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ClearGain® 1800 MHz and 2100 MHz Dual Inline Tower Mounted Amplifier System User Manual

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REVISION HISTORY

ISSUE	DATE	REASON FOR CHANGE
1	06/2006	Original
2	09/2006	Add support for 1800MHz System

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ABOUT THIS MANUAL

This document describes the ADC ClearGain 1800 and 2100 MHz Dual Inline Tower Mounted Amplifier (TMA) Systems and provides complete instructions for installing these products on a communications tower.

ADMONISHMENTS

Important safety admonishments are used throughout this manual to warn of possible hazards to persons or equipment. An admonishment identifies a possible hazard and then explains what may happen if the hazard is not avoided. The admonishments — in the form of Dangers, Warnings, and Cautions — must be followed at all times. These warnings are flagged by use of the triangular alert icon (seen below), and are listed in descending order of severity of injury or damage and likelihood of occurrence.

Danger: *Danger is used to indicate the presence of a hazard that* ***will*** *cause severe personal injury, death, or substantial property damage if the hazard is not avoided.*

Warning: *Warning is used to indicate the presence of a hazard that* ***can*** *cause severe personal injury, death, or substantial property damage if the hazard is not avoided.*

Caution: *Caution is used to indicate the presence of a hazard that* ***will*** *or* ***can*** *cause minor personal injury or property damage if the hazard is not avoided.*

CERTIFICATION

The ClearGain 1800 and 2100 MHz Dual Inline TMA have been tested and found to comply with the requirements of EN60950.

The ClearGain 1800 and 2100 MHz Dual Inline TMA have been tested and found to comply with all applicable CE Directives.

STANDARDS

The following is a listing of applicable regulatory standards:

Safety	EN60950
EMC	ETSI 300-342-2
Storage	ETSI 300 019-1-1
Transport	ETSI 300 019-1-2
Operation	ETSI 300 019-1-4

LIST OF ACRONYMS

AISG – Antenna Interface Standards Group

ANT – Antenna

AWG – American Wire Gauge

BTS – Base Transceiver Station

LED – Light Emitting Diode

LNA – Low Noise Amplifier

MHU – Masthead Unit

OOK – On/Off Key

PDU – Power Distribution Unit

RET – Remote Electrical Tilt

RF – Radio Frequency

TMA – Tower Mounted Amplifier

1 PRODUCT OVERVIEW

1.1 General Description

The ClearGain 1800 or 2100 MHz Dual Inline Tower Mounted Amplifier (TMA) system are composed of some combination of three functional components: a ClearGain Power Distribution Unit (PDU), a Masthead Unit (MHU) / Tower Mounted Amplifier (TMA), and a Bias-T. Figure 1 shows where these components are located in a typical application on a communications tower.

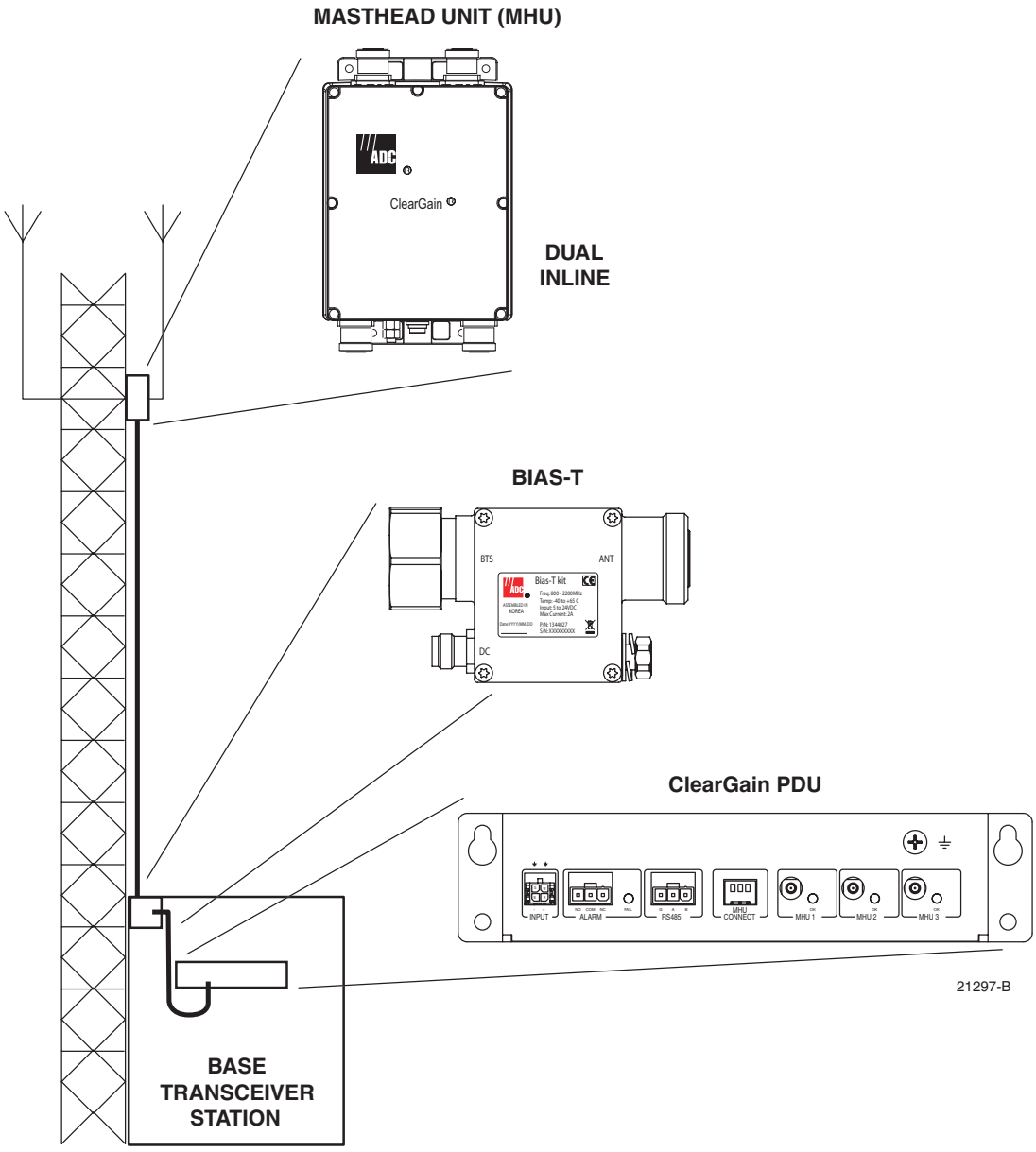


Figure 1. Functional Components of a ClearGain TMA System

One PDU may support up to three dual inline MHUs of the same frequency. Each MHU requires a separate Bias-T. The ClearGain TMA system also includes power cables and alarm cables.

1.2 Functional Description

The basic purpose of a ClearGain Dual Inline TMA system is to amplify the uplink signal just after the antenna. This is done to compensate for the loss in signal strength that occurs in passage of the signal through the coaxial cable to the Base Transceiver Station (BTS) at the base of the tower. The ClearGain TMA system improves the performance of the BTS by providing 12dB of uplink (reverse path) gain with a low noise figure. The ClearGain TMA system provides visual and dry contact output alarming and lightning protection. Figure 2 depicts how the system components are involved in system function.

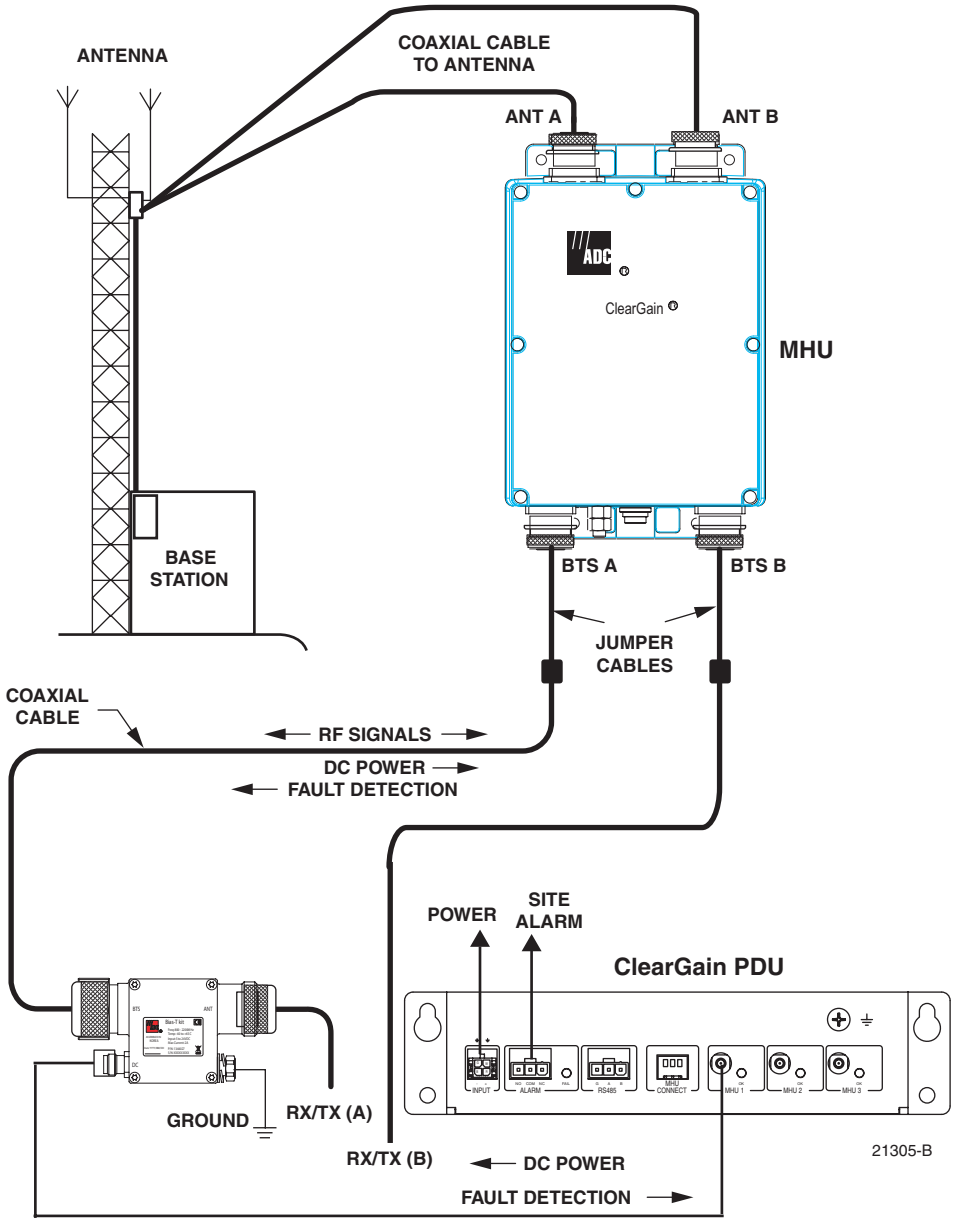


Figure 2. System Function

MHU – located as close to the antenna as possible, performs the amplifier function on the uplink signal. Three subcomponents of the MHU, two RF cavity filters, and a Low Noise Amplifier (LNA), are involved in the amplifier function. Downlink signal is not amplified but passed through an RF cavity filter.

PDU – located in the base station, provides DC current to power the LNAs and On/Off Key (OOK) modem signal for use in the Remote Electrical Tilt (RET). The PDU outputs the DC current through a front port from which it travels by way of a short linkage cable to the Bias-T. The injection of the DC power onto the coaxial cable will not cause interference with signal transmission.

The PDU monitors the MHUs simultaneously by sensing their current draws. If any of the MHUs fail, or if there is a cut or short circuit in the coaxial cable, the PDU sends an alarm to the BTS. The PDU thus also monitors the condition of the coaxial cable, not just the MHU. The PDU also has built-in lightning protection.

The PDU has a connector for RET communication with the BTS. The data bus is a two-wire bi-directional configuration and can be used for RS-485 communications link between the BTS and PDU. The OOK modem is AISG standard compliant.

Bias-T – located on the coaxial cable, is a passive device that physically injects DC power onto the coaxial cable to provide powering for the MHU. Bias-T may be installed indoors or outdoors. There are four Bias-T connector options:

- 7/16 DIN male to the BTS; 7/16 DIN female to the ANT
- 7/16 DIN female to the BTS; 7/16 DIN male to the ANT
- N male to the BTS; N female to the ANT
- N female to the BTS; N male to the ANT

A single PDU supports three dual inline MHUs (with one Bias-T required for each dual inline MHU). The Bias-T may be plugged into either of the RF cables to power the MHU.

2 SYSTEM INSTALLATION

2.1 Installation Overview

Installation consists of three main steps:

1. Installing the MHU: mechanical attachment, coaxial cables and ground cable.
2. Installing the PDU: mechanical attachment, operation power, alarms and ground cable.
3. Installing the Bias-T: mechanical attachment, coaxial cables, power cable and ground cable.

2.2 Masthead Unit Installation

Pole mounting kits are provided for installing the MHU. See Figure 3. Before any installation, check that the ClearGain MHU has no visible damages or defects. Place ClearGain MHU as close to the antenna as possible.

Note: All hardware is specified in metric units. The threads are sensitive to damage.

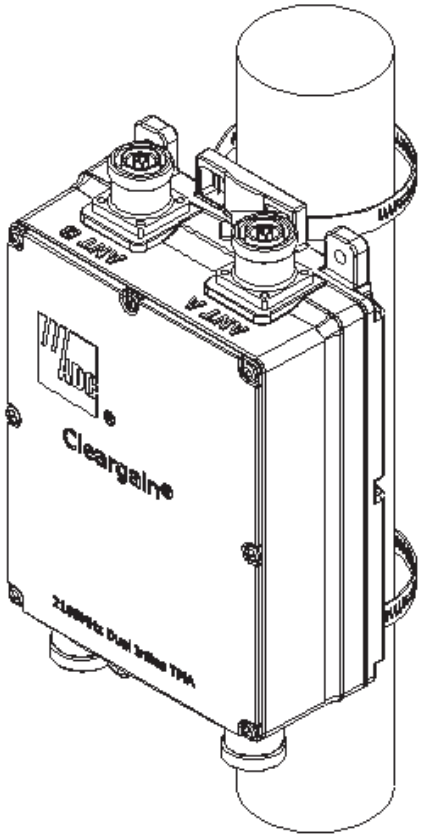


Figure 3. Typical MHU Clamp Mounting Kit Components

1. When installing on a pole a clamp kit (Figure 3) is required. The kit is designed for tube diameters of 30 to 140 mm.
2. Before going up to the mast, temporarily remove the connector protector plugs, inspect the 7/16 DIN connectors for damage, and return the connector protector plugs to their respective connectors.
3. Install clamps on pole and route through the mounting openings near the center of the MHU.
4. Position MHU at the desired location and tighten clamps securely.

2.2.1 Installing the MHU Ground Cable

Good grounding of the ClearGain MHU is important to protect the unit against voltage surges. These surges may be caused by lightning or inadvertent contact with high voltage power lines.

Install the ground cable as follows:

1. Connect the ground cable to MHU bottom using M8 star washer and nut.
2. Connect the other end of the cable to a good ground (site ground) with a reliable joint.

GROUNDING and BONDING CONSIDERATIONS

- Grounding is very important in tower top applications. Shipped with each MHU, is a 4mm (#6 AWG), one-meter (39-inch) ground cable with single hole crimp lug connectors on both ends. Installation hardware is provided to attach one end to the MHU.
- Keep ground wire as short and direct (no loops or knots) as possible, secure it to a good ground point (metal to metal).
- Always follow local grounding practices. The single hole lug is typically used to attach a dedicated tower ground bus.
- In the absence of a dedicated ground, the tower structure itself can be used by using a exothermic weld joint (not very common) or a mechanical ground clamp. If a clamp is used, it must be very tight and protected from corrosion effects with a corrosion preventative compound. It is recommended that the ground integrity/resistance at any mechanical junction be checked during periods of regular tower maintenance. Always follow local grounding practices.
- If the ground cable length is too short, customer may make a longer ground cable using 4mm (#6 AWG) wire as long as all the mechanical connections are tight and clean. Keep ground cables as short as possible.

2.2.2 Installing Coaxial Cables

⚠ **Caution:** *Before connecting any coaxial cables, ensure that the BTS transmitter output is turned off and that precautions are taken to ensure that the transmitter cannot be activated during the equipment installation.*

Four short coaxial jumpers should be pre-made. Two will connect the BTS ports to the hard line and the other two will connect the ANT ports to the antenna.

⚠ **Caution:** *Remote Electrical Tilt (RET) connector on MHU must be covered with protective cap if a cable is not connected to meet IP65 rating.*

Most installations require four good quality flexible coax jumpers, normally terminated with 7/16 DIN-7/16 DIN connectors. Check gender of hard line and determine if antenna pigtail is present, adjust accordingly for a correct match.

The coaxial feeder that runs from the base station to the antenna should be attached to the BTS port of the MHU using a jumper cable. The reason for the jumper cable is to ensure that mechanical forces caused by temperature change will not damage the MHU connectors. Tighten connectors to 25–30 Nm (18.43–22.13 ft. lbs.) torque.

To improve connection reliability the connector joint can be protected. This is done, by installing specific weatherproof tape over the cable connectors. Loose cable should be secured to the tower using cable brackets.

2.3 PDU Installation

2.3.1 Mechanical Attachment of PDU

⚠ **Warning:** *Never install the Power Distribution Unit in a wet location or during a lightning storm. When installing or modifying communication lines, disconnect lines at the interface before working with uninsulated lines or terminals to prevent electrical shock.*

The PDU should be mounted in accordance with local code using appropriate hardware. The PDU has two mounting holes on either side, as shown in Figure 4. Below are guidelines for standard wall mount, masonry wall mount, and rack mount of the PDU.

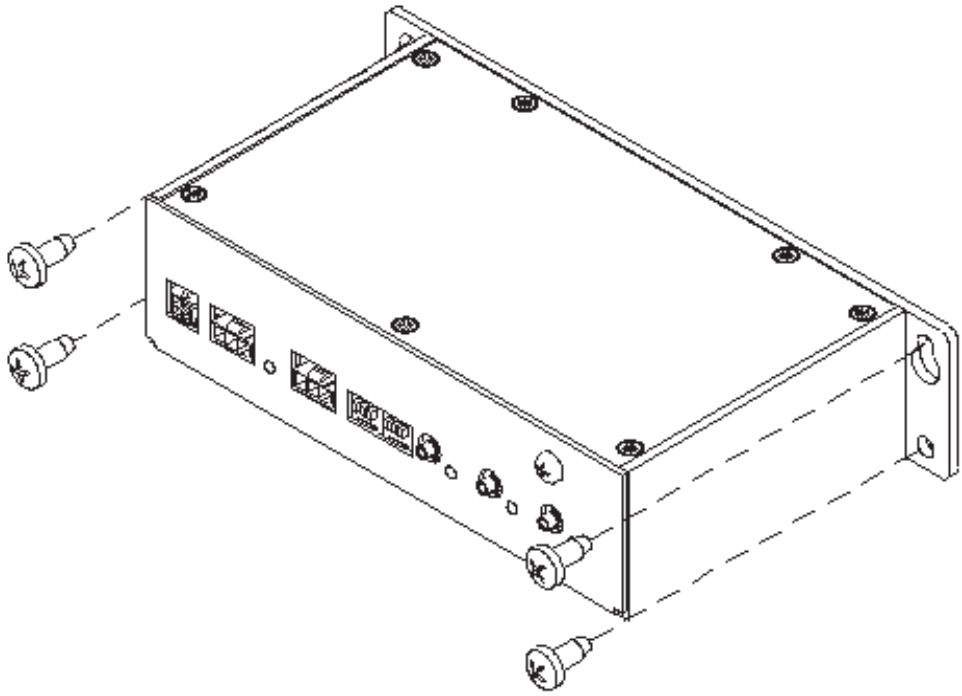


Figure 4. Example of PDU Standard Wall Mount

2.3.1.1 Standard Wall Mount

When mounting the PDU on a wooden or metal surface, it is recommended that it be installed on a secure surface.

2.3.1.2 Masonry Wall Mount

When mounting the PDU on a masonry surface, it is important that the bolts (especially the upper bolts) be located as close as possible to the center of bricks or blocks. Masonry mounting screws are not provided.

2.3.1.3 Rack Mount (Optional)

A mounting bracket, shown in Figure 5 is available that allows the PDU to be mounted in a rack. If mounting PDU in a rack, refer to the installation drawing provided with the mounting bracket.

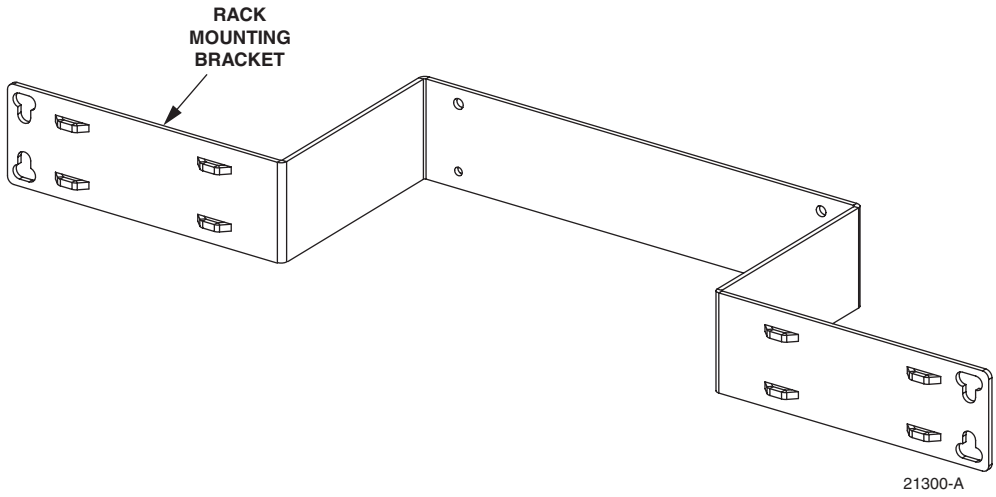


Figure 5. PDU Rack Mount Bracket

2.3.2 Installation of PDU Cables

There are fife PDU cables:

- Power cable
- Alarm cable
- Communication cables
- MHU (Bias-T) cables
- Ground cable.

Figure 6 shows the cable terminations on the front of the PDU. Connect the cables as follows:

(Left to Right: Power Cable, Alarm Cable, RS-485, Three MHU (Bias-T) Cables, and Ground Cable)

Figure 6. Cable Terminations on Front of PDU

1. Connect the ground cable under the grounding screw on the PDU front panel. Connect the other end of the cable to the site-grounding pole.
2. Connect the alarm cable leads to the base station or site alarm system. Use either "Normally Open" or "Normally Closed" contacts. Figure 7 shows the PDU alarm logic.
3. Connect the other end of the alarm cable to the PDU "ALARM" connector.
4. Connect communication cable leads to the base station or site control systems to control RET. The data bus is a two-wire bi-directional configuration and is used for the RS-485 communications link. Figure 7 shows the RS-485 connection.
5. Connect the power cable to the site DC power source. (The power cable has four leads. Red is positive, Black is negative, and White/Green is for ground.)
6. Connect the power cable to the "INPUT" connector on the PDU front panel.

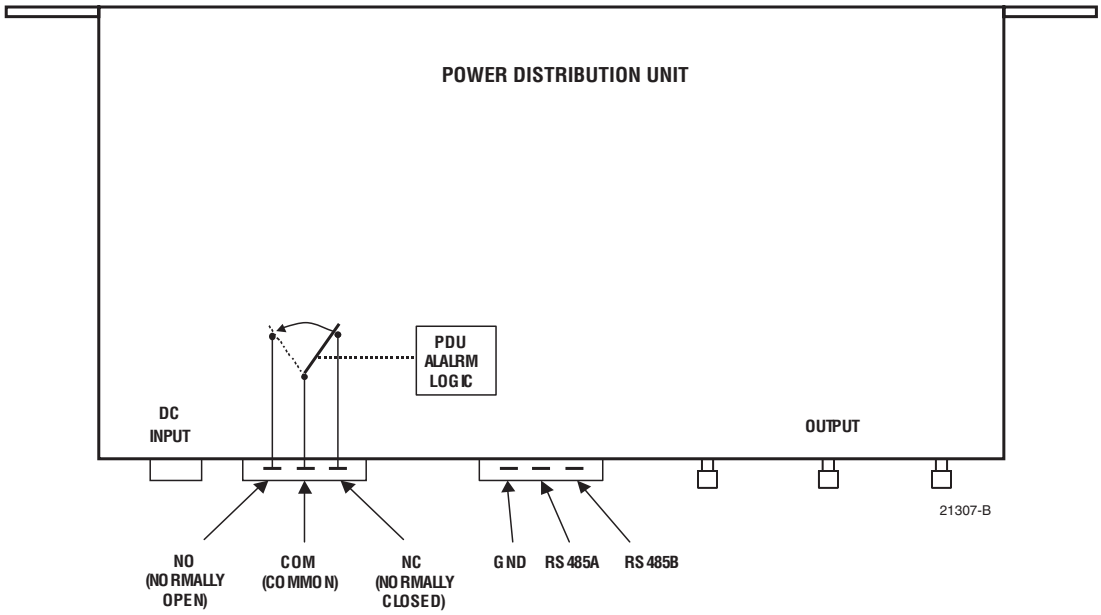
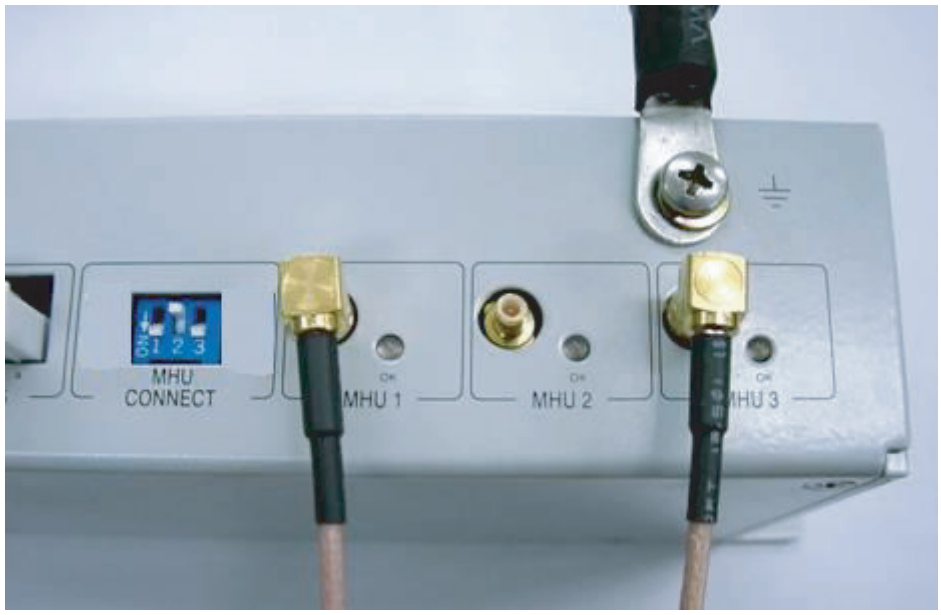


Figure 7. PDU Alarm Logic and RS-485 Connections

2.3.3 Setting the DIP Switch on the PDU

PDU has one set of dip switches to enable or disable the MHU ports. To disconnect unused MHU output (see Figure 8). For the MHU outputs that are used, the DIP switch must be in the "down" position or "ON". Unused outputs must be disconnected by setting DIP switch in the "up" position.



(Switch 1 and 3 Set to "ON" to Indicate Use of MHU Ports 1 and 3)

Figure 8. Example of DIP Switch Setting on the PDU

2.4 Bias-T Installation

2.4.1 Mechanical Attachment and Cable Connections

Caution: *Prior to installing any Bias-T unit, ensure that the BTS transmitter output is turned off and that precautions are taken to ensure that the transmitter cannot be activated during the equipment installation.*

The Bias-T is installed either inline with the antenna feeder cable or directly to the BTS antenna port. Integrated lightning protection is built into each Bias-T unit. There is no additional mounting hardware required. Bias-T can be installed in either of the two antenna feeder cables for each MHU. Connect the Bias-T as follows:

1. Connect the Bias-T "BTS" connector inline with the antenna feeder cable or directly in the BTS antenna port.

Note: Orientation of the Bias-T is critical, BTS end should face the BTS and ANT should face the antenna.

2. Connect the coaxial run going to the MHU to the "ANT" port of the Bias-T.
3. Connect the mini coax cable to the TNC connector of the Bias-T unit.
4. Connect the other end of the mini coax cable to the PDU front panel SMB connector MHU1…3 (whichever is being used).
5. Connect the ground cable to the Bias-T ground terminal (see Figure 9).
6. Connect the other end of the ground cable to the site-grounding pole.

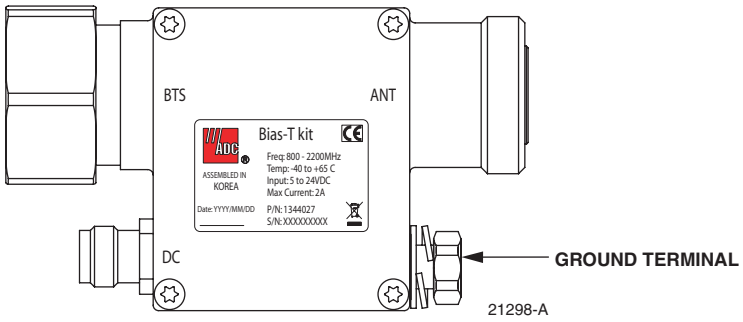


Figure 9. Bias-T Ground Cable Connection

2.4.2 Additional Lightning Protection

ADC recommends that the operator install further lightning protection between the MHU and Bias-T. It must allow the DC voltage to pass through the lightning protector, if it does not then the Bias-T should be mounted on the antenna side of the protection.

3 TROUBLESHOOTING

When a fault occurs with the system, the red alarm LED on the PDU and the PDU dry-alarm contact are activated. In such a case, troubleshoot for problems as follows:

1. Check that power is present at the PDU. The PDU will not operate if DC is not present, polarity is incorrect, or the DC presented is out of specifications (–56 to –20 VDC or +20 to +56 VDC).
2. Each MHU output has a status LED. Status LED for each MHU that is in use should be GREEN.
3. Disable or disconnect any unused MHU ports to prevent false alarm conditions.
4. Verify that DC voltage is present at the MHU port on the PDU. Disconnect the MHU (Bias-T) cable and measure output voltage using a multimeter (Voltage measurement, DC). Nominal DC output power should be 14–16 VDC.
5. Verify that DC voltage is present at the antenna side of the Bias-T. Disable RF transmit power or disconnect it from the BTS. Disconnect antenna feeder cable from ANT side of Bias-T and measure voltage using a multimeter (Voltage measurement, DC). Nominal DC output power should be 14–16 VDC.

4 TROUBLESHOOTING 4-PORT CLEARGAIN DUAL INLINE DUAL DUPLEX TOWER MOUNTED AMPLIFIERS

Trouble is visually indicated by LED's or no LED illumination on a specific MHU, swap Bias-T cables on PDU ports to see if trouble remains or moves (reference Figure 8). See Figure 10 for possible trouble points.

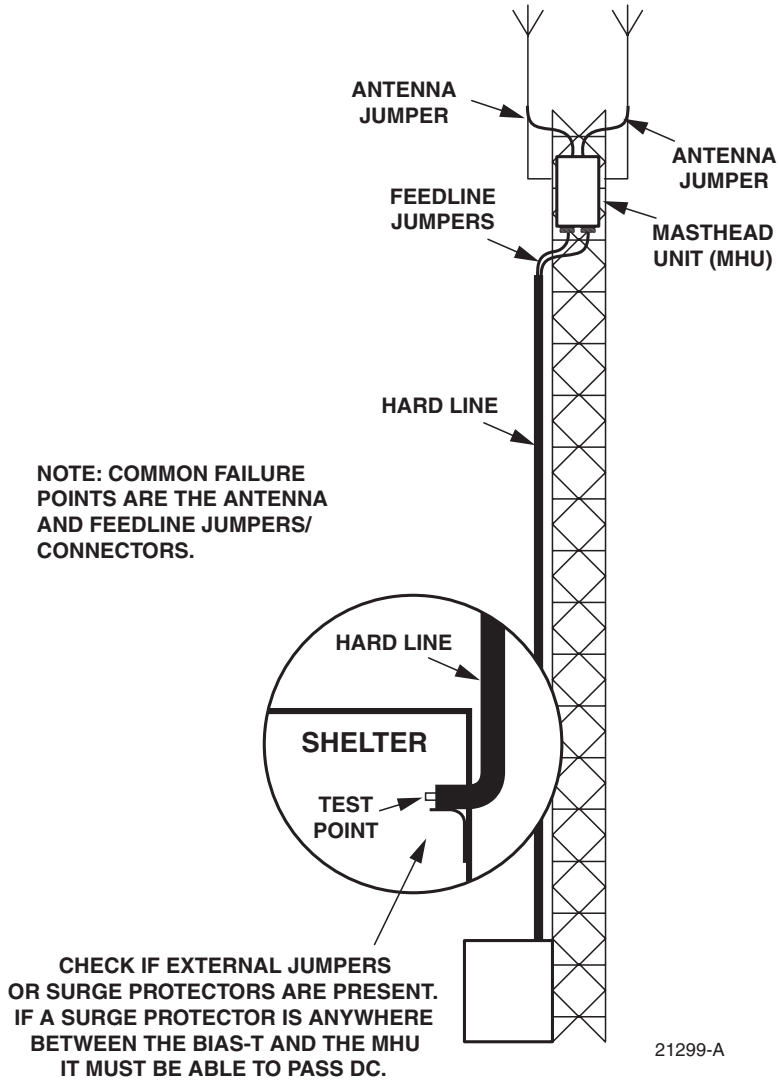
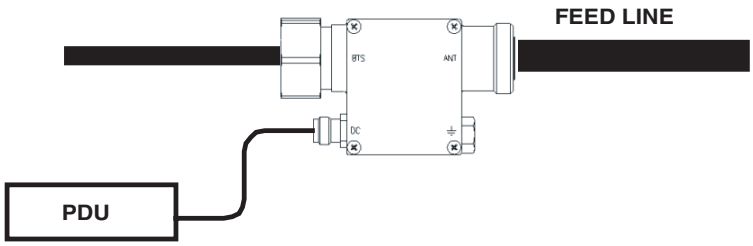


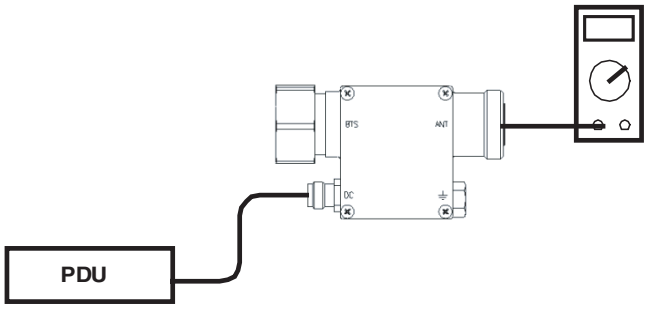
Figure 10. Tower Mounted Amplifiers

4.1 Troubleshooting

1. Observe and record PDU LED status. Disable or disconnect RF from BTS. Remove any surge protectors. Disconnect Bias-T from the antenna feedline / hardline / jumper / protector.

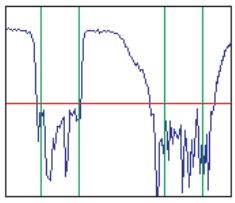


2. Multimeter checks:
   a. Measure voltage on the Bias-T _____ VDC. Normal is 15 VDC.

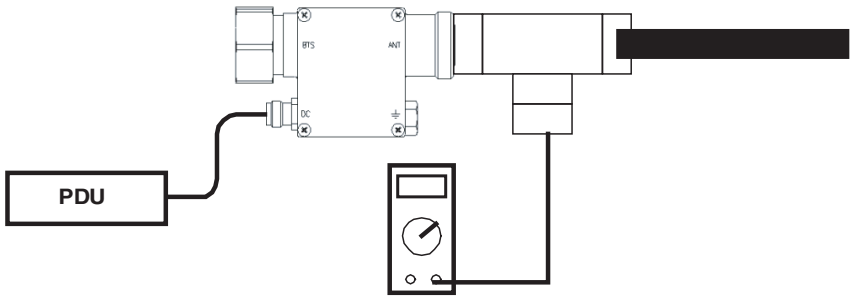


   b. Measure resistance of the feedline _____ Ohms. Normal is High or Very high Ω (KΩ/MΩ).

3. Antenna/cable analyzer checks. Measure the *in-band* RL/VSWR of the system _____ dB or ratio. Check distance to Fault for anomalies.



4. Re-connect Bias-T with a T adapter. Verify voltage on the T adapter _____ VDC. Normal is 15 VDC.



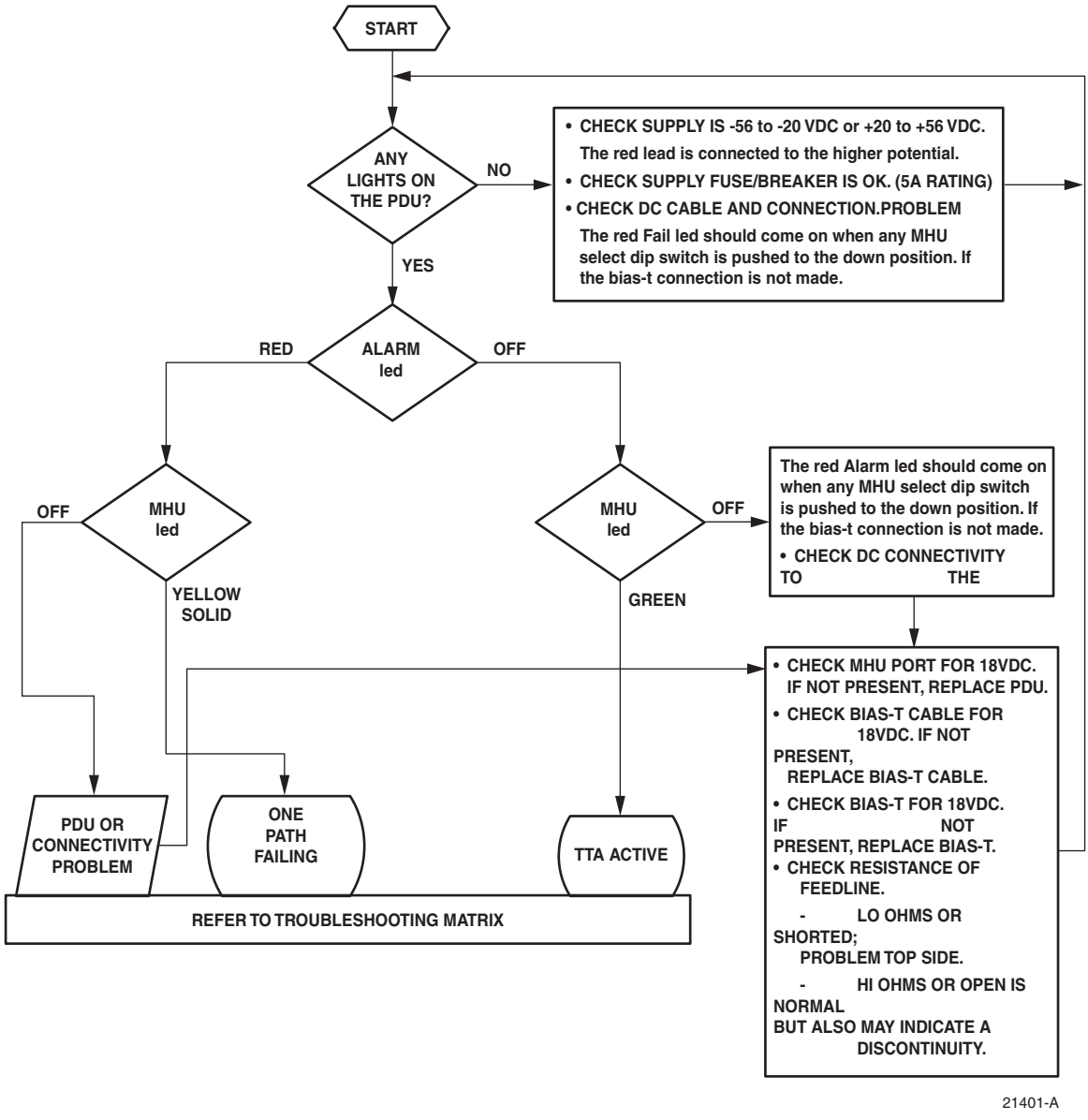
5. Re-connect to original configuration and return to service. PDU should illuminate a green LED for each active TMA if there are no faults in the system.
6. Check with operators for improved performance.

4.2 Troubleshooting Hints

- If voltage is outside of the normal range, trace it back towards the fault.
- If no resistance or low resistance, check protector, feedline, jumpers and MHU.
- If an infinite resistance reading (sometimes indicated by OL), check to see if MHU is installed or for a discontinuity exists up to the MHU.
- Normal in-band RL should be greater than 18dB. If less than 18dB, check protector, feedline, jumpers and antenna.
- Mark receive and transmit bands to verify correct filtering.
- Check the distance to fault to identify any anomalies on the feedline.

4.3 Troubleshooting Flowchart (For Systems With Three-Port MHUs)

If directed by the flowchart, refer to the troubleshooting matrix in Section 4.4 or to the return loss sweep guide in Section 4.5.



4.4 Troubleshooting Matrix

If directed in Section 4.3 to consult a troubleshooting matrix, see Table 1 below.

Note: ClearGain PDU DIP switches must be in the down position for each active MHU!

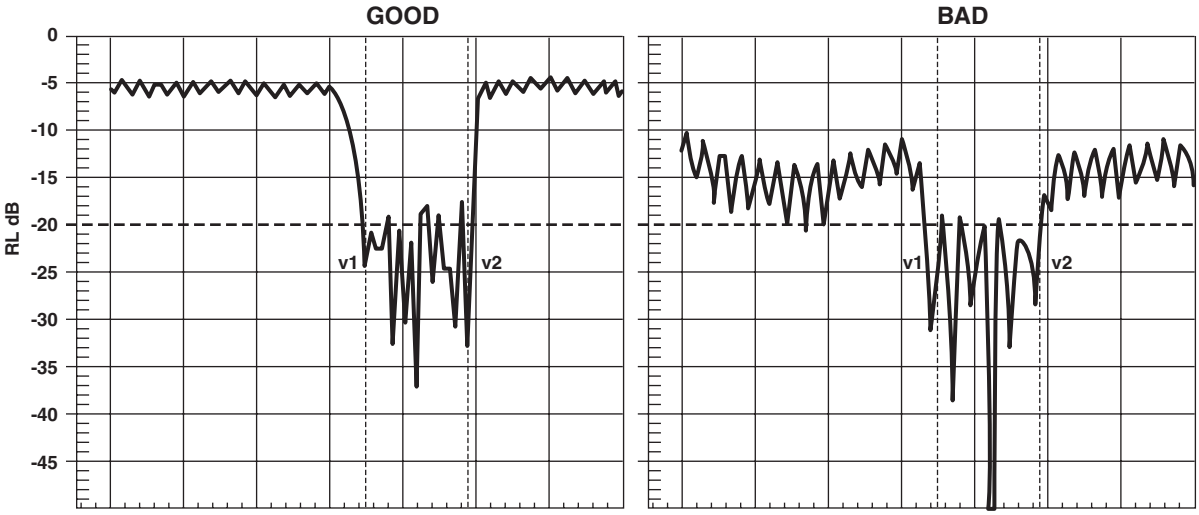
Note: ClearGain PDU input voltage must be in the range –56 to –20 VDC or +20 to +56 VDC.

Table 1. Troubleshooting Matrix

PARAMETER	SPECIFICATION	EXPLANATION	GREEN/YELLOW OK LED	RED GENERAL ALARM LED
Electronic Load				
Each Path OFF	< 180 mA	Fail	OFF	ON
Each Path ON	180 – 220 mA	OK	GREEN	OFF
Total Fail	370 – 400 mA	Fail	OFF	ON
Short Circuit Protection	1.5 A ± 10%	Fail	GREEN	ON
	Short state of MHU path does not affect other path. After generating Green alarm, the short state is held for ten seconds then Red alarm is generated by the PDU.			
Circuit Fluctuation	Min 180 mA Max 380 mA	One path failed.	YELLOW	ON
Input Voltage	–56 to –20 VDC / +20 to +56 VDC	OK	GREEN	OFF
Output Voltage	15 V, 4%	Total failure.	OFF	ON

4.5 Return Loss Sweep Guide

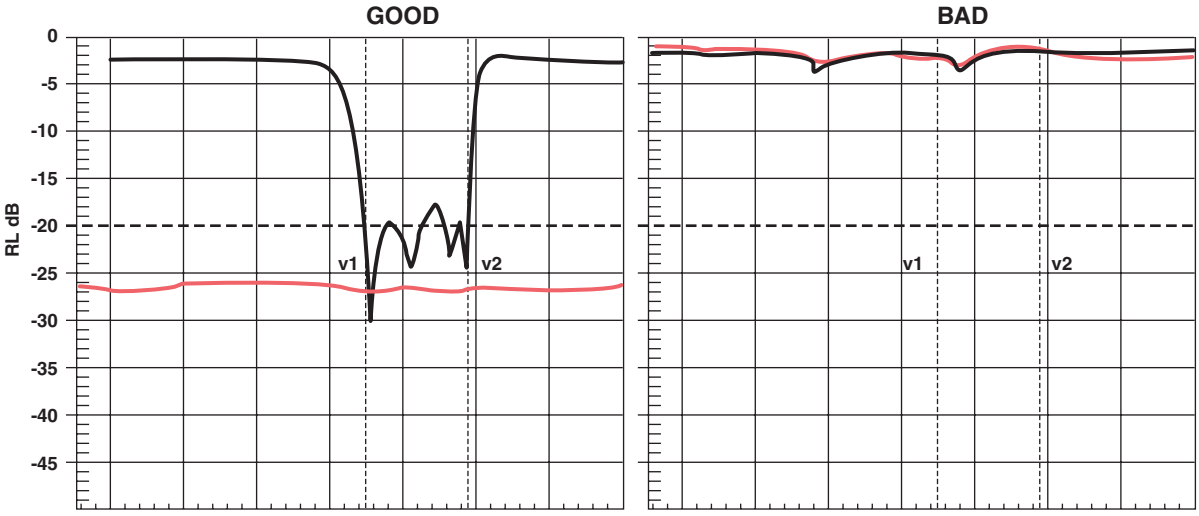
RETURN LOSS SWEEP GUIDE FOR THE RECEIVE SECTION OF THE MHUs.



NORMAL IN-SYSTEM SWEEP. TYPICAL.

DEGRADATION FROM NORMAL SYSTEM SWEEP.
RL IS STILL GOOD IN RX BAND.
RECOMMEND CONNECTOR/LINE/ANTENNA CHECKS DURING NEXT SCHEDULED MAINTENANCE PERIOD WHEN TOWER CREW AVAILABLE.

RESISTANCE LOOKING INTO THE FEEDLINE SHOULD INDICATE HIGH OR INFINITE OHMS.



ANTENNA PORT: TERMINATED WITH 50 OHM LOAD.
"PERFECT ANTENNA" < 50 OHM LOAD >

ANTENNA PORT: ANTENNA CATASTROPHICALLY FAILED "OPEN".
ANTENNA PORT: ANTENNA CATASTROPHICALLY FUSED "SHORT".

18270-A

5 SPECIFICATIONS

5.1 1800 Masthead Unit

Table 2 provides typical specifications for the 1800 Masthead Unit.

Table 2. 1800 Masthead Unit Specifications

CATEGORY	PARAMETER	SPECIFICATION
Filters	RX (up link) frequency range	1710–1785 MHz
	TX (down link) frequency range	1805–1880 MHz
	Tx path Insertion Loss	0.7 dB
	Power Handling Capability	200W
	Return Loss	18 dB
LNA with filter	Gain	12 ± 1 dB
	Noise Figure	< 1.6 dB
	IIP3	> + 13 dBm
	Bypass Loss	< 2.0 dB
Physical	Dimensions (W x H x D)	189.0 x 336.0 x 90.0 mm (7.4 x 13.2 x 3.5 inches)
	Weight	6.9 kg (15.2 lbs.)
	Color	Gray Metallic
Connectors	Antenna Connector	7/16 DIN Female
	BTS Connector	7/16 DIN Female
Intermodulation	Intermodulation	< –115dBm (2x20W)
Power	Operation Voltage	15 VDC
	Operation Current	220 mA
Environmental	Operating Temperature	–40°C to +65°C (–40°F to +149°F)
	Outdoor Protection	IP65
Quality	MTBF	>500,000 hours
	Lightning Protection	IEC 61000-4-5

5.2 2100 Masthead Unit

Table 3 provides typical specifications for the 2100 Masthead Unit.

Table 3. 2100 Masthead Unit Specifications

CATEGORY	PARAMETER	SPECIFICATION
Filters	RX (up link) frequency range	1920–1980 MHz
	TX (down link) frequency range	2110–2170 MHz
	Tx path Insertion Loss	0.5 dB
	Power Handling Capability	200W
	Return Loss	18 dB
LNA with filter	Gain	12 ± 1 dB
	Noise Figure	< 1.7 dB
	IIP3	> + 13 dBm
	Bypass Loss	< 2.0 dB
Physical	Dimensions (W x H x D)	166.0 x 210.0 x 80.0 mm (6.5 x 8.3 x 3.2 inches)
	Weight	4.2 kg (9.3 lbs.)
	Color	Gray Metallic
Connectors	Antenna Connector	7/16 DIN Female
	BTS Connector	7/16 DIN Female
Intermodulation	Intermodulation	< –106dBm (2x20W)
Power	Operation Voltage	15 VDC
	Operation Current	220 mA
Environmental	Operating Temperature	–40°C to +65°C (–40°F to +149°F)
	Outdoor Protection	IP65
Quality	MTBF	>500,000 hours
	Lightning Protection	IEC 61000-4-5

5.3 PDU (Power Distribution Unit)

Table 4 provides typical specifications for the PDU.

Table 4. Power Distribution Unit (PDU) Specifications

CATEGORY	PARAMETER		SPECIFICATION
Electrical	Input voltage range		20–56VDC positive/negative ground (Input polarization protected)
	Output voltage		15V, 4% (Over voltage protection)
	Output voltage accuracy		4% in 20mA – 400mAMAX 10% in 1.5A
	Output ripple		100mV pk – pk
	PDU Inrush Current		ETS300132-2, Part 2
	Short circuit protection		1500mA, 10%
Connector and LED	Outputs for TMA's		SMB connector Male (3 pcs)
	Input connector		Molex Micro-fit 43045 - 0400
	General alarm connector		Molex Mini-Fit 39-30-3035
	Communications link between BTS and RET		Molex Mini-Fit 39-30-3035
	Indicators		Two color LED (3 pcs) (green and yellow) Red LED 1 pcs
Physical	Dimensions (W x H x D)		194.4 x 43.6 x 100.0 mm (7.7 x 1.7 x 3.9 inches)
	Weight		0.5 Kg (1.2 lbs.)
	Color		Gray Metallic
Communication	Pin Number	Signal	Comments
	1	RS485 A	RET control command AISG Layer2. ISO/IEC 8482:1993 (RS485).
	2	RS485 B	
	3	RS485 GND	
	PDU only receives control command from BTS and modulates 2.176MHz Modem Signal and transmit to TMA through SMB connector, and vice versa.		
	Resistance between RS485 A and RS485 B		> 1k Ohm
	Resistance between RS485 A or RS485 B and DC return / RS485 GND		> 1k Ohm
	Capacitance between RS485 A or RS485 B		< 1nF
	Capacitance between RS485 A or RS485 B and DC/RS485 GND		< 1nF

5.4 Bias-T

Table 5 provides typical specifications for the Bias-T.

Table 5. Bias-T Specification

CATEGORY	PARAMETER	SPECIFICATION
RF Path	Frequency Rangy (MHz)	800–2200
	Insertion Loss (max)	0.2 dB
	Return Loss (min)	19 dB
	Power Handling (max)	500W RMS
	Isolation (RF to DC port)	> 30 dB
	Inter modulation (3rd order) 2x20W tones	<–108 dBm
DC Path	DC Input Voltage	5–24 V
	Input Current	0–2 A
	DC Path Resistance	< 1 Ohm
Physical	Dimension (HxWxD) mm	55.5 x 95.0 x 40.0mm (2.2 x 3.7 x 1.6 inches)
	Weight	0.3 Kg (0.7 lbs.)
	Color	Gray Metallic
	Housing	Aluminum
Environmental	Operating Temperature	–40 to +65° C (–40°F to +149°F)
	Storage Temperature	–40 to +70° C (–40°F to +158°F)
	Outdoor Protection	IP65
Quality	MTBF	500,000 hours
Lightning Protection	Current Peak	10 KA
	Raising Time (10–90)	8 ns
	Peak Half Voltage Time 50–50)	20 ns

6 CUSTOMER INFORMATION AND ASSISTANCE

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U.S.A. OR CANADA
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Technical Assistance: 1-800-366-3891
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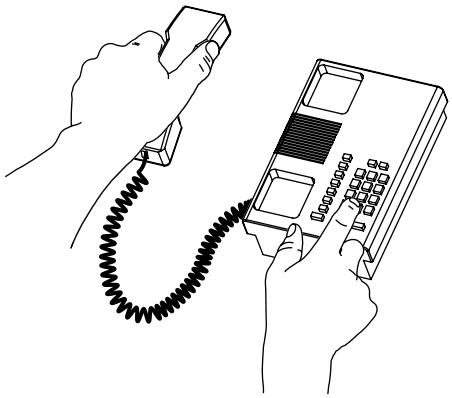

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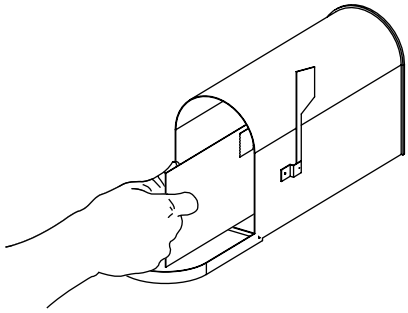
SINGAPORE 189702.

ADC EUROPEAN CUSTOMER SERVICE, INC
BELGICASTRAAT 2,
1930 ZAVENTEM, BELGIUM



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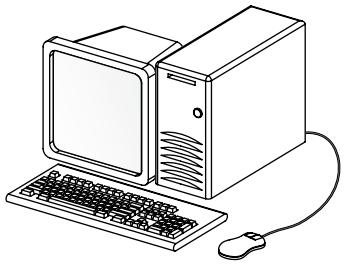

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