Up Converter (BUC).
- The unit receives an L-Band signal from an LNB and splits it into four outputs for delivery to four L-Band demodulators.
- The unit provides current monitoring and switch drive capability for a 1:1 BUC/LNB system
- The unit provides a 10 MHz reference for two ODU/BUCs and two LNBs. This eliminates the need for a high stability reference in the L-Band modem.
- The 10 MHz reference can be provided to four modems.
- FSK signals from one of the four modulators are passed through to the ODU/BUC.
- The unit supports hot swap redundant power supplies for itself and the ODU/BUC.
- Redundant, but not swappable, LNB power is developed internally.
- Redundant, but not swappable, power is internally generated for the ODU/BUC and LNB switch drivers.

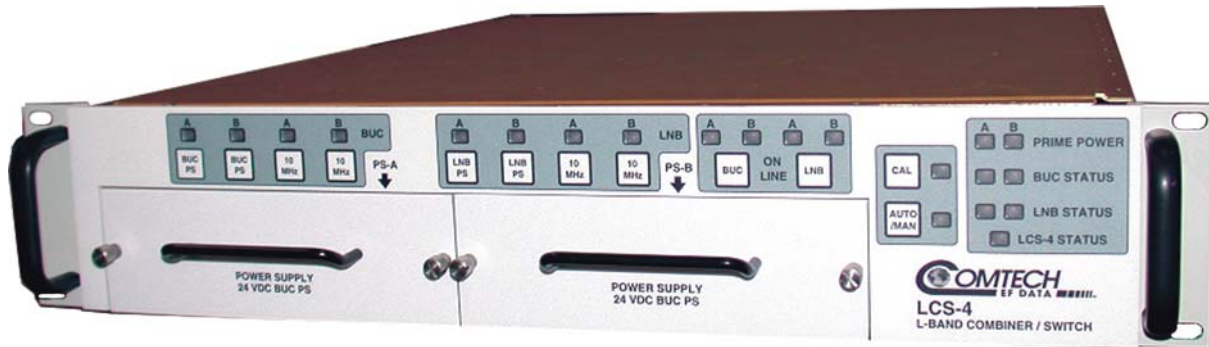


Figure 1-1. LCS-4 L-Band Combiner Switch

1.2 FUNCTIONAL DESCRIPTION

On the TX-side, the TX signals of up to four modems are combined. The combined output is transmitted to one of the two outputs that feed an antenna system. Each TX output provides a 10 MHz BUC reference signal, a BUC power supply, and FSK communications. Each 10 MHz BUC reference and power supply has an independent On/Off control. Figure 1-2 shows a block diagram of the unit.

On the RX-side, one of the two antenna systems feed a splitter. The splitter outputs provide the RX signal for up to four modem receivers. Each RX input provides a 10 MHz LNB reference signal, a LNB power supply, and DESQ communications. Each 10 MHz LNB reference and power supply has an independent On/Off control. The L-Band Multi-Modem has redundant internal power supplies, BUC power supplies, and LNB power supplies. L-Band Multi-Modem Module also provides a driver for an RF (baseball) switch.

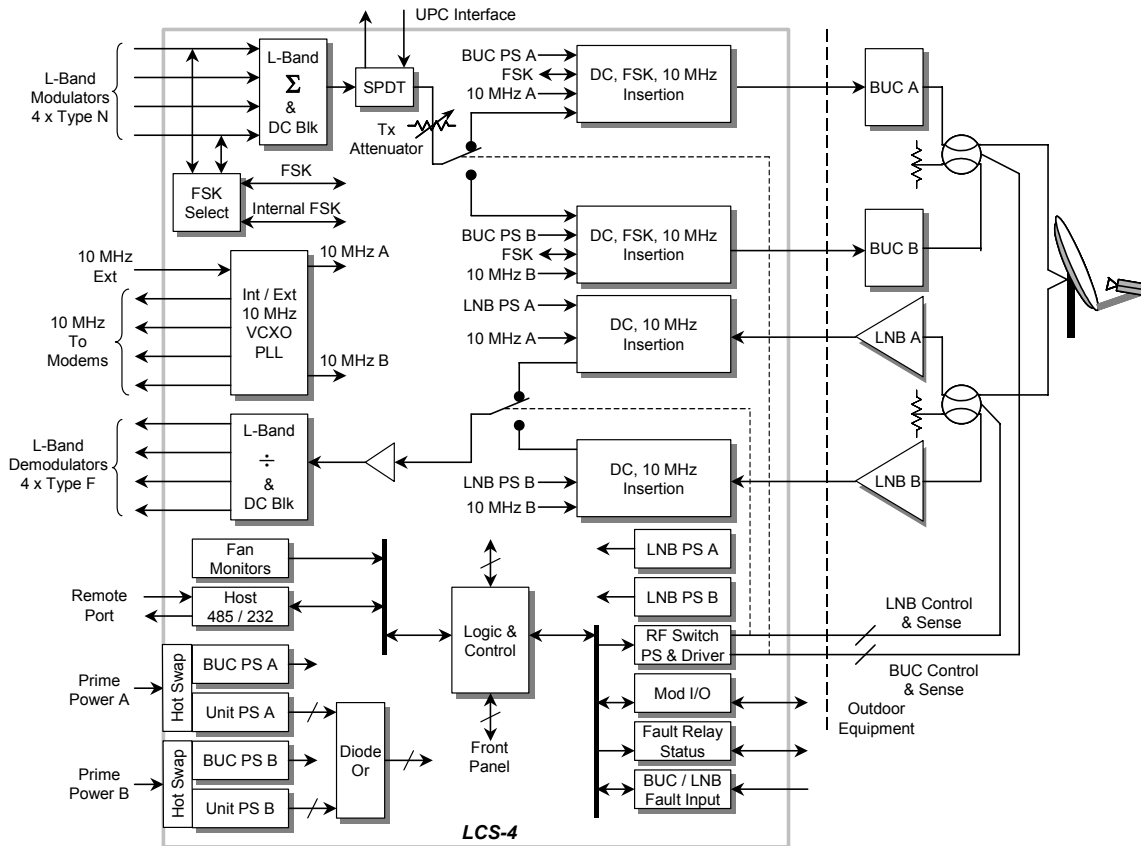


Figure 1-2. L-Band Multi-Modem Module Block Diagram (Redundancy)

1.3 FEATURES

Standard FAST, or Hardware	Phase	Description
Combiner, Splitter		
Hardware	1	Single or dual AC PS for unit or BUC (options)
Standard	1	L-Band Splitting/Combining
Standard	1	Flash of all programmable items via Remote RS-232 port
Standard	1	10 MHz External Reference input
Standard	1	Multiple fans and monitoring
Standard	1	BUC FSK control via modem (pass-through)
Standard	1	FSK driver/receiver hardware on RF card.
Standard	1	High temperature Alarm/Internal temperature report.
Standard	1	Front panel LED/Switch Control and Monitoring.
1:1 Switching Capability	1	Hardware support developed in Phase 1.
Standard	1	BUC/LNB switching
Standard	1	10 MHz sourcing to modems

Note: Separate definition of the ODU/BUC and LNB switches and interconnecting cables are required for this unit to operate.

1.4 OPTIONAL ITEMS

Option	Unit Power Supply	ODU/BUC Power Supply	Description
0	1 each, Non-redundant AC	N/A	Standard
1	2 each, Redundant AC	N/A	Optional
2	2 each, Redundant AC	2 each, 24 VDC 100W Redundant AC	Optional
3	2 each, Redundant AC	2 each, 48 VDC 150W Redundant AC	Optional

The following optional items are needed for this unit to function as a system.

Connector/Cable Assemblies	L-Band IF Cable (Optional) Outdoor LNB and BUC switch control (Optional) Modem/Modulator Interconnect Host (Optional)
ODU/BUC RF Switch Assembly and Mounting Kits	Ku-Band (Optional) C-Band (Optional) Ka-Band (Future) (Optional)
LNB RF Switch Assembly and Mounting Kits	Ku-Band (Optional) C-Band (Optional) Ka-Band (Optional)
PC to FSK BUC Cable	For charging address of BUC.

1.5 EXTERNAL BUC/LNB FAULT INPUT

Use of this connector is optional. This connector permits fault inputs from ODU/BUC or LNB that have fault contacts for fault indication. Normally, this connector is used in applications where the ODU/BUC power supply or LNB power supply is external to the LCS-4 to permit a means of indicating a fault to the LCS-4 so that ODU/BUC or LNB switchover still occurs.

The external fault inputs are enabled in one of two ways:

1. By grounding the BUC Input Enable and /or the LNB Input Enable.
2. Activating the DIP-switches that control the BUC Input Enabled and/or LNB Input Enable.

J21, 9-pin D Female

Pin #	Signal Name	Signal Direction	Description
1	BUCA_FLT	I	External BUC A Fault. (Grounded is OK)
2	BUCB_FLT_BUF	I	External BUC B Fault. (Grounded is OK)
8	BUC_FLT_EN	I	External BUC Fault Input Enable – with GND
6	LNBB_FLT	I	External LNB A Fault (Grounded is OK)
7	LNBB_FLT_BUF	I	External LNB B Fault (Grounded is OK)
3	LNB_FLT_EN	I	External LNB Fault Input Enable – with GND
4,5,9	GND	GND	Ground

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Chapter 2. INSTALLATION

2.1 UNPACKING

Inspect shipping containers for damage. If shipping containers are damaged, keep them until the contents of the shipment have been carefully inspected and checked for normal operation.

The LCS-4 and manual are packaged in pre-formed, reusable, cardboard cartons containing foam spacing for maximum shipping protection.



Do not use any cutting tool that will extend more than 1 inch into the container. This can cause damage to the equipment within.

Unpack the LCS-4 as follows:

1. Cut the tape at the top of the carton indicated by OPEN THIS END.
2. Remove the cardboard/foam space covering the LCS-4.
3. Remove the LCS-4, manual, and power cord from the carton.
4. Save the packing material for storage or reshipment purposes.
5. Inspect the equipment for any possible damage incurred during shipment.
6. Check the equipment against the packing list to ensure the shipment is correct.
7. Refer to the following sections for further installation instructions.

2.2 MOUNTING

If the LCS-4 is to be mounted in a rack, ensure that there is adequate clearance for ventilation, particularly at the sides. In rack systems where there is high heat dissipation, forced air-cooling must be provided by top and bottom mounted fans or blowers. **UNDER NO CIRCUMSTANCE** should the highest internal rack temperature be allowed to exceed 50°C (122° F).

Install optional installation bracket (Figure 2-1) using mounting kit, KT/6228-1.

Optional: Mounting Kit, KT/6228-1

Quantity	Part Number	Description
2	FP/6138-1	Bracket, Rear Support
4	HW/10-32x1/2RK	Bolt, #10 Rack
2	HW/10-32HEXNUT	Nut, #10 Hex
2	HW/10-32FLT	Washer, #10 Flat
2	HW/10-32x1/4SHC	Screw, Socket 10-32 x 1/4inch

The tools required for this installation are a medium Phillips™ screwdriver and a 5/32-inch SAE Allen Wrench™.

Refer to the Figure 2-1, and then install the LCS-4 rear support brackets as follows:

1. Install the rear support brackets onto the mounting rail of the rack. Fasten with the bracket bolts.
2. Mount the LCS-4 into the equipment rack ensuring that the socket heads engage into the LCS-4 slots of the rear support brackets,
3. Fasten the provided #10 socket head screws to the rear-side mounting slots on either side of the chassis and secure with #10 flat washers and #10 hex nuts.

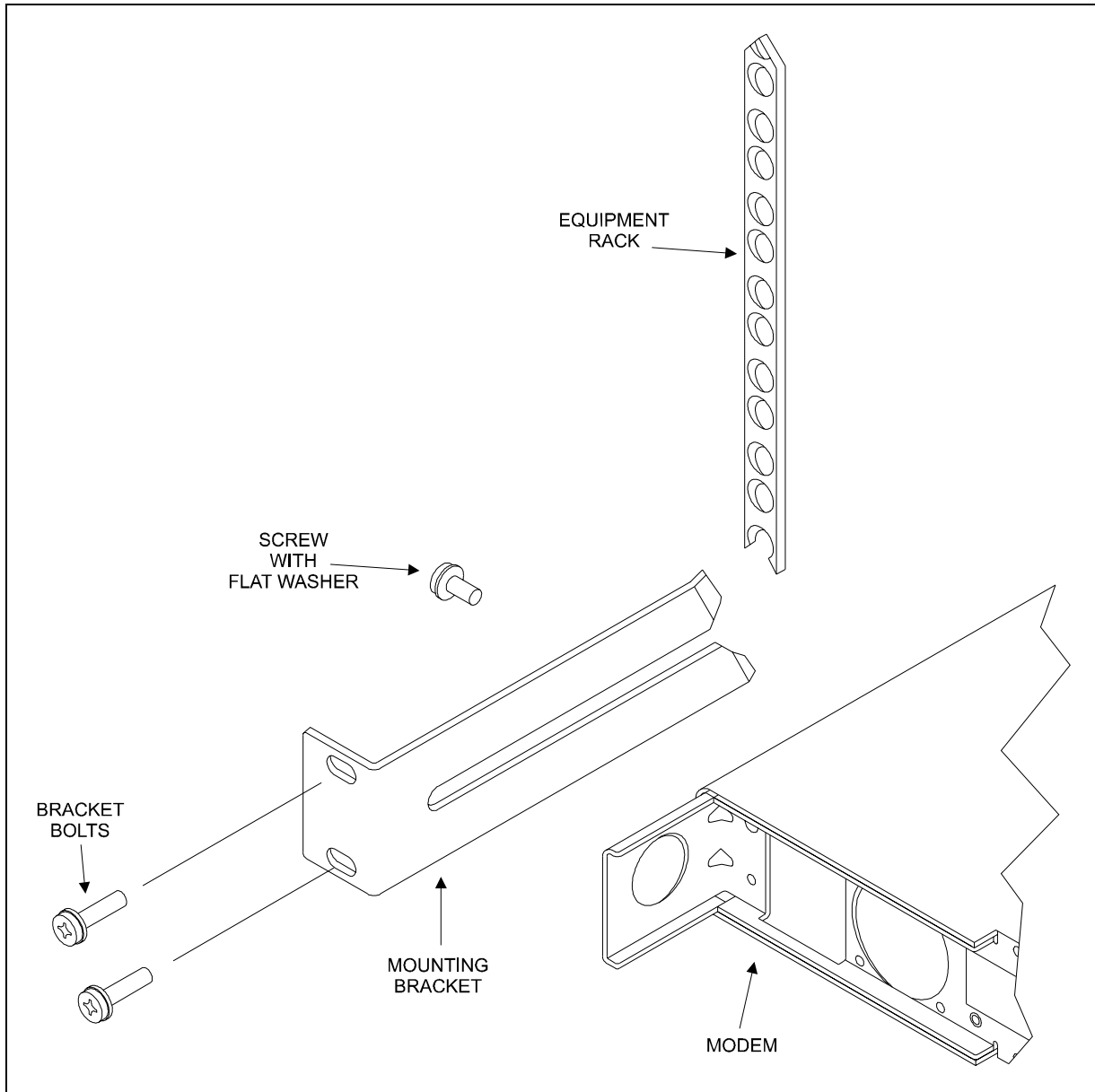


Figure 2-1. Typical Installation of the Optional Mounting Bracket, KT/6228-1

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Chapter 3. SYSTEM OPERATION



Figure 3-1. Rear Panel

3.1 COAXIAL CONNECTORS

Table 3-1. Coaxial Connectors

Coaxial Connector	Connector Type	I/O	Description
J1	Type N, Female	O	BUC B L-Band Output
J2	Type N, Female	O	BUC A L-Band Output
J3	Type N, Female	I/O	Modulator 1 L-Band Input, FSK I/O
J4	Type N, Female	I/O	Modulator 2 L-Band Input
J5	Type N, Female	I/O	Modulator 3 L-Band Input
J6	Type N, Female	I/O	Modulator 4 L-Band Input, FSK I/O
J7	Type N, Female	I/O	LNB B L-Band Inputs
J8	Type N, Female	I/O	LNB A L-Band Inputs
J9	Type F, Female	O	Demodulator 1 L-Band Output
J10	Type F, Female	O	Demodulator 2 L-Band Output
J11	Type F, Female	O	Demodulator 3 L-Band Output
J12	Type F, Female	O	Demodulator 4 L-Band Output
J13	BNC, Female	I	External 10 MHz Reference Input
J14	BNC, Female	O	10 MHz Output
J15	BNC, Female	O	10 MHz Output
J16	BNC, Female	O	10 MHz Output
J18	BNC, Female	O	10 MHz Output
J24	SMA, Female	O	TX IF to Uplink Power Control (UPC) (Optional)
J25	SMA, Female	I	TX IF from UPC

3.2 MULTI-PIN CONNECTOR PINOUT

Table 3-2. Multi-Pin Connector Pinout

Ref Des	Description
J18	RS-232/485 Remote Port
J19	Online and Fault Status: Status: Form C contacts ODC/BUC A/B Online and LNB A/B Online BUC Faults: Form C contacts BUC A and B fault status LNB Faults: Form C contacts LNB A and B faults status. Combiner Switch Faults: Form C contacts failed/OK status.
J20	Modulator Fault/TX OFF: Inputs and Mute
J21	BUC/LNB Fault Input: BUC A and B, LNB A and B, Enable BUC Faults, Enable LNB Faults.
J22	LNB RF Switch Driver
J23	BUC RF Baseball Switch Driver

3.3 REMOTE PORT CONNECTOR

J18, 9-pin D Male, Remote Port

Table 3-3. Multi-Pin Connector Pinout

Pin #	RS-232		RS-485		Description
	Signal Name	I/O	Signal Name	I/O	
1	GND	GND	GND	GND	GND
2	RS-232 TD	Output			TX Line
3	RS-232 RD	Input			RX Line
4					
5	GND	GND	GND	GND	GND
6			RS-485 RX+B	Input	RX Line
7			RS-485 RX-A	Input	RX Line Complement
8			RS-485 TX+B	Output	TX Line
9			RS-485 TX-A	Output	TX Line Complement

Note: For RS-485, 2-Wire, half-duplex operation, Pin 7 (RX-A) and Pin 9 (TX-A) are tied together to form TX/RX -. Similarly, Pin 6 (RX+B) and Pin 8 (TX+B) are tied together to form TX/RX+.

3.4 FAULT AND ONLINE STATUS CONNECTOR

J19, 25-pin D Female, Fault and Online Status.

Pins #	Signal Name	Signal Direction	Type	Pins Connected		
				Fault Alarm	OK (No Fault)	Power Off
2 1 14	BUC1_FLT_NO (BUC A) BUC1_FLT_COM (BUC A) BUC1_FLT_NC (BUC A)	I/O	Form C Form C Form C	1 - 14	1 - 2	1 - 4
16 15 3	BUC2_FLT_NO (BUC B) BUC2_FLT_COM (BUC B) BUC2_FLT_NC (BUC B)	I/O	Form C Form C Form C	15 - 3	15 - 16	15 - 3
5 4 17	LNB1_FLT_NO (LNB B) LNB1_FLT_COM (LNB B) LNB1_FLT_NC (LNB B)	I/O	Form C Form C Form C	4 - 17	4 - 5	4 - 17
19 18 6	LNB2_FLT_NO (LNB B) LNB2_FLT_COM (LNB B) LNB2_FLT_NC (LNB B)	I/O	Form C Form C Form C	18 - 6	18 - 19	18 - 6
8 7 20	SYS_FLT_NO SYS_FLT_COM SYS_FLT_NC	I/O	Form C Form C Form C	7 - 20	7 - 8	7 - 20
22 21 9	BUC2_ONLINE (BUC B) BUC_ONLINE_COM (BUC A/B) BUC1_ONLINE (BUC A)	I/O	Form C Form C Form C	–	–	9 - 21
11 10 23	LNB2_ONLINE (LNB B) LNB_ONLINE_COM (LNB A/B) LNB1_ONLINE (LNB A)	I/O	Form C Form C Form C	–	–	10 - 23
12 13 24 25	GND GND GND GND	GND GND GND GND	GND GND GND GND	–	–	–



IMPORTANT

The Fault/Alarm column shows the pins that are connected when a fault condition exists. The OK column shows the pins connected in the un-faulted/un-alarm condition. The conditions made when prime power is disconnected from the unit are shown in the Power Off column.

3.5 (FUTURE OPTION) MODULATOR FAULTS AND TX ON/OFF CONNECTOR

Use of this connector is optional. It permits control of two 1:1 modulators by sensing the fault status from the 1:1 modem pair.

Pin #	Signal Name	Signal Direction	Description
1	MOD1_FLT	I	Modulator 1 TTL Fault Input
2	MOD2_FLT	I	Modulator 2 TTL Fault Input
3	MOD3_FLT	I	Modulator 3 TTL Fault Input
4	MOD4_FLT	I	Modulator 4 TTL Fault Input
5	GND	GND	Ground
6	MOD1_TX_CNTRL	O	Turns Modulator 1 TX Carrier OFF TTL_OC Output
7	MOD2_TX_CNTRL	O	Turns Modulator 2 TX Carrier OFF TTL_OC Output
8	MOD3_TX_CNTRL	O	Turns Modulator 3 TX Carrier OFF TTL_OC Output
9	MOD4_TX_CNTRL	O	Turns Modulator 4 TX Carrier OFF TTL_OC Output

Notes:

1. Inputs not exceed +5 VDC or less than 0 VDC.
2. Outputs are TTL Open Collector and require an external pull-up resistor.
3. Fault is indicated by TTL high level. OK (NO LEVEL) is indicated by TTL Low Level.

Chapter 4. LOW NOISE BLOCK ASSEMBLY

4.1 GENERAL

The Low Noise Block (LNB) amplifies the input RF signal and down converts it to L-Band in the range of 950 to 1750 MHz (there may be instances that the L-Band range = 950 to 1450 MHz). The choice of which downlink frequency band is determined by the selection of a frequency range, usually from one of LNBs in the following bands:

For C-Band, GHz	For Ku-Band, GHz
3.625 to 4.2	10.95 to 11.70
4.50 to 4.80	11.70 to 12.20
	12.25 to 12.75

LNBs are available that are either externally reference (EXT REF) or internally referenced (INT REF).

- The EXT REF LNB accepts an external 10 MHz reference from the IDU. These units have the best phase noise performance and the lowest frequency drift.
- The INT REF LNB includes its own internal oscillator. DC power is supplied to the LNB through the IFL cable from the IDU.

The standard LNB noise temperature is: For C-Band < 35°K
For Ku-Band < 65°K

Optional: A TX Reject Filter (TRF) may be obtained with the system or supplied by the customer.

4.2 OPTIONS

Hardware	IFL Cables
Hardware	Externally Referenced from IDU or Internally Referenced
Hardware	TX Reject Filter
Hardware	Mounting Kits

4.3 REDUNDANT C-BAND LNB INSTALLATION

The KT/9526-1 Mounting LNB Switch Kit, is the kit for the Redundant Systems. It can be mounted using one of the following kits:

- SPAR Mount, 1 x 2 Antenna Mounting Kit P/N, AS/0422
- SPAR Mount, 1.75 x 4 Antenna, Mounting Kit, P/N AS/0501
- Feed Horn Mounting Kit, P/n AS/0502

4.3.1 TOOLS REQUIRED

The following tools are recommended for unit installation.

QTY	Description
1	Adjustable Wrench Alternate: Set of variable box wrenches.

4.3.2 C-BAND LNB MOUNTING KITS

Part No.	Nomenclature	QTY
PL/9526-1	Kit, LNB Switch Mounting	1

4.3.3 ASSEMBLE REDUNDANT C-BAND LNB

Part No.	Nomenclature	QTY
28P1084	Adapter	1
CN/CX50MALE	Termination, 50 Ω	1
GA/GSKTCPOR229FULL	Gasket, CPR229	4
HW/1/4-20X5/8BT	Bolt, 1/4-20	30
HW/1/4-FLT	Washer, Flat	30
HW/1/4-SPLIT	Washer, Split	30
SW/WGS+48V-229	Switch, Waveguide WR229, +48 VDC	1
*Customer-Furnished	LNB	2

Note: Not included in Kit. May be customer-furnished or ordered separately from CEFD.

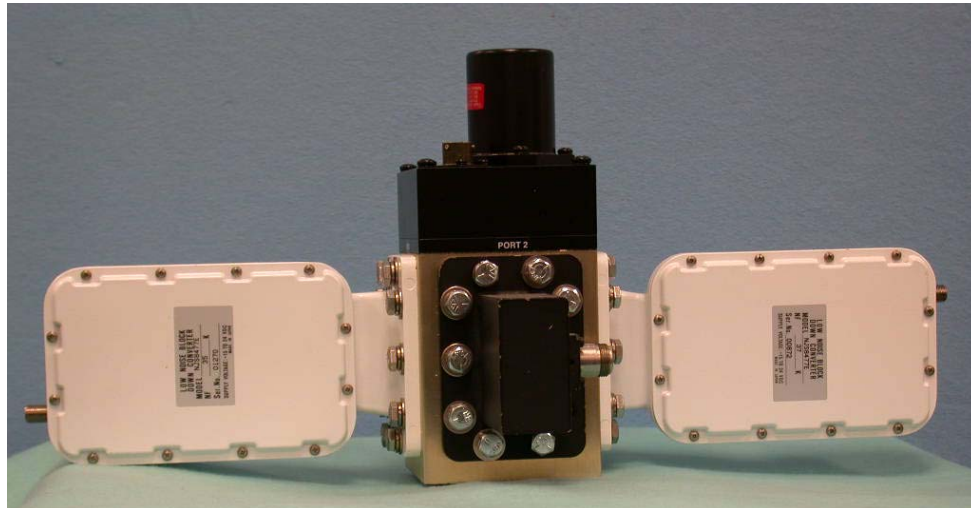


Figure 4-1. C-Band Redundant LNB (KT/9526-1)

1. Remove all protective tape from switch and keep it clean.
2. Position LNBS and gaskets (GA/GSKTCP229FULL) on Port 2 and Port 4 of switch.
3. Secure each LNB with eight bolts, flat washers, and split washers.
4. Position adapter (28P1084) and gasket on Port 3 and secure with bolts, flat washers, and split washers.
5. Place termination (CN/CX50NMALE) on threaded port of adapter.

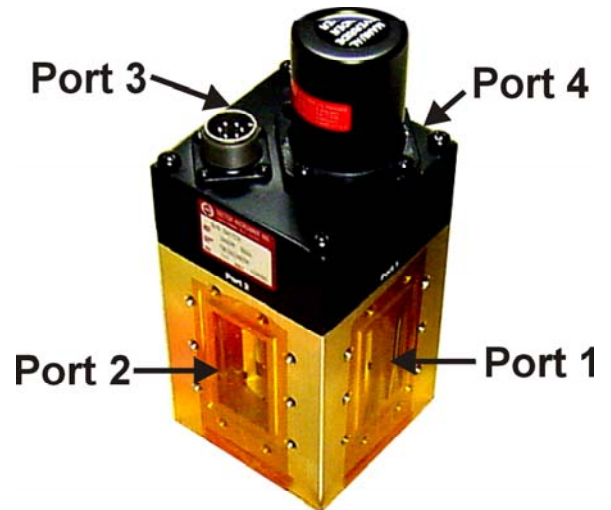


Figure 4-2. Switch Port locations

6. Position the customer-furnished TRF filter and a gasket on Port 4 of the switch.
7. Install the optional support bracket (FP/BR0085). Secure with eight bolts, flat washers, and split washers.
8. Set assembly aside for later installation.

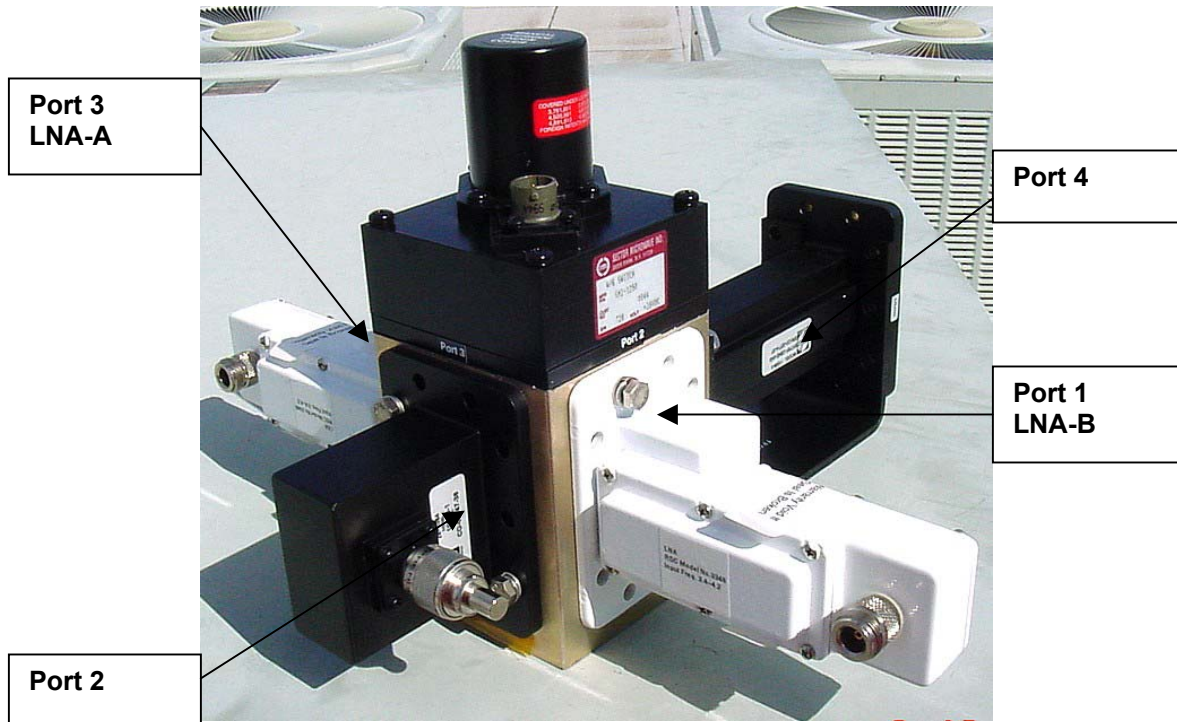


Figure 4-3. C-Band LNB Switch



Ensure that the OUTPUT flange of the filter is against the switch.

4.3.4 C-BAND LNB INSTALLATION

1. Remove the protective cover from the antenna OMT and LNB.
2. Install the appropriate gasket on the antenna end of the LNB, as follows:
 - a. If only one of the mounting surfaces has a groove, use the half-thick gasket.
 - b. If both mounting surfaces have grooves, use the full thick gasket.
3. Position the LNB (with gasket) in place on the antenna and fasten using the supplied hardware.

4.4 KU-BAND LNB INSTALLATION

The PL/10176-1, Mounting LNB Switch Kit, is the kit for the Redundant System. It can be mounted using one of the following kits:

- SPAR Mount, 1 x 2 Antenna Mounting Kit, P/L, AS/0422
- SPAR Mount, 1.75 x 4 Antenna, Mounting Kit, P/N AS/0501
- Feed Horn Mounting Kit, P/n AS/0502.

4.4.1 TOOLS REQUIRED

The following tools are recommended for unit installation.

QTY	Description
1	Adjustable Wrench Alternate: Set of variable box wrenches.

4.4.2 KU-BAND LNB MOUNTING KITS

Part No.	Nomenclature	QTY
PL/10176-1	Kit, LNB Switch Mounting	1

4.4.3 ASSEMBLE REDUNDANT KU-BAND LNB

Part No.	Nomenclature	QTY
99D1483	Waveguide Assy, WR75	2
CN/CX50NMALE	Termination, CN-50Ω	
GA/GSKTWR75HALF	Gasket, WR75 Half-Thickness	
HW/6-32X1/2SHSC	Screw, Socket Cap	
HW/6-FLT	Washer, Flat	
HW/6-SPLIT	Washer, Split	
KT/2819	Waveguide Kit	
KT/2820	Waveguide Kit	
RF/ADP-WR75N	Adapter, Waveguide	
RF/TRF-KU-WR75G	Filter, Transmit Reject	
SW/WGS+48V-75SB	Switch, Waveguide WR75, +48 VDC	1
*Customer-Furnished	LNB	2

Note: Not included in Kit. May be customer-furnished or ordered separately from CEFD.

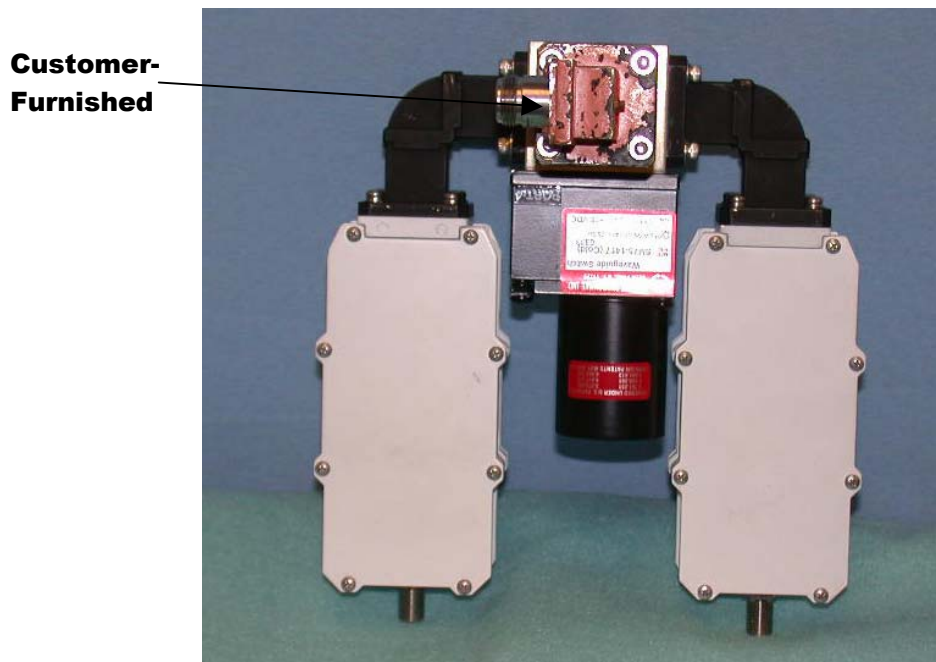


Figure 4-4. Ku-Band Redundant LNB (KT/10176-1)

1. Remove all protective tape from switch and keep it clean.
2. Position LNBS and gaskets (GA/GSKTCP75HALF) on Port 2 and Port 4 of switch.
3. Secure each LNB with eight bolts, flat washers, and split washers.
4. Position adapter (RF/ADP-WR75-N) and gasket on Port 3 and secure with bolts, flat washers, and split washers.
5. Place termination (CN/CX50NMALE) on threaded port of adapter.
6. Position the customer-furnished TRF filter and a gasket on Port 4 of the switch.
7. Install the optional support bracket (FP/BR0085). Secure with eight bolts, flat washers, and split washers.
8. Set assembly aside for later installation.

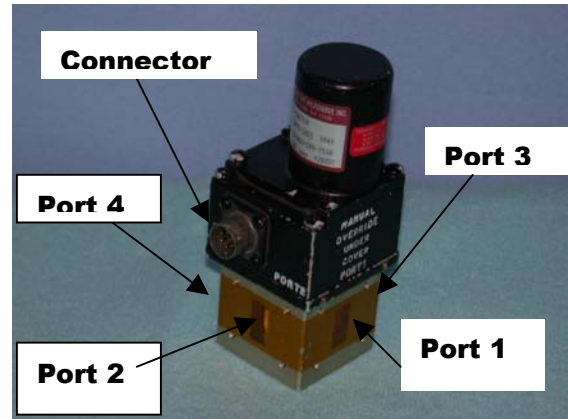


Figure 4-5. Switch Port Locations



Ensure that the OUTPUT flange of the filter is against the switch.

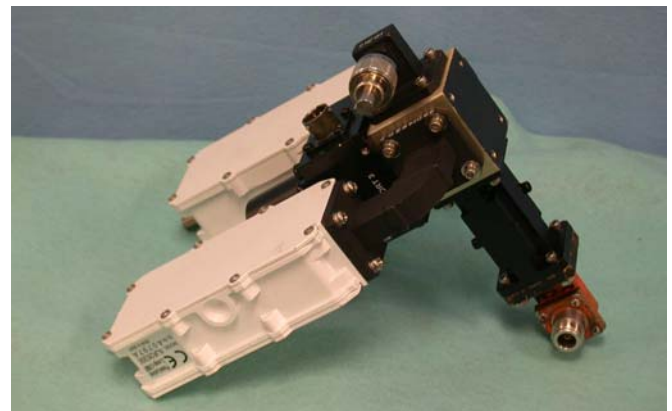


Figure 4-6. Ku-Band LNB Switch

4.4.4 KU-BAND LNB INSTALLATION

The Ku-Band LNB is mounted to the OMT, as follows:

1. Remove the protective cover from the antenna OMT and LNB.
2. Install the appropriate gasket on the antenna end of the LNB, as follows:
 - a. If only one of the mounting surfaces has a groove, use the half-thick gasket.
 - b. If both mounting surfaces have grooves, use the full thick gasket.
3. Position the LNB (with gasket) in place on the antenna and fasten using the supplied hardware.

4.5 SETTINGS (LNB) LO, MIX AND SPECTRUM

4.5.1 C-BAND

Table 4-1. For C-Band: LO and MIX Information for Demodulator and LNB

LNB Part No.	Description	LO (Offset) Frequency (MHz)	MIX (+/-)	Min LNB Satellite Frequency (MHz)	Max LNB Satellite frequency (MHz)	L-Band Frequency at LNB Min (MHz)	L-Band Frequency at LNB Max (MHz)	Demod Spectrum (Utility Demod Menu)	Operating Voltage, V	RF Connector
RF/LNB-C-55-35N	3.625 – 4.200 GHz EXT REF	5,150.00	-	3.625.00	4,200.00	1,525.00	950.00	Invert	18	Type N
RF/LNB3.6-4.2FE	3.625 – 4.200 GHz EXT REF	5,150.00	-	3.625.00	4,200.00	1,525.00	950.00	Invert	18	Type N
RF/LNB3.6-4.2F03	3.625 – 4.200 GHz EXT REF	5,150.00	-	3.625.00	4,200.00	1,525.00	950.00	Invert	18	Type N
xxxxxxxxxxxxx	3.625 – 4.200 GHz	5,150.00	-	3.400.00	4,200.00	1,525.00	950.00	Invert	18	Type N
xxxxxxxxxxxxx	4.500 – 4.800 GHz	5,150.00	-	4,500.00	4,500.00	1,525.00	950.00	Invert	18	Type N

4.5.2 KU-BAND

Table 4-2. For Ku-Band: LO and MIX Information for Demodulator and LNB

LNB Part No.	Description	LO (Offset) Frequency (MHz)	MIX (+/-)	Min LNB Satellite Frequency (MHz)	Max LNB Satellite frequency (MHz)	L-Band Frequency at LNB Min (MHz)	L-Band Frequency at LNB Max (MHz)	Demod Spectrum (Utility Demod Menu)	Operating Voltage, V	RF Connector
RF/LNB-10.9-11.7FE	10.95-11.7 GHz EXT REF	10,000.00	+	10,950.00	11,700.00	950.00	1700.00	Normal	18	Type F
RF/LNB-11.7-12.2FE	11.7 – 12.2 GHz EXT REF	10,750.00	+	11,700.00	12,200.00	950.00	1450.00	Normal	18	Type F
RF/LNB-12.2-12.7FE	12.25 – 12.75 GHz EXT REF	11,300.00	+	12,250.00	12,750.00	950.00	1450.00	Normal	18	Type F
RF/LNB10.9-11.7F03	10.95 – 11.7 GHz ± 3 ppm	10,000.00	+	11,200.00	11,700.00	950.00	1450.00	Normal	18	Type F
RF/LNB-11.7-12.2F03	11.7 – 12.2 GHz ± 3 ppm	10,750.00	+	10,950.00	11,700.00	950.00	1700.00	Normal	18	Type F
RF/LNB-12.2-12.7F03	12.25 – 12.75 GHz ± 3 ppm	11,300.00	+	12,250.00	12,750.00	950.00	1450.00	Normal	18	Type F

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Chapter 5. BLOCK UP CONVERTER

5.1 GENERAL

The Block Up Converter (BUC) translates the L-Band carrier output from the IDU (in the 950 to 1750 MHz range) to C- or Ku-Band frequencies typically between:

- C-Band: 5.845 and 6.425 GHz and amplifies the carrier to the desired TX power level.
- Ku-Band: 14.0 and 14.5 GHz and amplifies the carrier to the desired TX power level.

The local oscillator of the BUC locks to the 10 MHz reference signal from the IDU in order to provide an accurate frequency translation. In the event the BUC cannot lock to the 10 MHz reference, the output carrier is muted to prevent interference with adjacent carriers.

5.2 C-BAND REDUNDANT BUC ASSEMBLY PROCEDURE

Part No.	Nomenclature	QTY
PL/9528-1	BUC Assembly, C-Band	1
PL/9526-1	Mounting Kit, C-Band	1

5.2.1 ASSEMBLE WAVEGUIDE SWITCH KIT, AS/9528-1

Part No.	Nomenclature	QTY
FP/WG0034	Termination, Small Fins	1
FP/WG0043	Waveguide, CPRG137	1
FP/WG0051	Waveguide, CPRG137	1
GA/GSKTCP137FULL	Gasket, CP137 Full	4
HW/10-32X5/8SHC	Screw, Socket Head Cap	32
HW/10-FLT	Washer, Flat	32
HW/10-SPLIT	Washer, Split	32
SW-WGS+48V-137SB	Switch, Waveguide (CPR130)	1
*Customer-Furnished	LNB	2

1. Place gasket (GA/GSKTCP137FUL) on waveguide Port 1 of Switch (SW-WSC+48V-137SB).
2. Assemble one waveguide (FP/WG10359-1) and secure with six screws, flat washers, and split washers to Port 1 of Switch.
3. Place gasket on waveguide Port 3 of switch.
4. Assemble second waveguide to Port 3 of Switch and secure using six screws, flat washers, and split washers.
5. Install termination (FPWG00354) and gasket to Port 4 of switch and secure using six screws, flat washers, and split washers.



IMPORTANT

***Port 2 of the Switch is reserved for customer-furnished equipment.
Cover Port 2 until used.***

5.2.2 ASSEMBLE BUC MOUNTING KIT (KT/9826-1)

Part No.	Nomenclature	QTY
FP/BR10351-1	Bracket, Mounting	1
FP/BR10352-1	Bracket, Mounting	2
FP/WG0034	Termination, Small Fins	1
FP/WG10359-1	Waveguide 3.75X2	2
GA/GSKTCP137FULL	Gasket, Full Thickness, CP137	6
GA/GSKTCP137HALF	Gasket, Half Thickness, CP137	1
HW/1/4-20HEXNUT	Nut, Hex	2
HW/1/4-20X1/2SHSC	Screw, SS	4
HW/1/4-FLT	Washer, Flat	4
HW/1/4-SPIT	Washer, Split	4
HW/10-SPLIT	Washer, Split	4
HW/10-32X5/8SHSC	Screw, Socket Cap	32
HW/10-FLT	Washer, Flat	36
HW/10-SPLIT	Washer, Split	36
HW/M4FLAT	Washer, Flat	6
HW/M4LOCK	Washer, Split	6
HW/M4X.07X8MMPHMS	Screw, Panhead	6
SW-WGS+48V-137SB	Switch, Waveguide CPR137G	1

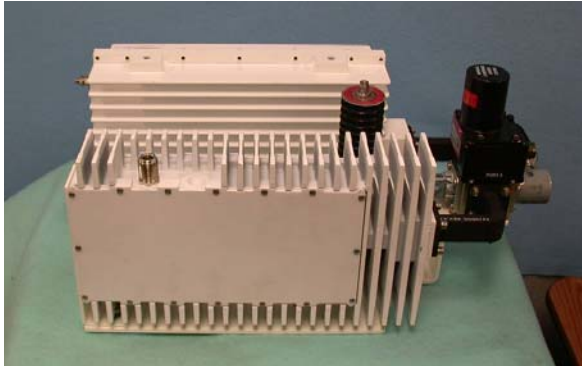


Refer to BUC manufacturer's documentation for installation on the Comtech EF Data assembly.

1. Assemble brackets (FP/BR10352-2) on bracket FP/BR10351-1) and secure with two bolts, flat washers, split washers, and two nuts.
2. Place gaskets on waveguides.
3. Install assembled waveguide to C-Band BUCs and secure using six screws, flat washers, and split washers.
4. Place BUCs on bracket (FP/BR10351-1) and secure with screws. Flat washers, and split washers.

5.3 KU-BAND REDUNDANT BUC ASSEMBLY PROCEDURES

Part No.	Nomenclature	QTY
PL/9527-1	BUC Assembly, Ku-Band	1
KT/9828-1	Mounting Kit, Ku-Band	1



5.3.1 ASSEMBLE WAVEGUIDE SWITCH KIT, PL/9527-1

Part No.	Nomenclature	QTY
FP/7943-1	Bracket, Support Redundant Switch	1
GA/GSKTWR75FULL	Gasket, Full Thickness	2
GA/GSKTWR75HALF	Gasket, Half Thickness	3
HW/6-32X1/2SHSC	Screw, Socket Head Cap	24
HW/6-FLT	Washer, Flat	24
HW/6-SPLIT	Washer, Split	24
RF/TERM-11923-2	Termination, RF 50W, 14.0 – 14.5 GHz WR75G	1
SW/WGS+48V-75SB	Switch, Waveguide, +48V, WR75	1

1. Place gaskets on waveguide Port 1 of switch.
2. Assemble one waveguide to Port 1 of switch and secure using six screws, flat washers, and split washers.
3. Place gasket on waveguide Port 3 of switch.
4. Assemble second waveguide to Port 3 of switch and secure using six screws, flat washers, and split washers.
5. Install customer-selected TRF to Port 4 of switch and secure using six screws, flat washers, and split washers.

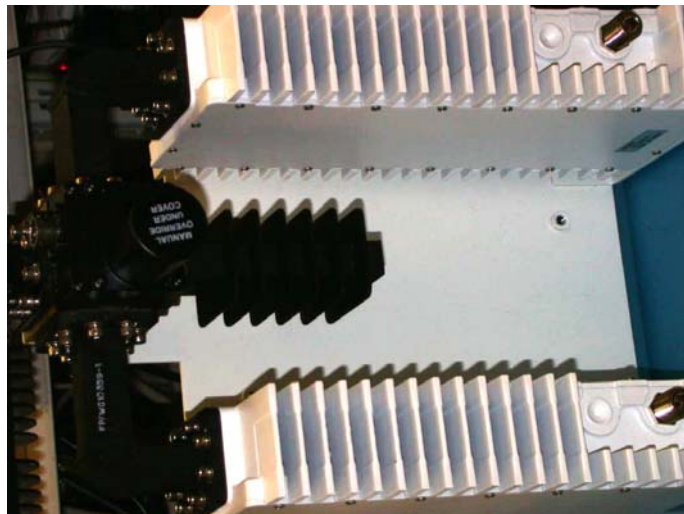
5.3.2 ASSEMBLE KU-BAND REDUNDANT BUCs



Refer to BUC manufacturer's documentation for installation on the Comtech EF Data assembly.

1. Optional: Assemble brackets (FP/BR10352-1) on Bracket (FP/BR10351-1) and secure with two bolts, four flat washers, four split washers, and two hex nuts.
2. Place gaskets on waveguides.
3. Install assembled waveguide Ku-Band BUCs and secure using six screws, flat washers, and split washers.
4. Place BUCs on Bracket (FP/BR10351-1) and secure with screws, flat washers, and split washers.

Part No.	Nomenclature	QTY
FP/BR5000	Waveguide, WG75G	
FP/BR10352-1	Bracket, Mounting	1
FP/BR10353-1	Bracket, Mounting	2
GA/GSKTCP75FULL	Gasket, Full Thickness, CP75	6
GA/GSKTCP75HALF	Gasket, Half Thickness, CP75	1
HW/1/4-20HEXNUT	Nut, Hex	2
HW/1/4-20X1/2SHSC	Screw, SS	4
HW/1/4-FLT	Washer, Flat	4
HW/1/4-SPLIT	Washer, Split	
HW/10-SPLIT	Washer, Split	4
HW/6-32X5/8SHSC	Screw, Socket Head Cap	
HW/6-FLT	Washer, Flat	32
HW/6-SPLIT	Washer, Split	36
HW/M4FLAT	Washer, Flat	6
HW/M4LOCK	Washer, Split	6
HW/M4X.07X8MMPHMS	Screw, Panhead	6
RF/TERM-11923-2	Termination, 50Ω 14.0 – 14.5 GHz WR75G	
SW-WGS+48V-75SB	Switch, Waveguide WR75, +48VDC	1



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5.4 LO, MIX AND SPECTRUM SETTINGS

5.4.1 C-BAND

Table 5-1. LO, MIX, and MOD Spectrum Settings for Modulator and BUC

P1dB_min	Band	FSK	CEFD Part #	RF Start Frequency (GHz)	RF End Frequency (GHz)	LO (Offset) Freq. (MHz)	MIX (+ / -)	Modem Spectrum (Utility Modulator Menu)	Supply Voltage	SPAR Mount Kit	Feed Mount Kit
5 Watt	C	Yes	RF/BUC05C-A-F-T	5.850	6.425	7,375.00	-	Invert	24 VDC	KT/8924-1	KT/9027-1
10 Watt	C	Yes	RF/BUC10C-A-F-T	5.850	6.425	7,375.00	-	Invert	48 VDC	TBD	TBD
1 Watt	C	No	RF/BUC01C-A-N-N	5.850	6.425	4,900.00	+	Normal	24 VDC	KT/8924-1	KT/9027-1
2 Watt	C	No	RF/BUC02C-A-N-N	5.850	6.425	4,900.00	+	Normal	24 VDC	KT/8924-1	KT/9027-1
5 Watt	C	No	RF/BUC05C-A-N-N	5.850	6.425	4,900.00	+	Normal	24 VDC	KT/8924-1	KT/9027-1
2 Watt	EXT C	No	RF/BUC02C-B-N-N	6.725	7.025	5,760.00	+	Normal	24 VDC	KT/8924-1	KT/9027-1
5 Watt	EXT C	No	RF-BUC05C-B-N-N	6.725	7.025	5,760.00	+	Normal	24 VDC	KT/8924-1	KT/9027-1

5.4.2 KU-BAND

Table 5-2. LO, MIX, and MOD Spectrum Settings for Modulator and BUC

P1dB_min	Band	FSK	CEFD Part #	RF Start Frequency (GHz)	RF End Frequency (GHz)	LO (Offset) Freq. (MHz)	MIX (+ / -)	Modem Spectrum (Utility Modulator Menu)	Supply Voltage	SPAR Mount Kit	Feed Mount Kit
*2 Watt	Ku	Yes	RF/BUC02KU-A-F-T	14.00	14.50	13,050.00	+	Normal	24 VDC	KT/8924-1	KT/9928-1
*4 Watt	Ku	Yes	RF/BUC04KU-A-F-T	14.00	14.50	13,050.00	+	Normal	24 VDC	KT/8924-1	KT/9928-1
*8 Watt	Ku	Yes	RF/BUC08KU-A-N-N	14.00	14.50	13,050.00	+	Normal	48 VDC	KT/8924-1	KT/9928-1
**1 Watt	Ku	No	RF/BUC01KU-A-N-N	14.00	14.50	15,450.00	-	Invert	24 VDC	KT/8924-1	KT/9928-1
**2 Watt	Ku	No	RF/BUC02KU-A-N-N	14.00	14.50	15,450.00	-	Invert	24 VDC	KT/8924-1	KT/9928-1
**4 Watt	Ku	No	RF/BUC04KU-A-N-N	14.00	14.50	15,450.00	-	Invert	24 VDC	KT/8924-1	KT/9928-1
*2 Watt	Ku EXT	Yes	RF/BUC02KU-B-F-T	13.75	14.25	12,800.00	+	Normal	24 VDC	KT/8924-1	KT/9928-1
*4 Watt	Ku EXT	Yes	RF/BUC04KU-B-F-T	13.75	14.25	12,800.00	+	Normal	24 VDC	KT/8924-1	KT/9928-1
*8 Watt	Ku EXT	Yes	RF/BUC08KU-B-F-T	13.75	14.25	12,800.00	+	Normal	48 VDC	KT/8924-1	KT/9928-1
**1 Watt (Typical) 28 dBm	Ku EXT	No	RF/BUC01KU-B-N-N	13.75	14.25	15,200.00	-	Invert	24 VDC	KT/8924-1	KT/9928-1
**2 Watt	Ku EXT	No	RF/BUC02KU-B-N-N	13.75	14.25	15,200.00	-	Invert	24 VDC	KT/8924-1	KT/9928-1

* Option A BUC Mounting

** Option B BUC Mounting

5.5 SINGLE-THREAD BUC INSTALLATION



After removing the protective covers, ensure that no foreign material (FOD) or moisture enters.

5.5.1 TOOLS REQUIRED

1/2-inch	Box Wrench (or equivalent)
5/16-inch	Box Wrench (or equivalent)
7/16-inch	Box Wrench (or equivalent)
7/64-inch	SAE Allen
M3	Metric Allen Wrench
Screw Driver	Phillips

5.5.2 MOUNTING KITS

Table 5-3. Optional: C-Band Mounting Kit, KT/5738-1 (BUC to OMT)

Part No.	Nomenclature	QTY
03P1097	Bolt, Hex	8
FP/5195	Gasket, CPR137-Full	1
HW/1-32HEXNUT	Nut, Hex	8
HW/10-FLT	Washer, Flat	16
HW/10-SPLIT	Washer, Split	8
HW/GKT-CPR137G	Gasket, CPR137-Half	1

Table 5-4. Optional: Ku-Band Mounting Kit, KT/8924-1 (BUC to OMT)

Part No.	Nomenclature	QTY
32P1037	O-Ring	3
32P1039	O-Ring	3
HW/6-32HEXNUT	Nut, #6	4
HW/6-32X7/8SHSC	Screw, Socket #6	4
HW/6-FLT	Washer, Flat, #6	8
HW/6-SPLIT	Washer, Split #6	4
HW/8-FLT	Washer, Flat #8	8
HW/8-SPLIT	Washer, Split #8	8
HW/M4X12SHSC	Screw, Socket, M4X12	4
HW/M4X25SHSC	Screw, Socket, M4X25	4

Item	Part No.	Nomenclature	QTY	**Remarks
1	FP/9026-1	Bracket, QP	1	
2	FP/BR9927-1	Bracket, Upper	1	Use with Option B BUC
3	HW/M4FLAT	Washer, Flat	2	Use with Option B BUC
4	HW/M4LOCK	Washer, Lock	4	Use with Option B BUC
5	HW/M4X16PH	Screw, Pan Head Phillips	2	Use with Option B BUC
6	HW/1/4-FLAT	Washer, Flat	2	
7	HW/1/4-SPLIT	Washer, Split	2	
8	03P1078	Bolt, Hex	1	
9	HW/1/4-20HEXNUT	Nut, Hex	1	
10	FP/BR9929-1	Bracket	1	Use with Option A BUC
11	HW/1/4-20X5/8HEX	Screw, Hex	1	Use with Option A BUC
*12 thru 19	Not Used			
20	HW/5/16-FLT	Washer, Flat	1	
21	HW/5/16-18X1.25	Bolt, Hex Head	1	
22	HW/5/16-SPLIT	Washer, Split	1	
23	HW/5/16-18HEXNT	Nut, Hex	1	

*Not Illustrated

**Refer to Table 3-3

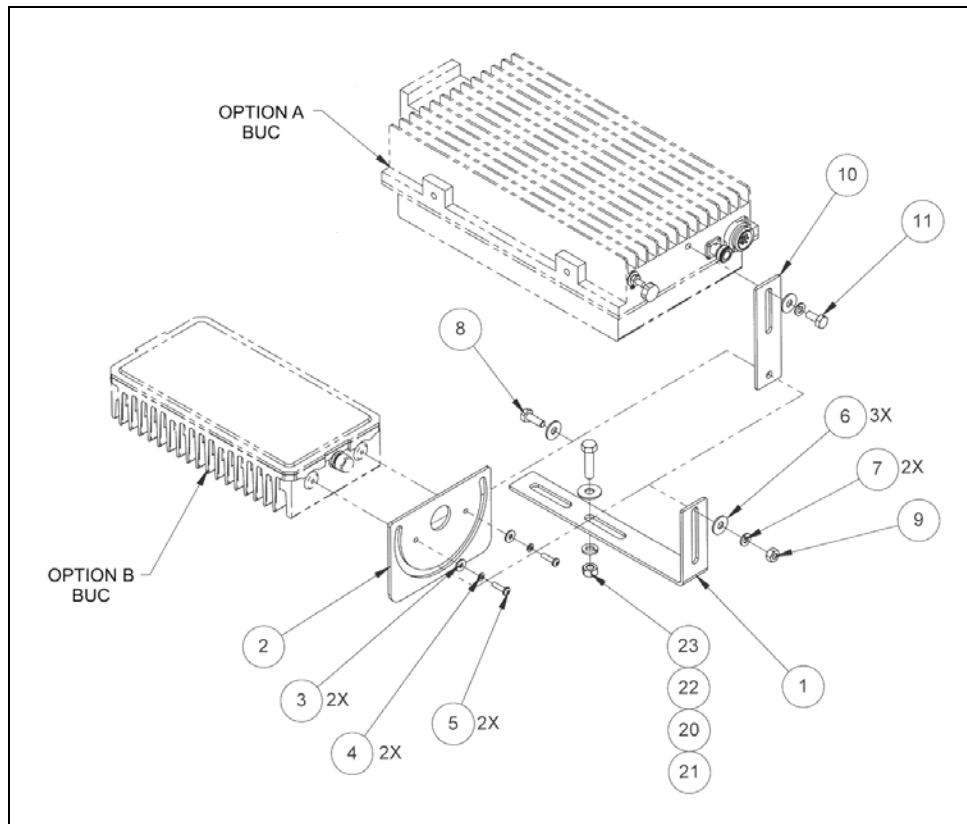


Figure 5-1. Mounting Kit, KT/9928-1

5.6 INSTALLATION

To install the BUC to the antenna:

1. If installed: Remove protective covers from the antenna OMT and SSPA.



After removing the protective cover, ensure that no foreign material (FOD) or moisture enters the antenna waveguide or BUC.

2. Install the appropriate gasket (From KT/8924-1 or KT/5738-1) on the antenna OMT, as follows:
 - a. If only one of the mating flanges is grooved, the thin gasket should be installed.
 - b. If both of the mating flanges are grooved, the thick gasket should be installed.
3. Position the SSPA (with gasket) in place on the antenna, and install with provided socket screws and washers (split and flat) from the mounting kit.
4. Install ODU Mounting Kit, KT/9928-1, as follows:

OPTION A BUC

Step	Procedure
a.	Install bracket (10, figure 5-9) to BUC and secure with flat washers (6), split washers (7), and screws (11).
b.	Position universal lower 'L' bracket (1) to feed horn, loosely fastens with bolt (21), flat washer (20), lock washer (22), and nut (23).
c.	Align bracket (1) with bracket (10) to adjust the position of the BUC.
d.	Insert bolt (8) with flat washer (6) through brackets (1, 10). Secure with flat washer (6), split washer (7), and nuts (9).
e.	Tighten all the hardware.

OPTION B BUC

Step	Procedure
a.	Install bracket (2, figure 5-9) to the BUC. Secure with two screws (5), two lock washers (4), and two flat washers (3).
b.	Position universal lower 'L' bracket (1) to feed horn, loosely fasten with bolt (21), flat washer (20), lock washer (22), and nut (23).
c.	Align bracket (1) with bracket (2) to adjust the position of the BUC.
d.	Insert bolt (8) with flat washer (6) through brackets (1, 2). Secure with flat washer (6), split washer (7), and nuts (9).
e.	Tighten all the hardware.

Chapter 6. CABLE INSTALLATION

6.1 INTRODUCTION

Take care during cable installation. Install the cables using the most direct route and secure with clamps and ties. Avoid all sharp bends.

Cable connectors used in outdoor applications shall be sealed to avoid leakage, particularly, N-Type connectors. Moisture can seep into junctions at the plug end of the connector, between the fixed and movable parts, and where the cable connects to the connector.

Signal attenuation and possible loss of signal can occur in the presence of moisture. All cable junctions shall be sealed with a self-amalgamating tape, such as 3M, Type 23 Scotch Self-Amalgamating tape, or equivalent, including military style (MS) connectors.

6.2 SINGLE CONFIGURATION CABLE INSTALLATION

The LCS-4 Single Configuration consists of the LCS-4, up to four modems, one LNB and one BUC. The LCS-4 shall be positioned above Modems A, B, C, and D. Refer to Figure 6-1.

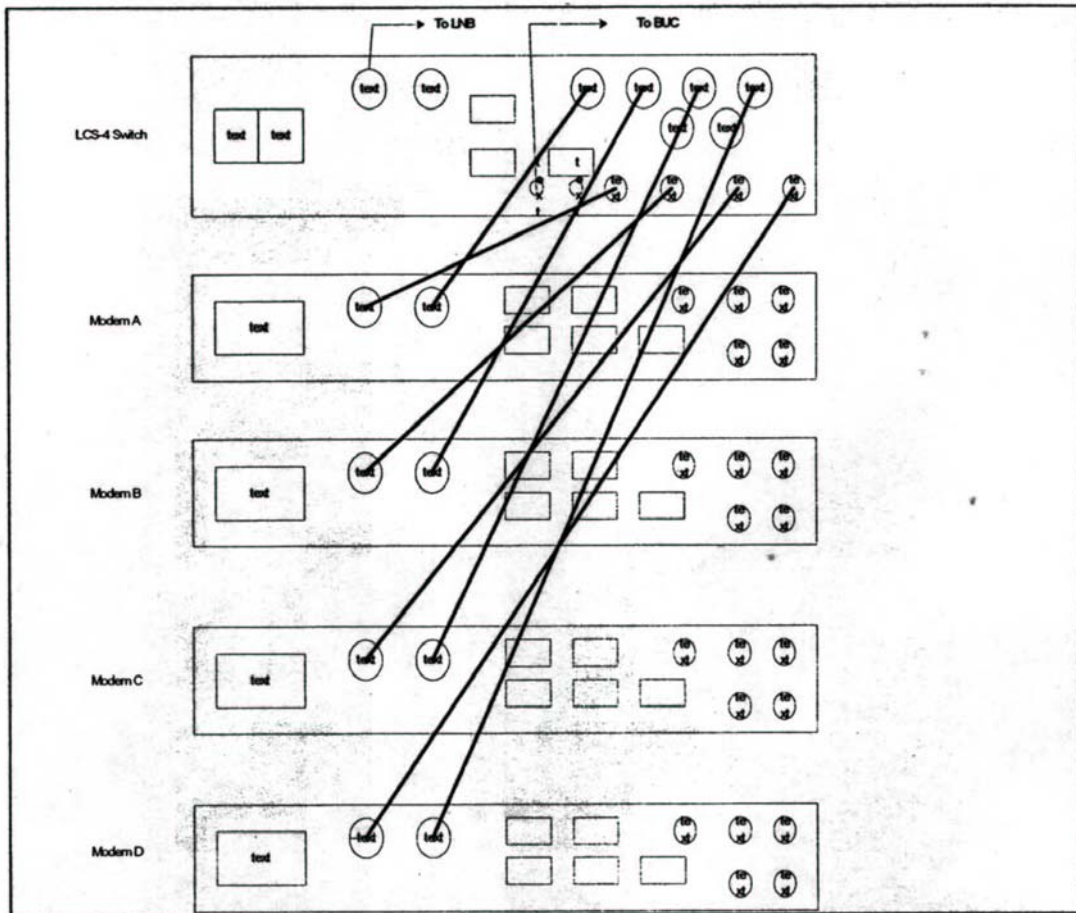


Figure 6-1. Single Configuration Cable Installation

6.3 REDUNDANT CONFIGURATION CABLE INSTALLATION

The LCS-4 Redundant Configuration consists of the LCS-4, up to four modems, two LNBS and two BUCs. The LCS-4 shall be positioned above Modems A, B, C, and D. Refer to Figure 6-2.

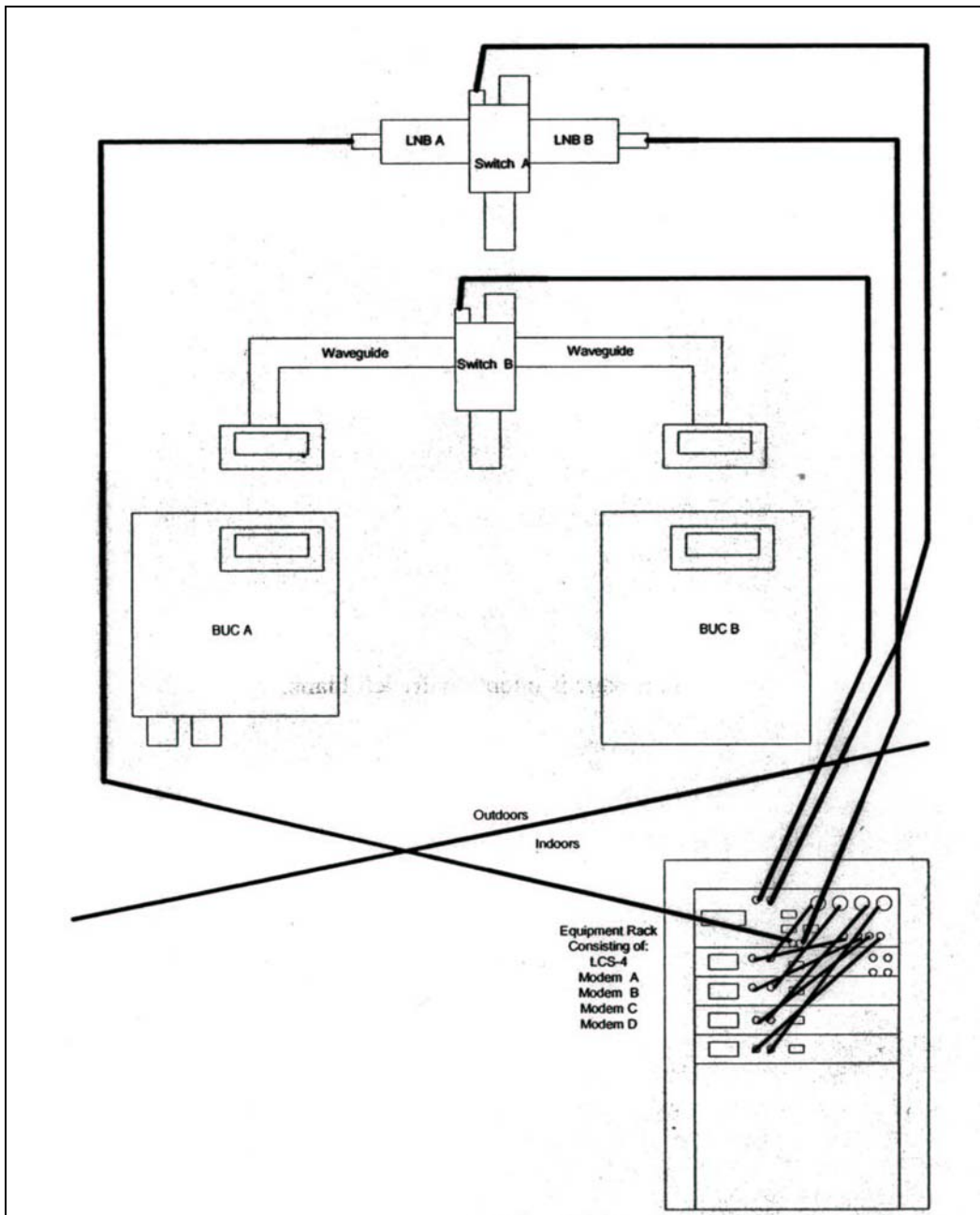


Figure 6-2. Redundant Configuration Cable Installation

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Chapter 7. FRONT PANEL CONTROL

7.1 INTRODUCTION

The purpose of the front panel is to control the state of the power supplies, the references, the online condition (in redundancy mode), and whether the redundancy mode is in Auto or Manual mode. It is also a visual indication of the fault status of the LCS-4 and the devices that are being monitored.

7.2 DESCRIPTION

The front panel (Figure 7-1) is comprised of 21 switches and 21 LEDs. Following is a description and functionality of each switch and any associated LED.

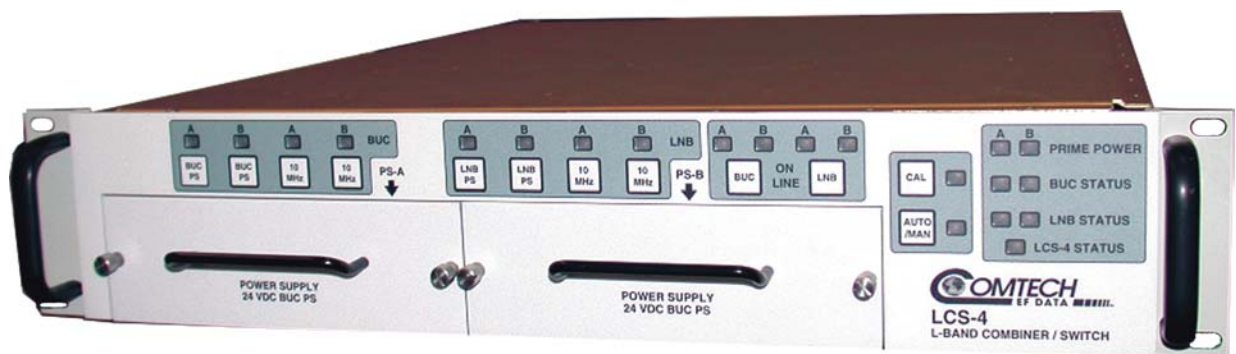


Figure 7-1. LCS-4 Front Panel

7.2.1 BUC CONTROL

The following controls the BUC power supplies and BUC 10 MHz reference.

Controls	Description
BUC A Power Supply	The BUC A power supply switch toggles the power supply from BUC A ON and OFF. The associated LED will show the status of the power supply. The conditions of the LED include: OFF, RED, GREEN, and FLASHING GREEN (see Table 7-1 for various LED conditions).
BUC B Power Supply	The BUC B power supply switch toggles the power supply from BUC B ON and OFF. The associated LED will show the status of the power supply. The conditions of the LED include: OFF, RED, GREEN, and FLASHING GREEN (see Table 7-1 for various LED conditions).
BUC A Reference	The BUC A reference switch toggles the 10 MHz reference for BUC A ON and OFF. The associated LED will show the status of the reference. The conditions of the LED include: OFF, RED, and GREEN (see Table 7-1 for various LED conditions). This provides a 10 MHz reference delivered up the coax cable to the BUC for BUC's that require an external reference for locking the internal synthesizer.
BUC B Reference	The BUC B reference switch toggles the 10 MHz reference for BUC A ON and OFF. The associated LED will show the status of the reference. The conditions of the LED include: OFF, RED, and GREEN (see Table 7-1 for various LED conditions). This provides a 10 MHz reference delivered up the coax cable to the BUC for BUCs that require an external reference for locking the internal synthesizer.
BUC Online	The BUC ONLINE switch toggles the online unit between BUC A and BUC B. The associated LED will show the ONLINE status of the BUC. The conditions of LED include: OFF, RED, and GREEN (see Table 7-1 for various LED conditions).

7.2.2 LNB CONTROL

The following controls the LNB power supplies and LNB 10 MHz reference.

Controls	Description
LNB A Power Supply	The LNB A power supply switch toggles the power supply from LNB A ON and OFF. The associated LED will show the status of the power supply. The conditions of the LED include: OFF, RED, GREEN, and FLASHING GREEN (see Table 7-1 for various LED conditions).
LNB B Power Supply	The LNB B power supply switch toggles the power supply from LNB B ON and OFF. The associated LED will show the status of the power supply. The conditions of the LED include: OFF, RED, GREEN, and FLASHING GREEN (see Table 7-1 for various LED conditions).
LNB A Reference	The LNB A reference switch toggles the 10 MHz reference for LNB A ON and OFF. The associated LED will show the status of the reference. The conditions of the LED include: OFF, RED, and GREEN (see Table 7-1 for various LED conditions). This provides a 10 MHz reference delivered up the coax cable to the LNB for LNB's that require an external reference for locking the internal synthesizer.
LNB B Reference	The LNB B reference switch toggles the 10 MHz reference for LNB A ON and OFF. The associated LED will show the status of the reference. The conditions of the LED include: OFF, RED, and GREEN (see Table 7-1 for various LED conditions). This provides a 10 MHz reference delivered up the coax cable to the LNB for LNB's that require an external reference for locking the internal synthesizer.
LNB Online	The LNB ONLINE switch toggles the online unit between LNB A and LNB B. The associated LED will show the ONLINE status of the LNB. The conditions of LED include: OFF, RED, and GREEN (see Table 7-1 for various LED conditions).

7.2.3 CURRENT CALIBRATION

The CAL switch performs a ‘calibration’ of system currents. The purpose of this is to allow the user to set up a ‘window’ in which, the various currents can be monitored and if the current goes outside of the ‘window,’ an alarm will be activated. This switch ‘calibrates’ all currents of active devices. When pressed, the associated LED flashes momentarily to indicate the ‘CAL’ process is occurring (refer to Table 7-1 for various LED conditions).

7.2.4 REDUNDANCY MODE

The Redundancy Mode switch enables/disables AUTO mode, this is indicated by the associated LED (refer to Table 7-1 for various LED conditions). When AUTO mode is enabled, the LCS-4 will automatically switch between BUC and LNB in Redundancy Mode when a fault occurs. The keypad and Remote Port are also ‘locked’ out when in AUTO mode to prevent any accidental configuration changes. When disabled, the LCS-4 will not switch automatically. This mode also is used to do manual changes in the configuration using the front panel and Remote Port.

7.2.5 LED CONDITIONS

Following is allowed conditions of the LEDs on the front panel.

LED	CONDITION				DESCRIPTION
	OFF	GREEN	RED	FLASHING	
Prime Power A	Disabled	ON	NA	NA	Prime Power A Status
Prime Power B	Disabled	ON	NA	NA	Prime Power B Status
BUC A PS	Disabled	ON/OK	Faulted	Not cal'ed	BUC A PS Status
BUC B PS	Disabled	ON/OK	Faulted	Not cal'ed	BUC B PS Status
BUC A REF	Disabled	ON/OK	Faulted	NA	BUC A REF Status
BUC B REF	Disabled	ON/OK	Faulted	NA	BUC B REF Status
BUC Status A	BUC A OFF	ON/OK	Faulted	NA	BUC A Status
BUC Status B	BUC B OFF	ON/OK	Faulted	NA	BUC B Status
LNB A PS	Disabled	ON/OK	Faulted	Not cal'ed	LNB A PS Status
LNB B PS	Disabled	ON/OK	Faulted	Not cal'ed	LNB B PS Status
LNB A REF	Disabled	ON/OK	Faulted	NA	LNB A REF Status
LNB B REF	Disabled	ON/OK	Faulted	NA	LNB B REF Status
LNB Status A	LNB A OFF	ON/OK	Faulted	NA	LNB A Status
LNB Status B	LNB B OFF	ON/OK	Faulted	NA	LNB B Status
CAL I	Normal	NA	NA	Not cal'ed	Current 'Calibration'
AUTO/MAN	Manual Mode	AUTO Mode	NA	NA	Redundancy Mode
Combiner Switch (status)	NA	System OK	System Faulted	NA	Summary Fault
BUC A ONLINE	OFFLINE	ONLINE/OK	Faulted	NA	BUC A Online Status
BUC B ONLINE	OFFLINE	ONLINE/OK	Faulted	NA	BUC B Online Status
LNB A ONLINE	OFFLINE	ONLINE/OK	Faulted	NA	LNB A Online Status
LNB B ONLINE	OFFLINE	ONLINE/OK	Faulted	NA	LNB B Online Status

7.3 OPERATION

7.3.1 AUTO / MAN OPERATION

The AUTO/Man switch selects automatic redundancy operation of the unit in the AUTO mode and permits operation of the unit from the front panel when MAN is selected.

The other keys on the front panel operate when MAN is selected and they are disabled when AUTO is enabled.

7.3.2 CAL SWITCH AND LED OPERATION

When CAL function is actuated the L-Band Combiner Switch measures the current supplied to the ODU/BUC(s) and LNB(s).

Senses BUC current and sets a measurement window of +20% and –20% of current measured when the CAL function is actuated. The window shall not exceed the capabilities of the power supply.

- This is accomplished automatically for the installed power supplies. If no BUC power supplies are installed, No Fault is indicated in the event the unit is deployed only as a combiner and power supplies are provided external to the unit.
- It is possible to program the other upper and lower limits via the remote port. In this case the CAL = ON enables the values set via the remote port.

Programs the LNB voltage window of 18 VDC +20% and –20% when the CAL function is actuated. The window must not exceed the capabilities of the power supplies.

- It shall be possible to program other upper and lower via the remote port. In this case the CAL = ON enables the value set via the remote port.

Senses LNB current and sets a measurement window of +20% and –20% of current measure when the CAL function is actuated. The window shall not exceed the capabilities of the power supply.

- It shall be possible to program other upper and lower limits via the remote port. In this case the CAL = ON enables the value set via the remote port.

Once CAL is completed, if as BUC or LNB power supply is tuned OFF (Power Supply changes require that the unit is in MAN mode) the faults associated with that BUC or LNB are disabled. The faults are still disabled if the unit is returned to AUTO mode.

7.3.3 LNB VOLTAGE/CURRENT TURN ON

Contact Comtech EF Data Customer Support for a procedure for setting the CAL current for the LNB in the event it uses an internal ovenized oscillator. These units draw a higher current at turn ON of the LNB voltage in order to heat up the crystal. After warm-up, the current drops back to the normal steady-state value.

7.3.4 ODU/BUC OR LNB ONLINE SWITCH

Note: User shall use ODU/BUC or LNB Switch with indicator contacts.

The RED condition indicates the ODU Switch has failed. The switch has a set of indicator contacts that are read by the unit controller to determine the position of the switch. When the A/B indicator does not agree with the programmed position:

- Contact Comtech EF Data for a procedure to correct the problem.
- A RED failure is activated if it is not possible to correct position of the switch.

7.4 FAULT DEFINITIONS FOR SWITCHOVER FOR LNB OR ODU/BUC

Table 7-1. Fault Definitions for Switchover for LNB or ODU/BUC

Characteristics	
TX Faults	BUC Power Supply HI or Low Voltage Alarm BUC Current HI or Low Current Alarm
RX Faults	LNB Power Supply HI or Low Voltage Alarm LNB Current HI or Low Current Alarm
Common Faults	10 MHz failure – reference to the BUC or LNB is compromised. Shut off the 10 MHz to the BUC and LNB
Switchover Time	Less than 1.5 second following fault detection.
Automatic Switchover	The starting point assumes both units are good. When a fault occurs in the ONLINE unit, it is replaced only with a functional standby unit. No switching occurs if both units have failed.
Manual Switchover	From front panel or remote port.
Modulator TX Carrier ON/OFF	Unit senses modulator faults and applies control (bypasses UP) to turn TX carrier Off at modulator for up to four modulators.

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Appendix A. REMOTE CONTROL OPERATION

A.1 DESCRIPTION

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

A.1.1 EIA-485

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

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

In the other direction, on the other pair, each target has a tri-stateable line driver connected, and the controller has a line-receiver connected. All the line drivers are held in high-impedance mode until one (and only one) target transmits back to the controller. Each target has a unique address, and each time the controller transmits, in a framed 'packet' of data, the address of intended recipient target is included. All of the targets receive the packet, but only one (the intended) will reply. The target enables its output line driver, and transmits its return data packet back to the controller, in the other direction, on the physical separate pair:

RS-485 (Full-duplex) summary:

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

A.1.2 EIA-232

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

A.2 BASIC PROTOCOL

Whether in RS-232 or RS-485 mode, all data is transmitted as asynchronous serial characters suitable for transmission and reception by a UART. In this case, the asynchronous character format is fixed at 8-N-1, exclusively with the baud rate set at 19,200 baud.

All data is transmitted in framed packets. The master is assumed to be a PC or ASCII dumb terminal, which is controlling the process of monitor and control. The controller is the only device that is permitted to initiate 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 Li characters are considered printable.

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

A.2.1 PACKET STRUCTURE

CONTROLLER-TO-TARGET:

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

Example: <0135/BSA=1 {CR}

TARGET-TO-CONTROLLER:

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

Example: >0654/BSA=1 {CR} {LF}

Each of the components of the packet is now explained.

A.2.1.1 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.

A.2.1.2 ADDRESS

Up to 9999 devices can be uniquely addressed. In RS-232 and RS-485 applications, the permissible range of values is 1 to 9999. It is programmed into a slave unit using the Set Physical Address (SPA) command.



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.

A.2.1.3 INSTRUCTION CODE

This is a three-character alphabetic sequence that identifies the subject of the message. Wherever possible, the instruction codes have been chosen to have some significance.

For example: BSA for BUC power supplies A, LCB for LNB Current window B, etc. This aids in the readability of the message, should it be displayed in its raw ASCII form. Only upper case alphabetic characters may be used (A-Z, ASCII codes 65-90).

A.2.1.4 INSTRUCTION CODE QUALIFIER

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

1. From Controller to Target, the only permitted values are:
 - = (ASCII code 61)
 - ? (ASCII code 63)

They have these meanings:

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

For example, in a message from controller to target, BSA = 1 would mean ‘enable the power supply for BUC A.’

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

For example, in a message from controller to target, ‘BSA?’ would mean return the current state of BUC A power supply.’

2. From Target to Controller, the only permitted values are:
 - = (ASCII code 61)
 - ? (ASCII code 63)
 - ! (ASCII code 33)
 - * (ASCII code 42)
 - # (ASCII code 35)

They have these meanings:

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

- First, if the controller has sent a query code to a target (for example BSA?, meaning 'is BUC A power supply on or off?'), the target would respond with, BSA=x, where x represents the state in question, 1 being on and 0 being off.
- 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 BSA= (with no message arguments).

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

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

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

- If the controller sends an instruction to set a parameter to a particular value, then, if the value sent in the argument is valid, but the modem will not permit that particular parameter to be changed at that time, the target will acknowledge the message by replying with (for example) with BSA* (with no message arguments).

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

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

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

- If the controller sends an instruction code which the target cannot currently perform because of hardware resource issues, the target will acknowledge the message by echoing the invalid instruction, followed by the BSA# character.

A.2.1.5 MESSAGE ARGUMENTS

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

A.2.1.6 END OF PACKET

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

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

Both indicate the valid termination of a packet.

A.3 COMMANDS OR RESPONSES

The commands and responses are provided to assist the technician in monitoring and controlling the unit.

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
BUC Power Supply A Enable	BSA=	1 byte, value of 0,1	Command or Query. BUC A Power Supply, where: 0=Disabled 1=Enabled Example: BSA=1 Parameter 2 of SGC Command	BSA= (message ok) BSA? (Received ok, but invalid arguments found) BSA*(message ok, but not permitted in current mode)	BSA?	BSA=x (same format as command arguments)
BUC Power Supply B Enable	BSB=	1 byte, value of 0,1	Command or Query. BUC B Power Supply, where: 0=Disabled 1=Enabled Example: BSB=1 Parameter 3 of SGC Command	BSB= (message ok) BSB? (Received ok, but invalid arguments found) BSB*(message ok, but not permitted in current mode)	BSB?	BSB=x (same format as command arguments)
BUC A Reference Oscillator Enable	BRA=	1 byte, value of 0,1	Command or Query. BUC A reference Oscillator, where: 0=Disabled 1=Enabled Example: BRA=1 Parameter 4 of SGC Command	BRA= (message ok) BRA? (Received ok, but invalid arguments found) BRA*(message ok, but not permitted in current mode)	BRA?	BRA=x (same format as command arguments)
BUC B Reference Oscillator Enable	BRB=	1 byte, value of 0,1	Command or Query. BUC B reference Oscillator, where: 0=Disabled 1=Enabled Example: BRB=1 Parameter 4 of SGC Command	BRB= (message ok) BRB? (Received ok, but invalid arguments found) BRB*(message ok, but not permitted in current mode)	BRB?	BRB=x (same format as command arguments)
BUC Fault Logic	BFL=	1 byte, value of 0,1	Command or Query. BFL controls whether or not the Summary Fault Relay (SFR) is affected by the BUC Volt or Current window monitor, where: 0=A BUC Volt/Current Fault does not effect the SFR, 1=A BUC Volt/Current Fault will effect the SFR. Example: BFL=1 Parameter 8 of SGC Command	BFL= (message ok) BFL? (received ok, but invalid arguments found)	BFL?	BFL=x (same format as command arguments)
BUC A Current Window	BCA=	2 bytes, numerical	Command or Query. BUC A Current Monitor Window, this command allows the user to set the alarm window in $\pm\%$ of	DAT= (message ok) DAT? (received ok, but invalid arguments found)	DAT?	DAT=xx.xx (same format as command arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
BUC A Current Window	BCA=	2 bytes, numerical	Command or Query. BUC A Current Monitor Window, this command allows the user to set the alarm window in $\pm\%$ of the calibrated BUC A Current. Valid inputs are 20 to 50 in increments of 1%. In addition, setting the value to 99 disables the alarm function. Example: BCA=30, set the alarm window at $\pm 30\%$ Parameter 6 of the SGC Command.	BCA= (message ok) BCA? (received ok, but invalid arguments found)	BCA?	BSA=xx (same format as command arguments)
BUC B Current Window	BCB=	2 bytes, numerical	Command or Query. BUC B Current Monitor Window, this command allows the user to set the alarm window in $\pm\%$ of the calibrated BUC B Current. Valid inputs are 20 to 50 in increments of 1%. In addition, setting the value to 99 disables the alarm function. Example: BCB=30, set the alarm window at $\pm 30\%$ Parameter 7 of the SGC Command.	BCB= (message ok) BCB? (received ok, but invalid arguments found)	BCB?	BSB=xx (same format as command arguments)
LNB Power Supply A Enable	LSA=	1 byte, value of 0,1	Command or Query. LNB A Power Supply, where: 0=Disabled 1=Enabled Example: LSA=1 Parameter 10 of SGC Command	LSA= (message ok) LSA? (received ok, but invalid arguments found) LSA*(message ok, but not permitted in current mode)	LSA?	LSA=x (same format as command arguments)
LNB Power Supply B Enable	LSB=	1 byte, value of 0,1	Command or Query. LNB B Power Supply, where: 0=Disabled 1=Enabled Example: LSB=1 Parameter 11 of SGC Command	LSB= (message ok) LSB? (received ok, but invalid arguments found) LSB*(message ok, but not permitted in current mode)	LSB?	LSB=x (same format as command arguments)
LNB A Reference Oscillator Enable	LRA=	1 byte, value of 0,1	Command or Query. LNB A reference Oscillator, where: 0=Disabled 1=Enabled Example: LRA=1 Parameter 12 of SGC Command	LRA= (message ok) LRA? (received ok, but invalid arguments found) LRA*(message ok, but not permitted in current mode)	LRA?	LRA=x (same format as command arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
LNB B Reference Oscillator Enable	LRB=	1 byte, value of 0,1	Command or Query. LNB B reference Oscillator, where: 0=Disabled 1=Enabled Example: LRB=1 Parameter 13 of SGC Command	LRB= (message ok) LRB? (received ok, but invalid arguments found) LRB*(message ok, but not permitted in current mode)	LRB?	LRB=x (same format as command arguments)
LNB Fault Logic	LFL=	1 byte, value of 0,1	Command or Query. LFL controls whether or not the Summary Fault Relay (SFR) is affected by the BUC Volt or Current window monitor, where: 0=A LNB Volt/Current Fault does not effect the SFR, 1=A LNB Volt/Current Fault will effect the SFR. Example: LFL=1 Parameter 16 of SGC Command	LFL= (message ok) LFL? (received ok, but invalid arguments found)	LFL?	LFL=x (same format as command arguments)
LNB A Current Window	LCA=	2 bytes, numerical	Command or Query. LNB A Current Monitor Window, this command allows the user to set the alarm window in $\pm\%$ of the calibrated LNB A Current. Valid inputs are 20 to 50 in increments of 1%. In addition, setting the value to 99 disables the alarm function. Example: LCA=30, set the alarm window at $\pm 30\%$ Parameter 14 of the SGC Command.	LCA= (message ok) LCA? (received ok, but invalid arguments found)	LCA?	LCA=xx (same format as command arguments)
LNB B Curent Window	LCB=	2 bytes, numerical	Command or Query. LNB B Current Monitor Window, this command allows the user to set the alarm window in $\pm\%$ of the calibrated LNB B Current. Valid inputs are 20 to 50 in increments of 1%. In addition, setting the value to 99 disables the alarm function. Example: LCB=30, set the alarm window at $\pm 30\%$ Parameter 15 of the SGC Command.	LCB= (message ok) LCB? (received ok, but invalid arguments found)	LCB?	LCB=xx (same format as command arguments)
Calibrate All Limits	CAL=	2 bytes, numerical	Command only. This command is used to set the calibration point for the BUC/LNB Current alarm feature. Example: CAL=	CAL=(message ok)	N/A	N/A
Calibrate BUC A Limits	CBA=	None/5 bytes numerical	Command or Query. This command is used to set the calibration point for the BUC A Current alarm feature. Command Example: CBA= Query Example: CBA=02120	CBA=(message ok)	CBA?	CBA=xxxxx (same format as command arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Calibrate BUC B Limits	CBB=	None/5 bytes numerical	Command or Query. This command is used to set the calibration point for the BUC B Current alarm feature. Command Example: CBB= Query Example: CBB=02120	CBB=(message ok)	CBB?	CBB=xxxxx (same format as command arguments)
Calibrate LNB A Limits	CLA=	None/5 bytes numerical	Command or Query. This command is used to set the calibration point for the LNB B Current alarm feature. Command Example: CLA= Query Example: CLA=120.8	CLA=(message ok)	CLA?	CLA=xxx.x (same format as command arguments)
Calibrate LNB B Limits	CLB=	None/5 bytes numerical	Command or Query. This command is used to set the calibration point for the LNB B Current alarm feature. Command Example: CLB= Query Example: CLB=120.8	CLB=(message ok)	CLB?	CLB=xxx.x (same format as command arguments)
Redundancy Control Mode	RAM=	1 byte, value of 0,1	Command or Query RAM controls whether or not the Redundancy Controller is in automatic or manual mode, where: 0=Manual Mode 1=Auto Mode Example: RAM=1 Parameter 22 of SGC Command.	RAM=(message ok) RAM? (received ok, but invalid arguments found) RAM*(message ok, but not permitted in current mode)	RAM?	RAM=x (same format as command arguments)
Redundancy Switch Control Mode	MOD=	1 byte, value of 0,1	Command or Query. MOD controls whether BOTH BUC and LNB switches switch together or independently when a fault occurs, where: 0=Dependent Switching Mode 1=Indendent Switching Mode Example: MOD=1 Parameter 23 of SGC Command	MOD=(message ok) MOD? (received ok, but invalid arguments found) MOD* (message ok, but not permitted in current mode)	MOD?	MOD=x (same format as command arguments)
Select TX LCS Function	STT=	1 byte, value of 0,1	Command or Query. STT Selects whether the LCS-4 will act as a 1:1 redundancy controller or a Combiner for the TX Where: 0=Combiner 1=Redundancy Controller Example: STT=0 Parameter 1 of SGC Command.	STT=(message ok) STT? (Received ok, but invalid arguments found) STT* (message ok, but not permitted in current mode)	STT?	STT=x (same format as command arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Select RX LCS Function	SRT=	1 byte, value of 0,1	Command or Query. SRT Selects whether the LCS-4 will act as a 1:1 redundancy controller or a Combiner for the RX Where: 0=Combiner 1=Redundancy Controller Example: SRT=0 Parameter 9 of SGC Command.	SRT=(message ok) SRT? (received ok, but invalid arguments found) SRT* (message ok, but not permitted in current mode)	SRT?	SRT=x (same format as command arguments)
UPC Control	UPC=	1 byte numerical	Command or Query This command is used to set UPC control, where: 0=Pass thru 1=UPC loop out Support Example: UPC=0 Parameter 24 of SGC Command.	UPC=(message ok) UPC? (received ok, but invalid arguments found)	UPC?	UPC=x (same format as command arguments)
TX Attenuator Control	ATT=	4 bytes, value or 1295 thru 4095	Command or Query. Sets Gain control for TX Example: ATT=1523	ATT=(message ok) ATT? (received ok, but invalid arguments found)	ATT?	ATT=xxxx (same format as command arguments)
BUC Online Control	BOC=	1 byte, numerical	Command or Query. This command is used to set which unit will be online, where: 1=BUC A 2=BUC B Example: BOC=1	BOC=(message ok) BOC? (received ok, but invalid arguments found) BOC* (message ok, but not permitted in current mode)	BOC?	BOC=x (same format as command arguments)
LNB Online Control	LOC=	1 byte, numerical	Command or Query. This command is used to set which unit will be online, where: 1=LNB A 2=LNB B Example: LOC=1	LOC=(message ok) LOC? (received ok, but invalid arguments found) LOC* (message ok, but not permitted in current mode)	LOC?	LOC=x (same format as command arguments)
Modem FSK Control	FSM=	1 byte, numerical	Command or Query. This command is used to set which unit will be used for the FSK link, where: 1=Modem 1 2=Modem 4 Example: FSM=1 Parameter 25 of SGC Command.	FSM=(message ok) FSM? (received ok, but invalid arguments found) FSM* (message ok, but not permitted in current mode)	FSM?	FSM=x (same format as command arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Set RTC Date	DAY=	6 bytes, numerical	A command in the form ddmmyy , where: dd=day of the month between 01 and 31 mm=month of the year, between 01 and 12 yy=year, between 97 and 96 (1997 to 2000, then 2000 to 2096) Example: DAY=240457 would be April 24, 2057	DAY= (message ok) DAY? (received ok, but invalid arguments found) DAY* (message ok, but not permitted in current mode)	DAY?	DAY=xxxxxx (same format as command arguments)
Set RTC Time	TIM=	6 bytes, numerical	A command in the form hhmmss , indicating the time from midnight: where: hh=hours, between 00 and 23 mm=minutes, between 00 and 59 ss=seconds, between 00 and 59 Example: TIM=231259 would be 23 hours, 12 minutes, and 59 seconds from midnight.	TIM= (message ok) TIM? (received ok, but invalid arguments found) TIM* (message ok, but not permitted in current mode)	TIM?	TIM=xxxxxx (same format as command arguments)
Serial Number	N/A	9 bytes alpha numerical 000000000 to 999999999	Query only. Used to Query the units 9 digit serial number. Target returns its S/N in the form XXXXXXXXXX. Example: RSN=000000165	N/A	RSN?	RSN=xxxxxxxx (same format as command arguments)
Retrieve Equipment Type	N/A	12 bytes alpha numerical	Query only. LCS-4 returns a string indicating the Model Number and the value of internal software revision installed. Example: RET=LCS-4 V1.0.3	N/A	RET?	RET=xxxxxxxxxxx (same format as command arguments)
Lamp Test	LMP=	1 byte, numerical	Command only. Indicates Test Mode to enable/disable all LED's, where: 0=Normal Operation 1=LED's all On 2=LED's all OFF Example: LMP=x Note: In Mode 1 or 2, the unit automatically switches to normal operation after 10 seconds.	LMP= (message ok) LMP? (received ok, but invalid arguments found)	N/A	N/A
Relay Test	RLY=	1 byte, value of 0,1	Command only. Indicates Test Mode to actuate/de-actuate Relays, where: 0=Normal Operation 1=Relays all actuated 2=Relays all de-actuated Example: RLY=x Note: In Mode 1 or 2, the unit automatically switches to normal operation after 10 seconds.	RLY= (message ok) RLY? (received ok, but invalid arguments found)	N/A	N/A

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Reference Oscillator Adjust	SRO=	3 bytes	Command or Query. Ref Osc Adjust, between 000 to 255 Resolution 001 Example: SRO=087 Note: SRO cannot be adjusted when the Switch is locked to an external reference source. Parameter 19 of SGC Command.	SRO=(message ok) SRO?(received ok, but invalid arguments found) SRO* (message ok, but not permitted in current mode)	SRO?	SRO=xxx (same format as command arguments)
External Reference Oscillator Enable	N/A	1 byte, value of 0,1	Query only. Ref OSC Status, where: 0=Internal Reference 1=External Reference Example: XRF=1	N/A	XRF?	XRF=x (same format as command arguments)
Reference Oscillator Source Select	RSS=	1 byte, value of 0,1	Command or Query. Ref OSC select, where: 0=Internal Reference 1=External Reference Example: RSS=1 Parameter 17 of SGC Command.	RSS=(message ok) RSS?(received ok, but invalid arguments found) RSS* (message ok, but not permitted in current mode)	RSS?	RSS=x (same format as command arguments)
Internal Reference Oscillator Power Control	VPC=	1 byte, value of 0,1	Command or Query. Ref Osc Power Control, where: 0=Off 1=ON Example: VPC=1 Used to disable internal VCXO in the case of failure. Parameter 18 of SGC Command.	VPC=(message ok) VPC?(received ok, but invalid arguments found) VPC* (message ok, but not permitted in current mode)	VPC?	VPC=x (same format as command arguments)
Reference OSC. Fault Logic	RFL=	1 byte, value of 0,1	Command or Query. RFL controls whether or not the Software monitors the external reference source. If enabled and no source is present a fault will be reported. 0=EXT Reference not monitored. 1=EXT Reference is monitored and the lock state reported. Example: RFL=1 Parameter 20 of SGC Command.	RFL= (message ok) RFL? (received ok, but invalid arguments found)	RFI?	RFL=x (same format as command arguments)
Synchronize Reference Cal	SRC= No Arguments	4 bytes	Command or Query. SRC synchronizes internal reference voltage with voltage of externally locked VCXO. Query shows current locked voltage. Command sets SRO value to match Vt. Command Example: SRC= Query Example: SRC=02.6	SRC=(message ok) SRC?(received ok, but invalid arguments found) SRC* (message ok, but not permitted in current mode)	SRC?	SRC=xx.x (same format as command arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Cold Start	CLD=	1 byte, value of 0,1	Command or Query. CLD enables masking reference lock detect for 3 minutes. During this time, the BUC references will be disabled during this time. Values are: 0=Normal Operation 1=Cold Start Enabled Example: CLD=1 Parameter 21 of SGC Command.	CLD= (message ok) CLD? (received ok, but invalid arguments found) CLD* (message ok, but not permitted in current mode)	CLD?	CLD=x (same format as command arguments)
Remote Address (Physical Address)	SPA=	4 bytes, numerical	Command or Query. Physical Address – between 0001 and 9999. Resolution 0001 Example:SPA=0890	SPA= (message ok) SPA? (received ok, but invalid arguments found) SPA* (message ok, but not permitted in current mode)	SPA?	SPA=xxxx (same format as command arguments)
Clear All Stored Events	CAE=	None	Command only. Instructs the target to clear all Stored Events. This command takes no arguments.	CAE=(message ok)	N/A	N/A
Retrieve next 5 unread Stored Events	N/A	145 bytes	Query only. LCS-4 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 mmddy hhmss Where: yyyyyyyyyy = being the fault description ZZ = being the alarm type FT=Fault OK=Clear IF=Information If there are no new events, the LCS-4 will reply with LNE*	AFR= (message ok) AFR? (received ok, but invalid arguments found)	AFR?	AFR=x (same format as command arguments)
Retrieve Number of unread Stored Events	N/A	2 bytes, numerical	Query Only. Returns the number of Stored Events, which remain unread, in the form xx. Example: reply: TNE=18	N/A	TNE?	TNE=xx (same format as command arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Summary Fault Status	N/A	1 byte, value of 0,1	Query only. Used to Query the status of the LCS-4 Summary Fault Relay. Where: 0=OK 1=FT Example: SFS=0	N/A	SFS?	SFS=x (same format as command arguments)
Terminal Status Change	N/A	1 byte, value of 0,1	Query only. Used to Query the status of the Terminal Status. Where: 0=No Change in Status 1=Change in Status Example: TSC=0	N/A	TSC?	TSC=x (same format as command arguments)
Restore Factory Defaults	RST=	1 byte, value of 1	Command only. Used to restore unit setting to factory default. Example: RST =1 Following is a list of restore values: RAM=0(manual) MOD=1(independent switching) SRO=Factory setting VPC=1(On) BCA, BCB, LCA, LCB=99 (Disabled) CBA,CB,CLA,CLB=0 (Zero out Cal Values) BSA, BSB, LSA, LSB=0 (PS Off) BRA, BRB, LRA, LRB=0 (Ref Off) BFL, LFL=0 (Summary Fault Unaffected) RFL=0 (EXT REF Not Monitored) CLD=0 (Disabled) FSM=1 (Modem 1 FSK Control) STT, SRT=0 (Combiner) UPC=0 (Passthru) ATT=2695 (Mid Point)	RST= (message ok) RST? (received ok, but invalid arguments found)	N/A	N/A

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Retrieve Maintenance Status	N/A	159 bytes, alpha numerical	Query only. Used to Query the maintenance status of the LCS-4 Example: RMS='cr' 48VPS=048.0'cr' 12VP1=012.0'cr' 12VP2=012.0'cr' P5.0V=+05.0'cr' N5.0V=-05.0'cr' BUCAV=024.0'cr' BUCBV=024.0'cr' BUCAC=02500'cr' BUCBC=02500'cr' LNBAV=018.0'cr' LNBBV=018.0'cr' LNBAC=125.0'cr' LNBBC=125.0'cr' REFVT=005.0'cr' FAN C=725.0'cr' TEMPO=025.0'cr'lf]	N/A	RMS?	RMS=x...x (same format as command arguments)
Concise Maintenance Status	N/A	80 bytes, numerical	Query only. Used to Query the Maintenance status of the LCS-4 Example: CMS=aaa.a,bbb.b,ccc.c,ddd.d,eee.e fff.f,ggg.g,hhh.h,iii.i,jjj.j,kkk.k,lll.l,mmm.m nnn.n,ooo.o,ppp.p'cr'lf where: aaa.a = Main 48V Power Supply bbb.b = 12V Power Supply 1 ccc.c = 12V Power Supply 2 ddd.d = +5V Power Supply eee.e = -5V Power Supply fff.f = BUC A Power Supply ggg.g = BUC B Power Supply hhh.h = BUC A Current in milliamperes iii.i = BUC B Current in milliamperes jjj.j = LNB A Power Supply kkk.k = LNB B Power Supply lll.l = LNB A Current in milliamperes mmm.m = LNB B Current in milliamperes nnn.n = Reference Tune Voltage ooo.o = Fan Current in milliamperes ppp.p = Unit Temperature	N/A	CMS?	CMS=x....x (see description for details of arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Concise Utility Status	N/A	32 bytes, alpha numerical	Query only. Used to Query the Utility status of the LCS-4 response in comma delimited. Example: CUS=aaaaa,bbbb,ccc.c,ddd.d,eee,f,g,h,'cr'lf] where: aaaaa = BUC A CAL Current bbbb = BUC B CAL Current ccc.c = LNB A CAL Current ddd.d = LNB B CAL Current eee = Reference Adjust setting f = External Reference Sense g = BUC Online Status h = LNB Online Status	N/A	CUS?	CUS=x....x (see description for details of arguments)
Retrieve Alarm Status	N/A	147 bytes, text	Query only. Used to Query the Alarm status of the LCS-4 Example: RAS='cr' 48VLT=OK'cr' 12VP1=OK'cr' 12VP2=OK'cr' P5VLT=OK'cr' N5VLT=OK'cr' BUCAV=OK'cr' BUCBV=OK'cr' BUCAC=OK'cr' BUCBC=OK'cr' BUCSW=OK'cr' LNBAV=OK'cr' LNBAC=OK'cr' LNBBC=OK'cr' LNBSW=OK'cr' FANMC=OK'cr' REFLD=OK'cr' BUCSW=OK'cr' LNBSW=OK'cr' SFLTS=ok'cr'lf]	N/A	RAS?	RAS=x....x (see description for details of arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Concise Alarm Status	N/A	41 bytes, numerical	<p>Query only. Used to Query the Alarm status of the LCS-4 response is comma delimited. Example: CMS=abcdefghijklmnopqr'cr'lf where: a thru t = 0 or 1, 0 = OK 1 = FT a = Main 48V Power Supply A Alarm b = 12V Power Supply B Alarm c = 12V Power Supply Alarm d = +5V Power Supply Alarm e = -5V Power Supply Alarm f = BUC A Voltage Alarm g = BUC B Voltage Alarm h = BUC A Current Alarm i = BUC B Current Alarm j = BUC Switch Alarm k = LNB A Voltage Alarm l = LNB B Current Alarm m = LNB A Current Alarm n = LNB B Current Alarm o = LNB Switch Alarm p = Fan Current Alarm q = REF Lock Detect PLL Alarm r = BUC Redundancy Switch Alarm w = LNB Redundancy Switch Alarm t = Summary Fault Status</p>	N/A	CAS?	CAS=abcdefghijklmnopqr (see description for details of arguments)

Parameter Type	Command (Instruction Code and qualifier)	Arguments for Cmd or Response to Query	Description of Arguments Note that all arguments are ASCII numeric codes between 48 and 57.	Response to Command (Target to Controller)	Query (Instruction code and qualifier)	Response to query (Target to Controller)
Switch Global Configuration	SGC=	56 bytes, with numerical entries fixed value entries, and delimiters	Command or Query. Global configuration of Unit, in the form: SGC=abcdefghijklmnopqrsstuvvwx'cr"lf] where: a = Tx LCS Function (STT) b = BUC A Power Supply Enable (BSA) c = BUC B Power Supply Enable (BSB) d = BUC A Reference Osc. Enable (BRA) e = BUC B Reference Osc. Enable (BRB) ff = BUC A Current Window (BCA) gg = BUC B Current Window (BCB) h= BUC Fault Logic (BFL) i = RX LCS Function (SRL) j = LNB A Power Supply Enable (LSA) k = LNB B Power Supply Enable (LSB) l = LNB A Reference Osc. Enable (LRA) m = LNB B Reference Osc. Enable (LRB) nn = LNB A Current Window (LCA) oo = LNB B Current Window (LCB) p = LNB Fault Logic (LFL) q = Ref Source select (RSS) r = VCXO Power Control (VPC) sss = Reference OSC. Adjust. (SRO) t= Reference Fault Logic (RFL) u = Cold Start Enable (CLD) v = Redundancy Switch Control Mode (RAM) w = Redundancy Switch Control Mode (MOD) x = UPC Support (UPC) y = Modem FSK control (FSM)	SGC= (message ok) SGC? (received ok, but invalid arguments found)	SGC?	SGC= abcdefghijklmnopqrsstuvvwx xy (same format as command arguments)

NOTES:

Appendix B. SPECIFICATIONS

B.1 GENERAL SPECIFICATION

Table B-1. General Specification

System Specification		
Operating Frequency Range	950 to 1950 MHz	
TX IF Connector:		
Modulator Side	Type N, Female, 4 combined inputs	
BUC Side	Type N, Female, 2 switched outputs, 1 ON at a time	
TX IF Impedance/Return Loss	50Ω/10 dB minimum	
TX Input Level, Modulator Side	0 to -40 dBm, operating per port, +10 dBm maximum per port	
TX Uplink Power Control (UPC) Access	Input and output SMA female connectors. Routes composite modulator signals through UPC equipment then back to LCS-4 for external power leveling.	
TX UPC Signal Level	Combined TX input level -7 dB typical both connections	
Isolation	TX input to unselected output 50 dB minimum TX input or TX output to RX Output 90 dB minimum.	
TX Gain, Combiner Input to TX Output	-10 dB maximum loss	
TX Gain, Balance Adjust	TX Level to BUC AB is adjustable ± 3 dB minimum with respect to BUC A level in approx 0.1 dB increments.	
TX Gain, Balance Control	Control is via a momentary center OFF SPDT switch or M&C.	
TX 3 rd Order Products (2-tone)	-55 dBc for two CW carriers at the TX Output each -6 dBm.	
TX 2 nd Order Products (2-tone)	-55 dBc for two CW carriers at the TX Output each -6 dBm.	
RX IF Impedance/Return Loss	75Ω/10 dB minimum 950 to 1750 (2150 goal) MHz	
RX IF Connector:		
LNB Side	Type F, Female, 2 switched inputs, 1 ON at a time	
Demodulator Side	Type F, Female, 4 outputs from a power splitter	
RX Input Level, LNB Side	-90 to -5 dBm, operating, +10 dBm maximum composite	
Gain RX In/Out	0 \pm 3 dB	
RX 3 rd Order Products (2-tone)	-30 dBc for two CW carriers at the RX Output each +7 dBm	
RX 2 nd Order products (2-tone)	-40 dBc for two CW carriers at the RX Output each +7 dBm	
Isolation	50 dB unused RX input to splitter output	
Internal Frequency Reference:		
Calibration	Internal reference adjustable ± 1 kHz	
Frequency	10.0 MHz	
Stability	± 0.02 ppm	
Phase Noise	db/Hz	Frequency Offset
	-80	1 Hz
	-110	10 Hz
	-135	100 Hz
	-140	1 kHz
	-150	10 kHz
	-150	100 kHz

Table B-1. General Specification (Continued)

10 MHz Reference: To BUC To LNB	Via TX (BUC)/RX (LNB) center conductor, selectable ON/OFF 0 ± 3 dBm -3 ± +3 dBm
Spurious Emissions TX Toward BUC or RX Toward Demodulator	-55 dBc over 55 MHz to 2.2 GHz measured in a 4 kHz BW with a CW source.
TX Output Level with TX Inputs Terminated	-60 dBm or less over 800 MHz to 2.2 GHz measured in a 4kHz BW.
TX Output with Modulated Carrier with Unused Ports Terminated.	-55 dBc over the operating frequency range measured in a 4 kHz BW -60 dBm over 1610 to 1 680 MHz in a 4 kHz BW for Inmarsat applications.
RF Input/RF Output Overload	All TX and RX inputs or outputs shall sustain +13 dBm per port without damage.
FSK Communications to BUC	Pass through from modem via ports 1 or 4 for primary and backup access Protocol: Interoperable with the SierraCom or Terrasat BUC.
FSK Drivers/Receivers	Hardware is provided – software support for FSK is future.
Outdoor RF Switch Control Connector	Indoor circuitry to drive outdoor BUC and LNB RF Switched.
Remote Port Connector	RS-232 and RS-485 Control or Unit.
Relay Fault Status Connector	ODU/BUC A ODU/BUC B/LNB A/LNB B and Combiner Switch Unit.
BUC/LNB Fault Input	BUC A/B FLT inputs LNB A/B FLT Separate FLT enable inputs for BUC and LNB
DIP Switch Sensing (4)	1 switch indicates EXT ODU/BUC Fault contact inputs 1 switch indicates EXT LNB fault contact inputs 2 switches - future
Prime Power: AC Inlet A AC Inlet B	85 to 264 VDC, 47 to 63 Hz, 60W maximum, excluding BUC PS 85 to 264 VDC, 47 to 63 Hz, 60W maximum, excluding BUC PS
Optional Prime 48 VDC Power: DC Inlet A DC Inlet B	38 to 64 VDC, 60W maximum, excluding BUC PS 38 to 64 VDC, 60W maximum, excluding BUC PS
LNB Voltage via 2 RX Connectors	18 VDC at 500 mA, maximum. Selectable ON OFF via M&C control. Voltage and current monitored with window limit sensing. Short circuit protected.
BUC Voltage via 2 RX Connectors	Optional 24 to 48 VDC BUC power. Selectable ON/OFF via M&C control. Voltage and current monitored with window limit sensing. Short circuit protected.
Power Consumption: 100W BUC PS 150W BUC PS	220W maximum (Estimated) 300W maximum (Estimated)

B.2 ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS

Table B-2. Environmental and Physical Specifications

Environmental Specifications	
Temperature	0 to -50°C (32 to 122°F)
Humidity	95% Non-condensing
Operation Shock	MILS-STD-167-1 When any one corner of the unit is dropped from 1 cm onto a hard surface, the unit will not take any errors or faults.
Survivability Shock and Vibration	MIL-STD-810D, Method 514.4, Procedure 8, 1 hour/axis
Agency Approval	CE Mark
Physical Specification	
Size	1.75H x 19W x 19.18D inches 1RU (4.44H x 48.26W x 48.72D cm)
Weight	14.5 lbs (6.51 kg) maximum
Mounting	Standard 19-inch (48.26cm) rack mounts front and rear accepts standard rack mount.
Airflow	Two or more fans with fan monitors
Internal Temperature	High temperature alarm/internal temperature report.

Metric Conversions

Units of Length

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

Temperature Conversions

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

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

Units of Weight

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



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