HR-11500 Microwave Linear Heterodyne Repeater

Operations Manual

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Revision A

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Safety Precautions

Radio Frequency Radiation Hazard

This symbol indicates a risk of personal injury due to radio frequency exposure. The radio equipment described in this guide uses radio frequency transmitters. Do not allow people to come in close proximity to the front of the antenna while the transmitter is operating. The antenna will be professional installed on fixed-mounted outdoor permanent structures to provide separation from any other antenna and all persons.

WARNING: RF Energy Exposure Limits and Applicable Rules[1] for 6-38 GHz. It is recommended that the radio equipment operator refer to the RF exposure rules and precaution for each frequency band and other applicable rules and precautions with respect to transmitters, facilities, and operations that may affect the environment due to RF emissions for each radio equipment deployment site.

Worst case RF Energy Radiation occurs when maximum transmitter power and maximum antenna gain are used. The referenced transmitter power is +33 dBm (2 Watts) and the antenna gain is 50.5 dBi (12 Ft diameter parabolic). The resulting EIRP is +83.5 dBm or +53.5 dBW. The minimum separation distance for all persons from the antenna is 17 meters in this case. Refer to applicable rules[1] for lesser EIRP exposures.

Appropriate warning signs must be properly placed and posted at the equipment site and access entries.

Installation by Professionals

This product is intended to be installed, used and maintained by experienced telecommunications personnel only. Personnel qualified to install or maintain Licensed Microwave Radio Transmitters and Antenna Systems in the United States of America, Canada or the European Union are normally qualified to install or maintain the HR-11500 Microwave Linear Heterodyne Repeater.

This product has been evaluated to the U.S. and Canadian (Bi-National) Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment, CAN/CSA C22.2, No. 950-95 * UL 1950, Third Edition, including revisions through revision date March 1, 1998, which are based on the Fourth Amendment to IEC 950, Second Edition. In addition, this product was also evaluated to the applicable requirements in UL 1950, Annex NAE.

WARNING - This unit is intended for installation in a Restricted Access location in accordance with Articles 110-18, 110- 26, and 110-27 of the United States National Electric Code ANSI/NFPA 70.

This equipment should be installed in accordance with Article 810 of the United States National Electrical Code.

When installed, this equipment is intended to be connected to a Lightning/Surge Protection Device that meets all applicable national Safety requirements. TO AVOID INJURY, RISK OF FIRE, AND DAMAGE, DO NOT CONNECT THIS PRODUCT DIRECTLY TO AN ANTENNA, AND ENSURE THAT PROPER LIGHTNING ISOLATION IS ALSO PROVIDED BETWEEN THIS UNIT AND OTHER EQUIPMENT.

Equipment is to be used and powered by the type of power source indicated on the marking label only.

This product is intended to be connected to a 24 or 48 VDC power source that must be electrically isolated from any AC sources and reliably grounded. Only a DC power source that complies with the Safety Extra Low Voltage (SELV) requirements in the Standard for the Safety of Information Technology Equipment, Including Electrical Business Equipment, CAN/CSA C22.2, No. 950-95 * UL 1950, Third Edition, can be used with this product. A 15-Amp circuit breaker is required at the power source. In addition, an easily accessible disconnect device should be incorporated into the facility wiring. Always use copper conductors only for all power connections.

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[1] US FCC Office of Engineering and Technology Bulletin 65 provides guidance for radiation hazards.

[2] SNMP: Simple Network Management Protocol; normally transmitted as packets (IP) over Ethernet,

WARNING - This equipment is intended to be grounded. If you are not using the power supply provided by Peninsula Engineering Solutions, you will need to connect the grounding conductor of your power source to the grounding terminal located on the bottom of the unit; or, connect a grounding conductor between the unit's ground terminal and your ground point. For safe operation, always ensure that the unit is grounded properly as described in this manual.

Do not connect or disconnect the power cable to the equipment when the other end of the cable is connected to the dc power supply.

Servicing of this product should be performed by trained personnel only. Do not disassemble this product. By opening or removing any covers, you may expose yourself to hazardous energy parts. Incorrect re-assembly of this product can cause a malfunction, and/or electrical shock when the unit is subsequently used.

Do not insert any objects of any shape or size inside this product while powered. Objects may contact hazardous energy parts that could result in a risk of fire or personal injury.

Do not spill any liquids of any kind inside this product.

Rear heatsink fins are provided for cooling. To protect this product from overheating, do not cover or block any of the fins except for the rear mounting bracket.

Always ensure sufficient amount of space is provided above and below this product.

Considerations should be given to the mechanical loading of the mounting supports and the equipment to avoid potential hazards.

If this product is to be powered from the same source as other units, ensure that the power supply circuit is not overloaded.

When installed in a rack, always ensure that proper airflow is provided for this product.

The maximum ambient temperature for this product is 50°C. When installed in a closed or multi-unit rack, consideration should be given to installing this equipment in an environment compatible with the maximum ambient temperature.

Protection from RF Burns

It may be hazardous to look into or stand in front of an active antenna aperture. Do not stand in front of or look into an antenna without first ensuring that the associated radio transmitter or transmitters are switched off. Do not look into open waveguides when the radio transmitter is active.

Risk of Personal Injury from Fiber Optics

DANGER: Invisible laser light radiation. Avoid direct eye exposure to the end of a fiber, fiber cord, or fiber pigtail. The infrared light used in fiber optics systems is invisible, but can cause serious injury to the eye.

WARNING: Never touch exposed fiber with any part of your body. Fiber fragments can enter the skin and are difficult to detect and remove.

Warning – Parts of this device are classified as unintentional radiators

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Proper Disposal

The manufacture of the equipment described herein has required the extraction and use of natural resources. Improper disposal may contaminate the environment and present a health risk due to the release of hazardous substances contained within. To avoid dissemination of these substances into our environment, and to lessen the demand on natural resources, we encourage you to use the appropriate recycling systems for disposal. These systems will reuse or recycle most of the materials found in this equipment in a sound way. Please contact your supplier for more information on the proper disposal of this equipment.

Contents

Figures

Tables

Chapter 1. Overview

General Information

The **HR-11500 Microwave Linear Heterodyne Repeater**, hereafter referred to as the HR-11500 (or *the repeater)*, is a low latency, linear, duplex, frequency shifting IF repeater for microwave point-to-point networks. The HR-11500 may be used with any manufacturer's compatible 11-GHz radio operating in the 10.7~11.7 GHz frequency range to provide an intermediate repeater. The HR-11500 is intended for all capacity applications typically found in 30 MHz channel bandwidth.

Applications

- Highly reliable 11-GHz, IF heterodyne repeater for longer, multi-hop microwave routes.
- Congested routes where different frequencies per hop are desired for interference coordination.
- Low Latency, physical layer, linear repeater. Enables long distance, low latency microwave routes.
- Radio terminal with external IF modem.
- Excellent performance with digital, or video microwave radios; channel capacity to 2688 PCM (4 DS3 or 180 Mb/s), OC-3, STS-3, STM-1 (155.52 Mb/s), Internet Protocol (185 Mb/s), multiple video or mixed traffic.
- Compatible with most manufacturers' 11-GHz radio terminals.

Features

- Low Latency, Propagation Delay: 200 nanoseconds, 0.20 microseconds per repeater pair.
- Greater Linear Gain, >100 dB.
- Independent from antenna isolation limitations typical of RF on-frequency homodyne repeaters.
- Linear Power Amplifier RF output power up to +34 dBm, 2.5 Watt in digital service.
- Power consumption 130 Watts, at -48 VDC per unit.
- Wide range DC power input, suitable for longer cable runs.
- Redundant DC power inputs and power supplies.
- Compact and weather protected -- ideally suited for tower mounting near antennas.
- Environmentally protected aluminum, weathertight, lockable cabinet. No extra environmental shelter required in most installations. Suitable for use at unimproved sites anywhere in the world -- Alaska to Saudi Arabia.
- Flexible cable connections: External Connectors or Conduit Entry.
- Receive AGC provided to correct input fades and adjust for varying input levels. Up-Fade protection included for abnormal propagation.
- Transmit ALC provided to regulate output power and reduce overload.
- Adaptable to new radio modulations and capacities as technology advances.
- Alarm system with SNMP over Ethernet remotely monitors the repeater.
- Equipped with directional couplers for in-service RF output power measurements.
- Conforms to standard frequency plans, US-FCC, CDN-IC, ITU-R.
- Very reliable, greater than 100,000 hours MTBF for duplex repeater pair.
- Available as a self-contained heterodyne repeater for use with customer-furnished antenna and power equipment or as a complete package including repeater, antenna, photovoltaic modules, battery charger and batteries.

Functional Description

1. The HR-11500 assembly is an IF through repeater designed for medium to heavy route tandem applications that benefit from low latency. Little alignment is required, and the use of highly reliable components and minimum active circuitry eliminates most subsequent maintenance. The repeater assembly consists of an equipment mounting panel and heatsink, contained in an aluminum, weatherproof, enclosure. In most applications, the complete assembly is pipe-frame or tower-mounted. Front, side and bottom views of the repeater are shown in Figures 1, 2 and 3.
2. In addition to the HR-11500 repeater assembly, Peninsula Engineering Solutions offers accessory equipment consisting of antennas and mounting hardware, waveguide, and complete site power supply systems. The recommended antennas are solid or high performance types chosen per application.

Basic Repeater

3. The HR-11500 heterodyne repeater receives 11 GHz microwave signals starting with an RF to IF, double-conversion, low noise amplifier/down-converter unit. At 140 MHz 2nd IF, signals are amplified and bandpass filtered. The IF includes automatic gain control, AGC, to compensate for variable input levels and propagation fading. In repeater applications, the 140 MHz IF output signal is connected to the IF input of the outbound HR unit via an external cable. In the transmit section of the HR-11500, the 140 MHz IF signal is moved to 11 GHz in a double-conversion, up-converter unit. A linear power amplifier follows the up-converter. The Level 4 linear power amplifier is rated 10 Watts at 1 dB gain compression point, GCP.
4. Bandpass filters and circulators, which form a duplexer network, direct the received signal to the LNA/down-converter and combine the power amplifier output with the received signal to a common antenna port for transmission (see Figures 4 to 7). These filters are located in the antenna coupling unit, ATCU, and mounted at the inside top of the enclosure. The heterodyne repeater supports frequency division duplex, FDD, radio link systems where separate frequencies are used in each direction.
5. A Delay Equalizer is added to the receive waveguide filter assembly to correct for slope and parabolic group delay introduced by the bandpass filters and branching networks. Equalized repeaters are recommended for high capacity systems and tandem repeater applications.
6. A CPR90G, waveguide flange, mounted on top of the enclosure, provides duplex 11 GHz RF connection to antenna feedlines.
7. An attenuator pad may be added to reduce the receive signal to approximate the recommended input level. An attenuator pad may be added to reduce transmit levels to less than can be internally set (+17 dBm at flange). Transmit pads may be required for very short hops for regulatory compliance. Pads are mounted on input of LNA/down-converter and output of the power amplifier. Nominal input and output power levels for various repeater channel configurations are listed at in Technical Summary following this section.

Channel Selection

8. Receive and transmit bandpass filters are fixed tuned to the assigned channels. These channels are further selected using the rotary switches in the control section of the heterodyne RF module. These settings program the synthesized local oscillators per the channel plan associated with each heterodyne RF module. See *Ordering Information* and *Spares* for details on heterodyne RF modules. Channel frequencies must be known when the factory order is placed.
9. When operating as an IF thru repeater, it is possible to have different frequency bands per radio hop. The HR equipment at the repeater station may be mixed bands, i.e. 11 GHz and Upper 6 GHz or Lower 6 GHz and 11 GHz. The HR units interconnect at 140 MHz IF.

Squelch Operation

10. The heterodyne RF module includes a squelch function. This function will disable the following transmit power amplifier and block all transmit signals when active. The squelch is driven by the receive signal level, RSL. When the RSL is less than the set point, the squelch activates. The squelch may be disabled or set in 15 each – 1 dB steps. Squelch control signal runs from the 140 MHz IF output to the 140 MHz IF input on the outbound transmit repeater unit. If the connecting IF cable is disconnected or does not pass DC, the squelch will become active. The squelch may be disabled if required.

Power Amplifier and ALC Adjustment

11. In digital radio applications, in order to maintain linearity over the entire signaling envelope, the transmit power amplifier operates at a reduced average power level to meet the output power level requirement as shown in Technical Summary. The power amplifier is part of the heterodyne RF module. There is a field-adjustable switch for setting the transmit power amplifier level. The settings are: 16 each - 1 dB steps. The recommended transmit power levels have adequate margin for tandem repeater station applications. Single repeater applications may operate at 1 to 2 dB increased power levels.

Directional Coupler

12. A directional coupler, built into the power amplifier, provides a signal monitor point, “SAMPLE PORT - RF MON”. This point allows in-service measurement of transmit output power. The monitor point is calibrated for calculating the actual RF output power at the power amplifier and then, at the antenna port flange. When measuring transmit power, the power meter reading obtained, plus the loss (in dB) marked at the monitor point, minus the branching filter loss (in dB) marked on the antenna coupling unit, ATCU, equals actual antenna port transmit output power.

Example 1 Amplifier Output	
Power Meter indication	+15.0 dBm
Cal Loss at RF MON	+19.0 dB
Power Amplifier Output =	+34.0 dBm

Example 2 Antenna Port Output	
Power Meter indication	+15.0 dBm
Cal Loss at RF MON	+19.0 dB
Tx ATCU Loss	- 2.5 dB
Antenna Port Output =	+31.5 dBm

Power Supply

13. External DC power supply operates the heterodyne repeater. Power supplies may be 24 VDC or 48 VDC. Either polarity is supported and is configured internal to the heterodyne repeater. Redundant, “A & B” battery power supplies are supported. Redundant selection is automatic. Operation from single “A” battery is permitted; internal power converters then share the single DC power input.

14. In areas where commercial power is available, an AC power supply can be provided. Typical power supplies are AC/DC rectifier/battery charger type with station battery. Although one AC power supply will provide ample current to power the repeater station, dual AC power supplies are recommended for greater reliability. The recommended dual AC power supply system also contains two rectifier/chargers and two sets of standby battery to provide power during AC power failures. Each battery is float charged while the power supply is on and has 100 Amp-hours as standard capacity. Additional batteries can be purchased if needed. The size of the battery plant is determined by station load and autonomy objective. System engineering will normally perform this analysis during planning and design phase.

15. The heterodyne repeater station may be powered from alternative energy sources such as solar photovoltaic arrays and wind turbine generators with battery plant. Storage batteries and photovoltaic modules are selected on the basis of the capacity across the temperature range and during periods when the output from the solar PV array is low or not available. Controllers are used with the solar array to efficiently charge the batteries without overcharging. Peninsula Engineering Solutions can determine the solar and battery capacity. The location of the site should be specified when requesting assistance.

16. In locations where commercial power is not available and solar panel charging is impractical, then alternative power sources such as thermal-electric generator, TEG, fuel cell or motor generator are available. Power sources may be used in combination to create hybrid power solutions capable of operating in very demanding applications. In such applications, the battery installation should be given an environmental shelter according to the manufactures' recommendations. Battery plant temperatures above and below nominal (+20C ~ +25C) can reduce capacity and usable life. Contact Peninsula Engineering Solutions for assistance in designing the best power supply system.

Alarm Reporting

17. The HR-11500 heterodyne repeater includes an alarm system to remotely monitor the repeater station. Conditions that are typically monitored are listed below:

Standard Telemetry:

a) Heatsink Temperature
b) A Battery Voltage
c) B Battery Voltage
d) RSL, RSSI, dBm
e) Tx Power, Watts

Standard Alarm Points:

f) Heatsink Temperature Low and High
g) A and B Battery Low and High Voltage
h) Squelch Active
i) RSL Low and High Levels
j) Tx RF Output Low and High Power
k) Heterodyne RF Module DC Alarm
l) Enclosure Door Open

18. Alarm indications are sent as SNMP[2] traps over Ethernet/IPv4[3] out-of-band data transport. Ethernet connections can be either ETH on copper (standard) or ETH on multi-mode fiber optic cable (optional). A standard MIB is provided that may be adapted to particular Network Management System, (NMS) applications.

19. Status of each heterodyne repeater can be observed on a web-browser screen generated by the ACU-SNMP unit. SNMP SETS and GETS are also supported and are defined in the MIB. A duplex Ethernet/IP connection is required.

20. Alarm data concentration and transport is not included in the HR-11500 equipment. Such equipment is typically configured for the project application. Contact Peninsula Engineering for more information.

21. The ACU module includes an event sensor expansion port. Custom requirements such as temperature and humidity sensor can be provisioned using this port.

[2] SNMP: Simple Network Management Protocol; normally transmitted as packets (IP) over Ethernet, (ETH) networks.

[3] IP: Internet Protocol, packet data and addressing scheme.

Licensing

All owners of the HR-11500 should consult with the appropriate local and national agencies for information about licensing.

US FCC ID	QFT-HR-11500
Applicable FCC Rule Parts	101 C; 2 C, I, J; 15 B
Applicable IC Regulations	SRSP 310.7
Emission Designator	Same as terminal radio or modem; typically 30M0D7W for 30 MHz channel bandwidth digital applications
Power Output	0.050 ~ 2.0 Watts (per modulation and application)
Frequency Range	10,700.0 ~ 11,700.0 MHz
Frequency Stability (note 2)	0.0025% per unit, 0.010% per modulation section with terminal equipment
Modulating Frequency, Data Rate	Dependant on terminal radio or modem equipment

Licensing Notes:

1. The HR-11500 series can be used with any compatible 11-GHz radio or modem equipment.
2. The heterodyne repeater meets 0.0025% stability with zero error sources. In repeater applications, US-FCC allows a maximum frequency tolerance of 0.010% to allow for tolerance of the terminal equipment and accumulations of tandem repeater stations over a modulation section. Modulation sections are typically limited to 5 hops, 4 tandem HR-11500 IF repeater stations plus 2 terminal stations.

MODEL: HR-11500

PENINSULA ENGINEERING SOLUTIONS, INC.

FCC ID: QFT-HR-11500

This transmitter complies with Part 101 of the FCC Rules.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Technical Specification Summary

General	
Frequency Range[4]	10.700 ~ 11.700 GHz
Receive Levels, Down Converter Input[5]	-75 dBm minimum rated, -80 dBm typical -25 dBm maximum rated
Receive AGC	45 dB down fade, 5 dB up fade; minimums
Squelch Range	-75 dBm to -61 dBm in 1 dB steps, and [Disable]
Noise Figure, Down Converter Input	3.5 dB[6] at weak signal, 20 dB at strong signal
Transmit Power, Level 4, Power Amplifier Output[7]	+34 dBm[8] maximum rated, see Table 2 +19 dBm minimum rated
ATCU Branching Losses, Rx and Tx	See Table 1 for configurations
Frequency Stability	±0.0025% per repeater pair. Typical ±0.000 050%
Antenna Connections, ATCU	
Antenna Port, Duplex T/R	CPR90G, Contact, Gasket Flange. At top of unit.
Waveguide Type	WR90
Return Loss, Antenna Port	≥ 24 dB across assigned channels
Intermediate Frequency Interface	
Intermediate Frequency, Receive and Transmit	140.000 MHz
Connectors, Impedance	External Type N(f), 50 Ohm Coaxial Internal SMA(f), 50 Ohm Coaxial (conduit entry)
Return Loss	> 10 dB, 140 MHz ± 20 MHz
Receive Output Level[9]	-2 dBm ± 2 dB for all modulations
Transmit Input Level	0 ~ -15 dBm for all modulations, auto adjust
Receiver to Transmitter IF Loss	0 ~ 10 dB, auto adjust
Frequency Plan	
HR Equipment Channel Bandwidth, 30 MHz	28 MHz Flat, 40 MHz @ -6 dB
Assigned Channel Bandwidth	30 MHz
T-R Spacing	130 MHz minimum
T-T Spacing on common feeders	80 MHz minimum
T-T Spacing on separate feeders	30 MHz minimum
Channel Response: Delay Equalized, 30 MHz channel bandwidth	
Amplitude	± 0.5 dB, f_0 ± 14 MHz
Group Delay Variation	10 nsec P-P, f_0 ± 14 MHz
Propagation Delay, Signal Latency, 1-Way[10]	200 ± 50 nsec at f_0

[4] See ordering information for specific configuration and channel plan part numbers.
[5] Not including receive antenna coupling unit loss.
[6] Guaranteed noise figure is 0.5 dB greater.
[7] 16QAM, not including transmit antenna coupling unit loss. See Table 3 for more levels.
[8] Guaranteed transmit power is 1 dB less.
[9] IF Output CW levels are typically 2 dB less than for QAM signals.
[10] Measured in IF repeater configuration from equipment waveguide antenna port in to waveguide antenna port out. Does not include external IF cables, feedlines or antennas.

Channel Response: Un-Equalized, 30 MHz channel bandwidth			
Amplitude		± 2.0 dB, f_0 ± 14 MHz	
Group Delay Variation		20 nsec P-P, f_0 ± 14 MHz	
Propagation Delay, Signal Latency[5]		180 ± 50 nsec at f_0	
Alarms and Monitored Points, ACU-SNMP			
Item Name	***Short Name***	***Alarm Point***	***Clear***
Power	POWER	12.5V DC Bus < 10V LED Dark	12.5V DC Bus > 10V Green w/ Blink @ 5 Sec
Sensor[11]	SENSOR	Event Sensor Disconnected[12] Dark	Event Sensor Connected. Green
Ethernet	ETH	ETH Disconnected LED Dark	ETH Active Green w/ Flash @ PKT
Summary Alarm	ALARM	Any Alarm or OOR Red	All Alarms Clear LED Dark
Heatsink Temperature	T	5°C > T > 50°C	5°C < T < 50°C
Heterodyne Module Current	HET DC	-20% > I > +20% Red	-20% < I < +20% LED Dark
Squelch Condition	SQL	Active – PA OFF Red	Inactive LED Dark
Local Oscillator	LO	Synthesizers UnLocked Red	Synthesizers Locked LED Dark
Enclosure Door	DOOR	Door Open Red	Door Closed LED Dark
Battery A, Volts	BATT A	21.0 V > V_{A24} > 28.5 V 42.0 V > V_{A48} > 57.0 V Red	21.0 V < V_{A24} < 28.5 V 42.0 V < V_{A48} < 57.0 V LED Dark
Battery B, Volts	BATT B	21.0 V > V_{B24} > 28.5 V 42.0 V > V_{B48} > 57.0 V Red	21.0 V < V_{B24} < 28.5 V 42.0 V < V_{B48} < 57.0 V LED Dark
Receive Signal Level, dBm[13]	RSL	-70 dBm > RSL > -30 dBm Red	-70 dBm < RSL < -30 dBm LED Dark
Transmit PA RF Power Level, W[14]	TX PWR	0.1 W > PWR > 2.5 W Red	0.1 W < PWR < 2.5 W LED Dark
Alarm Control Unit, ACU-SNMP, Communications			
Event Notification Message Protocols		SNMPv1 Traps, SNMPv2c SETS, GETS	
		SMTP E-Mail	
User Interface		Web Page Server, HTTP (not secure, SSL)	
Ethernet Connections (mating connectors and cables not included)		RJ-45 Copper, 10/100 Mb/s, 10/100BaseT to Bulgin panel mounted connector: Buccaneer® IP68. Mating Bulgin connectors: Buccaneer® IP68; PX0836/(2-5m length) Patch Cord, PX0834/A for PUR, shielded cable or PX0834/B for 3.5~8mm cables.	
		Fiber Optic, Multi-Mode with optional Media Converter Module. Internal ST 62.5/125µm Connector Pair, Tx, Rx. External LC 62.5/125 µm duplex panel mounted connector: Siemon IP66/IP67. Mating Siemon connector: XPLC2-MM. 100BaseFX 1300 nm, 2 km service distance rated.	

[11] Optional Event Sensors may be provisioned. External Temperature and Humidity Sensor is the only currently available selection.

[12] OOR: Out of Range. See specific sensor limit settings.

[13] RSL Alarm limits can be changed to meet customer application requirements.

[14] Tx Power Alarm limits can be changed to meet customer application requirements.

Controls	
Receive Squelch Drive	20 mA current sink on IF OUT.
Transmit Power Amplifier Enable	500 Ohms maximum shunt to ground on IF IN.
Electric Power Requirements	
Power Configuration	A & B Battery Inputs, Auto-Redundant
Nominal Voltage	24 or 48 VDC, see ordering options
Voltage Range	20 ~ 30 VDC 40 ~ 60 VDC
Polarity	Positive or Negative Ground, configurable
Power Consumption, Level 4	140 W typical, 165 W maximum per unit. 280 W typical, 330 W max per repeater station.
DC Connections	External Bulgin 3-Pin Jacks. Mating 3-socket Plug provided. Wire range 14 ~ 12 AWG. Cord 6~8 mm
	Internal 3-circuit compression Terminal Blocks. Wire range 14 ~ 10 AWG. Conduit entry.
Environmental Conditions	
Housing Type	Weather Tight Aluminum
Ambient Temperature	-20°C ~ +50°C
Relative Humidity	90% (housing internal) 100% (housing external)
Altitude	15,000 Feet, 4600 meters
Reliability	
MTBF	200,000 hours per HR unit 100,000 hours per HR repeater station (pair)
MTTR	40 minutes, on-site
Dimensions: HR Unit	
Height, without connectors	20.00 inches, 508 mm
Height, including antenna port and connectors	23.00 inches, 585 mm
Width, door closed	18.00 inches, 457 mm
Depth, including mounting bracket	21.55 inches, 547 mm
Weight, max with all options	72 lb, 33 kg

Table 1 ATCU Typical Branching Losses – HR-11500 Models

MODEL	BW MHz	Delay Equalized	Receive Branch Loss, Typical*, dB	Transmit Branch Loss, Typical*, dB
HR-11500-41 HR-11500-42	30	No	2.8	2.8
HR-11500-51 HR-11500-52	30	Yes	3.7	2.8

Note: * Guaranteed branching losses are 1 dB greater.

Table 2 Recommended Transmit and Receive Power Levels per Modulation Type

Modulation Type[15]	Level 4 PA Output[16]	Minimum RSL[17] at Down-Converter Input	System Gain[18]
FSK, MSK, BPSK	34.0 dBm	-75.0 dBm	102.5 dB
QPSK, OQPSK, 4PSK, 4QAM	34.0	-75.0	102.5
8PSK	34.0	-75.0	102.5
16QAM	32.0	-75.0	100.5
16APSK	32.0	-75.0	100.5
32APSK	30.0	-74.0	97.5
32QAM	30.0	-73.0	96.5
32TCM	29.0	-73.0	95.5
64QAM	28.0	-70.0	91.5
64TCM	28.0	-70.0	91.5
128QAM	26.0	-67.0	86.5
128TCM	26.0	-67.0	86.5

Note: Peninsula Engineering Solutions may change performance specifications where necessary to meet industry requirements.

See *Heterodyne Repeater System Applications Considerations* for additional guidance.

[15] Modulations listed are the most popular types. List is not exclusive. If a modulation is not listed, contact the company for specific details.

[16] Transmit power set point is reduced as the modulation becomes more complex.
This power level provides adequate linearity as required by the system performance objectives. Multi-hop tandem applications may require additional power reduction to manage IMD summation depending on radio characteristics. Single repeater applications may increase power by 1 to 2 dB depending on radio characteristics. The ALC rotary switch is used to set the output power level. To calculate the repeater's output power at the antenna port flange, take the power amplifier level output listed in this table, then subtract the transmit branch filter loss for the specific configuration from Table 1.

For Example: Level 4 Power Amplifier Output = +32 dBm for 16QAM, Tx Branch Filter Loss = 2.5 dB, Output power at antenna port flange = +32.0 – 2.5 = +29.5 dBm.

[17] RSL is typical for radio capacities found in 30 MHz channels, 21 ~ 27 MSymbols/sec. Actual RSL depends on terminal radio noise figure and associated modulation and traffic capacity. RSL at antenna port is determined by adding Rx Branch Filter Loss from Table 1 to value in this table. Recommended -75 dBm RSL minimum considers resulting transmit noise density.

For Example: Down-Converter RSL = -75 dBm for 16QAM, Rx Branch Filter Loss = 3.5 dB, RSL at antenna port flange = -75.0 + 3.5 = -71.5 dBm.

[18] At Antenna Port, assumes 3.7 dB Rx Loss, 2.8 dB Tx Loss.

Channel Plans

Each HR-11500 is factory configured for the desired channel plan and frequency pair. The Heterodyne RF Module is set to the assigned frequency pair using a pair of rotary switches internal to the module. The switch positions for each channel pair, Go and Return, are shown in the tables below.

Table 3 *Reserved*

Reserved

Table 4 Channel Plan, US-FCC, 11 GHz, 30 MHz, 11G-2 – Primary Plan

Channel Plan		11 GHz, 30 MHz US-FCC 101, 30 MHz BW		**Short Name**		11G-2	
				Frequency Band		10,700 ~ 11,700 MHz	
				Alt Band Jumper		None	
Regulatory		US-FCC		**Channel Bandwidth**		30 MHz	
T-R Separation		490.0 and 500.0 MHz		**Channel Separation**		30.0 and 40.0 MHz	
Channel Setting		**Channel Pairs, MHz**		**Channel Setting**		**Channel Pairs, MHz**	
MSB	LSB	Receive	Transmit	MSB	LSB	Receive	Transmit
0	0	10715.00	11215.00	1	3	11215.00	10715.00
0	1	10755.00	11245.00	1	4	11245.00	10755.00
0	2	10795.00	11285.00	1	5	11285.00	10795.00
0	3	10835.00	11325.00	1	6	11325.00	10835.00
0	4	10875.00	11365.00	1	7	11365.00	10875.00
0	5	10915.00	11405.00	1	8	11405.00	10915.00
0	6	10955.00	11445.00	1	9	11445.00	10955.00
0	7	10995.00	11485.00	2	0	11485.00	10995.00
0	8	11035.00	11525.00	2	1	11525.00	11035.00
0	9	11075.00	11565.00	2	2	11565.00	11075.00
1	0	11115.00	11605.00	2	3	11605.00	11115.00
1	1	11155.00	11645.00	2	4	11645.00	11155.00
1	2	11185.00	11685.00	2	5	11685.00	11185.00

Channels highlighted are the odd pairs with 500 MHz T-R and 30.0 MHz T-T separation.

Primary Plan Jumper Setting = NONE

Table 5 Channel Plan, Industry Canada, 11 GHz, 30 MHz, 11G-2 – Alternate Plan 1

Channel Plan	11 GHz, 30 MHz IC SRSP 310.7, 30 MHz BW		**Short Name**	11G-2	
			Frequency Band	10,700 ~ 11,700 MHz	
			Alt Band Jumper	AltBand1	
Regulatory	Industry Canada		**Channel Bandwidth**	30 MHz	
T-R Separation	490.0 MHz		**Channel Separation**	30.0 MHz	
Channel Setting		**Channel Pairs, MHz**	**Channel Setting**		**Channel Pairs, MHz**
MSB	LSB	Receive	Transmit	MSB	LSB	Receive	Transmit
0	0	10725.00	11215.00	1	6	11215.00	10725.00
0	1	10755.00	11245.00	1	7	11245.00	10755.00
0	2	10785.00	11275.00	1	8	11275.00	10785.00
0	3	10815.00	11305.00	1	9	11305.00	10815.00
0	4	10845.00	11335.00	2	0	11335.00	10845.00
0	5	10875.00	11365.00	2	1	11365.00	10875.00
0	6	10905.00	11395.00	2	2	11395.00	10905.00
0	7	10935.00	11425.00	2	3	11425.00	10935.00
0	8	10965.00	11455.00	2	4	11455.00	10965.00
0	9	10995.00	11485.00	2	5	11485.00	10995.00
1	0	11025.00	11515.00	2	6	11515.00	11025.00
1	1	11055.00	11545.00	2	7	11545.00	11055.00
1	2	11085.00	11575.00	2	8	11575.00	11085.00
1	3	11115.00	11605.00	2	9	11605.00	11115.00
1	4	11145.00	11635.00	3	0	11635.00	11145.00
1	5	11175.00	11665.00	3	1	11665.00	11175.00

Alternate Plan Jumper Setting = AltBand1

Table 6 *Reserved*

Reserved

Table 7 *Reserved*

Reserved

Ordering Information

The HR-11500 Heterodyne Repeater Assembly is ordered by specifying the system model number HR-11500-XX and part number (Table 8). Attenuators (if required due to very strong input signal, > -25 dBm) are provisioned by specifying their part numbers. Transmission engineering must be completed before ordering because the necessary attenuator values are determined from the path calculations. Part numbers are listed in Table 9.

When doing the initial system layout of a radio link which includes an HR-11500 Microwave Heterodyne Repeater Assembly, several factors must be considered prior to ordering, to ensure correct antenna connections and proper installation. Consider the following topics before ordering the HR-11500 Microwave Heterodyne Repeater:

Repeater Transmit and Receive Frequencies

Repeater frequencies are coordinated with the adjacent terminal radios. See the block diagrams for more detail. Orders cannot be accepted without firm frequencies. Peninsula Engineering can assist in determining the frequencies and assignments.

Terminal Radio Modulation, Traffic Capacity and Repeater Transmit Power Level

Repeater transmit power levels are set based on the modulation and traffic capacity of the adjacent terminal radios. Please include the modulation and traffic capacity details with the purchase order. Peninsula Engineering will determine the proper transmit power level. Modulations and traffic capacity beyond those listed in this manual may be possible to support, contact Peninsula Engineering Solutions for more details.

Electric Power System

The repeater site power system should be detailed during the system design phase. Peninsula Engineering Solutions can provide this design service and the power equipment. Power systems may include: Solar, Wind, AC, TEG, Motor Generator, Fuel Cell or other power sources. All power systems include a battery plant and associated charge control equipment. Battery capacity must be adequate for the load, location and power source.

Antennas

The types and sizes of antennas required to meet the system requirements. Transmission engineering can determine the antenna details. Transmission engineering and antennas are available from Peninsula Engineering Solutions.

Feedlines

Type and length required for antenna connections (including jumper assemblies); note that waveguide is available from Peninsula Engineering Solutions.

Mounting

Special requirements for the repeater and antennas specific to the intended tower or supporting structure. The repeater normally mounts outdoors in its all-weather enclosure. Peninsula Engineering Solutions can provide construction engineering support.

Alarm Components

The alarm equipment provides SNMP reporting over Ethernet on copper or multi-mode fiber. It may be desirable to combine the reporting from multiple HR units or other equipment on site for further transmission to a Network Operations Center, NOC. Please refer to Applications Notes on alarm management.

When ordering, specify a shipping destination and a billing address. Peninsula Engineering Solutions returns an order acknowledgment with the scheduled shipping date. Each shipment includes an equipment list showing the equipment ordered and shipped, including details about system and equipment options.

System Options and Assembly Part Number

Table 8 HR-11500 Microwave Linear Heterodyne Repeater Models

Standard Assembly	Part Number	Description	Battery Voltage	HR Chan	Channel Plan[19]
HR-11500-41	900-0531-41	Single Channel Duplex Tx/Rx, 11G-2, Un-Equalized, PA Level 4, 24VDC	24 VDC	30 MHz BW, UE	11G-2: 11 GHz, US-FCC, IC SRSP 310.7 10,700 ~ 11,700 MHz 30 MHz channel bandwidth 490/500/530 MHz T-R spacing 30/40 MHz T-T spacing
HR-11500-42	900-0531-42	Single Channel Duplex Tx/Rx, 11G-2, Un-Equalized, PA Level 4, 48VDC	48 VDC		
HR-11500-51	900-0531-51	Single Channel Duplex Tx/Rx, 11G-2, Delay Equalized, PA Level 4, 24VDC	24 VDC	30 MHz BW, EQ	
HR-11500-52	900-0531-52	Single Channel Duplex Tx/Rx, 11G-2, Delay Equalized, PA Level 4, 48VDC	48 VDC		

[19] T-R, Transmit to Receive and T-T, Transmit to Transmit spacings represent the specific channel plan raster. See HR-11500 equipment specifications for supported spacings and conditions.

Table 9 Coaxial Attenuator Pads

Part Number	Attenuation	Part Number	Attenuation
149-0128-01	1.0 dB	149-0128-11	11.0 dB
149-0128-02	2.0 dB	149-0128-12	12.0 dB
149-0128-03	3.0 dB	149-0128-13	13.0 dB
149-0128-04	4.0 dB	149-0128-14	14.0 dB
149-0128-05	5.0 dB	149-0128-15	15.0 dB
149-0128-06	6.0 dB	149-0128-16	16.0 dB
149-0128-07	7.0 dB	149-0128-17	17.0 dB
149-0128-08	8.0 dB	149-0128-18	18.0 dB
149-0128-09	9.0 dB	149-0128-19	19.0 dB
149-0128-10	10.0 dB	149-0128-20	20.0 dB

Coaxial Attenuator Pads: equipped with SMA male and female connectors and rated to 18 GHz and 1 Watt average power. May be inserted in receive or transmit line for RF level coordination. Transmission engineering will determine attenuator requirements.

Table 10 Spare and Accessory Equipment

Part Number	Description
090-1508-01	Heterodyne RF Module, Level 4, 11G-1
090-1508-02	Heterodyne RF Module, Level 4, 11G-2
090-1508-03	Heterodyne RF Module, Level 4, 11G-3
090-0410-01	Reference Oscillator Module, 10.000 MHz
090-0787-01	Alarm Control Unit (ACU) – SNMP, Ethernet
091-0501-02	Media Converter Kit, Ethernet to Fiber Optic Multi-Mode, ST-LC DX. Kit includes: module, wiring harness, fiber cables, and installation materials.
090-0790-01	Media Converter Module, Ethernet to Fiber Optic Multi-Mode (module only)
090-0286-06	Power Supply, DC-DC Converter Assembly, 24VDC to +12.5VDC, 400W
090-0286-07	Power Supply, DC-DC Converter Assembly, 48VDC to +12.5VDC, 400W
087-1242-01	DC Distribution Sub-Assembly, 24V
087-1242-02	DC Distribution Sub-Assembly, 48V
142-0315-01	Connector, Circular, Plug, Flexible Cable Power 3 Pole, Socket, Screw, IP68
142-0317-02	Connector, Circular, Plug, Flexible Cable Ethernet CAT5E, IP68
142-0318-01	Connector, Plug, LC DX Fiber-Optic Multi-Mode, IP66/IP67
175-0025-05	Fuse, 15-Ampere, Blade Type, ATO, 32VDC (for 24V)
175-0025-04	Fuse, 7.5-Ampere, Blade Type, ATO, 80VDC (for 48V)
550-0530-01	Manual, Operations, HR-11500 Microwave Linear Heterodyne Repeater

Alarm information is in SNMP format and reports over ETH TCP/IP networks. Ethernet on copper may be converted to Ethernet on fiber optic cables for transmission down a radio tower to a collection point.

Contact Peninsula Engineering Solutions for details and assistance.

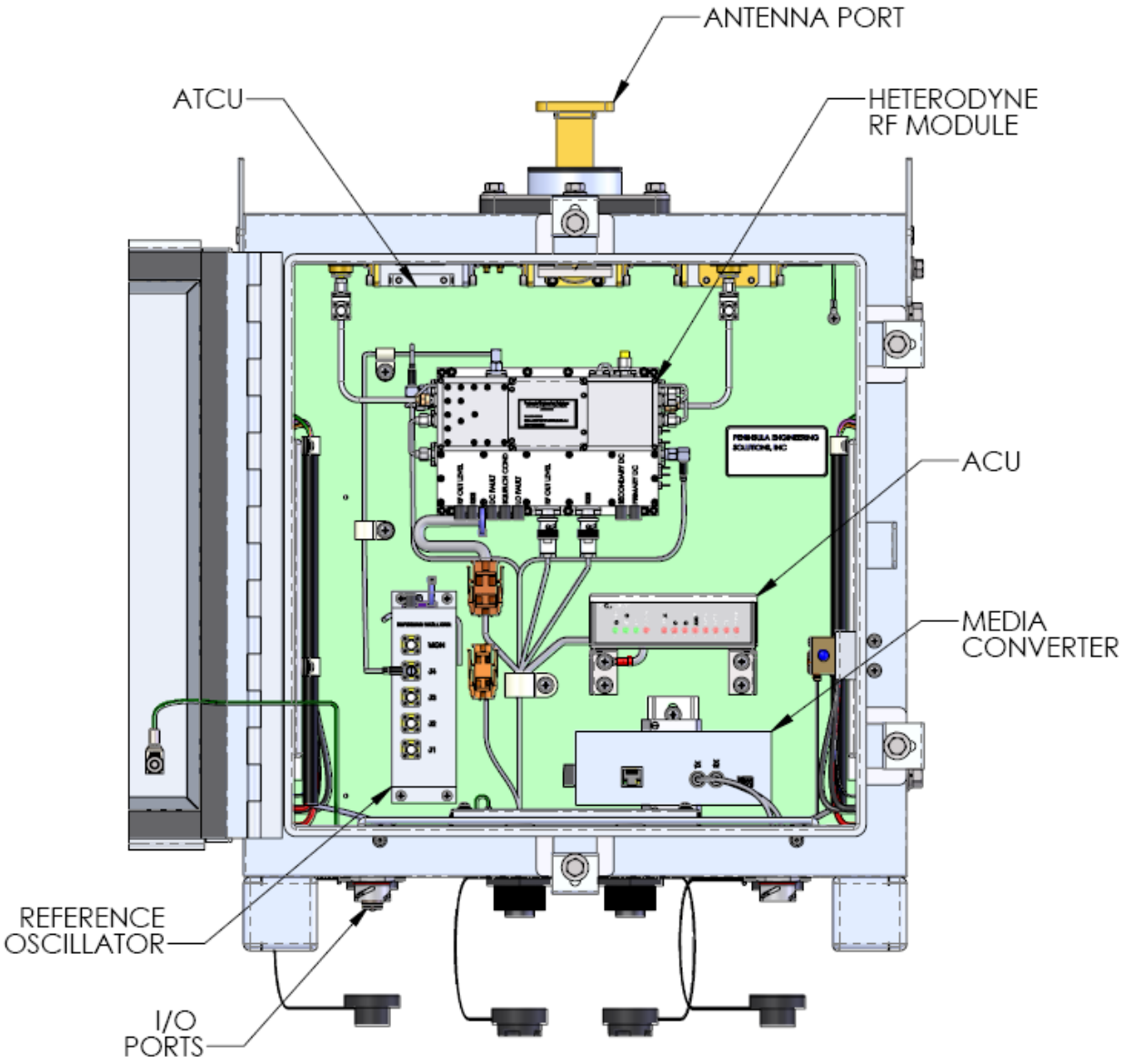

Figure 1 Mechanical Layout, HR-11500 Front View
Module Locations

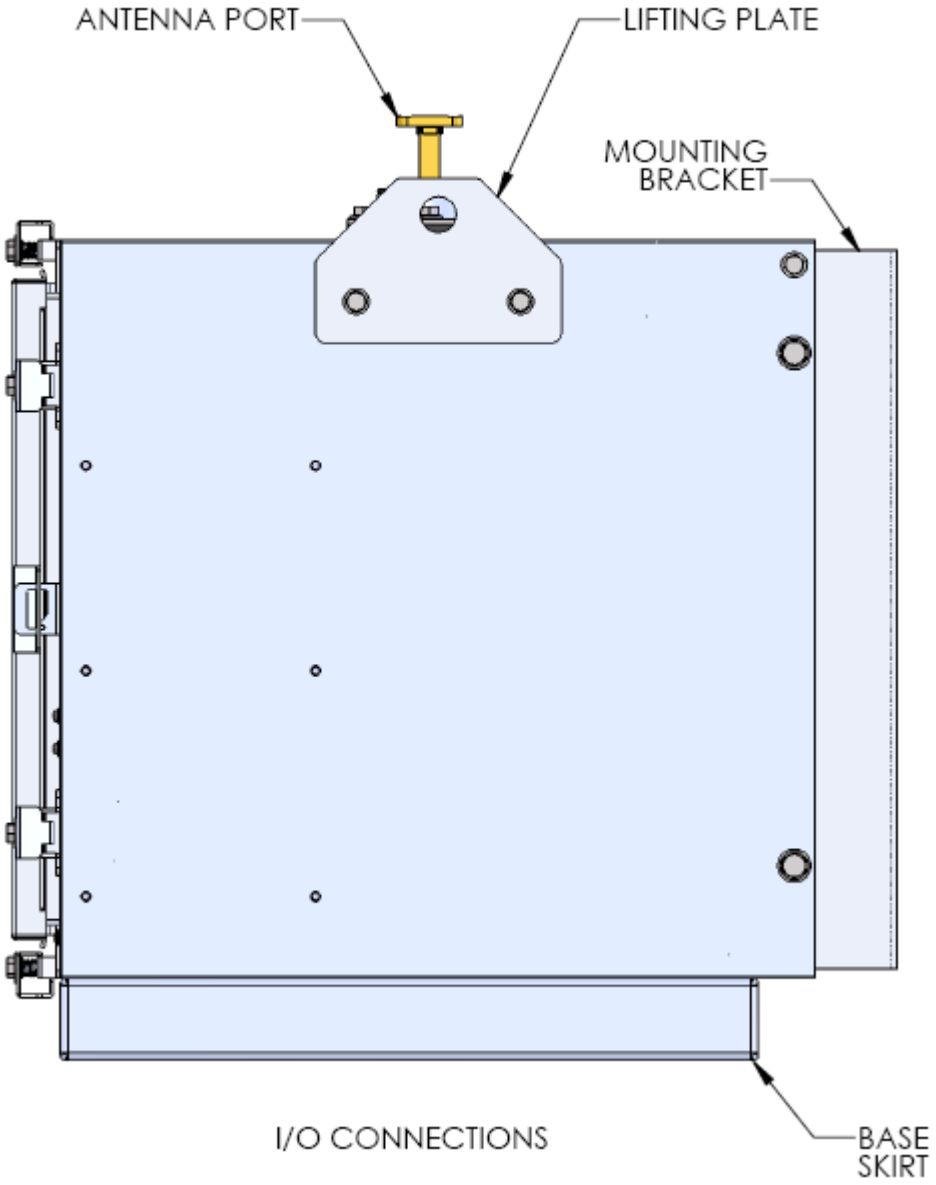

Figure 2 Mechanical Layout, HR-11500 Side View,
Note: Base Skirt is included on 090-0294-04 enclosures.

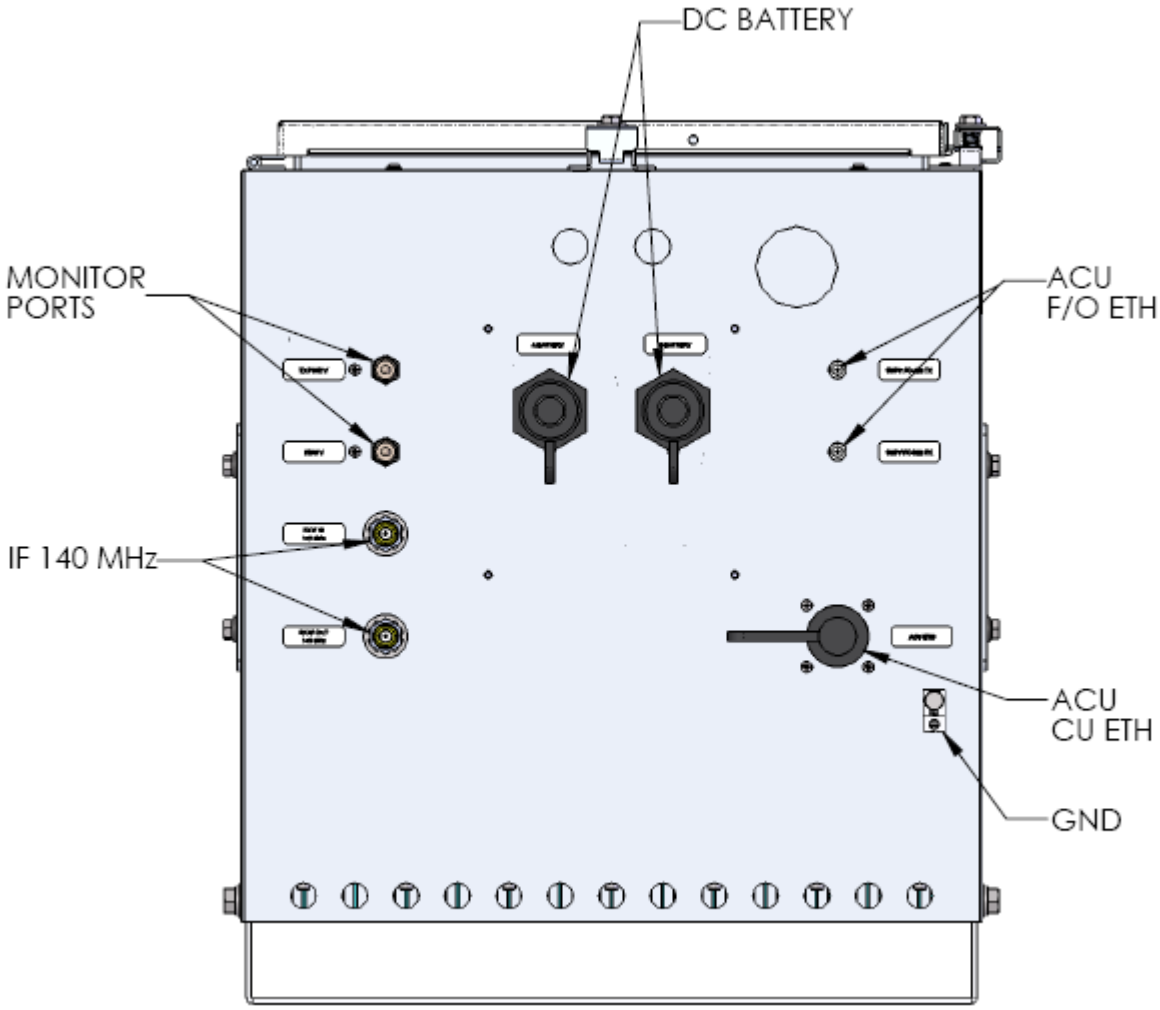

Figure 3 Mechanical Layout, HR-11500 Bottom View
I/O Connections, using 090-0294-03 Enclosure

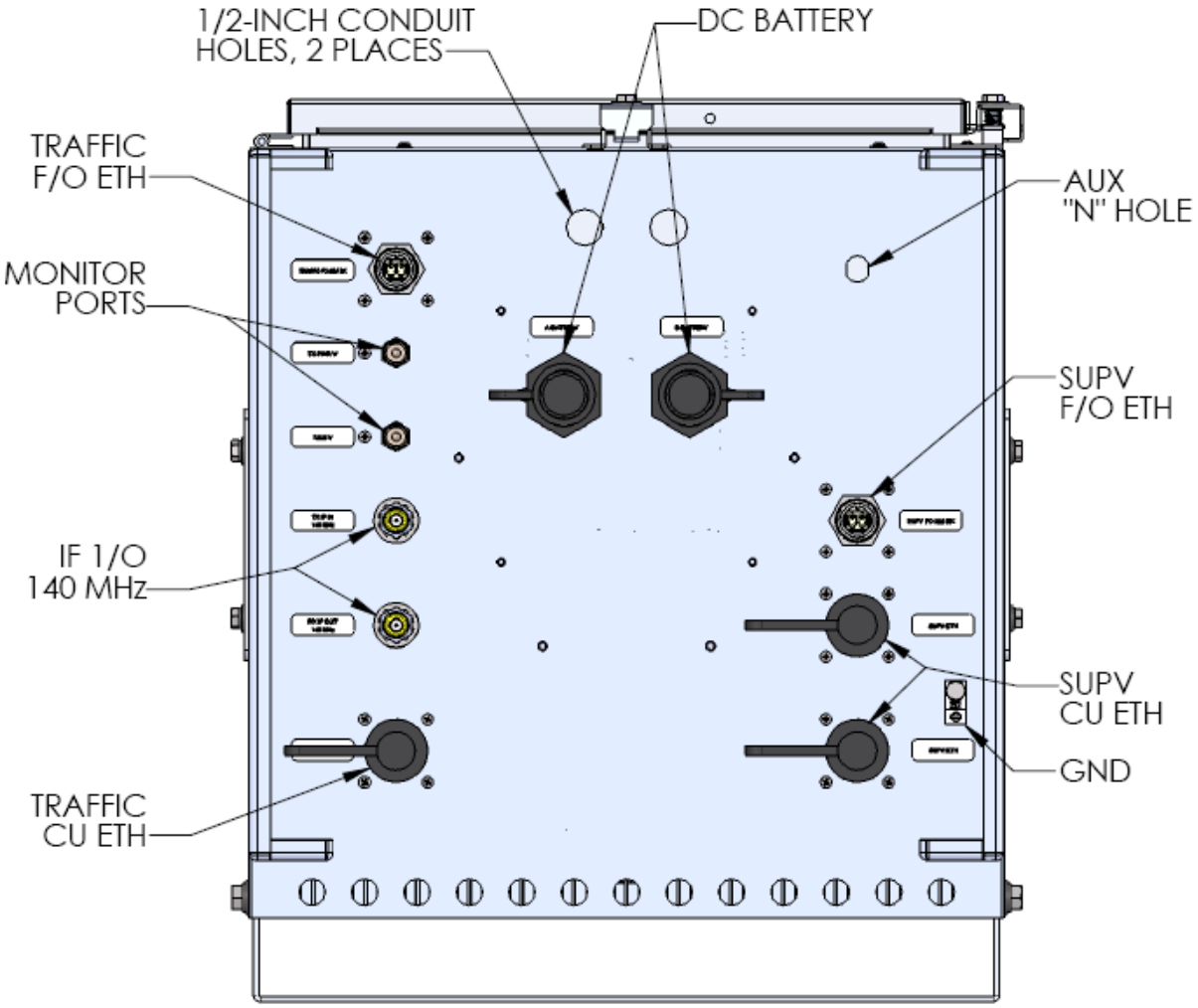

Figure 4 Mechanical Layout, HR-11500 Bottom View
I/O Connections, using 090-0294-04 Enclosure

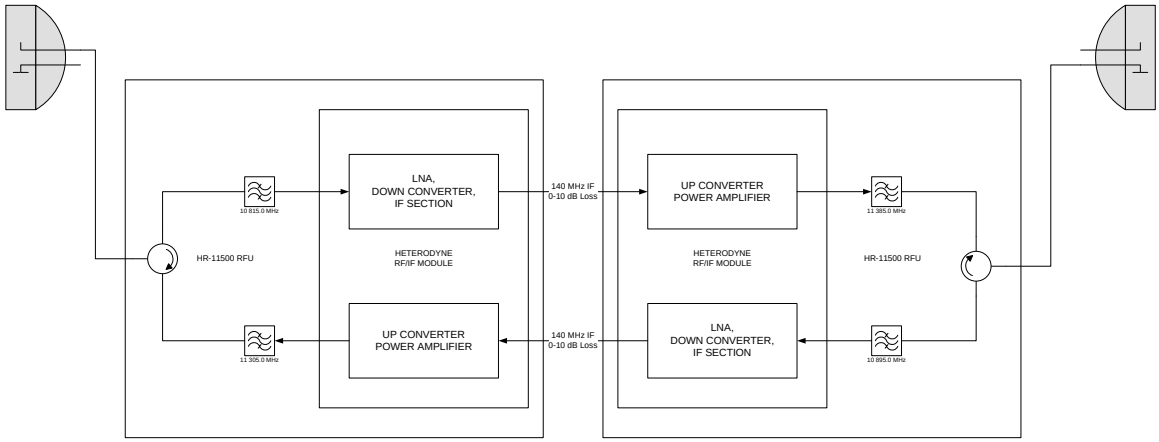

Figure 5 Block Diagram, 1+0, Heterodyne Repeater

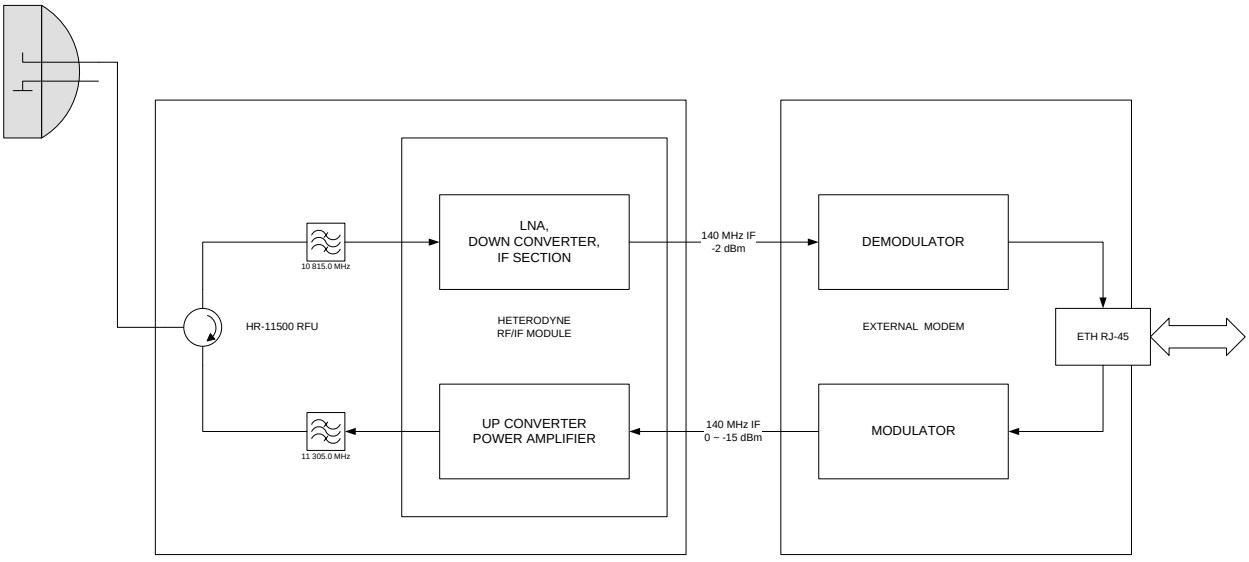

Figure 6 Block Diagram, 1+0, Heterodyne Terminal with External Modem

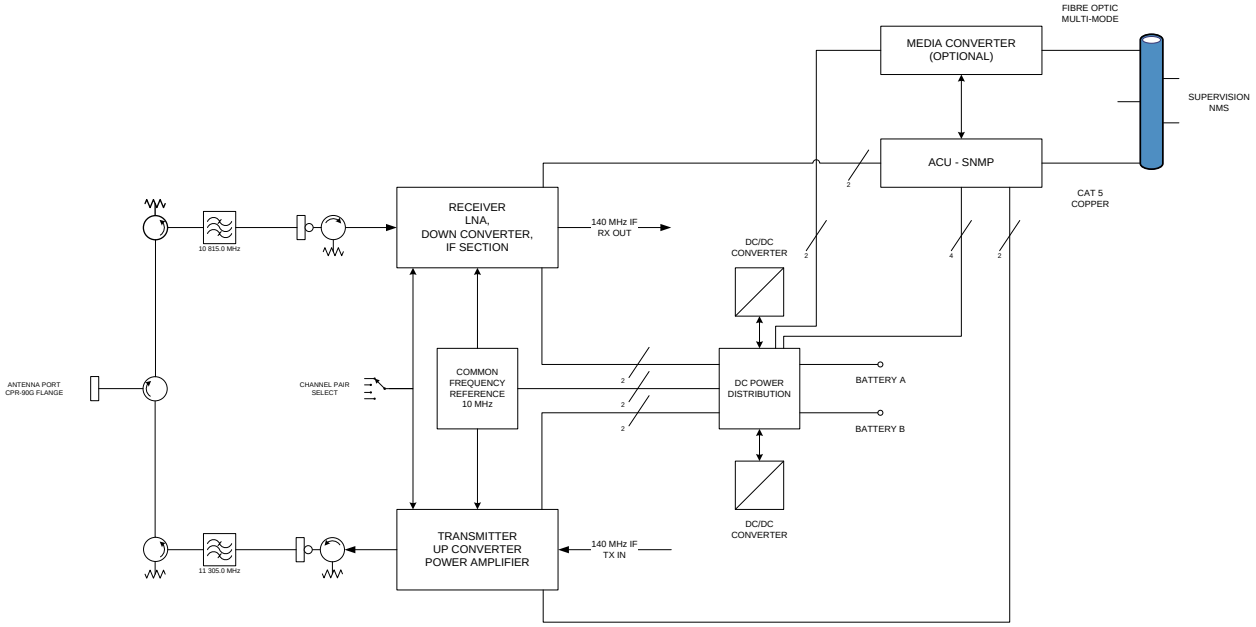

Figure 7 Block Diagram, RF Unit, 1+0 Single Channel Duplex, Un-Equalized

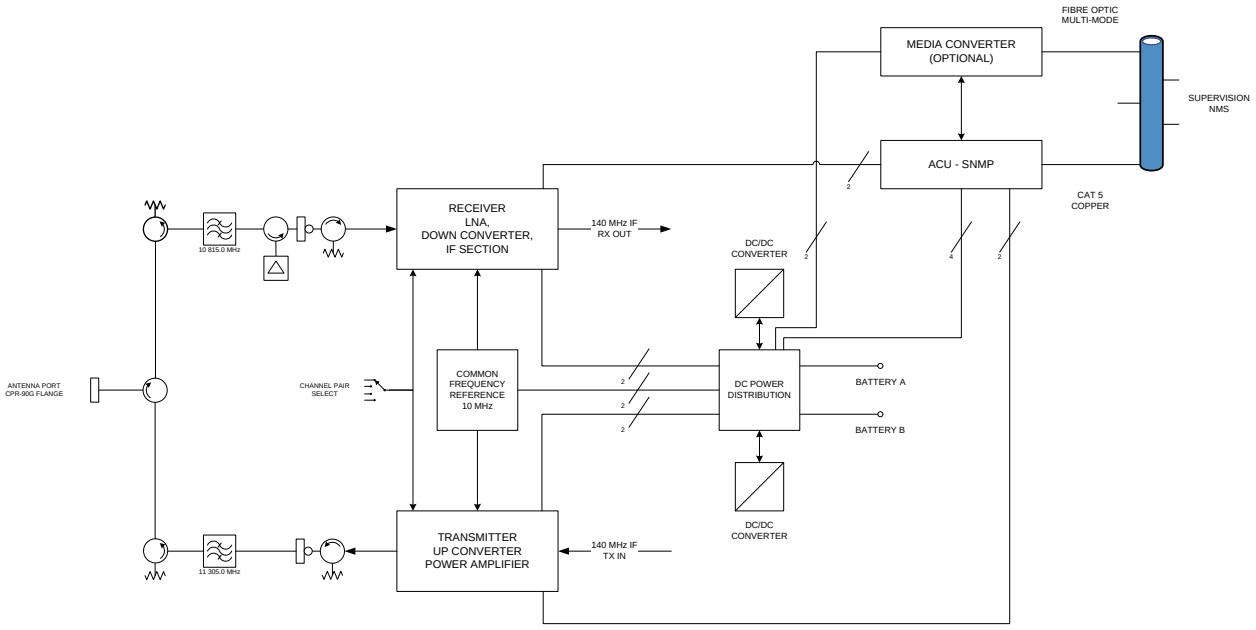

Figure 8 Block Diagram, RF Unit, 1+0 Single Channel Duplex, Equalized

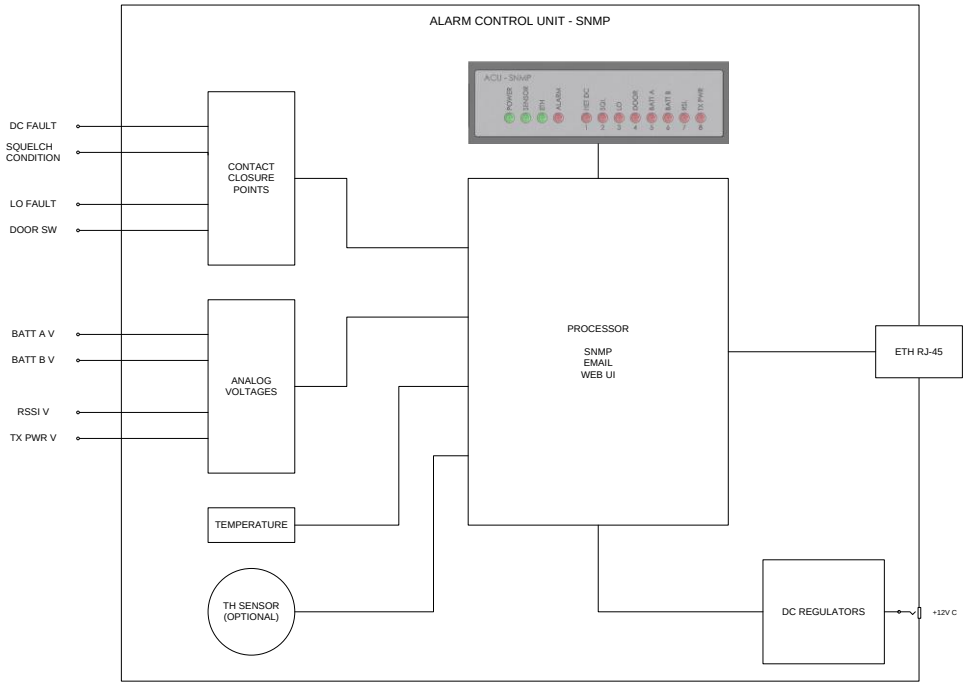

Figure 9 Block Diagram, Alarm Control Unit – SNMP

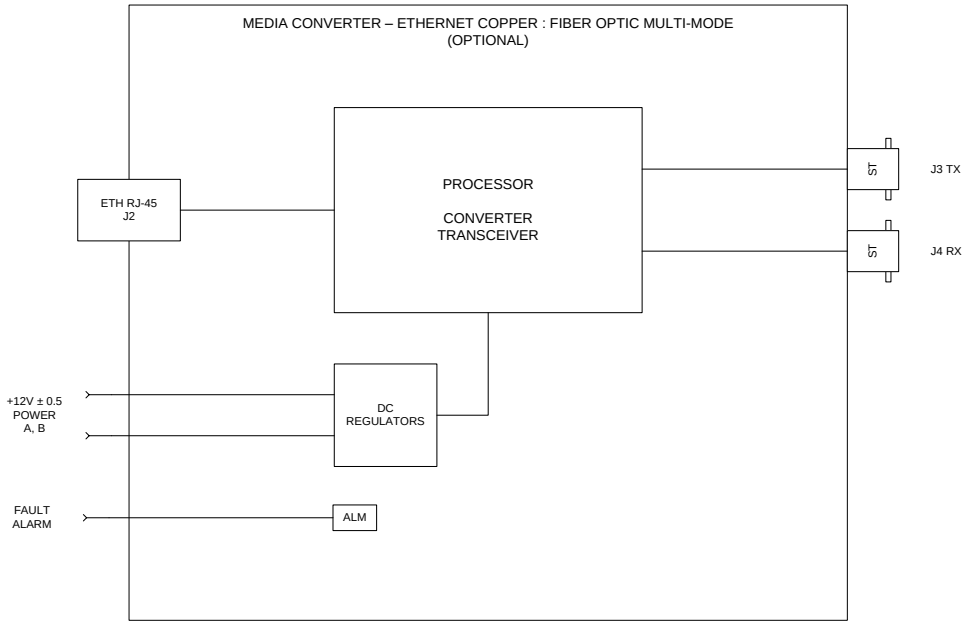

Figure 10 Media Converter, Ethernet Copper - Multi-Mode Fiber Optic

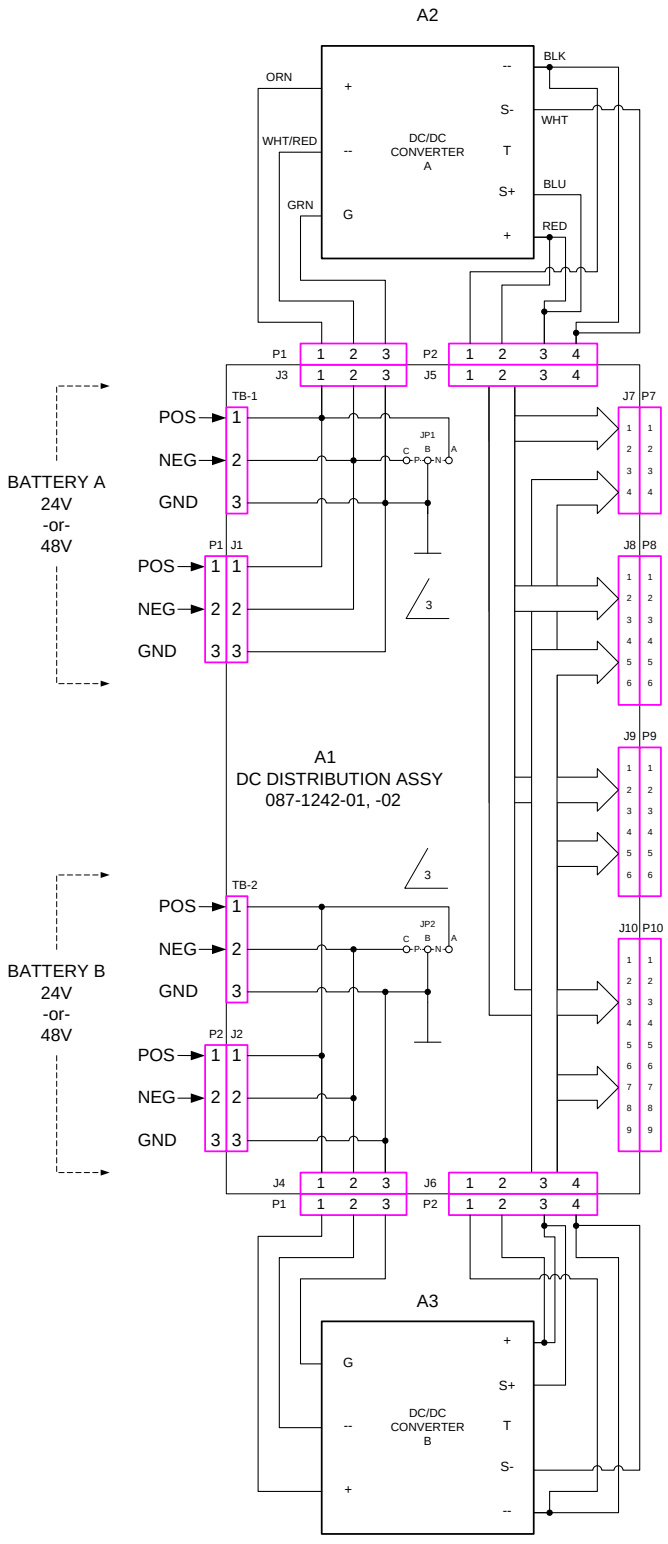

Figure 11 DC Power Connection Diagram, 24V or 48V

Technical Services

To supplement the manpower resources of service providers, Peninsula Engineering Solutions offers the following technical services:

- ⇒ Microwave Link design
- ⇒ Power System design
- ⇒ Site and construction surveys
- ⇒ Project management
- ⇒ Installation
- ⇒ Providing accessories (antennas, waveguide, power equipment, and so on)
- ⇒ Training

Quotations for technical services are available upon request.

Contacting Peninsula Engineering Solutions

Contact the Peninsula Engineering Solutions corporate headquarters for sales information or technical assistance for the HR-11500 Microwave Linear Heterodyne Repeater, or any other of our communications or related products.

Corporate Headquarters

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39 Grand Canyon Lane
San Ramon, California 94582
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Telephone: +1 925 901-0103

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Internet: http://www.peninsulaengineering.com/

E-Mail: info@peninsulaengineering.com

Chapter 2. Installation Preparation

Installation Overview

The HR-11500 is designed for indoor or outdoor installation and can be tower, wall or pole mounted. The unit's compact cabinet simplifies installation.

NOTE: *Only qualified service or technical personnel should install and service the HR-11500*.

Receipt and Inspection of the HR-11500 Heterodyne Repeater

Immediately upon receipt of the HR-11500 heterodyne repeater, unpack and inventory the contents against the packing lists, including the contents of the accessory kit and any optional equipment ordered with the unit—see Tables 8, 9, and 10. Contact Peninsula Engineering Solutions if any items are missing.

Note: Retain the foam packing in place on the repeater to protect connections during movement, rigging and mounting.

Inspect the unit and accessories thoroughly for shipping damage, especially for damage that may be hidden by the packaging. Pay particular attention to the following:

⇒ Bent or dented sheet metal

⇒ Loose or broken components

⇒ Damaged connectors and waveguide flanges

⇒ Damaged or broken wiring or coaxial cables

⇒ Missing or damaged contents of the accessory kit

⇒ Missing or damaged optional equipment

Note any damage on the waybill and request that the delivery agent sign it for verification. Also, notify the transfer company as soon as possible, submit a damage report to the carrier, and inform the Customer Service Department of Peninsula Engineering Solutions in writing.

NOTE: *Save original shipping crate and packing materials for any future transport of the unit.*

If the HR-11500 repeater is to be stored for later installation or shipment, reseal the packaging of the accessory kit and the repeater.

If power system batteries are to be stored for later installation, the batteries must be recharged monthly and especially, prior to installation. Lead acid batteries stored without charging can degrade to an un-usable condition and will not be covered under warranty.

The following figure illustrates a typical installation with external equipment.

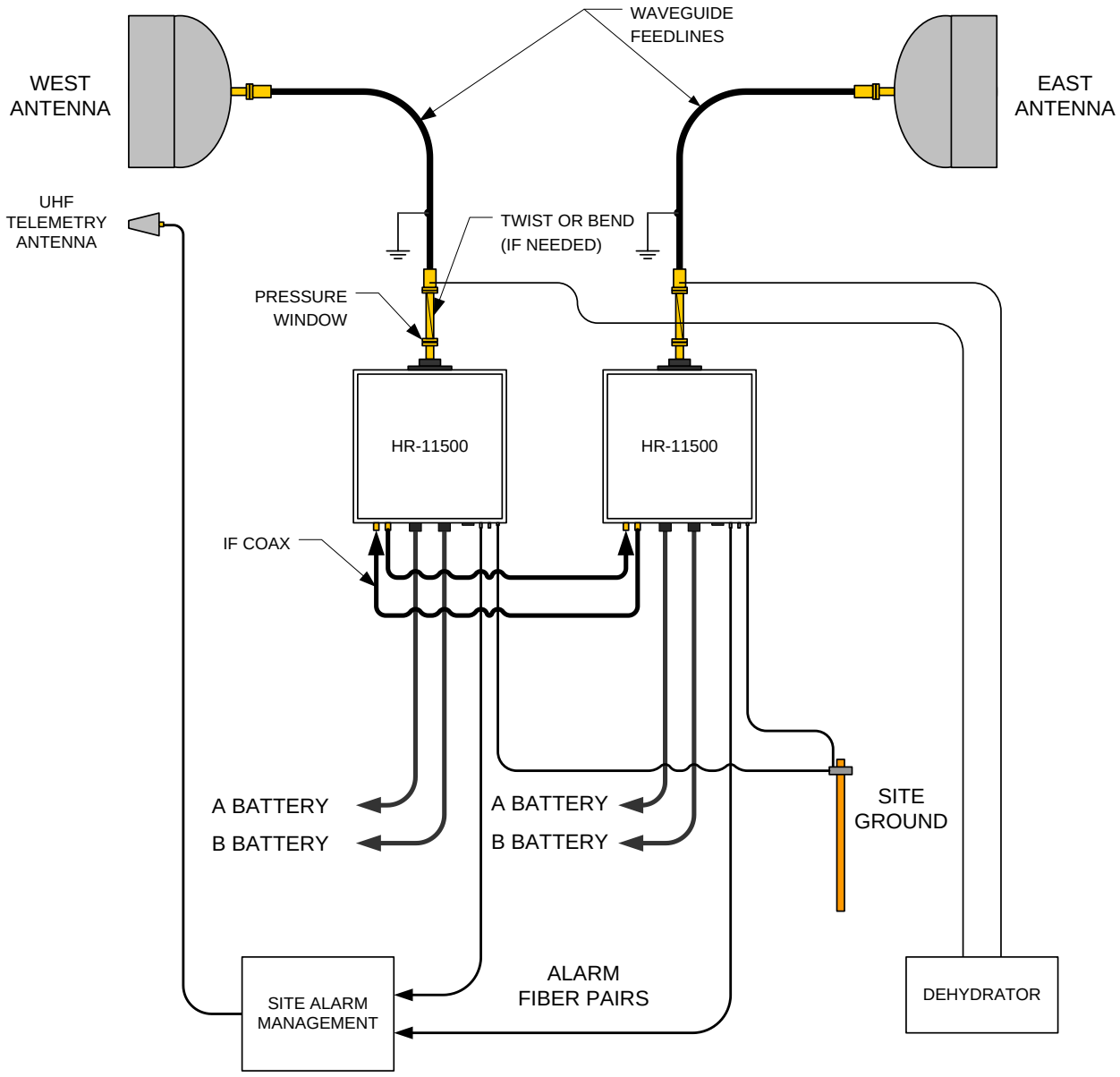

Figure 12 Typical Heterodyne Repeater Station Installation

Installation Equipment

See the following table for a list of required installation equipment. Additional equipment may be needed, depending on specific installation site requirements and optional accessories ordered.

Table 11 Recommended Installation Equipment

Equipment or Item	Function
Site Plan and Path Calculation documentation	To correctly configure the repeater to operate in the microwave network.
1/8-inch small flat blade screwdriver	Used for wiring DC input power terminal blocks.
3/8-inch or ½-inch Ratchet	To drive sockets
7/16-inch or 3/8-inch socket or wrench	For repeater door clamp bolts.
Digital Voltmeter, 0 ~ 200 V	To test power connections and analog test points.
Clamp-On Current Meter or Probe, 0 ~ 100 ADC	To test power systems and loads.
Spectrum Analyzer, 10 MHz ~ 15 GHz†	For signal identification and alignment
Power Meter, Agilent (HP) 435B with 8481A Sensor*	To test RF power output.
Sweep test equipment, Anritsu SiteMaster™ S820D*	To test feedlines and antennas.
Antenna-Path Alignment Test Set, Pendulum Instruments, XL Microwave Path Align-R™ 2241*	To align the antennas on path per hop.
Pressure Window, for CPR90G, 1 ea.	To seal HR for waveguide pressurization.
Coax Adapters, SMA M-F RT Angle, SMA(m) to N(f)	For power measurements at SMA ports.
Coax Adapters or cables, BNC(m) to DVM probes.	For Tx Power and RSSI Voltage measurements.
RF Test Jumper Cables, 50 Ohm, SMA(m), 2 ea.	For test equipment, length depends on application.
IF Test Jumper Cables, 50 Ohm, N(m), 2 ea.	For test equipment, length depends on application.
RJ-45 Ethernet Connectors, 2 ea†.	To build ACU Copper ETH cable (1 run per HR)
CAT-5 Ethernet Cable, 1 Run†.	To build ACU Copper ETH cable (1 run per HR)
Fiber Connectors, LC-MM Duplex, 2 ea†.	To build ACU F/O ETH cables (1 paired run per HR)
Multi-mode Fiber Optic cable, 1 Run†.	To build ACU F/O ETH cables (1 paired run per HR)
Mounting Hardware	To mount repeater and antennas.
Electrical Wiring Equipment (as needed)	To connect external systems to inputs and outputs.
Wrist Grounding Strap	To protect against static discharge.
**Equivalent substitutes may be used.* *†If necessary.* *Qty are per HR Unit, double for repeater station.*	

Note that the site plan and network engineering documentation is used during installation to refer to the intended parameters of the project including gain settings, and antenna location. If necessary, consult a network administrator for more information.

Accessory Kit

Table 12 Accessory Kit

Part Number	Description	Quantity
550-0530-01	Heterodyne Repeater Operations and Maintenance Manual, CD-ROM	1
142-0315-01	Connector, Circular, Flex Cable 3 Socket, Screw Connections	2
175-0025-05	Fuse, 15-Amp, Blade Type ATO (included with 24V applications)	4
175-0025-04	Fuse, 7.5-Amp, Blade Type ATO (included with 48V applications)	4
137-0144-04	Cover, Waveguide, CPR90G	1
137-0166-03	Gasket, Half, Waveguide, CPR90G	1
137-0126-03	Cap, LDP 5/8-24 x .41 (IF Connector covers)	2
125-0002-02	Screw, FHP 82° Under Cut, 2-56 x .250 S/S (spares)	10

Pre-Installation Site Review

Each site should be thoroughly reviewed before any equipment is mounted. Site review should include, but not necessarily be limited to, the following factors:

Weather

Determine whether environmental conditions necessitate special shielding of the repeater or other equipment.

Security

Determine whether some type of barrier is needed to protect equipment and if a security light is required.

Aviation

Review tower heights and obstruction lighting requirements as specified by the national aviation authority, e.g. US-FAA, US Federal Aviation Administration or TC, Transport Canada. Normally towers 200 Ft AGL and taller require obstruction lighting. Towers closer to airports have additional lighting and marking requirements. See FAA AC 70/7460-1K. File NOTAM[20] as required during construction.

Optional Site Equipment

Determine whether additional site equipment, such as a convenience power outlet, pump, generator, or light is required, and, if so, where equipment is to be located and whether special enclosures for any equipment is required.

Wiring and Wiring Access

Determine if there are any special wiring requirements.

Cabinet Access

Determine whether there is enough room for the repeater door to open, once mounted.

The HR-11500 assembly can be mounted on a steel tower, on a steel pipe or square-rail frame, or on a wall. The length of all power leads should be limited and the wire size adequate to minimize the voltage drop. The repeater assembly, battery boxes, solar panels, and antennas should all be mounted before any wiring is done. Mounting-hole dimensions for the repeater enclosure are shown in Figure 13.

Prior to cutting to length and connecting the waveguide feedlines, verify which HR Unit's frequencies associates with each antenna port and associated terminal radio or repeater site. The heterodyne repeater's receiving frequency and transmitting frequency are marked on the top of repeater, near waveguide antenna port. Coordinate site name is marked in the same location, when known.

The waveguide feedlines are terminated in CPR90G, Waveguide Flange. The heterodyne repeater is not designed for pressurization. Use external pressure windows at the CPR90G, Waveguide Flanges in all cases.

CAUTION: *In an extremely hot and sunny environment, such as a desert, shading from direct sunlight may be necessary to prevent the heterodyne repeater and associated equipment from overheating. Locating battery enclosures in the shade is recommended.*

[20] NOTAM: Notice to Airmen, FAA or TC AIM

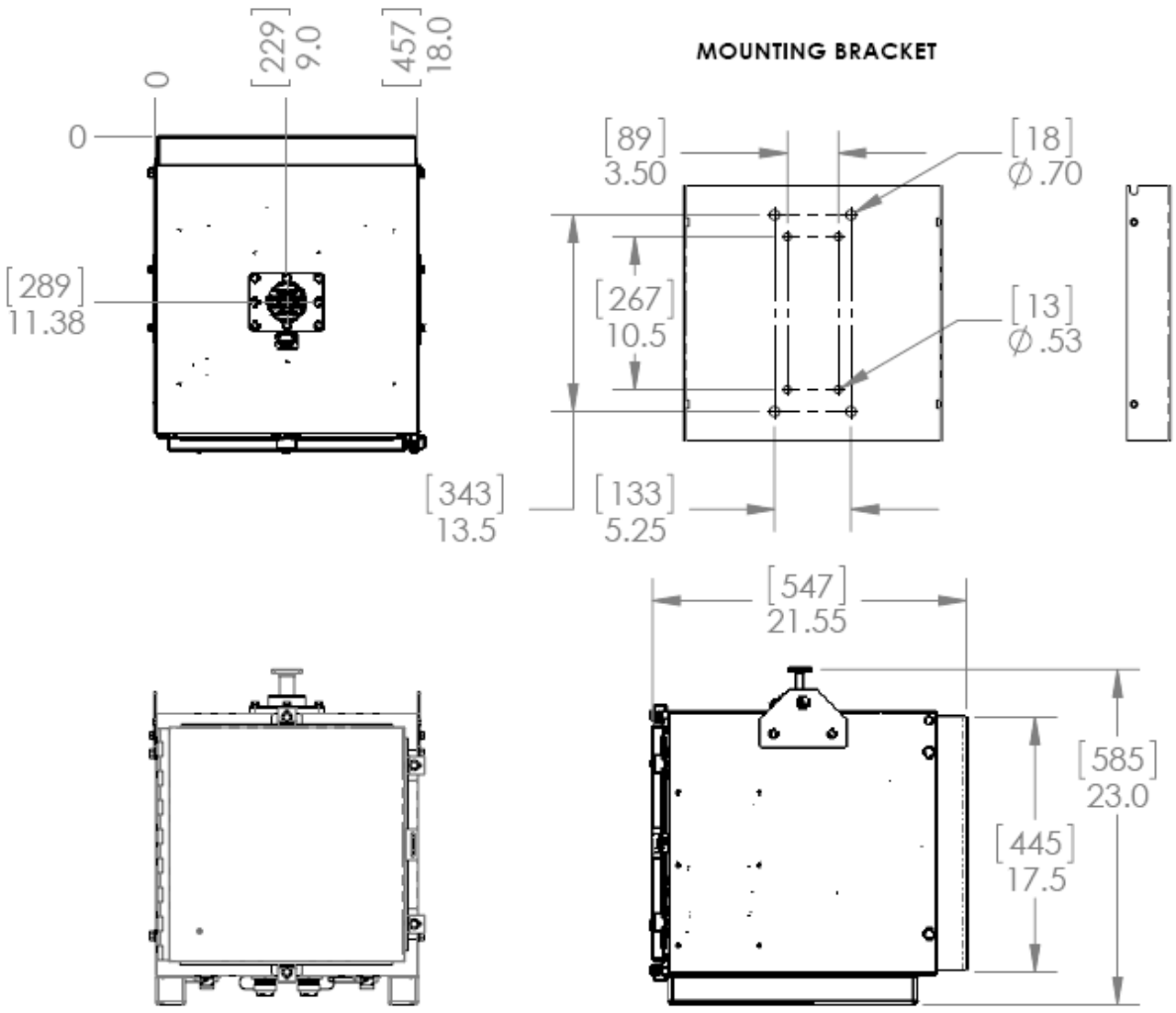

Figure 13 Enclosure Mounting Dimensions
HR-11500, Single Channel Duplex

Dimensions are in Inches [mm]

See block diagrams and Mounting Dimension drawing M900-0530-XX (Appendix) for more details.

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Chapter 3. Mounting the Antennas

Mount Antennas

Mount all antennas, antenna feedlines, grounding, dehydration and lightning protection. Test the completed antenna system installation prior to heterodyne repeater equipment installation. Follow details of the site plan if available.

Antenna Types

Microwave Linear Heterodyne Repeaters can use any one of four typical parabolic antenna types:

- ❑ Standard performance, single or dual polarized.
- ❑ Improved performance, single or dual polarized *(Deep Dish, PAR, PAD)*.
- ❑ High Performance, single or dual polarized.
- ❑ Ultra-High Performance, single or dual polarized.

NOTE: *Antenna type is normally determined by the system requirements. System path calculations, path data sheet, are used to determine the antenna sizes and type.*

Mount the antennas securely on adequate mounting structures. Mounting structures must meet strength, twist and sway requirements for 11 GHz antenna systems. Provide means for alignment adjustments.

Antenna Alignment

Coarse Alignment

To initially orient the antennas:

1. Align the “bore-sight” of the antenna to the calculated azimuth as shown in the site layout or path calculations. Be sure to account for geomagnetic declination when using a magnetic compass. Azimuths are normally shown as True North. Geomagnetic declination varies by site location and typically drifts every year as the location of the earth’s magnetic pole moves.
2. Adjust the elevation to match the calculated elevation angle.

Fine Alignment using test radios

3. Peninsula Engineering recommends using test radios[21] to do the alignment over the hop. This is much easier than attempting to use the limited repeater level indications or measurements. The test radios also provide a talk channel to allow the alignment teams to rapidly communicate with each other.
4. Identify the polarization determined for the hop. Consult the antenna manufacturer’s documentation on identifying the vertical or horizontal antenna port on dual polarized antennas or how the feed assembly is installed and oriented in single (plane) polarized antennas. Failure to properly identify polarizations will result in antenna misalignment and violate the station license.
5. Attach the test radios to the proper antenna waveguide port at each end of the hop.
6. Consult the path data sheet calculations, PDS, for the net path loss calculated between the antennas. Correct for feedline losses when connected directly to the antenna waveguide ports.
7. Begin aligning the antennas. It should be possible to meet the calculated net path loss ± 1 dB.
8. Record the alignment and loss details. Provide the records to the end customer or controlling authority.

[21] Path Align-R™ is a popular test radio. Manufactured by: Spectracom Corp, XL-Microwave, Pendulum

Alternative Fine Alignment using heterodyne repeater level measurements

9. This method requires the HR-11500 repeater to be installed, connected to the antenna feedlines and powered up. See Chapter 4 for repeater installation details.

10. Connect the DVM to the RSSI BNC located on the bottom of the HR enclosure. The DC voltage increases with stronger received signal level. The range is 0 to +10 VDC. Refer to the factory Test Data Sheet, TDS, for calibration.

11. With a signal transmitted from the previous station, position the antenna for a maximum voltage reading on the meter. Align the distant end antenna for maximum receive power.

12. Align any other antennas toward their coordinate station similarly.

13. To generate a transmit signal from a Heterodyne Repeater alone or used with a modem, apply a CW carrier at 140 MHz, 0 dBm, thru a 3 to 6 dB attenuator pad to the HR IF IN Type N connector. The attenuator is required to provide a DC path to ground and activate the transmitter.

14. After the antenna orientation has been completed at both terminals and the repeater, Receive Signal Level (RSL) readings should be taken at all stations and logged for reference. Provide the records to the end customer or controlling authority.

Antenna Feedlines

The HR-11500 repeater uses waveguide feedlines. For the 10.7 ~ 11.7 GHz band, typical feedlines are elliptical waveguide such as EWP90 and EP105. The HR-11500 has CPR90G Waveguide Flanges at the top antenna port. The equipment end of the waveguide feedline must have a matching CPR90G flange installed. Two half height gaskets are used when a pressure window is installed. The antenna end of the waveguide feedline must have a connector flange that matches the installed antenna's flange. Typical antenna flanges in this band are CPR90G and PDR100.

Waveguide feedlines require dehydration equipment to maintain a dry atmosphere within the waveguide to prevent moisture accumulation which leads to corrosion and higher transmission losses. For sites that have adequate electric power available, AC or DC powered dehydration and pressurization equipment can be used. Mount the equipment at the tower base, or where convenient. This equipment normally requires weather protection.

Tower mounted heterodyne repeater applications typically have shorter waveguide runs and thus, a smaller volume of air within the waveguide. Static desiccators are ideal in this situation. A static desiccator will passively dry air passed through its silica gel as daily temperature and pressure changes gently move the air. These units do not require any power to operate and provide 1 to 2 years field lifetime before requiring replacement or service. Peninsula Engineering recommends mounting static desiccators inside a weatherproof enclosure to protect against aging from direct sunlight unless outside, UV rated desiccators are used. Peninsula can provide an assembled dual static desiccator enclosure with pressure test ports. See manufacturer's specifications and recommendations when considering static desiccators.

Dry Nitrogen is another method to keep waveguides dry without using power. Nitrogen supplied in high pressure bottles is reduced in pressure with a regulator and then passed to a gas pressurization manifold with distribution to the feedlines. Nitrogen replaces the air within the waveguide (purged at installation) and the positive pressure helps force moisture away from entering the waveguide. To warn of an empty gas bottle, external alarm equipment can be optionally provisioned with a low pressure switch that can be added to the pressurization manifold. When gas pressure drops below 1 psi, 7 kPa, a warning alarm is issued.

HR-11500 repeater station configurations require one feedline per equipment antenna port, typically:

⇒ One for the primary West antenna

⇒ One for the primary East antenna

⇒ One per direction and polarization in Y-Junction applications

The allowable transmission loss for antenna feedlines is specified in the site plan or path calculation, path data sheet documentation for the project. Do *not* install feedlines different than as specified.

Feedline Installation

To install waveguide feedlines:

1. Install the top connector (goes to the antenna). Use a flaring tool for best attachment and impedance, Z_0, match.
2. Raise the waveguide up the tower to the antenna. Use a hoisting grip.
3. Position the waveguide and secure the top section. Carefully bend the elliptical waveguide to align with the antenna flange. Be mindful of the bend and twist specified limits of the waveguide. If necessary, use rigid twist and bend sections to aid in alignment.
4. Connect the waveguide to the antenna.
5. Securely install the feedline so that it reaches to the installation site of the HR-11500, with enough room to connect to the heterodyne repeater.
6. Secure the cable to the tower or structure about every 3 feet or 0.9 meters.
7. Carefully measure and cut to length the waveguide.
8. Terminate the waveguide with a CPR90G flange connector.
9. Position the waveguide and secure the bottom section. Carefully bend the elliptical waveguide to align with the repeater equipment top flange. Be mindful of the bend and twist limits of the waveguide. If necessary, use rigid twist and bend sections to aid in alignment.
10. Flexible twist-flex waveguide jumper may be used at either end if needed. These jumpers have higher loss and shorter life than rigid twist and bend sections.
11. Trial fit the bottom connector to the repeater equipment top antenna port flange or intended flange location. Do not permanently install until the feedlines are sweep tested.
12. Install waveguide grounding kits. Normally the waveguide is grounded at the top and bottom and at the shelter entrance. Follow grounding practices prescribed by the controlling authority.
13. Pressure windows are recommended at the repeater equipment top antenna port.
14. Install dehydration equipment.
15. If gas ports are not available on the waveguide connectors, install a pressure inlet flange above the pressure window.

Lightning Protection

Peninsula Engineering Solutions strongly recommends installing protection on the tower, structure and on all feedlines to the heterodyne repeaters. A direct lightning strike can damage any electronic equipment. Damage resulting from a lightning strike is not covered under the equipment warranty, whether or not lightning protection is used. However, using lightning protection can minimize the risk of damaging a repeater unit, and of losing equipment operation during thunderstorms.

Elliptical waveguides are protected by installing grounding kits, typically at the top, bottom and at shelter entrance.

Lightning rods mounted adequately above the highest antenna or power equipment, provide a diversion path for lightning strikes. Multiple lightning rods may be required.

Towers, shelters and all equipment must be bonded and grounded to minimize any potential differences that can occur due to a lightning strike.

Follow grounding practices prescribed by the controlling authority.

Sweeping the Antenna Feedlines

Sweep testing of the installed feedlines and antennas is recommended. Sweep testing is the same as performed at a terminal radio site. Measurement of impedance match and insertion loss over the operating frequencies insures that the antenna system is installed properly and is ready to perform.

Most microwave operating companies have developed their own performance standards for antenna systems. Use such standards if available. If company standards are not available, consider the following:

- Sweep frequency range: 10,700 ~ 11,700 MHz or across assigned channel bandwidth.
- Impedance Match: 20 dB Return Loss or 1.2:1 VSWR across the channel bandwidth or better. If tunable connectors are provisioned, adjust the tuning screws to optimize the match.
- Insertion Loss: Per calculated. Typical waveguide loss[22] is 3.05 dB/100 Ft or 10.0 dB/100 m.
- Distance to Fault, DTF: Measure Return Loss of the antenna system components and isolate troubles. Use DTF function of Anritsu Site Master™ (or equivalent) test equipment.

If the impedance match or insertion loss is not met, troubleshoot the feedlines and antennas for the source of the problem. Use the “Distance to Fault” function to assist in localizing the trouble. Correct as required before proceeding.

[22] EWP90, EP105. Consult manufacturer’s specifications for loss at the intended frequencies.

Chapter 4. Mounting the HR-11500 Repeater

Installation Overview

The HR-11500 assembly can be mounted on a steel tower, on a steel pipe or square-rail frame, or on a wall. The length of all power leads should be limited and the wire size adequate to minimize the voltage drop. The heterodyne repeater assembly, electric power system, battery boxes, solar panels, and antennas should all be mounted before any wiring is done.

NOTE: *Only qualified service or technical personnel should install the repeater.*

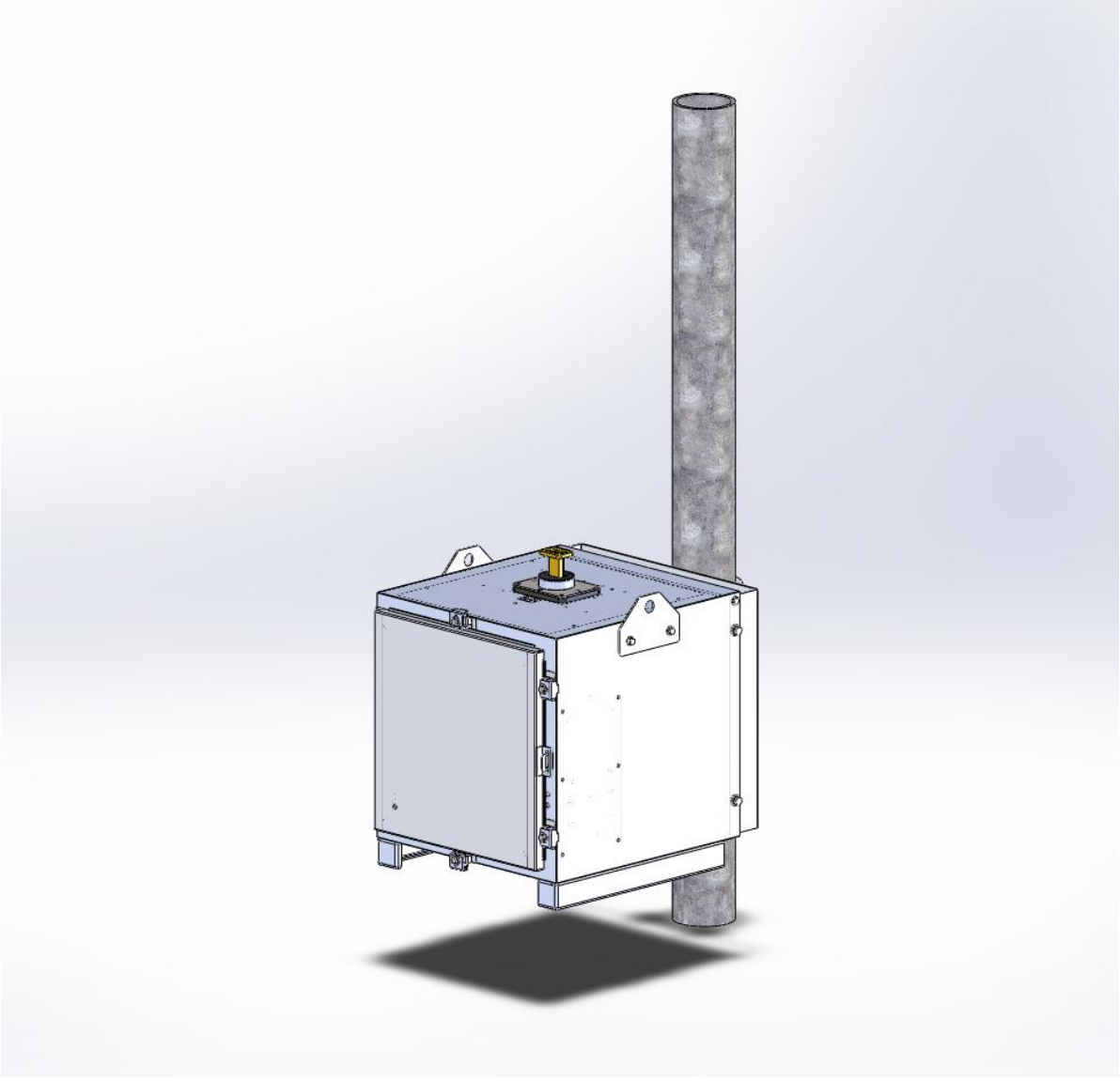

Figure 14 Heterodyne Repeater Installation on pipe mount

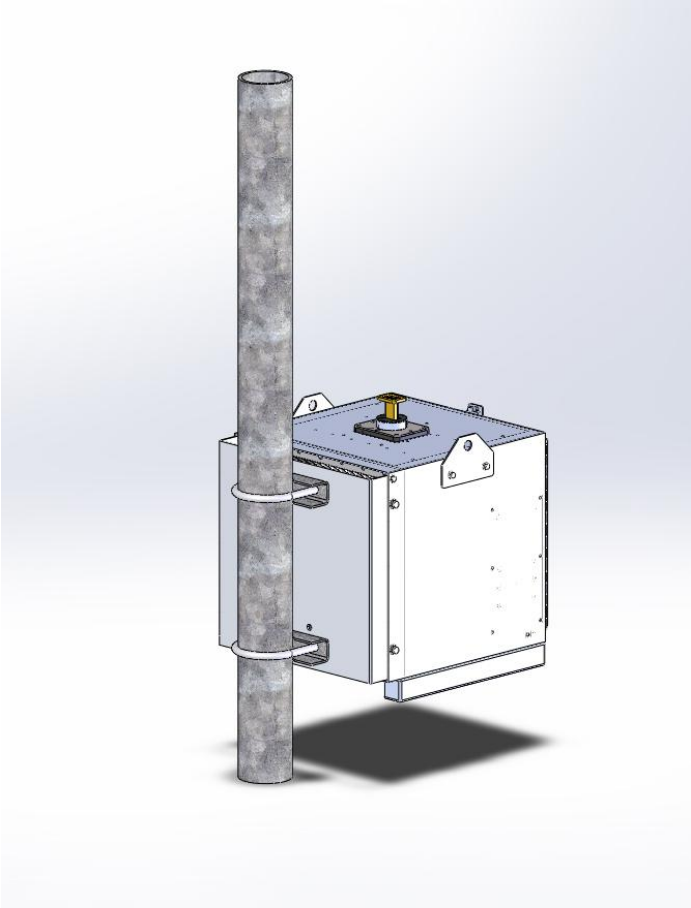

Figure 15 Heterodyne Repeater on pipe mount, rear view

Mounting Associated Equipment and Space Planning

Mount the site power system and any other associated equipment before mounting and wiring the repeater. Plan the site equipment layout prior to beginning installation.

Recommended power system installation sequence:

1. Ground Ring or grounding provision
2. Battery Enclosures and Batteries
3. AC/DC Rectifier and Battery Charger
4. Photovoltaic Array, mounting frame and modules
5. Wind Turbine Generator, pipe mount and generator
6. PV Array Combiners
7. PV Controller

Figure 16 Example of Solar and Wind Power Installation

Mounting the Repeater

The HR-11500 has a detachable rear mounting bracket. The mounting holes fit 3/8-inch to 5/8-inch hardware. Mounting-hole dimensions for the mounting bracket are shown in Figure 13. The HR enclosure attaches to the mounting bracket using 3/8-inch hardware provided. The enclosure is first aligned using the ½-inch alignment spacer and slot in the mounting bracket. The enclosure is secured to the mounting bracket using the 3/8-inch hardware provided.

The HR unit may be lifted to a high mounting location using the lifting plates attached to the sides of the enclosure. Use carabineers and a rope cable sling for balance. The top rear edge with the alignment spacer will tip to the rear making attachment to the mounting plate easier. Avoid using a rope cable across the top of the enclosure as this can damage the waveguide antenna port.

Once the HR unit is securely mounted, it is recommended to remove, invert and reattach the lifting plates. Inverting the lifting plates reduces the chance of ice buildup on the top of the repeater from causing damage to the waveguide entry boot. Make sure the bolts have sealant in the threads to prevent water from propagating along the thread helix.

Pipe Mount

The mounting bracket may be attached to 4.5-inch OD pipes using the outer hole pattern or 2.375 ~ 2.5-inch OD pipes using the inner hole pattern. Pipe saddle and U-bolt clamps[23] can be used to attach the bracket. Cut off excess U-bolt thread near the mounting nut. This provides clearance to the HR heatsink fins.

Figures 14, 15 and 17 show the suggested pipe mounting.

[23] Clamp sets are provided by others.

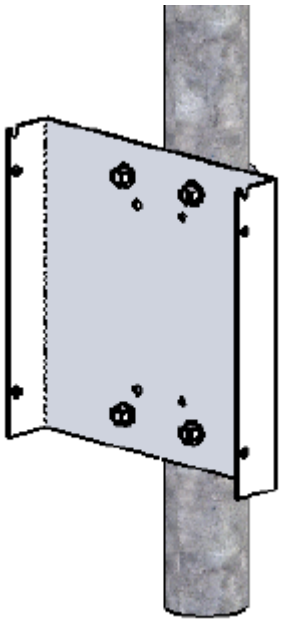

Figure 17 Mounting Bracket attached to 4.5-inch Pipe

H-Frame Mount

The HR-11500 may be mounted to an H-frame or wall using Unistrut™.

Fabricate a mounting frame using 3/8-inch square rail or Unistrut™ fastened to the tower members, wall or monopole. The square rail sections directly attached to the mounting bracket are normally best horizontal. Attach the mounting bracket first using 3/8-inch spring nuts and bolt, washer hardware.

Attach the repeater to the mounting bracket using the 3/8-inch hardware provided.

See Figure 18 for a suggested mounting frame.

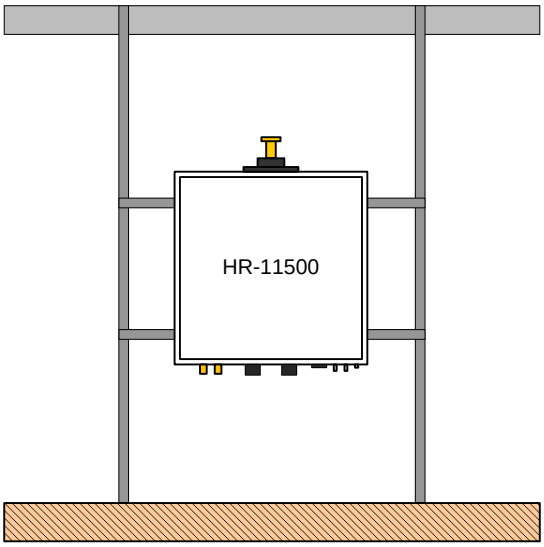

Figure 18 Suggested Mounting H-Frame

Earth, Ground, and Lightning Protection

When grounding the HR-11500 and associated equipment, follow the general guidelines in the Peninsula Engineering Solutions application note, 650-0002-01: *Installation Standards for Grounding Requirements*.

Note is available at www.peninsulaengineering.com *Microwave RF Repeaters/Engineering Notes*.

Installing the input power to the repeater includes installing the standard electrical service grounds. However, you must also make sure that the heterodyne repeater enclosure is properly grounded to an earth ground.

The enclosure includes an external grounding lug on the bottom surface as shown in the following figure.

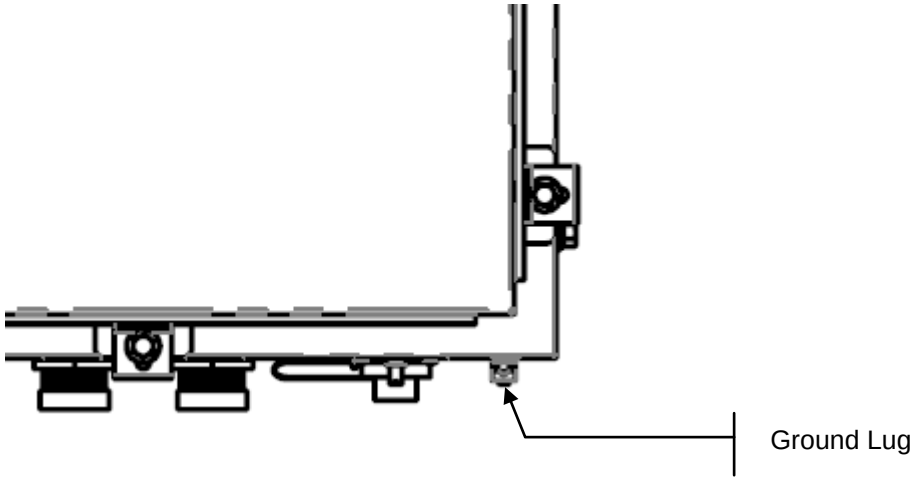

Figure 19 Location of Ground Lug on Heterodyne Repeater Enclosure

1. Connect the screw-compression ground lug to a suitable earth ground—copper ground rod, copper pipe, ground ring, grounded steel building frame or similar ground point—using 2 to 4 mm, No. 12 to 6 AWG copper wire.
2. Carefully dress the wire along cabinet, and the mounting surface, to the Repeater Grounding System or the Ground Rod. Recommend using CADWELD® to attach the ground wire to the rod or ground point.

NOTE: *When dressing the grounding wire, and forming it around corners; avoid making sharp bends in the wire. Use a generous radius for each wire bend. Sharp bends will cause arc points for lightning surges and strikes.*

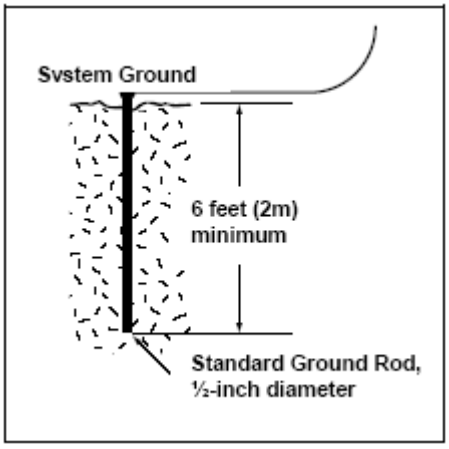

Figure 20 Typical System Ground Rod

CAUTION: *Ground all other cabinets, enclosures, antennas, waveguides, and coaxial cables used for installation to reduce any damage from a lightning strike or power surge.*

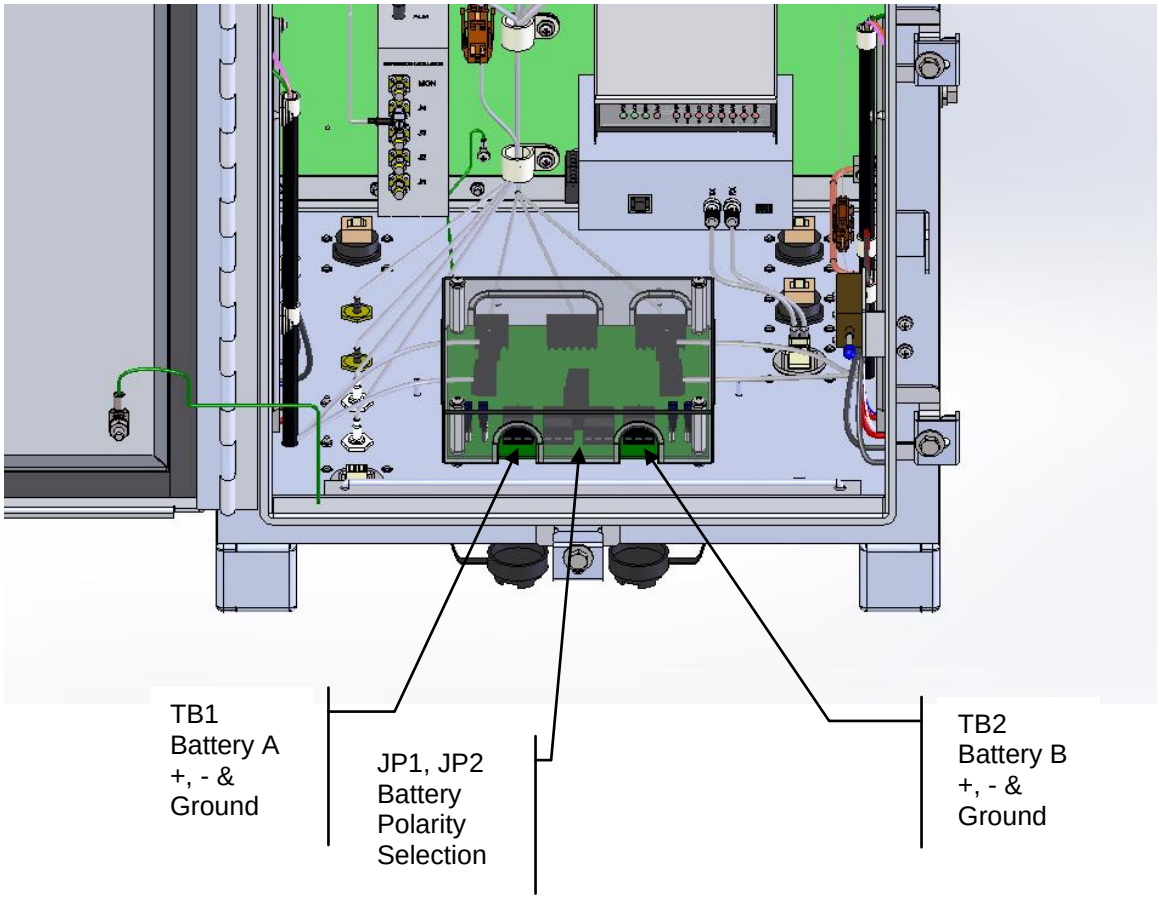

Figure 21 Wiring and Ground Connections, Power Distribution Assembly, (Aluminum cover shown as transparent)

IF Connections

In IF Heterodyne Through-Repeater applications, the IF 140 MHz ports are cross connected between Heterodyne Repeater Unit pairs. See Figure 4.

- West IF OUT to East IF IN.
- East IF OUT to West IF IN.

Recommend using 50 Ohm Foam Dielectric coaxial cable for low loss, low latency and high isolation. Maximum rated cable loss is 10 dB. Connectors are Type N(m) at each end to attach to external IF ports.

- Return Loss should be 14 dB or better across 120 ~ 160 MHz.
- Cable must pass DC in order for the squelch to work and Tx PA to activate.

Table 13 IF Cable Types

Cable Type	Maximum Length	Signal Delay, Latency
Times Microwave LMR-200	250 Ft, 75 mtr	V_P .83, 122 nsec/100 Ft, 402 nsec/100 m
Times Microwave LMR-400	650 Ft, 200 mtr	V_P .85, 120 nsec/100 Ft, 392 nsec/100 m
Times Microwave LMR-600	1000 Ft, 300 mtr	V_P .87, 117 nsec/100 Ft, 383 nsec/100 m
Times Microwave LMR-900	1450 Ft, 450 mtr	V_P .87, 117 nsec/100 Ft, 383 nsec/100 m
Times Microwave LMR-1200	2000 Ft, 600 mtr	V_P .88, 116 nsec/100 Ft, 379 nsec/100 m
Comscope/Andrew LDF1-50	650 Ft, 200 mtr	V_P .86, 118 nsec/100 Ft, 388 nsec/100 m
Comscope/Andrew LDF2-50	775 Ft, 235 mtr	V_P .88, 116 nsec/100 Ft, 379 nsec/100 m
Comscope/Andrew LDF4-50A	1200 Ft, 365 mtr	V_P .88, 116 nsec/100 Ft, 379 nsec/100 m
Comscope/Andrew AVA5-50	2400 Ft, 730 mtr	V_P .91, 112 nsec/100 Ft, 366 nsec/100 m
Comscope/Andrew AVA6-50	3200 Ft, 975 mtr	V_P .92, 110 nsec/100 Ft, 363 nsec/100 m

For IF Terminal applications; the IF 140 MHz ports are connected to an external modem unit. See Figure 5.

- Modem IF OUT to HR IF IN.
  Heterodyne IF IN requires: -15 ~ 0 dBm and DC path to ground to activate Tx PA.
  Maximum DC resistance, shunt to ground, is 500 Ohms.
- HR IF OUT to Modem IF IN.
  Heterodyne IF OUT provides: -2 dBm and DC switched shunt to ground upon Squelch activation.

Install Grounding Kits on the IF Cables for lightning protection.

Install weather protection boots, casings or sealing tape at the N connectors.

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Chapter 5. Equipment Tests

Overview

This chapter describes how to test the HR-11500 equipment, to configure settings and to verify that it is operating properly.

Test Equipment Required

Table 11, in Chapter 2, lists test equipment and tools required for testing the HR-11500 repeater. Equivalent equipment may be substituted.

Configuring the Heterodyne RF Module

The HR-11500 is configured in the factory to customer and project requirements. Normally it is not necessary to change the configuration settings. Should it be necessary to change settings, proceed as follows:

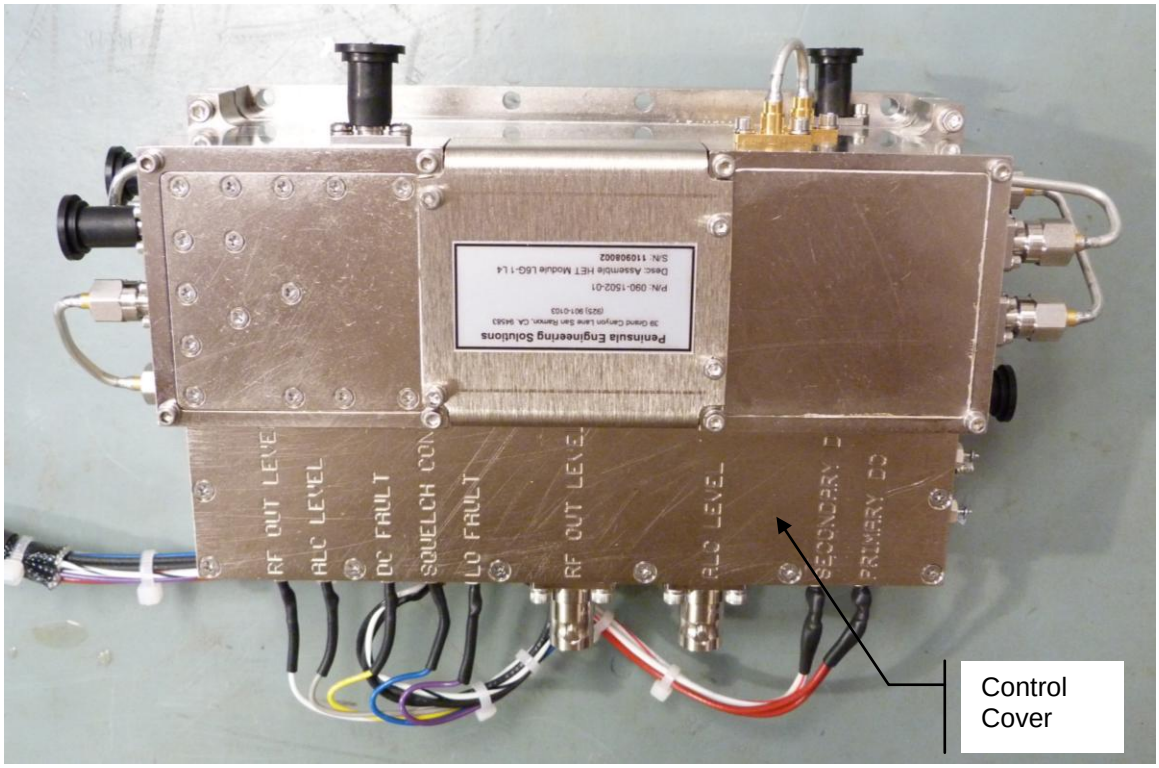

Figure 22 Heterodyne RF Module

1. Power down the heterodyne repeater unit for safety if possible. At this point the HR should be OFF anyway.
2. Locate the Heterodyne RF Module inside the unit enclosure. See Figure 22.
3. Remove the Control Cover to expose the configuration switches. The screws are small 2-56 FHP x .250 and are easy to drop and loose. Spare screws are included in the accessory kit.
4. Identify the configuration switches. See Figure 23.

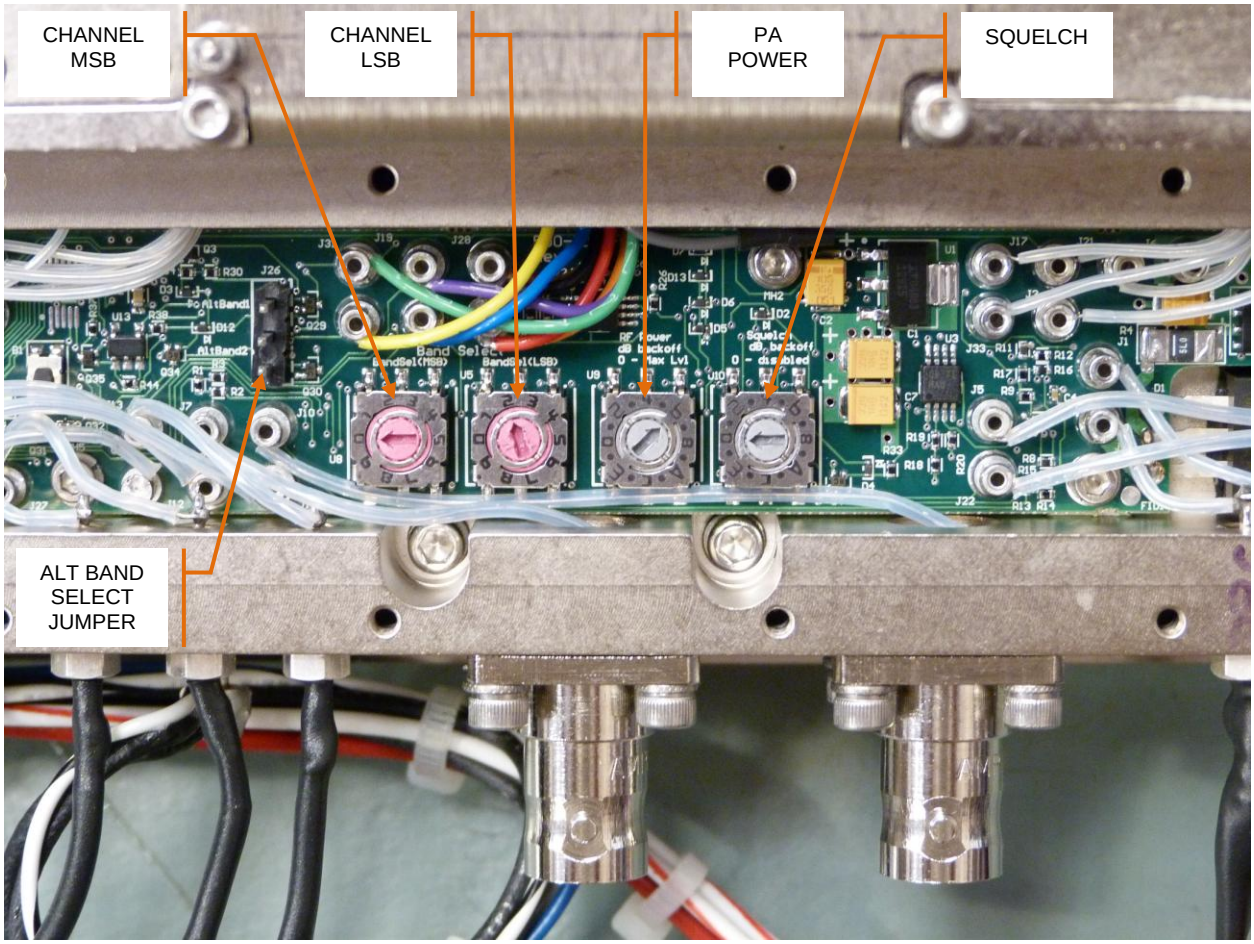

Figure 23 Configuration Switches and Jumper

5. See the Channel Plans in Tables 3 to 7 for the Channel MSB and LSB settings. The channel pair must match the filter frequencies in the antenna coupling unit, ATCU!
6. Set the **Channel MSB** and **LSB** switches (2 left switches, 0~9 BCD) for the desired channel pair. Note the receive and transmit frequency directions when selecting the pair. Certain channel plans have alternate T-R spacing capability. Set ALT BAND SELECT jumper as listed in the channel plan table.
    a. Note: to enable the channel settings, the heterodyne unit must be power cycled. Power down the unit for at least 10 seconds and then restart.
7. **Transmit Power Amplifier Power** is set using the 0~F HEX switch, 3rd from the left or RF input end. Table 14 lists the power settings. The power level is referenced to the module RF output SMA connector. Subtract transmit branch filter loss from this value to calculate the level at the waveguide antenna port. Transmit branch filter loss is marked on the ATCU panel. See Table 1 for typical loss values.
8. **Squelch** level is set using the 0~F HEX switch 4th from the left or RF input end. Table 14 lists the squelch level settings. The squelch level is referenced to the module RF input SMA connector. Add receive branch filter loss to this value to calculate the level at the waveguide antenna port. See Table 1 for typical loss values.
9. Changes to Transmit Power and Squelch levels will be immediately enabled if the heterodyne unit is powered ON. Otherwise, the changes will be effective on next power up.

Table 14 Configuration Settings, Tx Power and Squelch levels

Tx PA POWER LEVEL		SQUELCH LEVEL	
HEX	dBm	HEX	dBm
0	+34	0	DISABLE
1	+33	1	-75
2	+32	2	-74
3	+31	3	-73
4	+30	4	-72
5	+29	5	-71
6	+28	6	-70
7	+27	7	-69
8	+26	8	-68
9	+25	9	-67
A	+24	A	-66
B	+23	B	-65
C	+22	C	-64
D	+21	D	-63
E	+20	E	-62
F	+19	F	-61

Configuring DC Power

Heterodyne Units are ordered for 24V or 48V battery power. If the battery polarity is known, the input polarity will be set at the factory. Should it be necessary to change the polarity jumpers, proceed as follows:

1. Open the Heterodyne Unit enclosure door. Locate the DC Distribution Subassembly circuit board at the inside bottom.
2. Tables 15, 16 and 17 list the connections and jumper positions for the available configurations. Figure 10 shows the DC power connection schematic. Figure 24 shows the board layout.
3. Wire jumpers are used at JP1 and JP2.
4. In applications were a single battery supply is used, recommend combining the A and B inputs to provide internal DC/DC power supply redundancy and to normal standing alarms. See Tables 16 and 17 for connection details.
5. In applications were power is run to the heterodyne unit thru conduit; connections can be made to TB1 and TB2 on top of the DC Distribution Subassembly. Knockouts for 2ea ½-inch conduits and 1ea 1-1/2 inch conduit are available for terminating the conduit.
    a. The maximum wire size is 10 AWG.
    b. Minimum recommended wire size is 14 AWG.
    c. Wire size is determined by run length and allowable voltage drop.
6. In applications were power is run to the heterodyne unit via cords and Bulgin 3-socket plugs; connections are to the Bulgin 3-pin jacks J1 and J2 on the enclosure outside bottom.
    a. The maximum wire size is 12 AWG, cord OD range is 6 ~ 8 mm, (0.24 ~ 0.32-in).
    b. Minimum recommended wire size is 14 AWG.
    c. Wire size is determined by run length and allowable voltage drop.

Table 15 DC Battery Configurations, A & B

24V 087-1242-01			48V 087-1242-02		
+24V A Battery, NEG GND	JP1: 2-3		+48V A Battery, NEG GND	JP1: 2-3	
-24V A Battery, POS GND	JP1: 1-2		-48V A Battery, POS GND	JP1: 1-2	
A Battery POS input	TB1-1	J1-1	A Battery POS input	TB1-1	J1-1
A Battery NEG input	TB1-2	J1-2	A Battery NEG input	TB1-2	J1-2
A Battery GND input	TB1-3	J1-3	A Battery GND input	TB1-3	J1-3
+24V B Battery, NEG GND	JP2: 2-3		+48V B Battery, NEG GND	JP2: 2-3	
-24V B Battery, POS GND	JP2: 1-2		-48V B Battery, POS GND	JP2: 1-2	
B Battery POS input	TB2-1	J2-1	B Battery POS input	TB2-1	J2-1
B Battery NEG input	TB2-2	J2-2	B Battery NEG input	TB2-2	J2-2
B Battery GND input	TB2-3	J2-3	B Battery GND input	TB2-3	J2-3

Table 16 DC Battery Configuration, A-Only Positive Voltage

+24V 087-1242-01			+48V 087-1242-02		
+24V A Battery, NEG GND	JP1: 2-3		+48V A Battery, NEG GND	JP1: 2-3	
A Battery POS input	TB1-1	J1-1	A Battery POS input	TB1-1	J1-1
A Battery NEG input	TB1-2	J1-2	A Battery NEG input	TB1-2	J1-2
A Battery GND input	TB1-3	J1-3	A Battery GND input	TB1-3	J1-3
+24V B Battery, NEG GND	JP2: 2-3		+48V B Battery, NEG GND	JP2: 2-3	
A to B Combining Jumper	JP1-1 to TB2-1		A to B Combining Jumper	JP1-1 to TB2-1	

Table 17 DC Battery Configuration, A-Only Negative Voltage

-24V 087-1242-01			-48V 087-1242-02		
-24V A Battery, POS GND	JP1: 1-2		-48V A Battery, POS GND	JP1: 1-2	
A Battery POS input	TB1-1	J1-1	A Battery POS input	TB1-1	J1-1
A Battery NEG input	TB1-2	J1-2	A Battery NEG input	TB1-2	J1-2
A Battery GND input	TB1-3	J1-3	A Battery GND input	TB1-3	J1-3
-24V B Battery, POS GND	JP2: 1-2		-48V B Battery, POS GND	JP2: 1-2	
A to B Combining Jumper	JP1-3 to TB2-2		A to B Combining Jumper	JP1-3 to TB2-2	

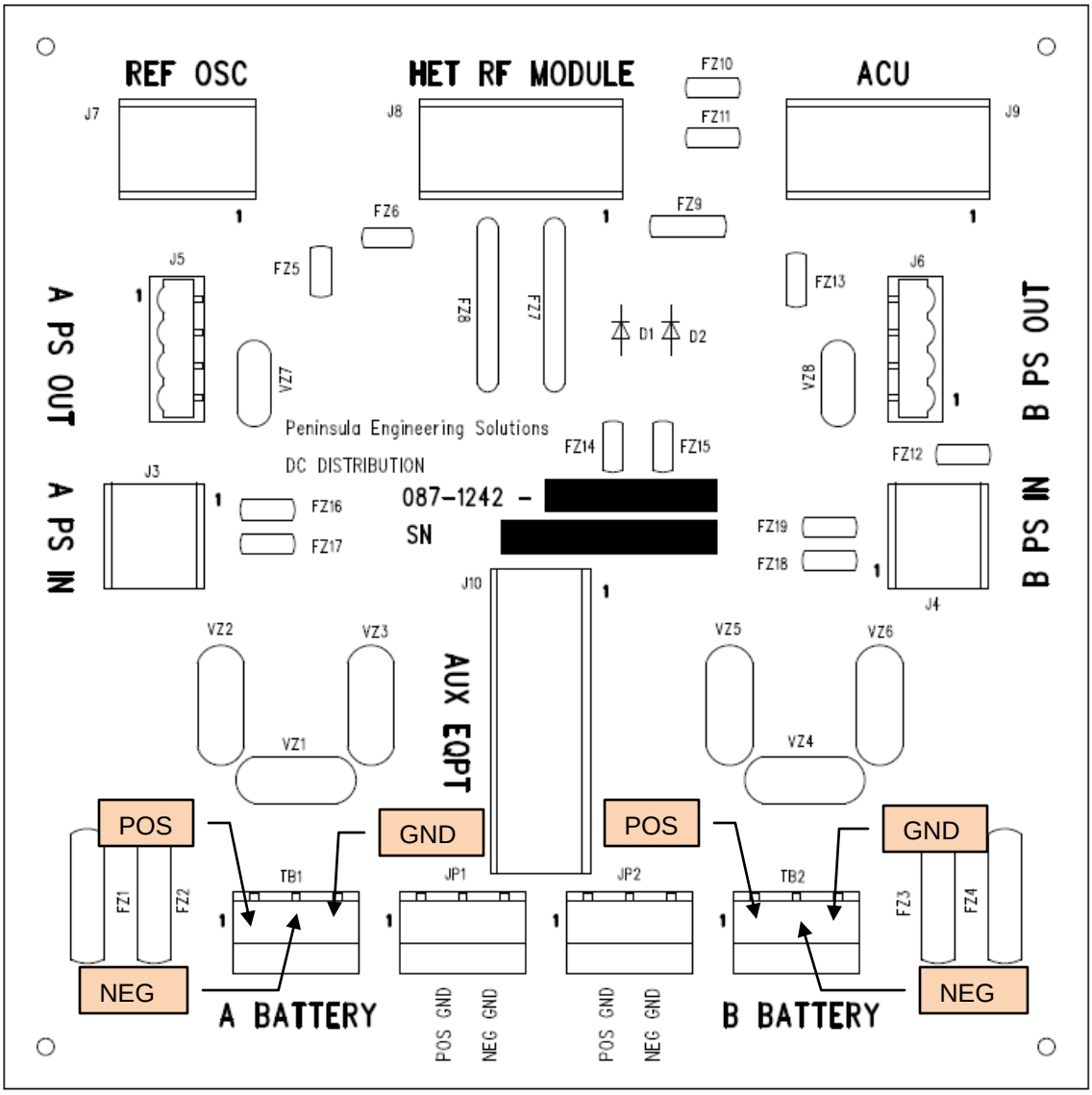

Figure 24 DC Distribution Assembly and Battery Input Blocks

Applying Power to the Heterodyne Repeater

1. Confirm the repeater is connected to the antenna feedlines, is grounded and that the power system has been installed and tested. Confirm that battery polarity jumpers are in place and correct. See Tables 15, 16, 17 and Figure 24.

2. When a single battery supply is used, parallel the DC inputs at the DC Power Distribution Assembly. See Tables 16, 17 and Figure 24.

3. Apply primary DC power to battery connections, internal or external as required.

4. Measure the DC voltage at TB1 1(+), 2(-) and TB2 1(+), 2(-).
   Make sure that the voltage is within the operating parameters of the repeater:
   - 24 Volts DC: 20 ~ 30 VDC. Nominal lead acid battery voltage is 25.2 VDC when fully charged and 27.0 VDC when being charged. Correct as necessary.
   - 48 Volts DC: 40 ~ 60 VDC. Nominal lead acid battery voltage is 50.4 VDC when fully charged and 54.0 VDC when being charged. Correct as necessary.
5. If the ACU-SNMP alarm module is provisioned, it will start-up on power up. ACU start-up takes about 5~10 seconds. Power LED should be ON and GREEN.

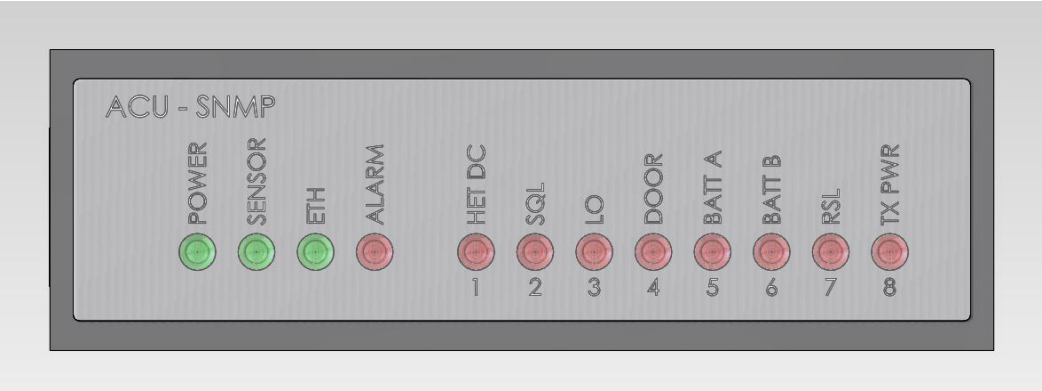

Figure 25 ACU - SNMP Module, Front Panel

6. On initial power-up, these ACU conditions should be present as displayed on front panel:

Table 18 ACU Conditions at power-up

Item	Condition	Alarm Point	Clear
POWER	**ON - Green**	12.5V DC Bus < 10V	12.5V DC Bus > 10V
SENSOR	**OFF**	*Not Used*	
ETH	ON, FLASH - Green	Ethernet Disconnected	Ethernet Active
ALARM	ON – Red (Summary)	Any Alarm or Temperature	All Alarms Clear
HET DC	Clear	Current Out of Range Squelch Active LO Fail	Current Normal
SQL	Clear	Squelch Active LO Fail	Squelch Inactive
LO	Clear	Synthesizers UnLock Loss of 10 MHz Ref.	Local Oscillators Normal
DOOR	Alarm, ON – Red	Door Open	Door Closed
BATT A	**Clear**	Battery A V < 21V, > 28.5V Battery A V < 42V, > 57V	Battery A V Normal
BATT B	**Clear**	Battery B V < 21V, > 28.5V Battery B V < 42V, > 57V	Battery B V Normal
RSL	Clear	RSL < -70 dBm, > -25 dBm	RSL Normal
TX PWR	Clear	PWR < 0.3 W, > 4W	PWR Normal

7. Once the Battery A and B alarms clear, then the repeater is powered and ready for testing.
8. Current Test: Measure the Battery A and B current flowing into the heterodyne repeater. Each battery will normally supply close to half of the total current listed in the Technical

Summary. If either battery input has a low or zero current, check the battery source and distribution system. A battery source with lower voltage will typically supply less current.

- Record A and B currents for reference.

9. The heterodyne repeater can operate on a single A or B battery input when needed. Each module can draw power from both DC/DC converters and thus either battery input. When one battery source is removed or failed, all the current will flow into the remaining working battery feed. This can be observed by switching OFF one of the battery feeds, observe, then restore this feed to ON and then switch OFF the other battery feed, observe.

Transmit Power Adjustment

At this point, the antennas should be mounted, feeders swept, and antennas aligned. The heterodyne repeater's power amplifier (PA) has been factory set to the specified output power level per the system modulation, when known. Greater than recommended power levels can result in amplitude distortion, increased error vector magnitude (EVM), radio and line errors (BER). Less than recommended power levels may have been selected by transmission engineering (e.g. short hops or tandem hops). Refer to system path calculations and path data sheets for details.

To measure and adjust PA output power:

1. Three methods may be used to measure PA output power:

A. Tx Power Voltage and factory Test Data Sheet calibration. (Easiest)

B. ACU Web Page user interface.

C. RF Power Meter at RF MON – SAMPLE PORT. (Most Accurate, Most Work!)

2. A signal source must be present:

2.1. Repeater Applications: The far end transmitter must be transmitting at this time.

2.2. Heterodyne Terminal Applications: An IF modem sending 140 MHz signal to IF IN.

2.3. Test: A suitable signal source sending 11 GHz RF or 140 MHz IF signals.

3. Confirm the Power Amplifier is active; no HET DC fault should be present.

4. Method A.

4.1. Use a DVM and BNC adapter to measure the Tx Power Voltage at the BNC connector on the enclosure bottom.

4.2. See the factory test data sheet (TDS) for voltage to power (Watts) conversion.

4.3. Record the PA Output Power Level.

5. Method B.

5.1. Connect to the ACU Web Page and read the Tx Power value.

5.2. Record the PA Output Power Level.

5.3. Note: ACU network connections must be previously setup. See Section 6.

6. Method C.

6.1. Calibrate the RF Power Meter for 11 GHz operating frequencies.

6.2. Remove the SMA Termination and then connect the power meter to the RF MON – SAMPLE PORT on the side of Power Amplifier. This is an SMA-female connector. A right-angle adapter with a between series (e.g. SMA to N) adapter (if needed) to fit the power meter sensor are needed to access the test port. See Figure 26.

6.3. Measure and record the power meter reading. Typically, this reading will be between -3 dBm and +16 dBm at RF MON - SAMPLE PORT.

6.4. Replace the SMA Termination.

6.5. Add the Cal Loss marked near the RF MON (see Figure 26) to the power meter reading, the result is the Power Amplifier Output Power.

6.6. Record the PA Output Power Level.

7. Power Adjustment

7.1. Compare the Power Amplifier Output Power reading to Table 2, using the listing for the radio modulation type used.

7.2. Set the Tx Power Switch as required setting the power amplifier output level equal to the listing in Table 2 and per Table 14.

- Note: Lower levels may have been selected by transmission engineering, please refer to system path calculations and path data sheets for details.

7.3. Once the power levels have been set, confirm the ACU Transmitter Power alarm is clear. If the Tx PWR alarm remains active and the transmit power is correct, then the ACU alarm point must be reset. Please refer to the ACU section for details.

8. To determine the Antenna Port Output Power Level, subtract the Tx Branch Loss from the Power Amplifier Output Level. The Tx Branch Loss is marked on the ATCU panel above the PA. Include any transmit attenuator pad loss if equipped.

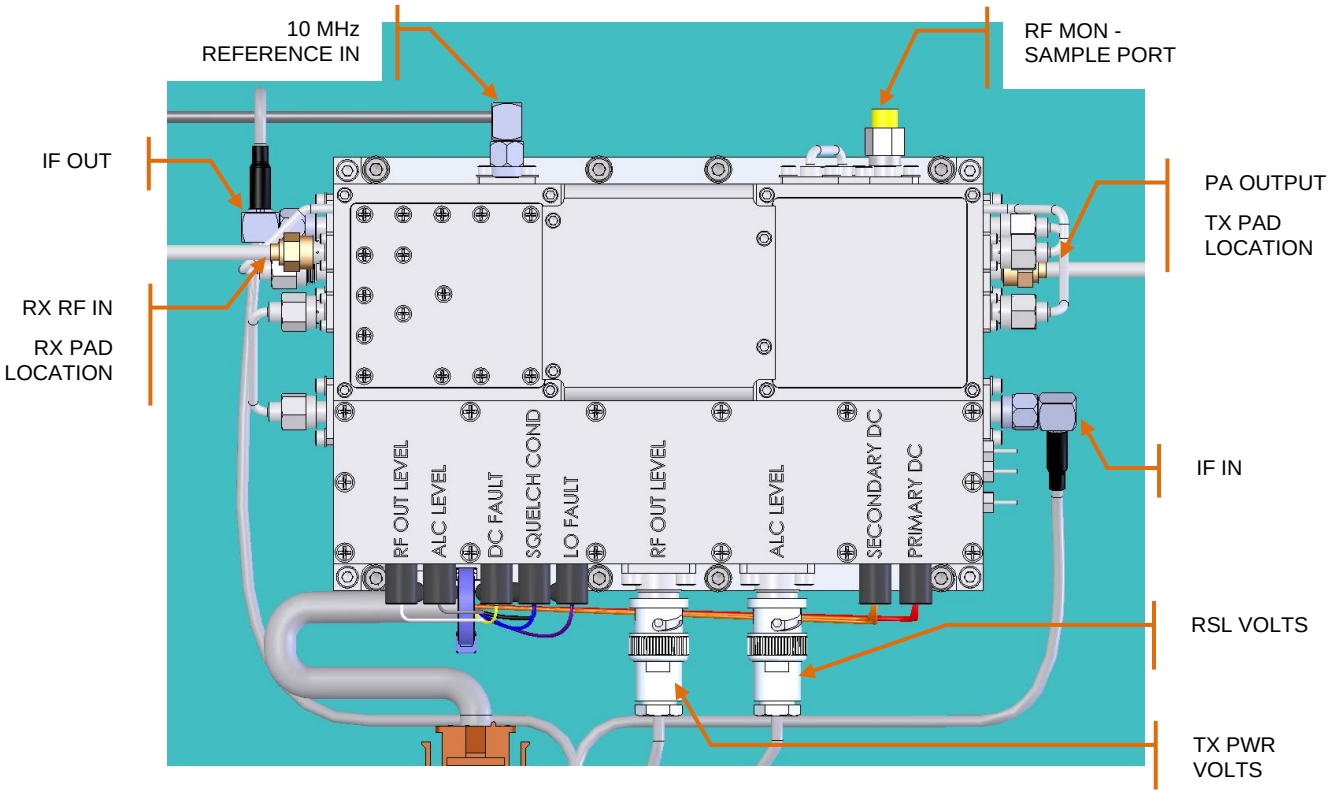

Figure 26 Heterodyne RF Module Connector Ports

Receive and Transmit Attenuator Pads

Receive, Rx, pads attenuate input signals that are greater than can be compensated by the repeater amplifier's AGC circuits. Receive pads are installed on the RF Down-Converter input (RF IN) jack.

Transmit, Tx, pads attenuate output signals. Transmit signals can first be reduced by adjusting the PA Power Set Switch. In cases of very short hops, more power reduction may be needed. In these cases a Tx Pad is normally installed. Transmit pads are installed on the Power Amplifier output (RF OUT) jack. Power Amplifier output should be reduced to between +19 and +30 dBm before adding an attenuator pad.

Pad Installation:

1. If required in the field, the Rx/Tx attenuator pads should be installed at the RF input or output of the heterodyne RF module.
2. To install the pad, turn OFF the DC power supply first.
3. Disconnect the input or output semi-rigid coax cable from the heterodyne RF module.
4. Connect the SMA male end of the pad to the module's SMA female input or output; and then connect input or output cable to the female end of the pad. Cable will require slight bending by hand, use care when bending.
5. Check all coaxial connections for tightness (8 in-lbs).
6. Turn ON the DC power supply.
7. Set output power level by adjusting PA Power Switch.

ACU – SNMP Network Configuration

The ACU – SNMP module reports status and alarms via IP on Ethernet. Private IP Network or Public Internet may be used for message transport. Each ACU must be configured for proper reporting. Section 6 details ACU setup.

Radio Link Tests

Once the repeater levels have been set and confirmed and antenna alignment is accepted, then confirm microwave signals are received at each terminal radio. Observe and record the receiver AGC or RSL indications for reference.

End to end link tests can now be run. These tests may typically include un-faded BER, radio errors, system thermal and intermodulation noise. Refer to the radio terminal equipment documentation and system engineering requirements for the link test plan.

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Chapter 6. ACU – SNMP Module Setup

The ACU – SNMP module is factory configured. This module must be configured for the customer network in order to communicate. This section describes network setup plus the procedure to change alarm conditions.

Network Setup

Connect the local Ethernet to the Heterodyne Repeater Unit. Connect to the RJ-45 connector on the enclosure bottom or Fiber LC duplex connector on the enclosure bottom. See Figures 3 and 4 for I/O connection detail.

The ACU Copper Ethernet RJ-45 connector jack may be connected directly to a LAN switch or router.

The ACU Fiber Optic Ethernet LC connector jacks must be first connected to compatible multi-mode fiber optic transceiver. The F/O transceiver may be part of a media converter, switch or other network device.

The fiber optic pair is used as the supervisory communications path from a tower mounted heterodyne unit to a ground mounted network switch or router. Fiber optic pair provides improved immunity to electrical interference on such longer runs.

The LAN switch, router or similar network collection point plus transmission means from the microwave site to a network operations center, is provided by the user. ACU – SNMP messages are carried by “Out-of-Band” network transport.

Accessing the HR-ACU via the Web Page User Interface

1. Assign and IP address to the HR - ACU using one of these two methods:

A. <u>OmniDiscover utility application (Best Method)</u>

1) This is a small computer program included with the documentation CD.
2) Install OmniDiscover application on a Personal Computer (PC) and then connect the PC to the local Ethernet.
3) Power on the HR-ACU and perform the following steps within 5 minutes. This is an intentional limitation. If 5 minutes passes, network data cannot be modified without power-cycling the HR-ACU.
4) Open the OmniDiscover application, and select Search on the top menu bar. The ACU will be displayed in the main window including the MAC address, Site ID, and default Subnet Mask (255.255.255.0)
5) Right click the ACU line, and select “Setup” from the menu that appears.
6) Enter the desired IP Address, Subnet mask (if not default) and Gateway router address you want to assign to the ACU.
7) Press/click the “OK” button and you’ll be returned to the main OmniDiscover window where you should see displayed the network address configurations just entered.
8) Right click the ACU line again, and select “Web”. The ACU login will be displayed.
9) Alternatively, open a Web Browser and type the ACU’s IP/URL in the address line: http://nnn.nnn.nnn.nnn. The ACU login will be displayed.

B. ARP/Ping

1) Power ON the HR- ACU, no time limitation.

2) From a command prompt on the PC, issue the following two commands
Note: the ACU must have no IP address (0.0.0.0) configured for this to work:

ARP-S *nnn.nnn.nnn.nnn* xx-xx-xx-xx-xx-xx

Ping *nnn.nnn.nnn.nnn*

(where nnn.nnn.nnn.nnn is the desired ACU IP address, and xx-xx-xx-xx-xx-xx is the MAC address)

3) Open a Web Browser and type the ACU's IP/URL in the address line: http://nnn.nnn.nnn.nnn. The ACU login will be displayed.

2. Login: Default login credentials are **admin/password**. These can be changed on the Network Settings screen.

3. The Device Status screen is displayed next. All operational status information is shown on this page.

4. You are now connected and ready to configure remaining settings.

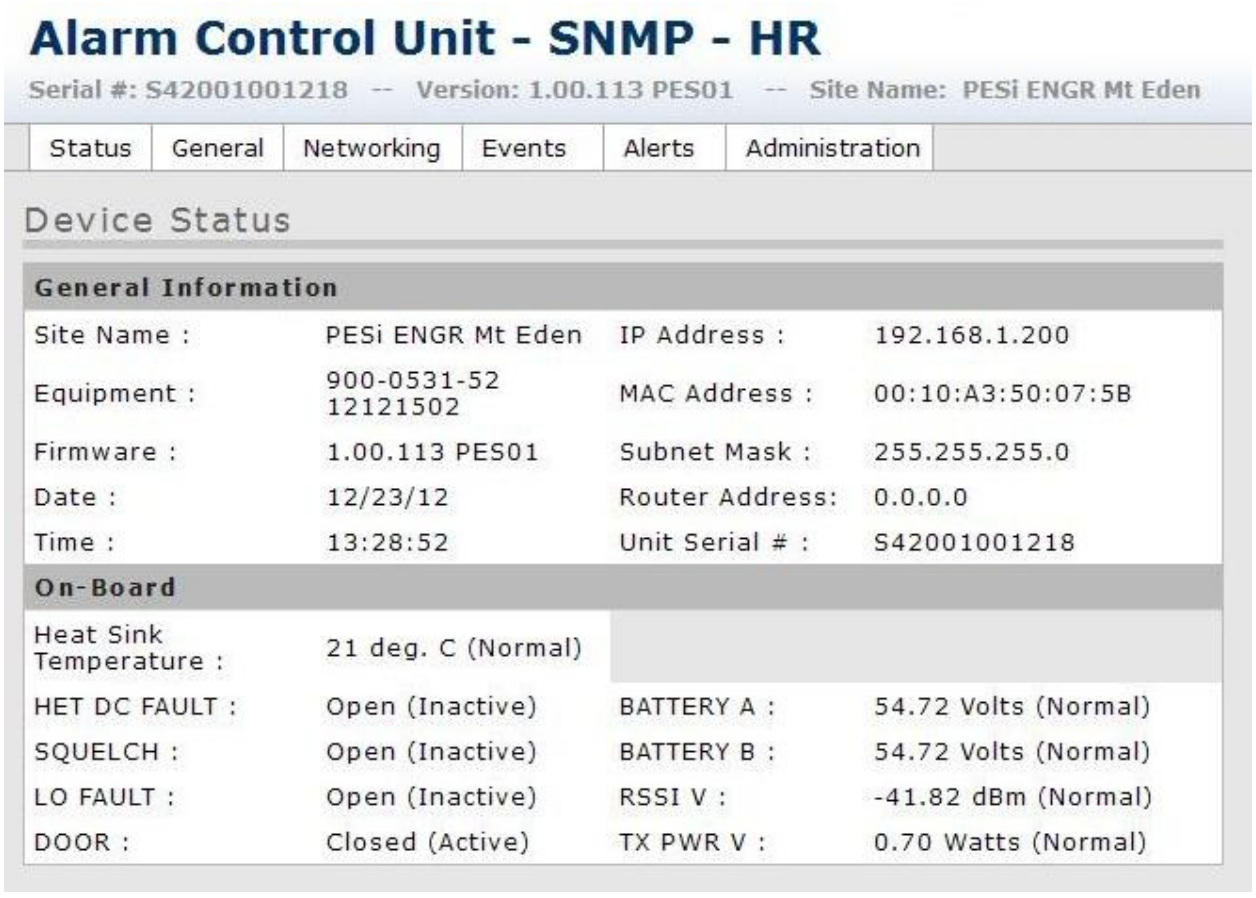

Figure 27 Opening ACU Status Screen

Settings Tabs

1. The HR-ACU web user interface provides 6 tabs across the top of the main screen. Each tab allows access to different settings. This section describes each tab and the settings contained.

   Status ..... Displays the Device Status screen where current data about the HR-ACU is displayed. This screen is informational only, with no user configurable settings.

   General ..... Displays the General Settings screen where Site Name, Equipment, Current Date & Time, and Daylight Savings Time adjustment can be configured.

   Networking ..... Displays the Networking Settings screen where IP Address, Subnet Mask, Router Address, SNMP Community names, and login credentials can be configured.

   Events ..... Displays Events Settings sub-tabs for configuring the On-Board Sensors (internal Temperature Sensor and internal I/O) and any connected EventSensors.

   Alerts ..... Displays the Alert Settings screen where general alert settings, as well as specific Email and SNMP alert settings can be configured.

   Administration .... Displays the Administration Settings screen where general administrative functions for the unit can be conducted. These include uploading a new firmware file, resetting the unit, resetting all parameters to their default settings, and uploading/download the Setting Keys file.

2. At the bottom of each screen where settings can be configured are a Submit button and a Cancel Changes button. If you make changes and are satisfied with them, press the Submit button. New configurations will be applied immediately. Press the Cancel Changes button before pressing the Submit button to reset any configuration changes to what they were previously.

Note: *Take care when making changes to Network Settings. Because these take effect immediately, thus network connection to the HR-ACU will be lost and must be reconnected using the new configurations.*

Device Status Screen

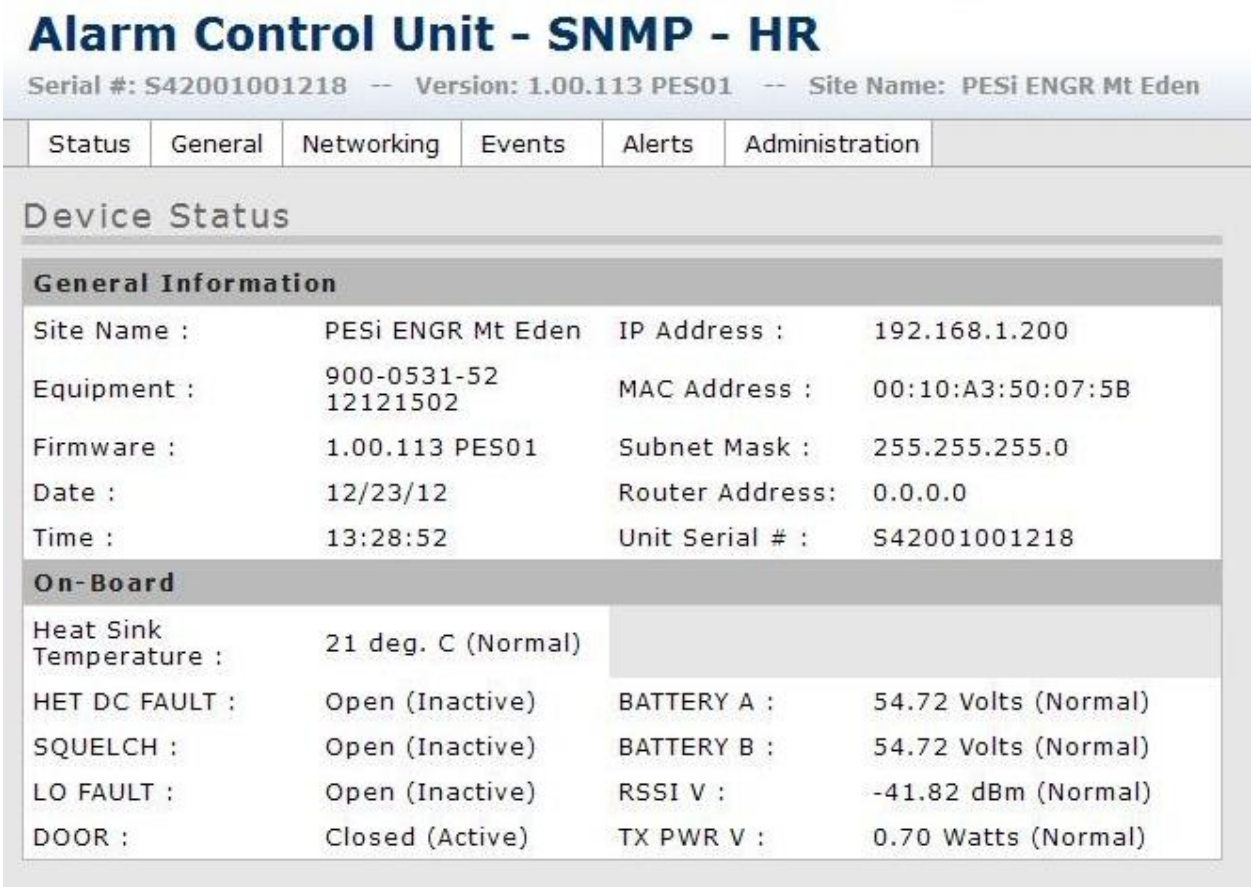

Figure 28 ACU Status Screen – Door Open

General Information

Site Name	Identifier assigned to each HR-ACU. This is entered in the Site Name field on the General tab.
Equipment	Type of Heterodyne Repeater equipment. This is entered in the Equipment field on the General tab.
Firmware	Installed firmware version.
Unit Serial #	Unique serial number assigned to this HR-ACU. Serial number is fixed.
IP Address	Network IP address assigned to this HR-ACU. See the Network Administrator for IP address information. An addressing scheme should be developed to manage these network elements. Address is entered on the Networking tab.
MAC Address	Unique, hard coded, MAC address of the Ethernet interface for this HR-ACU. The MAC address can also be found on the ACU serial number label. The MAC address cannot be changed.
Subnet Mask	Network subnet mask assigned to this HR-ACU. See the Network Administrator for mask information. Mask is entered on the Networking tab.
Router Address	IP address for the network gateway or router to which this HR-ACU is connected. See the Network Administrator for this address. Address is entered on the Networking tab.
Date	Current Date in MM/DD/YY format. Date is set on the General tab.
Time	Current Time in HH.MM.SS format. Time and Daylight Savings adjustment are set on the General tab.

On-Board

Heat Sink Temperature	Current temperature of the Heterodyne Repeater unit's rear heatsink in Celsius. Alarm status is displayed next to the temperature reading.
HET DC	Displays current Open/Closed and Active/Inactive status for the Heterodyne RF Module Current Alarm. Closed = Alarm Active
SQUELCH	Displays current Open/Closed and Active/Inactive status for the Heterodyne RF Module Squelch Condition. Closed = Squelch Active.
LO	Displays current Open/Closed and Active/Inactive status for the Heterodyne RF Module Local Oscillator UnLock Alarm. Closed = Alarm Active.
DOOR	Displays current Open/Closed and Active/Inactive status for the Enclosure Door. Closed = Door Open, Active.
BATT A	Displays the translated voltage reading for Battery A input. Reading is always Positive. Alarm status is displayed next to the voltage, (Normal).
BATT B	Displays the translated voltage reading for Battery B input. Reading is always Positive. Alarm status is displayed next to the voltage, (Normal).
RSL	Displays the receive signal level in dBm. RSSI Voltage is measured and translated to dBm. Alarm status is displayed next to the level, (Normal).
TX PWR	Displays the Power Amplifier output level in Watts. Tx PA Voltage is measured and translated to Watts. Alarm status is displayed next to the level. (Normal)

General Settings Screen

Figure 29 ACU General Settings Screen

Settings: Click “Submit” to send the settings to the HR-ACU.

Site Name	Enter the HR-ACU identifier. Typically this is the site name. Maximum length is 40 characters.
Equipment	Enter the Heterodyne Repeater nomenclature, such as HR-11500-52 11G-1. Maximum length is 40 characters.
Current Date, Time	Displays the current Date and Time. Click on the “Set Date/Time” button to open a pop-up dialog where the date and time can be reset.
Adjust for DST	A drop-down selection menu where Daylight Savings Time function can be turned ON or OFF.

Notes: Date and Time settings are maintained in an internal clock. An internal backup battery will maintain the time when power is removed from the HR-ACU. Daylight Savings Time is not automatically changed at the beginning and end of DST season.

Figure 30 ACU Time and Date Set

Networking Settings Screen

Figure 31 ACU Networking Settings Screen

Settings: Click "Submit" to send the settings to the HR-ACU.

IP Address	Sets the IP Address to this HR-ACU. Default is 0.0.0.0 upon reset.
MAC Address	HR-ACU's hard coded Ethernet Interface MAC address. Address is fixed.
Subnet Mask	Sets the network subnet mask provided by the network administrator. Default is 255.255.255.0 upon reset.
Router Address	Sets the router or gateway IP address provided by the network administrator. Default is 0.0.0.0 upon reset.
SNMP Trap/Read/Write Community	Sets the SNMP trap community name for each. Default is "public". Sets the SNMP Read and Write Community names for GETS and SETS. Default is "public".
Web Login Username, Password	Sets the login credentials required by the Web User Interface. Default is: Username: **admin** and Password: **password**. The password is always masked. For security reasons it is highly recommended that this password be changed. Record all configured passwords in a secure location. If locked out of the HR-ACU because the password has been forgotten, it is possible to reset the unit to its default login credentials. Refer to the Resetting Defaults section.

Note: *Take care when making changes to Network Settings. Because these take effect immediately, thus network connection to the HR-ACU will be lost and must be reconnected using the new configurations (IP Address, etc.).*

Events Screens

Each Sensor has been factory configured for each specific HR-11500 model. It is strongly recommended that existing settings are recorded before making any changes. Factory settings are included in the Test Data Sheet, TDS provided with each Heterodyne Repeater Unit. A "settings file" can be downloaded and saved for reference, see the Administration screen.

Alarm State enables or disables alarm actions. Normal setting is ON.

Alarm Actions are set to T1 or SNMP manager #1 by default. Alarm actions are configured as T*n* where *n* corresponds to the SNMP Manager index number on the SNMP Alerts tab. Email actions are configured as E*n* where *n* corresponds to the Email Address index number on the Email Alerts tab. Multiple actions are listed with no delimiters, for example: T1T2E1E3. These can be changed as required. See Alerts screen.

Deadband sets the range (translated units) on either side of a temperature or analog reading that prevents the event from repeatedly going in and out of alarm or "event state", also known as hysteresis.

Severity selection name will appear in SNMP Trap Alerts, but does not appear in Email Alerts.

Figure 32 ACU Events - Temperature Sensor

Temperature	Units	Alarm State	Alarm Actions	Deadband
Heat Sink Temperature	Celsius	ON	T1	3
Temp Threshold	**Very Low**	**Low**	**High**	**Very High**
Temperature Value	0 C	5 C	50 C	60 C
Severity	Minor	Info	Minor	Major

Figure 33 ACU Events - Analog Settings Screen (Top)

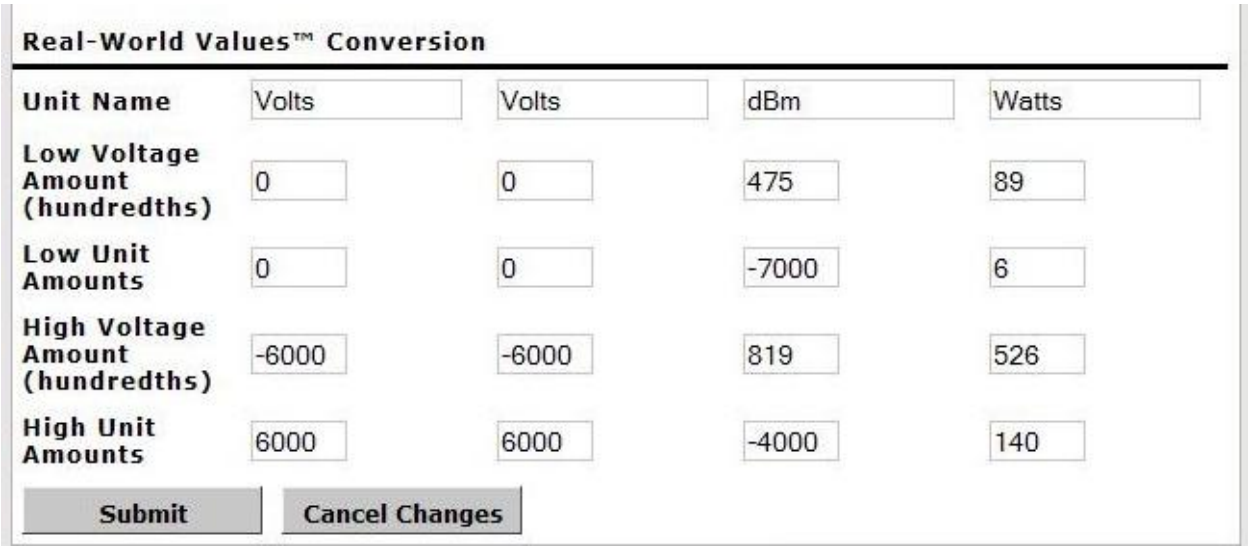

Figure 34 ACU Events - Analog Screen, Conversions (Bottom)

Analog voltages are set in hundredths of a volt. 100 = 1.00V, 1000 = 10.00V.
Maximum rated voltage is ± 60.00V (6000).

Analog Calibration[24]	Low V	Low Unit	High V	High Unit	Enable	Alarm Actions
Battery A (POS V)	0	0	6000	6000	ON	T1
Battery B (POS V)	0	0	6000	6000	ON	T1
Battery A (NEG V)	0	0	-6000	6000	ON	T1
Battery B (NEG V)	0	0	-6000	6000	ON	T1
RSSI V / RSL[25]	V = -70 dBm	-7000	V = -40 dBm	-4000	ON	T1
Tx PWR V / TX PWR[26]	V = 0.1 W	6	V = 1.8 W	140	ON	T1
Analog Threshold	**Very Low**	**Low**	**High**	**Very High**	**Deadband**	
Battery A or B (24V)	2000	2100	2850	3000	30	
Battery A or B (48V)	4000	4200	5700	6000	30	
Severity	Critical	Minor	Minor	Major		
RSSI V / RSL Value	-7500	-7000	-3000	-2500	30	
Severity	Major	Minor	Info	Minor		
Tx PWR V Value	6	25	160	500	5	
Severity	Major	Info	Info	Minor		

[24] Analog Calibrations use ACU Real-World Values™ conversion or translation to change measured voltages into more meaningful values. Conversions use a 2-point match and then interpolate and extrapolate resultant values. RSL and PWR voltages have some deviation from linear curves and thus, there is some amount of error at other than the Low V and High V matching points.

[25] RSSI / RSL values are derived from the Test Data Sheet.

[26] Tx PWR values are derived from the Test Data Sheet.

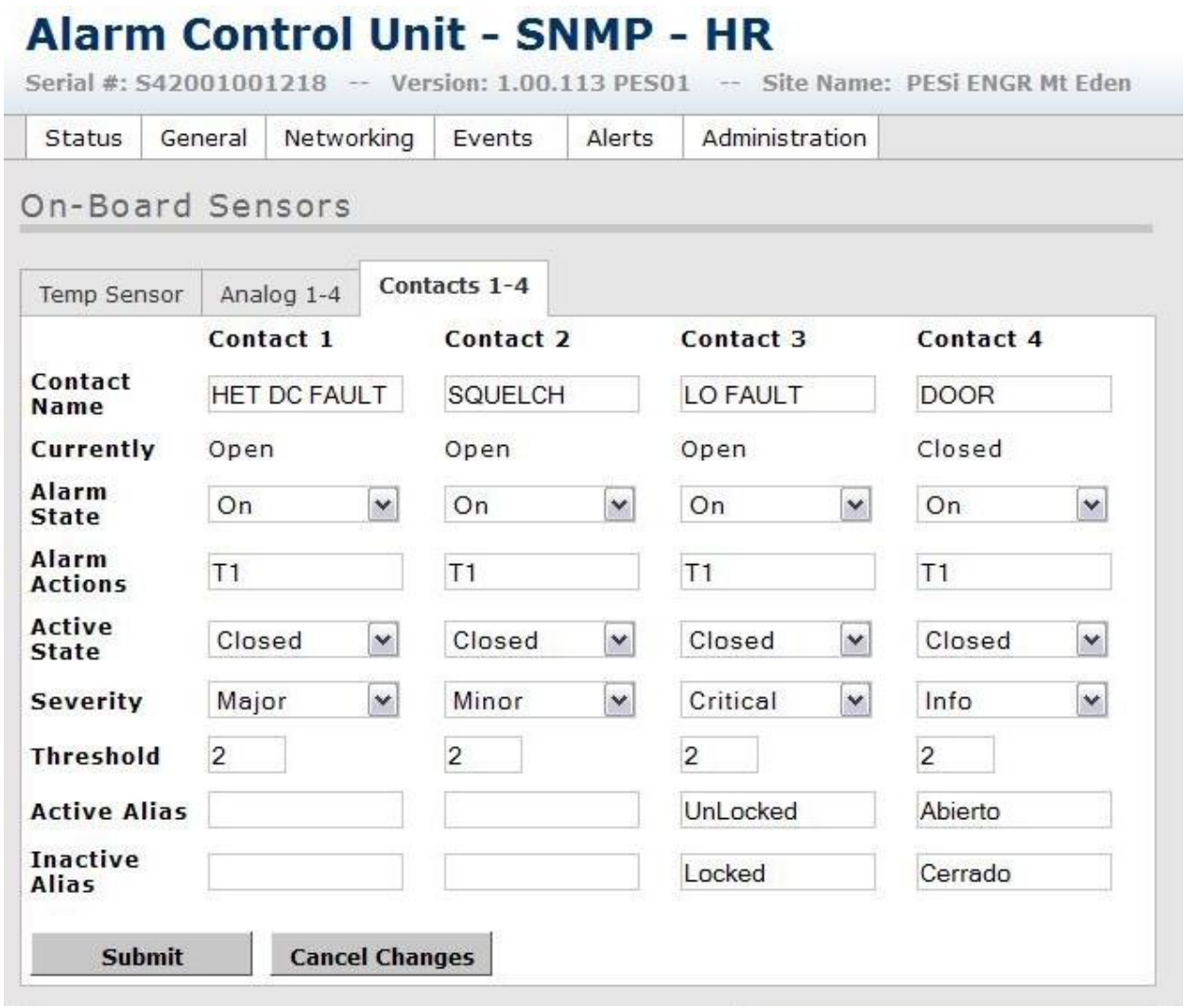

Figure 35 ACU Events - Contacts Settings Screen

Contact Closures	Alarm State	Active State	Severity	In-Active Alias	Active Alias	Alarm Actions
HET DC	ON	CLOSED	MAJOR			T1
SQUELCH	ON	CLOSED	MINOR			T1
LO	ON	CLOSED	CRITICAL	Locked	UnLocked	T1
DOOR[27]	ON	CLOSED	INFO	Cerrado	Abierto	T1

[27] DOOR alias names are used to reduce confusion between Active State (Door Switch Closed) and physical Door Open condition. Other favorite alias names may be used.

Alerts Screen

Figure 36 ACU Alert Settings, General Settings Screen

General Settings: "Submit" to send the settings to the HR-ACU.

System Alert Actions	Sets the action(s) taken when the Power-Up Alert is triggered, if enabled. Alarm actions are configured as T*n* where *n* corresponds to the SNMP Manager index number on the SNMP Alerts tab. Email actions are configured as E*n* where *n* corresponds to the Email Address index number on the Email Alerts tab. Multiple actions are listed with no delimiters, for example: T1T2E1E3. These can be changed as required. See Alerts screen.
Power-Up Alert	An ON/OFF toggle to enable an alert to be sent whenever the HR-ACU goes from powered-down to power-up state. Default setting is OFF.
Individual Alert Repeat Frequency	Sets the number of minutes (0 – 65535) between repeat alert notifications. This applies to ALL alerts for ALL enabled events. 0 means no repeat alert notifications are sent. Default setting is 0.
Send Return to Normal Alerts	This is an ON/OFF toggle to send an alert when an event returns to it's "normal" or "inactive" state. The alert is sent via the same alert or alarm actions that are configured for the event itself. Default setting is ON.

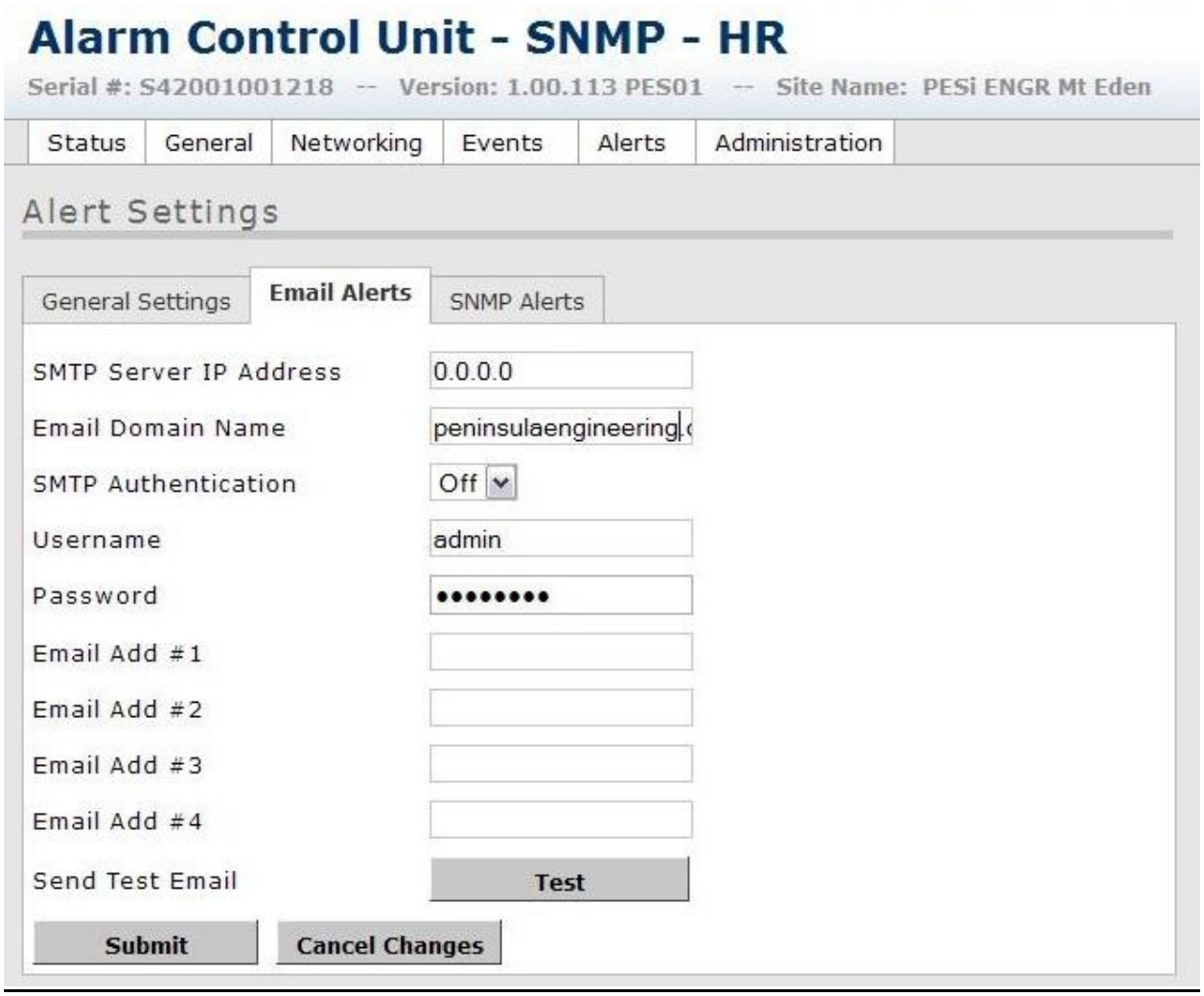

Figure 37 ACU Alerts Settings, Email Alerts Screen

Email Alerts Settings: "Submit" to send the settings to the HR-ACU.

SMTP Server IP Address	IP Address of the outbound mail server.
Email Domain Name	Sets the *@domain_name.com* to use when the HR-ACU sends an Email Alert. Maximum length is 48 characters.
SMTP Authentication	This is an ON/OFF toggle to allow Emails to be sent to SMTP servers that require authentication. The Username and Password fields below set the credentials for successfully logging into the SMTP server.
Username, Password	Sets the login credentials for SMTP Authentication. Maximum length is 32 characters.
Email Add *n*	Sets the Email address of the person or entity receiving Email Alerts. The number (1~4) corresponds to the "index" number for Email Alerts used when configuring alarm actions.
Send Test Email	Click the **Test** button to send a test Email to each configured Email address.

Figure 38 ACU Alert Settings, SNMP Alerts Screen

SNMP Alerts Settings: "Submit" to send the settings to the HR-ACU.

SNMP Manager *n*	Sets the IP address of the device(s) receiving SNMP Traps when the HR-ACU sends a trap as an alarm action.
Sent Test Trap	Click the **Test** button to send a test SNMP Trap to each configured SNMP Manager.

Administration Screen

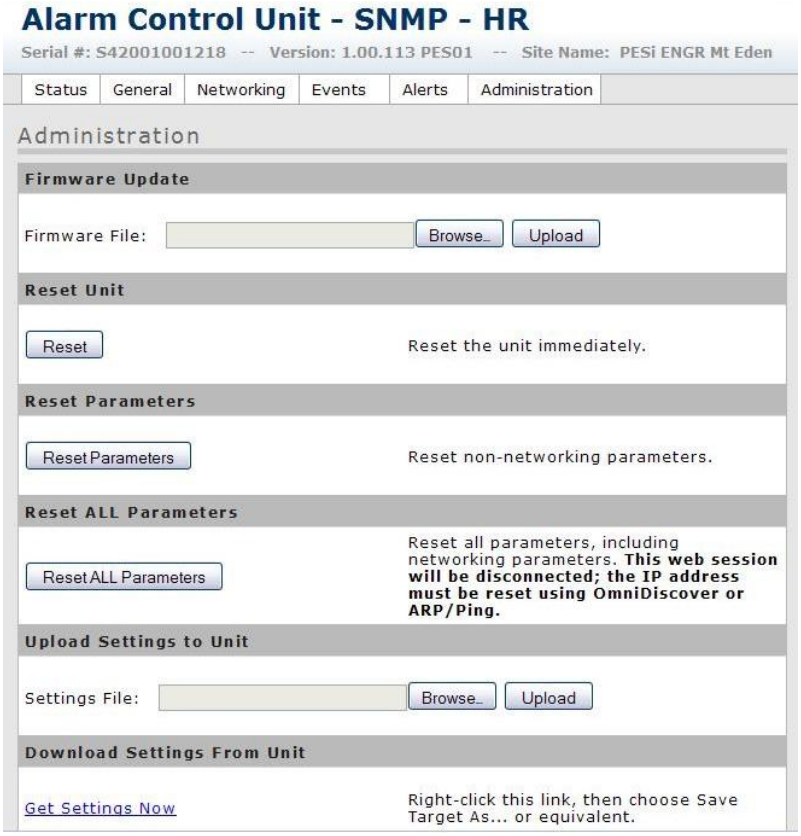

Figure 39 ACU Administration Screen

Firmware Update	The Firmware File field allows the user to set, via direct entry or the Browse button, the path to the firmware update file (i.e. ACU_1.00.111.udf). Once the path has been set, press the Upload button to begin the immediate upload and processing of the update file. Note that all LEDs are turned on after the update file is transferred; they stay on until after the update completes, which is normally about 15 seconds.
Reset Unit	Clicking the **Reset** button immediately resets the ACU. All configurations are preserved.
Reset Parameters	Clicking the **Reset Parameters** button immediately resets all configurations except Networking Settings to their default settings.
Reset ALL Parameters	Clicking the **Reset ALL Parameters** button immediately resets all configurations, including Networking Settings, to their default settings. Since the web session will be disconnected, the IP address must be reset using OmniDiscover or the ARP/Ping method, as described in the Accessing the unit via the Web Interface section previously. See Resetting Defaults section for more information on resetting all parameters using DIP switches and the physical **Reset** button.
Upload Settings to Unit	Allows the user to upload the “Setting Keys” file to the ACU. Use the Browse button to specify the path to the file. (i.e. Setting Keys.txt). Once the path has been set, click the Upload button to begin the immediate upload of the Setting Keys file.
Download Settings from Unit	Allows the user to download the “Setting Keys” file from the ACU. Right-click the “Get Settings Now” link and choose “Save Target As” from the menu to select the location where the Setting Keys file should be saved. See the section on Setting Keys for an example of a default Setting Keys file.

Resetting Defaults

Refer to Figure 40, ACU Rear Panel. The ACU must be removed from the Heterodyne Repeater to adequately access the rear panel.

All settings, including network settings, can be set to their default values using this procedure:

- Set all DIP switches to the OFF (down) position
- Briefly press the Reset button until the front-panel LEDs start flashing. Let go of the button as soon as the LEDs start flashing; if the button is pressed in too long, the unit will reset and the default settings operation may not complete.

The web login username and password settings can be reset to their defaults (admin/password), without affecting any other settings, by using a similar procedure:

- Counting from left to right, set the first three DIP switches to the OFF (down) position, and set the fourth DIP switch to the ON (up) position.
- Briefly press the Reset button until the front-panel LEDs start flashing. Let go of the button as soon as the LEDs start flashing; if the button is pressed in too long, the unit will reset and the operation may not complete.

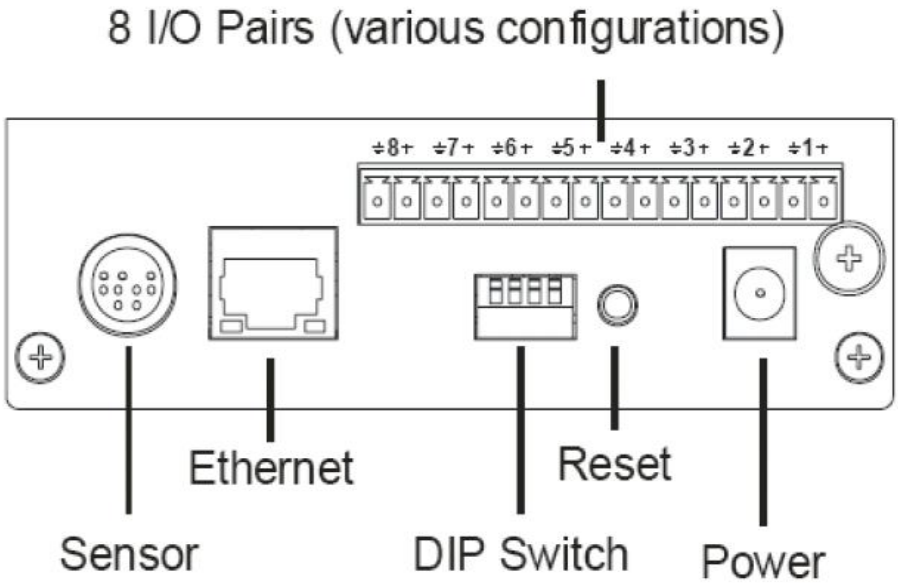

Figure 40 ACU Rear Panel

Settings Keys

Setting Keys (SK) provide a flat file, human readable means of setting and retrieving settings within the unit. Setting Keys are commonly used to clone settings across multiple units or in automated processes. The SK file can be downloaded from an S420, settings changed and saved. Then the file can be uploaded to the same or other HR-ACU's. Settings that are changed to invalid values or to settings that are 'read-only' will not be applied then uploaded to the HR-ACU.

Chapter 7. Maintenance and Troubleshooting

The HR-11500 active components are the linear heterodyne RF module, 10 MHz reference oscillator, Alarm Control Unit, DC/DC converters and the optional media converter equipment if equipped. Heterodyne Repeaters provide long field operating life, often 15 to 20 years. Technologies and traffic needs often drive upgrades or replacement rather than old age.

Routine maintenance checks of the heterodyne repeater and its supporting equipment will ensure reliable operation and early detection of problems.

Routine Maintenance

Peninsula Engineering Solutions recommends an annual maintenance schedule for the heterodyne repeater. The following is a procedure for routine maintenance:

1. Observe the general condition of the installation site and correct any problems.
2. Verify that the heterodyne repeaters and all associated hardware, including antennas, are securely mounted and properly in place.
3. Check input electrical wiring and power system for damage and ensure that connections are tight. Replace any wiring that is suspect.
4. Check any battery terminals for corrosion; clean terminals, if necessary.
5. Check the battery storage capacity condition. Battery impedance testers are recommended. Battery life expectancy is typically 5 to 10 years in an outdoor environment. Replace any weak batteries or cells.
6. Clean solar panels and remove obstructions, if applicable. A mild detergent and water are recommended. Clean solar panels when they are cool, avoid putting cold water on hot panels, this may cause damage. Dirt, thick dust and bird droppings can reduce the output by 30%. Shadows from antennas, lightning rods or trees reduce PV output. Life expectancy of PV arrays is 20 years or more. Horizontally tilted panels collect more soils than if tilted 45° or more. Lower tilt panels should be cleaned annually. Greater tilt panels may be cleaned every 3 years.

CAUTION: *Follow manufacturer's instructions when cleaning solar panels. Abrasive or acetone-based solutions can cause damage.*

7. Look for lightning strike damage. Solar panels with "holes" punched in the backing material indicate a lightning strike. Damaged solar panels or equipment should be replaced.
8. Check antennas and feedlines for damage and ensure that connections are tight.

9. If the feedlines are pressurized, check that pressure is holding correctly, dehydrators are working or Nitrogen gas tanks are full.
10. If static desiccators are used to dry the feedlines, check the desiccant color. Blue or Orange is normal, Pink indicates the desiccant is full of water and needs changing. Static desiccators should be changed typically, about every 1 to 2 years.
11. If feedline pressure is zero or desiccants are very pink, it's best to check the feedlines for water. Drain and dry as required. Inspect for corrosion, correct or replace as required.
12. Check the alarm control unit, ACU, for indications of alarms or trouble.
13. Observe the Receive Signal Level by measuring the RSSI / RSL Voltage at its BNC connector. Refer to HR-11500 Test Data Sheet for signal level value. Compare to records.

14. Observe the Transmit Power Level by measuring the Tx PWR Voltage at its BNC connector. Refer to HR-11500 Test Data Sheet for power value. Compare to records.
15. Measure the DC battery load currents. Compare to records.

Administrative Requirements

The US FCC, Federal Agency or other local Telecommunications Administrations may require measurement of the output power of the heterodyne repeater at installation or when any changes are made which cause the output power to change. Using the power meter method, measure and log the output power as directed in Chapter 5.

Troubleshooting

Reported alarms may appear in combination due to the root cause. The alarm matrix, Table 19 provides information about the probable cause. Assumes an IF repeater configuration of 2 heterodyne units.

Table 19 Alarm Matrix

IDX	ALARM	HET DC	SQL	LO	DOOR	BATT A	BATT B	RSL	TX PWR	CAUSE
1	X	X	**X**					X	X	Squelch disables PA and causes HET DC, TX PWR. RSL if low signal level. Very low RSL or far end transmitter OFF will cause Squelch to activate.
2	X	X	X	**X**				X	X	LO fault causes mixer fault thus RSL, SQL, HET DC, and TX PWR. Check 10 MHz reference signal.
3	X	**X**							X	No DC path on IF IN, IF Cable Fault Detect, thus HET DC and TX PWR. See #13.
4	X	**X**								Heterodyne RF Module – Current out of range. Most likely PA section fault.
5	X			**X**						LO UnLocked. Possibly off frequency. Het RF Module has 4 synthesized LOs. Any LO can cause alarm.
6	X				**X**					Enclosure door open, door switch closed. No other alarms should be caused.
7	X					**X**				Battery A voltage out of range but not to failure point. HR operating on Battery B.
8	X						**X**			Battery B voltage out of range but not to failure point. HR operating on Battery A.
9	X					**X**	**X**			Battery A & B voltage out of range but not to failure point. Single Battery supply. HR close to failure.

Table 19 Alarm Matrix, continued

IDX	ALARM	HET DC	SQL	LO	DOOR	BATT A	BATT B	RSL	TX PWR	CAUSE
10	X		X	X		**X**	**X**	X	X	Battery A & B voltage very low. DC/DC converter power supply output low. HR failing now due to low voltage.
11	X							**X**		Receive signal level out of range, low or high. Possible signal fade if low.
12	X								**X**	Transmit power level out of range, low or high. Possible PA fail. If Low: no or low IF IN signal level.
13	X	**X**							**X**	Transmit power level low but not zero. PA current out of range. Possible PA section failure.
14	**X**									Heatsink Temperature out of range, low or high.

If the received signal at the terminals is low but does not indicate a complete failure on heterodyne repeater, then, the most likely cause is low voltage from the batteries. Low voltage is an indication of a possible DC/DC converter power supply failure, battery failure, or a failure of the charging system. Check the batteries and all power lead connections. If solar panels are used, be sure they are not obstructed from sunlight and that the surfaces are clean. If an AC power supply is used, low voltage is probably the result of a power failure, the duration of which exceeded the reserve power limits of the standby battery. Check the standby battery in accordance with the instructions given by the manufacturer of the power supply.

NOTE: *Contact the Customer Service Department of Peninsula Engineering Solutions whenever problems with the unit cannot be resolved.*

Table 20 System Troubleshooting

Problem	*Cause*	*Solution*
Overheating	Inefficient Cooling⇒	• Clear any airflow obstructions. • Shade the unit if it is in an extremely hot environment.
Low Voltage or No Voltage *(Low Battery Alarm)*	Improper Solar Charging⇒	• Clean solar panels or remove obstructions. • Do not use an acetone-based solution for cleaning.
	Power Supply Failure⇒	• Check the condition of the power source. • Check all wiring and power leads to the power source. • Check any fuses or circuit breakers in power supply equipment. • Check condition of battery plant. • Check AC power service for outages or other service problems.
	Overload, blown fuse⇒	• Determine the cause of failure. • Correct the failure. • Replace fuse with a spare.
	Internal DC/DC Converter Failure⇒	• Cycle the DC Battery input power to reset and restart the converter. The converter has built-in safety shutdown circuits. Output bus is 12.5 VDC. • Contact Peninsula Engineering Solutions to replace unit.
Heterodyne Repeater fails overnight and then restarts the next day *(Solar Powered)*	Improper PV Charging⇒	• Check the PV array for damage, obstructions or dirt.
	PV Array wired to wrong voltage⇒	• Check the PV open circuit voltage, V_{oc}. • Typically the V_{oc} will be 1.5 to 2 x the battery nominal voltage. If V_{oc} is more than 3 x the battery nominal voltage and PWM[28] type PV controllers are used, the array is mis-wired. • V_{oc} may be greater only if MPPT[29] type PV controllers are used.
	Alarm Conditions⇒	• Check for alarm conditions and resolve, if necessary.
	Battery capacity low⇒	• Batteries may be worn out or undersized, replace and correct as necessary.
	Prolonged storms⇒	• Storms or series of storms can reduce battery recharging for days. Batteries may be fully discharged causing the system to fail. Re-evaluate the power source capacity, increase the PV array or add wind turbine generators, increase the battery plant Ah capacity.

[28] PWM: Pulse Width Modulator. PV Controller type that uses a rapid switch to reduce the average charging current when batteries are fully charged. PV Array V_{oc} should be 1.25 to 2.0 x the nominal battery voltage. Higher Voc can indicate the array is mis-wired (series instead of parallel) resulting in less charging current and power.

[29] MPPT: Maximum Power Point Tracking. PV controller type includes a DC/DC converter to "step down" higher voltage PV arrays. Maximum V_{oc} is limited to the maximum rating of the MPPT controller, typically 150 to 200 VDC.

Table 20 System Troubleshooting, continued

Problem	*Cause*	*Solution*
Low RF Output - or – No RF Output	Power Amplifier power level not set⇒	• Set the power amplifier output power level per radio modulation.
	Antennas Oriented or Polarized Incorrectly⇒	• Check antenna orientation and re-align, if necessary. • Confirm the correct polarizations are used.
	Alarm Conditions⇒	• Check for alarm conditions and resolve, if necessary.
	Power Amplifier Failure⇒	• Replace the Heterodyne RF Module.
	Terminal radio OFF⇒	• Confirm the terminal radio is transmitting.
	Improper gain setting⇒	• Check gains and re-set, if necessary.
RF Output cannot be set	IF Input level LOW⇒	• Confirm the terminal radio or previous repeater is transmitting. • Confirm frequencies and polarizations match. Refer to path calculations for expected levels.
	RF or IF Amplifier low gain failure⇒	• Damage to an amplifier can cause low gain which in turn will reduce the available RF output power. • Replace the Heterodyne RF Module.
No Receive Signals at both ends	Problem Common to both directions.⇒	• Check items in common with both directions of transmission. Antennas, Feedlines, Site Power or Multiple Failures. • Check Feedline connections; confirm correct heterodyne unit to antenna direction. Feedline reversal will result in no signals at the ends and input to the heterodyne repeater amplifiers due to the bandpass channel filters.
	Antennas Oriented or Polarized Incorrectly⇒	• Check antenna orientation and re-align, if necessary. • Confirm the correct polarizations are used.
Radio Errors and Distortion, BER, high EVM or low S/N, SNR	Active Alarm⇒	• Resolve alarm.
	Improper Gain Settings⇒	• Correctly adjust Tx Power level.
	Power Amplifier level too high⇒	• Adjust the Tx Power level to recommended levels. • If errors persist, try reducing the power by 1 dB more.
	MW Radio terminal power too high⇒	• Check radio transmit power level, adjust to recommended levels. • If errors persist, try reducing the power by 1 dB more.
	Radio Adaptive Equalizer setting or disabled⇒	• Enable adaptive equalizer. Check settings.
	Radio Forward Error Correction, FEC, setting or disabled⇒	• Enable FEC. Check settings on FEC bit length. FEC can correct low error rates but will add latency.

Heterodyne RF Module Replacement

Heterodyne Repeater RF Modules are band segment and channel plan specific. These modules must be configured for the channel pair assigned to the heterodyne repeater and must match the bandpass filters in the Antenna Coupling Unit. Modules with the same part number can be used as replacements. Configure the replacement module's frequency, Tx power level and squelch before installing in the heterodyne unit if possible. See Chapter 5: Configuring the Heterodyne RF Module.

When a heterodyne RF module must be replaced, do the following:

a) Power down the heterodyne repeater unit.

b) Unplug module's power connector.

c) Disconnect input and output SMA semi-rigid cables.

d) Disconnect the IF input and output SMA flexible cables.

e) Disconnect the Reference Oscillator SMA flexible cable.

f) Disconnect the BNC cables from RF Out Level and RSSI (ALC) monitor points.

g) Remove mounting hardware (8 ea #6-32 screws and washers). Hardware uses Socket Head Cap screws. The socket head cap screw hardware takes a 3/32 or 7/64-inch Hex Allen Wrench.

h) Remove module.

To install the replacement module:

a) Apply heat sink compound to the mounting surface of the amplifier. Use a very thin layer.

b) Mount the module on the heatsink panel, secure with mounting hardware.

c) Connect the two BNC cables to DC monitor points.

d) Connect input and output SMA flexible and semi-rigid coax cables. Use care to align the SMA connector. Misaligned connectors can destroy the center pins.

e) Check all coax connections for tightness (8-inch/lbs)

f) Plug-in the module's power connector.

g) Power up the heterodyne repeater unit.

h) Verify operation by measuring power at SMA power monitor, PWR MON.

i) Set output power by adjusting Tx Power Level switch per Chapter 5.

j) Confirm the Transmitter power alarm clears. Adjust the Tx Power calibration as required.

ii) Power Amplifier's RF Detector DC sensitively and output can vary, thus requiring calibration adjustment.

k) Receiver RSSI V typically varies somewhat, thus RSSI V calibration is required. Calibrate the ACU readings at -40 dBm and -70 dBm. For best results, use QAM signals. See Chapter 6, ACU-SNMP Module Setup.

Reference Oscillator Replacement

Reference oscillators are all 10 MHz modules with four equal primary outputs and one monitor port. Modules with the same part number can be used as replacements. No configuration is required.

Removing the Reference Oscillator Module:

a) Power down the heterodyne repeater unit.

b) Unplug the module's DC power connector.

c) Disconnect the SMA flexible cable from the output used.

d) Remove the mounting screws (4 ea #6-32 pan head Philips screws and washers.)

e) Remove module.

To install the replacement module:

a) Orient the module with the power connector cable on top.

b) Mount the module on the heatsink panel, secure with mounting hardware.

c) Connect the SMA flexible cable. Normally the cable connects to J4. Use care to align the SMA connector. Misaligned connectors can destroy the center pins.

d) Check the coax connection for tightness (8-inch/lbs)

e) Plug-in the module's power connector.

f) Power up the heterodyne repeater unit.

g) Verify operation by measuring frequency and level at SMA Monitor "MON". Frequency[30] should be 10.000 000 00 MHz ± 2 Hz. Level at monitor is between 0 and -6 dBm.

   a. Level at the primary outputs J1 ~ J4 is between +3 and +8 dBm.

[30] Frequency Counter must be capable of at least 1 Hz precision and have a frequency standard reference sufficiently accurate to measure the reference oscillator output.

ACU – SNMP Module Replacement

Alarm Control Modules are the same physical unit for all HR-11500 repeaters. Each module is program configured for the particular heterodyne repeater unit. If the settings file was saved from the previous ACU, it may be uploaded to the replacement module. Otherwise, follow the instructions in Chapter 6 for configuring the HR-ACU module.

Removing the ACU – SNMP Module:

a) Power down the heterodyne repeater unit.

b) Reach behind the ACU module and remove the power plug and 16-position plug-in connector strip. Both pull out to the rear.

c) Remove the mounting screws holding the left and right brackets to the heatsink panel. Hardware used is 4 ea #8-32 pan head Philips screws and washers. Note the location of the ground lug.

d) Remove the support brackets from the bottom of the ACU module. Hardware used is 6 ea #4-40 pan head Philips screws and washers.

e) Remove the ground lug from the side of the module.

f) Unplug the Ethernet cable from the jack on the rear of the module.

g) Remove the temperature sensor probe from the heatsink panel. The probe is secured with an adhesive strip. Epoxy may also secure the temperature probe, use a knife to carefully cut the adhesive strip or shrink sleeve around the probe.

To install the replacement module:

a) Attach the left and right mounting brackets to the module using #4-40 hardware.

b) Attach the ground lug to the side of the module.

c) Plug-in the Ethernet cable, 16-position connector and power plug to sockets on the rear.

d) Mount the module's mounting brackets to the heatsink panel using #8-32 hardware. Remember to include the ground lug.

e) Locate and mount the temperature sensor probe on the heatsink panel using the adhesive strip provided. Epoxy may be added to secure the temperature probe. The adhesive can otherwise loosen at higher temperatures.

f) Power up the heterodyne repeater unit.

g) Verify operations by observing the front panel LEDs.

h) Configure the replacement ACU if required per Chapter 6 or load the previous settings file.

DC/DC Converter Power Supply Assembly Replacement

The DC/DC converter power supply assemblies are available in 4 types based on input voltage and power rating. Assemblies with the same part number can be used as replacements. There are two power supply assemblies in standard heterodyne repeater units, A on left and B on right.

Removing the Power Supply Assembly

a) Power down the heterodyne repeater unit.

b) The B power supply is blocked by the door switch. Remove the door switch first. The switch assembly is secured to the enclosure using 2 ea #6-32 screws and washer hardware.

c) Unplug the input and output cables from the DC Power Distribution PCB assembly.

d) Remove the nuts securing the assembly to the inside wall of the enclosure. Hardware is 6 ea #10-32 nuts with nylon patch.

e) Slide the power supply assembly off the studs and remove from the enclosure.

Installing the replacement assembly

a) Slide the power supply assembly over the 6 studs on the enclosure wall and then secure with #10-32 nuts.

b) Plug-in the input and output cables to the DC Power Distribution PCB assembly. The plugs are size and orientation keyed.

c) Replace the door switch assembly over the B power supply.

d) Power up the heterodyne repeater unit.

e) Verify operation by measuring the power supply's output voltage. Voltage at the output connector, (DC Power Distribution J5, J6), should be 12.5 VDC ± 0.2V.

Keeping Spares

Because microwave heterodyne repeaters are often used to provide critical coverage, customers are advised to follow a sparing policy. While most telecommunications carriers or system operators have internal policies relative to equipment sparing, in the event that one does not exist, Peninsula Engineering Solutions recommends maintaining a minimum of one (1) spare unit for every increment of 8 units or fraction thereof. This assumes that all spares are immediately available to the technician in need for installation. Remember that heterodyne RF modules are band plan specific.

When travel time to a site is long or access is difficult (helicopter, hike or horse), then, more spares located close to or at the repeater site are recommended. Maintain stored spares in anti-static packaging. Storage locations should be dry and protected from salt air or corrosive atmospheres.

Each organization should develop a company-specific, equipment-specific policy that meets their needs, taking into account geographic considerations and the quantity of repeaters used in the network.

Returning the Heterodyne Repeater Equipment for Repair

If a repair or return of the HR-11500, or its components, is necessary, contact the Peninsula Engineering Solutions Customer Service Department for instructions. When calling, include the following information:

- ⇒ Nature of the problem
- ⇒ Model name
- ⇒ Part Number
- ⇒ Unit serial number

For equipment returns, a representative issues an RMA (Return Material Authorization) and shipping and packaging instructions. When returning the repeater to Peninsula Engineering Solutions, always use the original shipping carton and packaging materials or suitable equivalents. If the original shipping materials are unavailable, Peninsula Engineering Solutions can send replacement materials at your cost.

CAUTION: *If equipment is not returned to Peninsula Engineering Solutions in the original packaging materials, possible damage could result. Peninsula Engineering Solutions is not liable for any damage resulting from improper shipment.*

The telephone number and email for the Customer Service Department follows:

- ⇒ Telephone: +1 925 901-0103
- ⇒ E-mail RMA Administrator: rma_admin@peninsulaengineering.com
- ⇒ Internet, Online RMA Form: http://www.peninsulaengineering.com/sup_rma.html

Product Warranty

A one-year, limited warranty is provided with the repeater. A copy of the product warranty is included with the Standard Terms and Conditions. Extended warranties are available for continued protection. For more information, contact the Peninsula Engineering Solutions Customer Service Department.

Peninsula Engineering Solutions, inc.
39 Grand Canyon Lane
San Ramon, California 94582
United States of America

http://www.peninsulaengineering.com/

Table 21 HR-11500 Maintenance Record

Date				
PV-A Voltage, V_{oc}				
PV-A Voltage, V_{charge}				
PV-B Voltage, V_{oc}				
PV-B Voltage, V_{charge}				
Rectifier/Charger-A Current				
Rectifier/Charger-B Current				
Battery-A Voltage				
Battery-A Temperature				
Battery-A Charge Current				
Battery-A Load Current				
Battery-B Voltage				
Battery-B Temperature				
Battery-B Charge Current				
Battery-B Load Current				
Power Amplifier PWR MON				
Tx PWR VOLTS				
Receive RSSI VOLTS				
Reference Oscillator FREQ				
ACU Tx PWR, WATTS				
ACU RSL, dBm				

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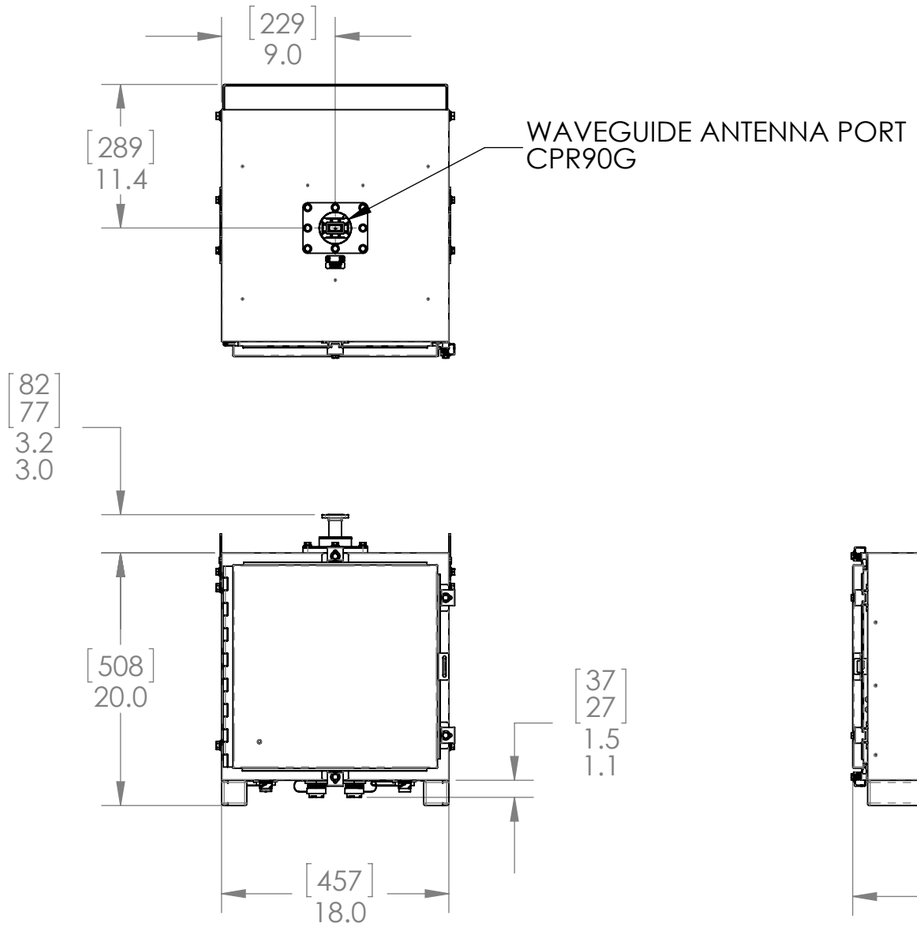
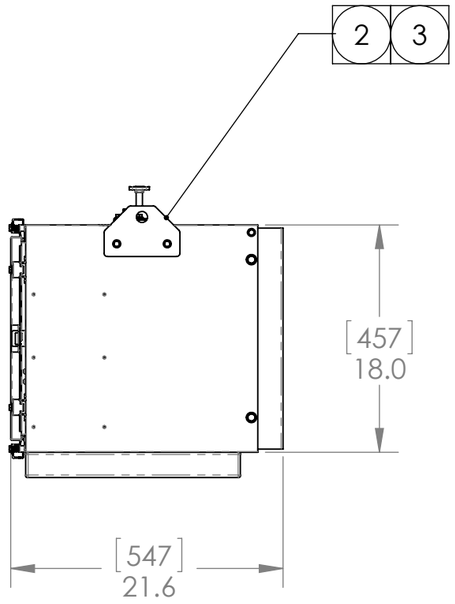
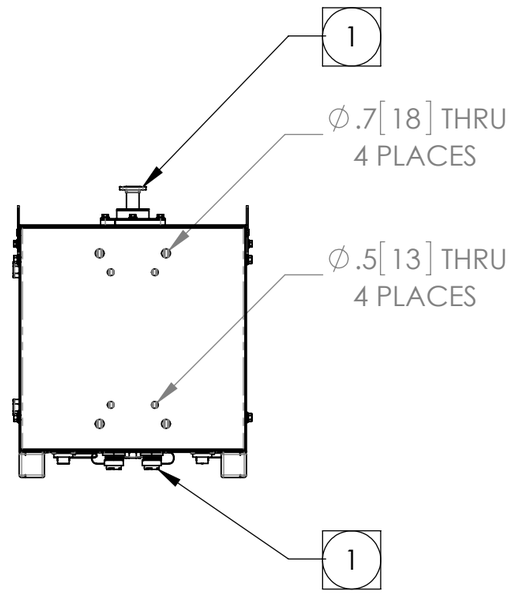
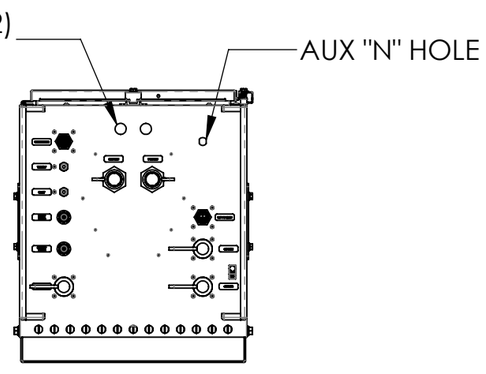
Appendix

1. M900-0530-XX HR-11500 Mounting Dimensions Drawing









NOTES:

1. CONNECTORS ON TOP AND BOTTOM HAVE PROTECTIIVE COVERS INSTALLED WHEN READY TO SHIP. MAXIMUM DIMENSIONS INCLUDE COVERS.
2. LIFTING PLATES MAY BE MOUNTED INVERTED FOR SHIPMENT.
3. LIFTING PLATES SHOULD BE INVERTED AFTER INSTALLATION ON TOWER.
4. WEIGHT IS APPROX 70 LBS, 32 KG.

PENINSULA·ENGINEERING SOLUTIONS Inc

www.peninsulaengineering.com

900-0532-XX	
900-0531-XX	
900-0530-XX	HR-11500
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH PER SPEC

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	ERJ	12/24/12
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

PENINSULA ENGINEERING SOLUTIONS, INC.
SAN RAMON, CALIFORNIA, USA

TITLE:

HR-11500 HET RF UNIT MOUNTING DIMENSIONS

SIZE	DWG. NO.	REV
B	M900-0530-XX	A

SCALE: 1:12 | WEIGHT: 69.39 | SHEET 1 OF 1