PTM-1000
Transmitter/Receiver
Assembly (TRA)

P/N: 7150-0018-00

EFFECTIVITY: December, 3, 1999

PROPRIETARY - FOR INTERNAL USE ONLY

REVISION HISTORY

Revision	Description / Changes	Printed Name	Signature	Date
01	Initial Release	M. Fuchikami		12/03/99

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1.0 Introduction

The purpose of this document is to describe the functionality of the Transmitter/Receiver Assembly (TRA). This document also provides an overview of the Hub system and defines TRA electrical functions of each interface point, in a general sense, which will allow the reader to get a cursory understanding of the TRA architecture. For the purpose of this document, the TRA are considered as "intentional radiators" and the Hub IDU, Hub ODU, and Remote IDU is considered as "non-intentional radiators". This document is not intended to differentiate between the 28GHz, 31GHz, and 38GHz TRA designs. Description of modulation system is defined in reference b) 7020-0012-00, Peregrine Tracelink™ Specification. See other reference documents for more detailed design information.

1.1 Glossary of Terms and Acronyms

Term	Definition
ANT	Antenna
BH	Backhaul
CCH	Coax Control Channel
CPE	Customer Premise Equipment
FE	Millimeter Wave Front End
IDU	Indoor Unit
IF	Intermediate Frequency
IFD	IF and Distribution Board
IMP	Indoor Unit Processor Board
MCA	Modem Control Assembly
NET	Network Interface Board
ODB	Outdoor Distribution Box
ODF	Outdoor Frame
ODU	Outdoor Unit
PTM	Point-to-Multipoint
RSSI	Received Signal Strength Indication
SWD	Switch and Distribution Box
TRA	Transmitter/Receiver Assembly
TRX	Transmit/Receive Circuit Board

1.2 References

For the purpose of this document, the following references and subsequent revisions take precedence.

a) 7020-0031-00	MMW Transceivers 1.0
b) 7020-0012-00	Peregrine Tracelink™ Specification
c) 7020-0000-00	Hub and Subscriber Antenna Specifications
d) 7020-0034-00	ODB P3 Functional Requirements and Specifications (available upon request)
e) 7150-0008-00	IF Distribution Board Hardware Design Specification (available upon request)

2.0 System Overview

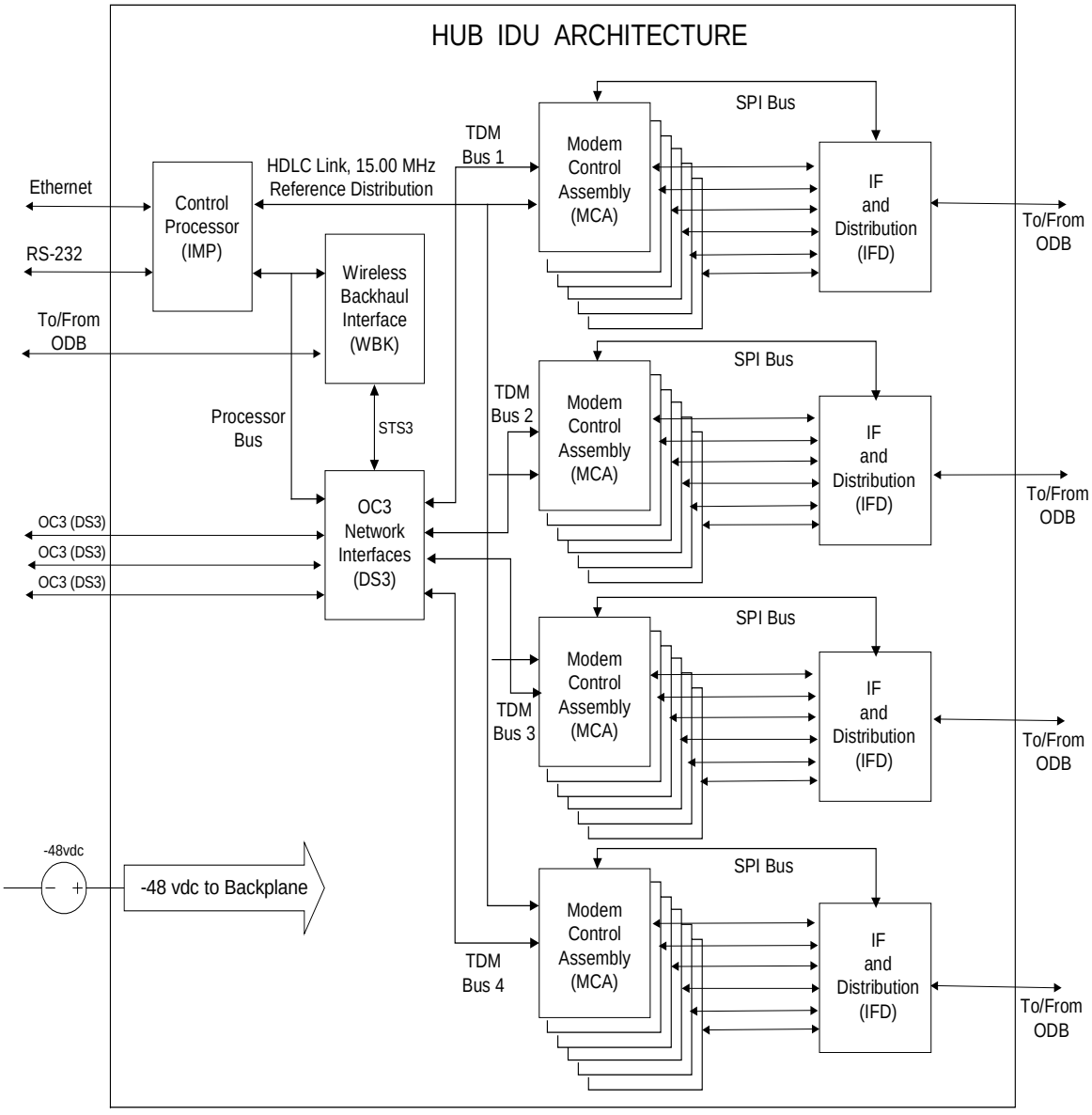
2.1 Hub Overview

The Wavtrace broadband wireless system is comprised of two primary elements, a Hub unit and multiple subscriber units as shown in the figure below. The Hub is the central unit and is equivalent to a base station in cellular terminology. The Hub has a maximum coverage radius of 3km and communicates to fixed subscriber units. The subscriber units are intended for use by commercial organizations that require high speed data communications connectivity to broadband networks that are not readily available via twisted pair or fiber connections. Initially, the system is not intended to deliver voice services. Once a wireless data communications infrastructure is available, however, customers may decide to add voice capabilities.

The Hub interconnects and switches between three types of communication interfaces – high-speed wireless airlinks to multiple Remotes, OC3 or DS3 links to wireline broadband networks, and wireless backhaul links to other Hubs. Each subscriber airlink can support up to 4 Remotes and the Hub can support up to 24 of these airlinks in its initial release. Two hubs may be interconnected to support up to 48 airlinks. Each subscriber unit interfaces to the Hub via a single high-speed airlink and provides one or more customer premise data ports for DS1 or ethernet connection.

The system provides a mechanism for a Remote subscriber to access a broadband network over a wireless loop. In its simplest view, the Hub and Remote bridge the network to the subscriber. This wireless loop provides the subscriber a means to access a broadband network without the normal issues of broadband network access such as running DS1 lines from a switch to the subscriber premise, delays in service due to slow installation, and construction costs required for installation. A simplified block diagram of the Hub IDU system is shown below:

Figure 1 – Hub IDU Architecture



The Hub consists of an Indoor Unit (IDU) and an outdoor unit (ODU). The IDU is a rack of electronic equipment, which may be housed in a stand-alone cabinet, or in a free standing rack. The ODU consists of multiple horn antennas with their associated interface electronics and mounting frames. As the names imply, the IDU is placed within an office building or other interior structure and the ODU is placed on top of the office building or other external structure.

The interface between the Hub IDU and ODU consists of two coaxial cables used to transport IF frequencies from the IDU to the ODU (downlink) as well as from the outdoor unit to the indoor unit (uplink). Power, -48Vdc, from the IDU is delivered to the ODUs on both the downlink and uplink cables.

PTM 1000 system outdoor units consists of multiple TRAs with their associated interface electronics and mounting frames. Each TRA assembly has its own antennae interface electronics provided by a Transmit and Receive circuit board (TRX) and a millimeter wave Front End (FE). The antenna, TRX circuit board, millimeter wave FE, and the mechanical housing which contains the electronics are referred as the Transmit and Receive Antenna Assembly (TRA). The Hub TRA and Remote TRA or Customer Premise Equipment (CPE) are electrically the same, except for the antennae.

Two tiers of Hub TRAs consisting of up to six TRAs per tier can be mounted on an outdoor frame (ODF). Four ODFs will typically be used to service a 360 degrees area surrounding a building. Horn Antennas with azimuth of fifteen degrees and thirty degrees are used to service different population densities of Remotes. Thirty degrees antennas are used in areas with sparse subscriber density, while fifteen degrees horn antennas are used in areas with higher density. Three thirty degrees horn antennas or six fifteen degrees antennas are mounted on an ODF to cover a ninety degrees quadrant. Fifteen and thirty degree horn antennas may be intermixed on the same ODF. Remote antennae uses a 10.5 inch dish mounted to a TRA.

Up to six TRAs connect to an Outdoor Distribution Box (ODB) which interfaces the IF signals from the TRAs to the two coax cables connecting the Hub IDU and ODUs. The Hub IDU multiplexes 6 IF frequencies (484.167MHz, 592.5MHz, 697.5MHz, 802.5MHz, 982.5MHz and 1087.5MHz) on to one of the coax cables and the ODB then de-multiplexes these frequencies into 6 intermediate frequencies (IF), each at 484.167MHz, which are fed to each of the 6 TRAs. This same mechanism is used on the receive side and then sent down the other coax that connect between the IDU and ODB. Up to two ODBs providing coax interfaces for twelve TRAs can be mounted on an ODF. An ODU can have up to four ODFs to provide RF coverage of a 360 degree area surrounding a building (See Reference d) for more detailed ODB information). The ODU including the TRAs and ODBs will be physically located on the roof of an office building and will be subjected to environmental extremes without the aid of fans or cooling systems.

The Hub IDU also provides –48VDC power, Coax Control Channels (CCH), and Wireless Backhaul (Forward = 355MHz and Reverse = 140MHz) to the ODB. The CCH forward (256MHz) and reverse (898MHz) signaling channels are provided for communication between the MCAs and TRAs. The protocol of these channels are described in the IFD FPGA Hardware Description document, reference d) (available upon request). An RSSI is used at each end of the CCH link to determine the cable length used. The Wireless Backhaul interface is used to interconnect Hubs over a microwave radio channel (optional feature).

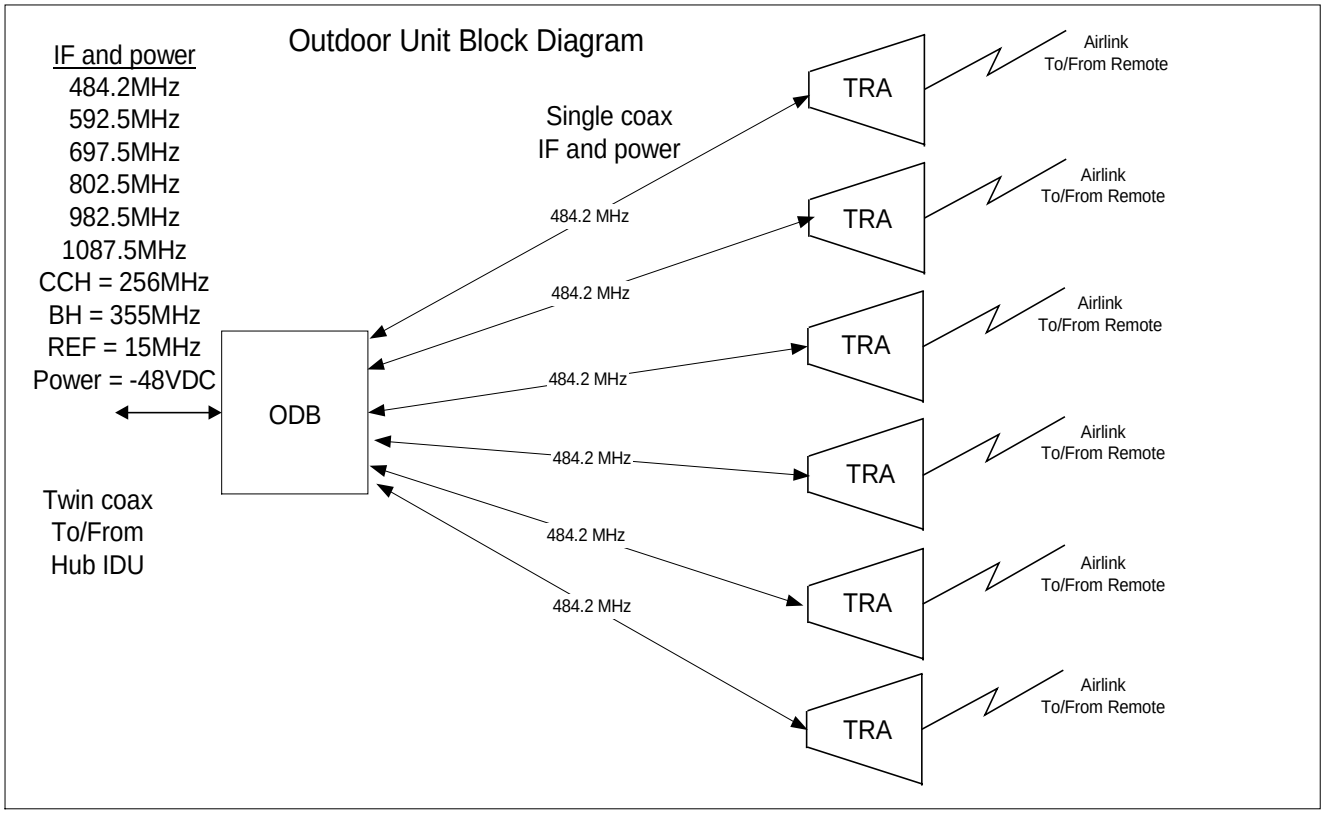


Figure 2 – ODB to TRA Interface

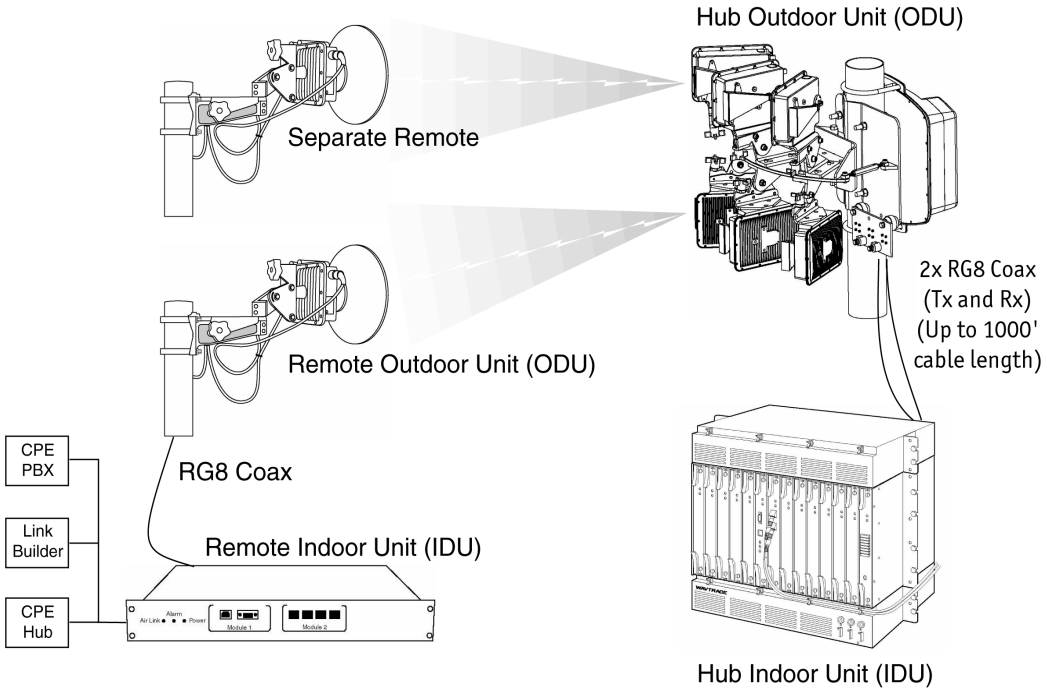


Figure 3 – Hub to Remote Overview

The TRA is comprised of the TRX Controller, TRX IFP, TRX DC/DC Converter, Millimeter wave Front End (FE), and the horn or dish antenna assembly that forms a single digital airlink interface. The TRX boards and its associated millimeter wave FE provide all of the processing of the RF signals to and from the antenna. The millimeter wave FE detects the receive signal while the TRX boards conditions the signal to be passed on to the IDU via the ODB. The TRX boards itself provides all of the processing of the transmit signal. The TRX has an on board processor which controls many of its functions. The system functions provided by the TRX board are described below including a block diagram.

1. The TRX on board processor interfaces with the Hub Indoor Unit (IDU) MCA processor via the IF control channel for alarm notification, configuration management, transceiver performance monitoring, and fault management.

2. The TRX processor interfaces with the on board phase lock loop ICs for initialization, control and monitoring, interfaces to on board A/D and D/A converters for control and monitoring of variable filters, RF output power, and temperature sensing.

(See references for more detailed information; a) 7020-0031-00, MMW Transceivers 1.0; b) 7020-0012-00, Peregrine Tracelink™ Specification; c) 7020-0000-00, Hub and Subscriber Antenna Specifications)

2.2 TRX

The TRX consists of IF Processor Board, FE Controller, MMwave FE and DC/DC converter.

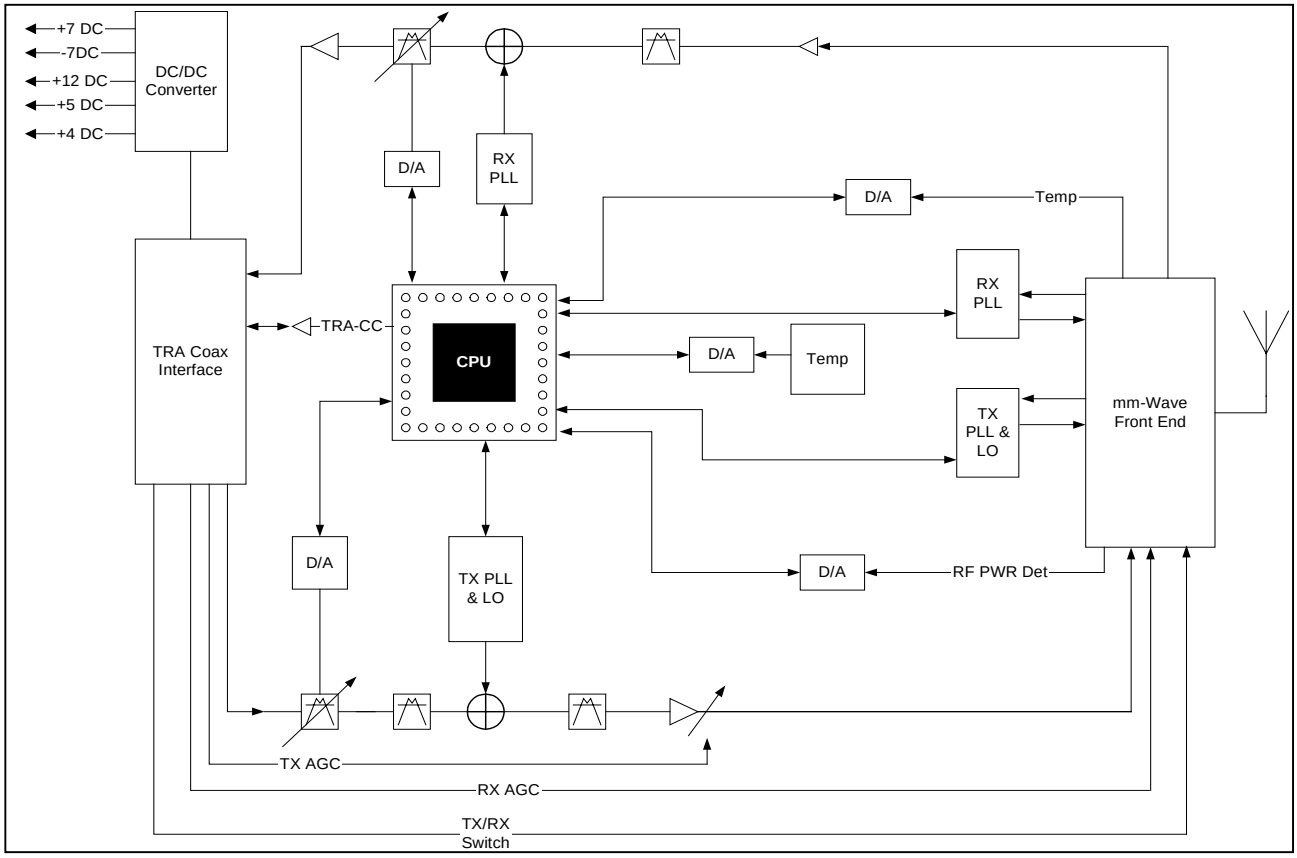


Figure 4 – TRA Block Diagram

2.2.1 MMWave FE

The Mmwave FE is essentially an up/down converter. It up converts signals at 2445 MHz to 28GHz,or 31GHz, or 38 GHz and down converts these signals to 2445 MHz. This module will also output a voltage that is proportional to temperature in order to make up for loss of gain in the MMwaveFE due to an increase in temperature. The measurement of temperature occurs at close proximity to the final amplifier stage of the MMwaveFE. The MMwaveFE also outputs a power detection voltage, proportional to output power, primarily for an alarm condition.

2.2.2 IF Processor Board

The IF Processor board takes the 484.167MHz signal from the ODB and up converts it to 2445MHz for input into the MMwave FE. It also takes the receive signal at 2445MHz from the MMwave FE and down converts it to 484.167MHz. It also provides means of power control and AGC functions.

2.3 TRX Controller

The TRX controller communicates to the IDU in order to provide all IFP and MMWave FE conditioning for correct management of the TRX. It also provides alarm and monitoring status to the IDU.

2.4 TRX DC/DC Converter

The TRA DC/DC Power Supply components are designed to operate in a noise sensitive, telecommunications system environment and be fully functional over the industrial temperature range of -40°C to +85°C (-40°F to +185°F). The supply is be powered at all times except for minimal periods of down time associated with system preventative maintenance.

The supply consists of multiple, tightly regulated, outputs designed to power analog, digital, and RF circuits mounted in close proximity within a sealed enclosure. Two outputs supply power to duty-cycled (dynamic) loads. The design provides fast load transient response for these outputs and minimize the effects of these transients on the surrounding power, analog, and digital circuits.

A double-ended input filter is be employed to reduce reflected ripple current and converter switching noise from the input power source. The supply will also utilize a soft-start feature to minimize the in-rush current on power up.

Efficient thermal management methods are utilized throughout the design to minimize temperature rise within the enclosure.

2.4.1 Electrical Specifications

2.4.1.1 Power Requirements

24W @ 48VDC (Nominal)

2.4.1.2 Input Specifications

Input Voltage Range: 30 to 60VDC (48VDC, nominal)
Input Current: 500mA @ 48VDC (nominal)
Inrush Current: TBD
EMI/RFL: Five-Sided Faraday Boundary
Fusing: Polyswitch (PTC), or Fuse
Input Connector: Molex, 2-Pos.; Molex 3-Pos. (optional)

2.4.1.3 Output Specifications

Output Voltages (+5%, -0%)

Steady State Outputs:

+12VDC @ 93mA (1.12W)
+7VDC @ 290mA (2.03W)
-7VDC @ 230mA (1.61W)
+5VDC @ 565mA (2.82W)
+4VDC @ 1220mA (4.88W)

Duty Cycled (Dynamic) Outputs:
+7VDC @ 550mA (3.85W @ 100% DC)
+5VDC @ 400mA (2.00W @ 100% DC)

Load Regulation: 200mV of nominal
Line Regulation: 200mV of nominal
Noise and Ripple: ≤10mV PP

2.4.2 Performance Specifications

2.4.2.1 Input Protection

Reverse Input Voltage: FET Reverse Input Voltage Protection
Over-Current: PTC/Fuse
Over-Voltage: Transient Voltage Suppressor (TVS) Clamp
Under-Voltage: Under-Voltage Lockout Circuitry (<30VDC)

2.4.2.2 Output Protection

Over-Current: Thermal Shutdown
Short-Circuit Current: Short-Circuit Protection, Thermal Shutdown
Thermal Protection: Thermal Shutdown

2.4.2.3 Efficiency

≥80% @ FL

2.5 TRA Mechanical Specifications

HUB TRA Dimensions: 10.5 in. x 5 in. x 10.5 in. (L x W x H) (includes mounting)
Weight: 9 lbs. (includes mounting)
Remote TRA Dimensions: 10.5 in. x 5 in. x 10.5 in. (L x W x H) (includes mounting)
Weight: 11 lbs. (includes mounting)
Mounting: Screw Mount to Mating Housing
Cooling: Free-Air Convection

2.6 TRA Environmental Specifications

Table 1 – Environmental Specifications

Environmental	Specification	Reference
Operational Temp Range	-30°C to +52°C (-22°F to +125.6°F)	(GR-63-CORE 4.1.2)**
Operational Humidity Range	5% to 95%	(GR-63-CORE 4.1.2)**
Solar Loading -Operational	+52°C (+125.6°F) with 753 W/m2 solar load	GR-487-CORE 3.25 (R3-152)
Wind-Driven Rain Intrusion	5.8 in/hr rain, 70 mph wind, each surface 30 minutes	(GR-487-CORE 3.27 (CR3-156))**
Wind Resistance	Operational 112 mph (less than 3db loss), Survival 156 mph	(GR-487-CORE 3.31 (R3-160))**
ICE/Snow Loading	Operate and Survive with 2" of Ice on the ODF	

Environmental	Specification	Reference
Packaged Equipment Shock Criteria	Drop from 18.5" - 29.5" based on mass	GR-487-CORE 3.37 (R3-167)
Transportation Vibration	.5g, 5-50Hz, .1 oct/min & 3.0g, 50-500Hz, .25 oct/min	GR-487-CORE 3.39 (R3-169)
Installation Shock (excluding Antenna)	Dropped from 1" to 3.9" based on mass	GR-487-CORE 3.40 (R3-170)
Environmentally Induced Vibration - Operational	Sine wave .1g, 5-100Hz, .1 oct/minute, 3 axes	(GR-487-CORE 3.41 (CR3-171))**
Earthquake resistance of Frame & Components	Zone 4	GR-487-CORE 3.42 (CR3-172)
Corrosion resistance – Salt fog test	Salt fog spray for 14 days	GR-487-CORE (R-165)
Storage - Low Temperature Exposure	-40°C to +23°C (-40°F to +73.4°F)	GR-63-CORE 3.25 (R4-3)
Storage - High Temperature Exposure	-23°C to +70°C (-9.4°F to +158°F)	GR-63-CORE 3.25 (R4-4)
Storage - High Relative Humidity Exposure	0 to 95%, Non-condensing	GR-63-CORE 3.25 (R4-5)
** The Wavtrace (WT) reference is based on and intended to meet or exceed the identified external specification.		

TRA shall also meet Surge / EMI Immunity: ANSI / IEEE surge withstand and fast transient testing per ANSI/IEEE C37.90.1, 1989.