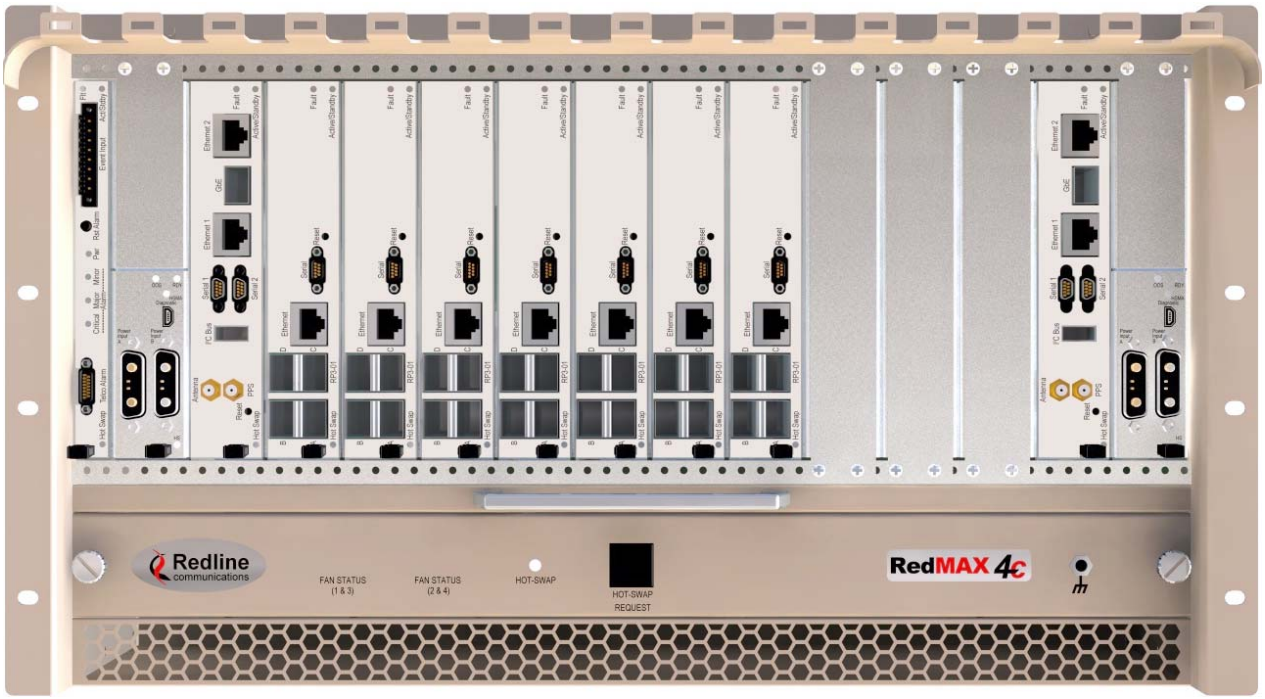
Redline communications

RedMAX 4c™



WiMAX FMC

(Fixed Mobile Convergence)

Base Station

User Manual

Copyright Information

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Safety & Service Notices

1.1 Safety Recommendations

WARNING

Redline strongly recommends that end-users of the equipment observe all warnings and cautions during operation, installation, and maintenance of the system.

Failure to comply with these warnings and cautions, or with specific warnings and cautions elsewhere in the manuals, or displayed directly on system equipment, violates the safety standards incorporated into the design, manufacture, and intended use of the system equipment.

Redline Communications assumes no liability for the customer's failure to comply with these requirements.

1.2 Important Warning Symbols

The following symbols may be encountered during installation or troubleshooting. These warning symbols mean danger. Bodily injury may result if you are not aware of the safety hazards involved in working with electrical equipment and radio transmitters. Familiarize yourself with standard safety practices before continuing.

Electro-Magnetic Radiation

Important Safety Notice

High Voltage

1.3 IC RF Exposure Warnings

WARNING: To satisfy IC RF exposure requirements for RF transmitting devices, where an externally mounted antenna is employed in point-to-multipoint applications, each antenna must be separated from all persons by a distance of at least 230 centimeters. To ensure compliance, operations at closer than this distance is not recommended. The antenna used for this transmitter must not be collocated in conjunction with any other antenna or transmitter.

1.4 Safety Advisories

1. **WARNING** Read this manual and follow all operating and safety instructions.
2. Installation of the antenna and transceiver must be performed by professional trained installers.
3. Position power cables to avoid possible damage to the cables.
4. Disconnect power before cleaning.
5. Protect the unit by disconnecting the power if it is not used for long periods.
6. DC power supply connection warning:

DC Power Supply Connections: *Warning to Service Personnel*	
WARNING Caution for all models:	Units are not equipped with power switches and activate immediately when connected to a power source.

7. Mount the base station shelf securely in a 19-inch rack.
8. The radio transceiver units must not be located near power lines or other electrical power circuits.
9. The system must be properly grounded to protect against power surges and accumulated static electricity. It is the user's responsibility to install this device in accordance with the local electrical codes: correct installation procedures for grounding of the transceiver unit, mast, lead-in wire and discharge unit, location of discharge unit, size of grounding conductors and connection requirements for grounding electrodes.
10. DC input source must be an isolated secondary DC SELV supply (60V DC max).
11. This equipment must be installed in compliance with relevant articles in National Electric Code-NEC including chapter 8 (and equiv. Canadian Electrical Code CEC).
12. Keep all product information for future reference.

1.5 Frequency Selection

NOTICE

Operation in the FWA band is subject to license. The radio power and channel frequency selections must be set correctly before the installed system is allowed to transmit. The installed system must comply with all governing local, regional, and national regulations. Contact authorities in the country of installation for complete information regarding the licensing regime and operating restrictions for that regulatory domain.

Declarations of conformity are available at the following web site address:

http://www.redlinecommunications.com/conformance/

1.6 Deployment in the USA -- FCC Notices

1. The model SC-1000 base station, radio transceiver, and antenna system must be professionally installed.
2. ⚠WARNING -- FCC RF Exposure Warning:

   To satisfy FCC RF exposure requirements for RF transmitting devices, a minimum distance of 230 cm should be maintained between any antenna of this device and persons during device operation. To ensure compliance, operation at closer than this distance is not recommended.
3. The antenna system must be fixed-mounted on permanent structures and must not be collocated in combination with the antenna of any other equipment.
4. FCC Information to Users @ FCC 15.21 & 15.105:

   This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
5. FCC Information to Users @ FCC Part 27:

   Allowable frequency settings are 2498.5 - 2687.25 MHz (5 MHz channel only).
6. The 2498.5 - 2687.25 MHz frequency range is a licensed band and operators must have a valid spectrum license to operate the Redline SC-1000 base station equipment using this band in the USA.
7. This device has been designed to operate with antenna systems having a recommended gain of 17 dBi. The required antenna impedance is 50 ohms.
   The RF output power and selection must be professionally programmed and the equipment must be installed by the manufacturer or a trained professional installer.
8. Warning: Changes or modifications of equipment not expressly approved by Redline Communications could void the user's authority to operate the equipment.

1.7 Electrical Safety

1. To minimize shock hazard, the equipment chassis and enclosure must be connected to an electrical ground. All power outlets and plugs must meet International Electrotechnical Commission (IEC) safety standards.
2. Do not operate the system equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.
3. Only qualified maintenance personnel may remove equipment covers to replace internal subassemblies, components, or perform internal adjustments.

4. Disconnect power and discharge circuits before touching them. Do not replace components with power cable connected -- dangerous voltages may exist even when the power cable fusing has been removed.
5. Do not attempt internal service or adjustment, without backup personnel available, capable of rendering first aid and resuscitation.

1.8 Handling Static Sensitive Devices

NOTICE

Electrostatic Discharge (ESD) must be avoided to prevent damaging or destroy static sensitive components. Please observe proper ESD handling procedures.

Metal oxide semiconductor (MOS) devices may be susceptible to damage from electrostatic charge. Charges can be created by the use of nylon overalls, friction, and by pushing hands into some types of insulation packing material, or ungrounded soldering irons.

Observe the following precautions when handling electronic components:

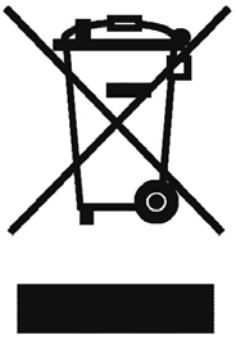
- Always wear a ground strap connected to the electrostatic point on the equipment.
- Cotton clothing produces less static than nylon and other synthetic materials.
- Use a grounded metal surface or anti-static mat. Wipe clean with an anti-static cloth.
- Use all-metal tools and place on grounded surface when not being used.
- Use caution when removing components connected to electrostatic sensitive devices. The components may provide protection from static shock.
- Do not remove the replacement device from its protective packaging until actual installation of the device. It may be necessary to replace foam with wire, due to space constraints.
- Printed circuit boards (PCBs) should always be handled with care. Handle only by the edges and do not directly touch connectors, tracks, or pins.

1.9 Security Features

Redline Communications wireless systems provide security setting that can be adjusted by the operator to meet specific applications. Redline recommends these parameters be set according to industry recognized security practices. Considerations include confidentiality, integrity, and availability of information. Implementation of these recommendations and the final responsibility for the system security is the responsibility of the system administrator and operators.

1.10 WEEE Product Return Process

In EU countries, dispose of equipment in accordance with the WEEE (Waste from Electrical and Electronic Equipment) directive, 2002/96/EC, Redline Communications equipment is marked with the logo shown below. The WEEE directive seeks to increase recycling and re-use of electrical and electronic equipment. This symbol indicates that this product should not be disposed of as part of the local municipal waste program. Contact your local sales representative for additional information.



In non-EU countries, dispose of equipment in accordance with national and regional regulations.

2 Overview

Congratulations on your purchase of the Redline Communications RedMAX 4C wireless broadband base station. Redline Communications is a world leader in design and production of Broadband Wireless (BFW) systems. The RedMAX 4C base station is a complete Mobile WiMAX (IEEE 802.16e-2005) compliant broadband wireless base station. Fully designed as a WiMAX-based solution, the base station has demonstrated interoperability with an emerging base of WiMAX subscriber equipment.

Services

The base station is (part of) the IEEE 802.16e-2005 definition of a base station. A base station functions as a central hub or concentrator, connected to a WAN network access point, and managing wireless links for remote subscribers. The base station enforces the Quality of Service (QoS) settings over the air interface by controlling all uplink and downlink traffic scheduling -- providing non-contention based traffic with predictable transmission characteristics.

The base station delivers fixed, nomadic, portable, and mobile services. Portable services provide limited handover for users moving within and across neighboring sectors and base stations. Mobile services provide full roaming capability to maintain all QoS (quality of service) and SLAs (service level agreements) while moving at vehicular speeds through WiMAX coverage areas.

Equipment

The base station consists of an indoor chassis and outdoor transceiver and antenna. Each operational wireless broadband network segment is comprised of a base station and one or more WiMAX Forum Certified™ subscribers. Each subscriber registers and establishes a bi-directional data link with the base station.

The base station operates under the control of an ASN gateway providing supporting management functions including: Accounting, Inter-Base Station Mobility, Base Station Management, Admission Control, and Access Authentication.

Network

High reliability is provided through comprehensive OAM&P (Operation, Administration, Maintenance and Provisioning) features including: fault tolerance, alarms and TCAs (Threshold Crossing Alerts), performance and inventory reports, and software management. Chassis management can be performed (via the SOAP/XML interfaces) using the Redline Management Suite (RMS) or a third party Element Management System (EMS). The RMS uses the TMF 814 NBI (Northbound Interface) to the OSS (Operations Support System) and SNMP MIBs.

2.1 Feature Summary

Mobile WiMAX base station

- Compliant with IEEE 802.16e-2005
- Compliant with Certification Wave II Profile

Modular components

- PICMG standard MicroTCA AMC form factor
- Multiple chassis sizes and configurations

OBSAI architecture (Open Base Station Architecture Initiative)

- Contains the main components of the OBSAI architecture
- Implements standard OBSAI interface specifications

Scalable

- Deployment in one to six sector configuration

High-availability

- Complies with the Service Availability Forum requirements

2.2 WiMAX Forum Defined Architecture

The ASN Controller performance monitoring features allow the ISP/NSP to analyze, troubleshoot, and plan network upgrades. The ASN Controller monitors radio and IP network performance to collect key performance indicators including RSSI, CINR, HO activity, QoS requirements and fulfillment, IP bandwidth usage, and then forwards performance data to an EMS/NMS. The ASN Controller also supports TCA (Threshold Crossing Alerts) which enable the network administrator to react to network performance problems in real-time.

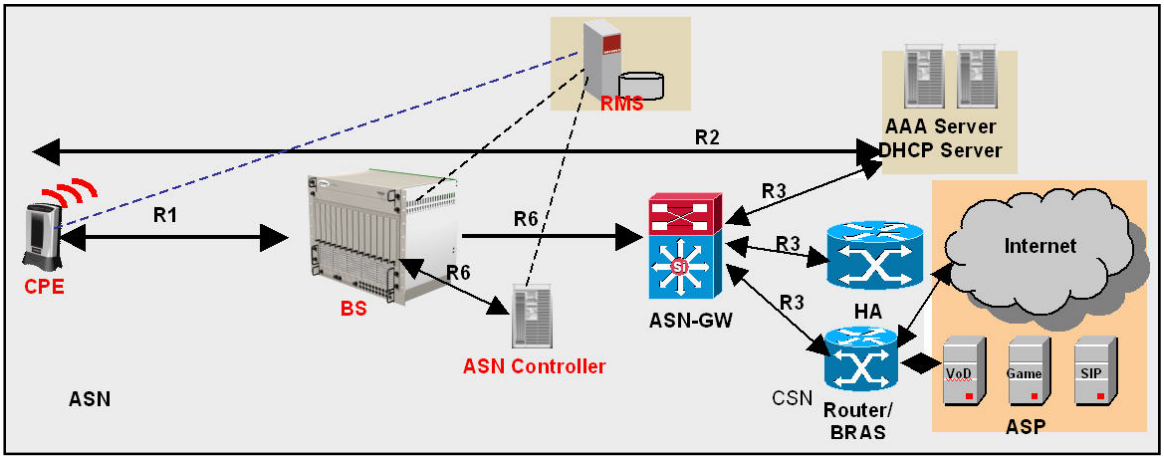


Figure 1 Overview - Base Station Network Architecture

2.3 Feature Details

2.3.1 IEEE 802.16e / WiMAX Compliance

The RedMAX 4C base station supports the following Certification Wave II Mobile WiMAX System Profile:

- WiMAX Certification Wave 2: Profile 3A: 2.5-2.7 GHz, 5/10 MHz, TDD

2.3.2 High Availability Features

The modular design of the base station chassis provides the following High Availability (HA) features:

- Hot-swap capability for field replaceable modules
- Parallel paths with no single point of failure
- In-service software upgrade
- Fault Management: monitoring, detection, and reporting
- Checkpoint service

2.3.3 PHY Specification

The base station is designed for 2-11 GHz operation based on the WirelessMAN-OFDMA PHY definition in the IEEE 802.16e-2005 specifications. Refer to the system specifications for supported frequency ranges.

2.3.4 OFDMA

Orthogonal Frequency Division Multiple Access (OFDMA) is a multi-user version of the OFDM digital modulation scheme. Multiple access is achieved in OFDMA by assigning subsets of subcarriers to individual users - allowing simultaneous transmission from several users.

OFDMA uses the Fast Fourier Transform (FFT) algorithm to implement modulation and demodulation functions. Using adequate channel coding and bit-interleaving, OFDMA can perform very well in severe multipath environments, mitigate frequency selective fading and provide high spectral efficiency.

2.3.5 Privacy

The base station implements IEEE 802.16e-2005 Privacy Sublayer and the NWG Standalone Model Security Architecture. The base station provides an Authentication Relay function to manage exchanges with an Authenticator in the ASN (Authentication Relay Protocol-EAP), and a Supplicant function in the CPE (PKMv2-EAP). This standards-based framework provides user/device authentication and services authorization using off-the-shelf AAA servers.

2.3.6 Time Division Duplexing (TDD)

The base station system uses time division duplexing (TDD) to transmit and receive on the same RF channel, or separate RF channels using HD-FDD (half-duplex FDD). These are both non-contention based methods for providing an efficient and predictable two-way PTP or PMP cell deployment. All uplink and downlink transmission scheduling is managed by the base station. The base station sends data traffic to subscribers, polls for grant requests, and sends grant acknowledgements based on the total of all traffic to all subscribers.

2.3.7 CTC (Convolutional Turbo Codes) and Coding Rates

Turbo codes are used for error correction. When used in combination with parity-check codes, these techniques can approach the theoretical limit (Shannon limit) of maximum information transfer rate over a noisy channel.

As part of the error correction technique, each burst of data transmitted over the wireless interface is padded with redundant information, making it more resistant to potential over-the-air errors. The coding rate is the ratio of user data to the total data transmitted including the redundant error correction data. The base station supports coding rates of 1/2, 2/3, 3/4, and 5/6.

2.3.8 Modulation

The modulation technique specifies how the data is coded within the OFDMA carriers. The base station supports BPSK, QPSK, 16 QAM (Quadrature Amplitude Modulation), and 64 QAM modulation.

2.3.9 Channelization

The base station is a frequency-specific system, with the frequency band defined by the transceiver unit. The base station divides the available frequency band into channels. Allocation of channels during deployment is dependent on spectrum availability in the licensed FWA band and local licensing requirements and conditions. Channel selection allows planners to obtain the maximum geographic coverage, while avoiding frequency contention in adjacent sectors.

2.3.10 Service Flows

A Service Flow represents a unidirectional data flow with separate QoS settings for uplink and downlink. Service flows provide the ability to set up multiple connections to each subscriber in a sector. Separate service flows can be established for uplink and downlink traffic, where each service flow is assigned a unique service level category and separate QoS settings. This feature allows segregation of high-speed/high-priority traffic from less time-critical flows.

Table 1: Overview - Base Station Service Class Types

Service Class		Description
UGS	Unsolicited Grant Service	Provides the most stringent scheduling, maintaining guarantees on throughput, latency, and jitter to the levels necessary for Time Division Multiplexed (TDM) services.
RT-VR	Real Time –Variable Rate Service	Provides guarantees on throughput and latency, but greater tolerance on latency. Applicable for VoIP and video conferencing applications.
ERT-VR	Extended Real Time – Variable Rate Service	Provides services as RT-VR, except that committed maximum rate can be changed on the fly as requested by subscriber signaling.
NRT-VR	Non-Real Time – Variable Rate Service	Guarantees throughput only. Applicable to mission critical data applications that are not latency-dependent.
BE	Best Effort	No guaranteed minimum throughput. Does allow setting a maximum data rate.

QoS is guaranteed by a unique prioritization and rate-limiting algorithm that dynamically adapts to wireless conditions, adjusting data throughput to maintain prioritization of traffic. Up to five classes of service to be assigned to each subscriber.

Payloads can be classified by multiple parameters including L2 MAC source and destination address, 802.1p/Q settings, DSCP and TOS bits, L3 IP source and destination address, and L4 TCP/UDP port number. Ingress classification for payload admission into the Service Flow architecture is performed at the subscriber/MS for uplink forwarding, and at the ASN-GW for downlink forwarding.

Requests for specific QoS settings can originate from the subscriber, a host connected to the subscriber, or a source outside the WiMAX network (e.g., an intermediate server). Unique QoS settings can be applied for individual users.

3 Physical Description

3.1 Block Diagram

The base station design uses modular building blocks based on Open Base Station Architecture Initiative (OBSAI). This standard defines the main base station modules.

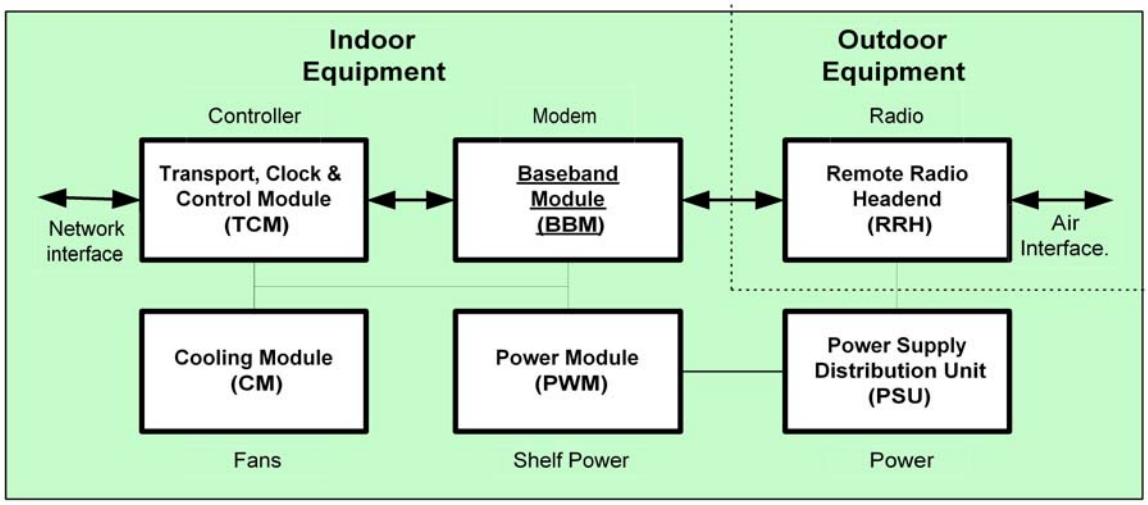


Figure 2: Overview - Base Station Simple Block Diagram

The main base station components are:

TCM: Transport, clock & control module provides traffic aggregation, control and clock functions.

BBM: Baseband module is the WiMAX wireless modem.

RRH: Radio module is a MIMO-ready dual-head radio/antenna system.

PWM: Chassis power supply module controls power for the base station modules and the cooling module.

CM: Cooling module contains fans providing all forced-air cooling for the base station chassis.

PSU: PSU provides conditioned power for the base station chassis and/or the outdoor RRH.

3.2 Base Station Chassis

The base station chassis is a carrier grade PICMG compliant MicroTCA telecom platform. The front-loading shelf supports redundant power modules and up to 14 PICMG AMC (Advanced Mezzanine Card) modules. All cards may be inserted in any slot with the exception of the power and MicroTCA Carrier Hub modules.

Figure 3: Phy - MicroTCA Chassis

Table 2: Phy - Chassis: Weight and Dimensions		
Description	**Excluding Cable Tray**	**Including Cable Tray**
Height	266.7 mm / 10.5 in	266.7 mm / 10.5 in
Width	482.6 mm / 10.5 in	482.6 mm / 19 in
Depth	237.0 mm / 9.33 in	277.0 mm / 10.35 in
Empty Chassis - (incl. fans)	12.5 Kg / 27.5 lb	12.5 Kg / 27.5 lb
Full Chassis	19 Kg / 42 lb	19 Kg / 42 lb

3.3 PWM - Power Module (Chassis)

The PWM power module provides regulated DC power for all modules in the base station chassis.

3.3.1 Module Description

The PWM features redundant inputs, allowing power to be supplied from two independent DC sources. A second PWM module may be installed to provide redundancy. When two PWM modules are installed and operating normally, the failure of one PWM module will not affect operation of the base station.

The PWM module is fully 'hot swappable' and the standby unit may be removed and installed without affecting operation of the base station (refer to 'Using the Hot-Swap Feature' in the installation guidelines).

The TCM manages the power for each uTCA module. The uTCA Power Module incorporates a MicroTCA EMMC (Enhanced Module Management Controller) that can operate independently or be controlled by the TCM module. The EMMC reports voltage and current levels, faulty power conditions, and local temperature status to the TCM.

Table 3: Phy - PWM: Power Module Types

Model	Description
PWM 380	-48 VDC power supply. Maximum power output is 380 Watts.
PWM 760	-48 VDC power supply. Maximum power output is 760 Watts.

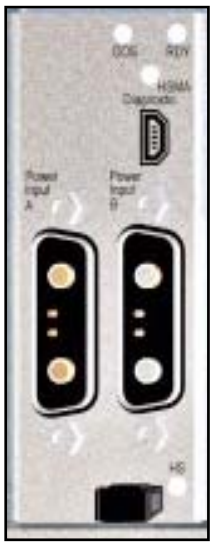


Figure 4: Phy - PWM: Power Module

3.3.2 Front Panel Interface

The following ports and controls are provided:

Table 4: Phy - PWM: Front Panel Interface		
Label	**Type**	**Description**
[Handle]	SPST	Hot-Swap request handle Completely inserted – the module is mechanically locked and is requesting activation Extracted half way – the module is mechanically locked and is requesting deactivation Completely extracted – the module is mechanically unlocked and can be removed when the blue led is solid on
Diagnostic	USB	The port is used only for factory diagnostics.
Power I/P A / B	D-Sub 7W2	Dual input MicroTCA standard module accepts -48 VDC (nominal battery range) from two independent sources.

Table 5: Phy - PWM: Power Input Pinout (A & B)	
Pin	**Description**
A2	- Ve
1	Connected to pin 2
2	Connected to pin 1
3	Not Used
4	Not Used
5	Not Used
A1	+ Ve

3.3.3 LED Indicators

The PWM module has the following front panel LED indicators:

Table 6: Phy - PWM: Power Module LED Indicators		
LED	**Color**	**Description**
OOS	Red	Out of Service Indicator Solid On - one or more input or output voltages are below normal level or the module temperature is exceeding critical threshold Solid Off – the module is functional.
RDY	Green	Power Supply Ready Indicator Solid On – the module is operational and selected as active (for redundant configurations) Long Blink – the module is operational and designated as standby for redundancy Fast Blink – the module is operational only for TCM and CM power channels Solid Off – the module is not operational
HSMA	Amber	Hardware System Management Activity (HSMA) Blink - indicates that the PWM is communicating with the TCM

Table 6: Phy - PWM: Power Module LED Indicators		
LED	**Color**	**Description**
HS	Blue	Hot-Swap Ready Indicator Solid ON – the module is deactivated and can safely be extracted Long Blink – module activation in progress Short Blink – module deactivation in progress Solid Off – the module is activated and unsafe for extraction

3.4 TCM - Transport, Clock & Control Module

The Transport, Clock & Control Module (TCM) is a multi-purpose card combining the OBSAI Transport Block and Control & Clock Block functions.

3.4.1 Module Description

The transport function manages traffic aggregation and the control and clock functions provide synchronization between the base station modules. Downstream data traffic received from the core network is distributed to the baseband modules for transmission over the wireless network, while upstream traffic from the wireless system is aggregated and sent over the backhaul connection to the core network.

The base station clock is synchronized by a GPS reference signal. Clock signals are sent through the backplane to the other base station modules.

The shelf may contain up to two TCM modules for redundancy. The TCM module is fully 'hot swappable' and the standby unit may be removed and installed without affecting operation of the base station (refer to 'Using the Hot-Swap Feature' in the installation guidelines).

The following TCM models are available:

Table 7: Phy - TCM: Controller Module Types	
TCM 1000	The TCM 1000 is the first generation base station controller module.

Figure 5: Phy - TCM: MicroTCA Controller Hub Front Panel Interface

3.4.2 Module Description

The following ports and controls are provided:

Table 8: Phy - TCM: Front Panel Interface		
Label	**Type**	**Description**
[Handle]	SPST	Hot-Swap request handle Inserted completely – the module is mechanically locked and is requesting activation Extracted half way – the module is mechanically locked and is requesting deactivation Extracted completely – the module is mechanically unlocked and can be removed when the blue led is solid on
Reset	Push-to-Make	Press this switch to reboot the module.
Antenna	SMA	GPS antenna input for Trimble Bullet III or equivalent antenna.
PPS	SMA	External 1 PPS GPS clock signal (LvTTL pulse). Currently not supported by the module.
I^2C Bus	USB	Factory diagnostics only. Do not connect USB devices !
Serial 1	DB-9 Micro	RS-232 port accepts a standard GPS 1 PPS synchronization signal. DTE pinout - requires cross over cables.

Table 8: Phy - TCM: Front Panel Interface		
Label	**Type**	**Description**
Serial 2	DB-9 Micro	RS-232 port for out-of-band management. DCE pinout – requires direct cables.
Ethernet 1	RJ-45 8P8C	10/100Base-T Ethernet port. This port has an associated MAC address. Used for out-of-band management, base station configuration and remote power supply management.
Ethernet 2	RJ-45 8P8C	10/100Base-T Ethernet port. This port has an associated MAC address. Used for managing a remote PSU power supply.
GbE	SFP	Main transport connection between the base station and the core/backhaul network. This port has an associated MAC address. Copper: 100/1000Base-T Optical: 1000Base-X

3.4.3 LED Indicators

The TCM module has the following front panel LED indicators:

Table 9: Phy - TCM: LED Indicators		
LED	**Color**	**Description**
Hot Swap	Blue	Hot-Swap Ready Indicator Solid ON – the module is deactivated and can safely be extracted Long Blink – module activation in progress Short Blink – module deactivation in progress Solid Off – the module is activated and unsafe for extraction
Fault	Red	Out of Service Indicator Solid ON – the module is out of service due to a hardware fault detection or the module temperature is exceeding critical threshold Long Blink – the module is out of service due to the missing reference clock or missing synchronization frame from the GPS Solid Off – the module is functional
Active/ Standby	Green Amber	TCM Ready Indicator Green Solid ON – the module is performing startup and is selected as active (for redundant configurations) Amber Solid ON – the module is performing startup and is selected as standby for redundancy Green Long Blink – the module is operational and is selected as active (for redundant configurations) Amber Long Blink – the module is operational and is selected as standby for redundancy Solid Off – the module is not receiving power from the PWM

3.5 BBM - Baseband Module

The baseband module (BBM) is a WiMAX wireless modem (IEEE 802.16e PHY and MAC).

3.5.1 Module Description

Downstream data traffic received from the core network is distributed to the baseband modules for transmission over the wireless network, while upstream traffic from the wireless system is aggregated and sent over the backhaul connection to the core network. This port has an associated MAC address.

Each BBM connects to one RRH (one sector) and supports two SISO channels or one MIMO channel. Up to six BBM (plus two standby) modules may operate concurrently. The BBM is frequency agnostic (frequency band determined by RRH). The base station shelf supports an N+1 redundancy configuration. The OBSAI RP3-01 interface cabling must be provided from each standby BBM module to a radio.

The BBM module is fully 'hot swappable' and may be removed and installed without powering off the chassis. Removing and replacing a BBM module will not affect operation of the base station.

Table 10: Phy - BBM: Module Types	
BBM 1000	SISO-based baseband module.
BBM 2000	MIMO-based baseband module.

Figure 6: Phy - BBM: Baseband Module (BBM2000)

3.5.2 Front Panel Interface

The following ports and controls are provided:

Table 11: Phy - BBM: Front Panel Interface		
Label	**Type**	**Description**
[Handle]	SPST	Hot-Swap request handle Inserted completely – the module is mechanically locked and is requesting activation Extracted half way – the module is mechanically locked and is requesting deactivation Extracted completely – the module is mechanically unlocked and can be removed when the blue led is solid on
A, B, C, D	SFP	Connection from the base station RRH. Optical: 1000Base-X, 100/1000Base-T 50/125 UM Fiber Optic, Type OFNR, -40°C to +75°C Outdoor Rated – 7 mm (0.28 in) OD. X 91 m (300 ft) max. length Max. allowable cable signal loss: 8 dB
Reset	Push-to-Make	Press this switch to reboot the module.

Table 11: Phy - BBM: Front Panel Interface		
Label	**Type**	**Description**
Ethernet	RJ-45 8P8C	10/100Base-T Ethernet port. Used only for factory diagnostics.
Serial	D-Sub-9	RS-232 serial port. Used only for factory diagnostics.

3.5.3 LED Indicators

The module has the following front panel LED indicators:

Table 12: Phy - BBM: LED Indicators		
LED	**Color**	**Description**
Hot Swap	Blue	Hot-Swap Ready Indicator Solid ON – the module is deactivated and can safely be extracted Long Blink – module activation in progress Short Blink – module deactivation in progress Solid Off – the module is activated and unsafe for extraction
Fault	Red	Out of Service Indicator Solid ON – the module is out of service due to a hardware fault detection or the module temperature is exceeding the critical threshold Long Blink – the module is out of service due to the missing reference clock or missing synchronization frame from TCM Solid Off – the module is functional
Active/ Standby	Green/ Amber	BBM Ready Indicator Green Solid ON – the module is performing startup and is selected as active (for redundant configurations) Amber Solid ON – the module is performing startup and is selected as standby for redundancy Green Long Blink – the module is operational and selected as active (for redundant configurations) Amber Long Blink – the module is operational and selected as standby for redundancy Solid Off – the module is not receiving power from PWM

3.6 RRH - Remote Radio Headend

The Remote Radio Headend (RRH) is the outdoor radio transceiver.

3.6.1 Module Description

The RRH contains an OBSAI RP3-01 interface and two identical TDD RF head-ends (RFHEs). Each RRH supports two SISO channels or one MIMO channel. Frequency bands and power are determined by the RRH (the BBM is frequency band agnostic).

The RRH interfaces to one baseband module (BBM) using the OBSAI RP3-01 optical interface to exchange data and control signals. Power is supplied to each RRH through separate cabling from dedicated power modules (not base station PWM). The RRH may be mounted up to 300 m (984 ft) away from the base station chassis. This distance can be extended based on the fiber type and method of supplying power to the RRH.

Each RRH module has two optical interfaces. These interfaces may be used in one of the following configurations:

- Connect RRH to a standby BBM module. The optical interface cabling must be provided from the standby BBM modules to the radios.
- Interconnect two RRH modules (daisy-chain) to provide 1+1 redundancy or 4-branch MIMO (future option).

Each RRH module contains two RF head-ends. The failure of one radio within the RRH enclosure results in graceful degradation, but not loss of service.

Table 13: Phy - RRH: Module Types	
RRH R2500	2.5 GHz MIMO Radio

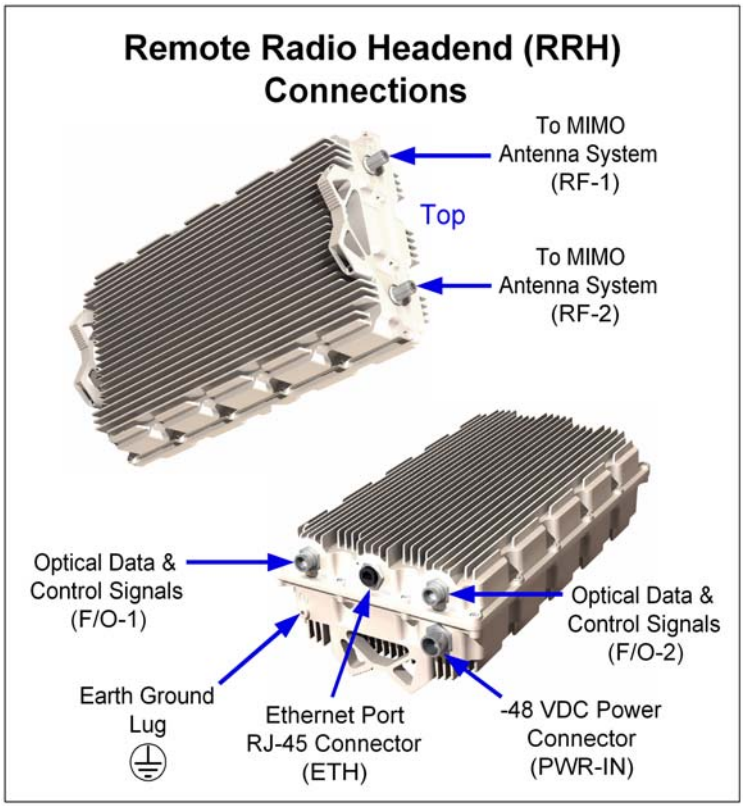


Figure 7: Phy - RRH: A2500 Remote Radio Headend

3.6.2 A2500 Radio Interface

The following ports and controls are provided:

Table 14: Phy - RRH: Front Panel Interface		
Label	**Type**	**Description**
Antenna RF Port	N-type, female	Connection to external antenna. One output port for each (2) radio.
DC Power	TBD	Power supply input. The RF Module receives - 48 VDC power compliant to ETS300132-2.
Fuse	TBD	External access to replaceable primary fuse.
Ground Lug	TBD	Connect earth ground to this lug.
Optical Data & Mgmt	TBD	Interface to BBM or another radio (daisy chain). The RRH module uses the OBSAI RP3-01 optical interface to exchange data and management signals with the BBM.

3.7 CM - Cooling Module

The cooling module (CM) provides forced-air cooling for the MicroTCA chassis.

3.7.1 Module Description

The CM is integral with the base station chassis and installs in a special slot below the MicroTCA modules. The CM contains a processing system that monitors the fan operation and reports alarm conditions. Detected component failures and predictive failure status is logged as a system alarm event and annunciated on the front panel LEDs.

The shelf contains multiple fans for redundancy. The CM module is fully 'hot swappable' and may be removed and installed without powering off the chassis. Removing and replacing a CM module will not affect operation of the base station. It is important to note that the CM is disabled (not cooling) when the blue Hot-Swap LED is on. The base station chassis may be safely operated for up to 10 minutes with the cooling module disabled or removed from the chassis.

Figure 8: Phy - CM: Cooling Module Front Panel

3.7.2 Front Panel Interface

The following ports and controls are provided:

Table 15: Phy - CM: Front Panel Interface

Label	Type	Description
Hot-Swap Request Pushbutton	SPST Push-to-Make	Hot-Swap Request toggle pushbutton Push and release completely - module is requesting deactivation/activation
⏚	Ground Lug	Use this ground plug to connect an anti-static wrist strap when servicing the base station modules.

⚠ CAUTION

Correct grounding procedures are essential to preventing damage to base station electronic modules.

3.7.3 LED Indicators

The module has the following front panel LED indicators:

Table 16: Phy - CM: Cooling Module LED Indicators

Label	Color	Description
Fan Status (1 & 3)	Green Red	Fan Status Indicator for fans 1 & 3 Green Solid On – the module is operational, the fans are spinning under TCM control Green Blinking Red – the module is operational, the fans are spinning without TCM control Red Solid On – the module is not operational, the fans are not spinning Solid Off – the module is not receiving power from the PWM

Table 16: Phy - CM: Cooling Module LED Indicators		
Label	**Color**	**Description**
Fan Status (2 & 4)	Green Red	Fan Status Indicator for fans 2 & 4 Green Solid On – the module is operational, the fans are spinning under TCM control Green Blinking Red – the module is operational, the fans are spinning without TCM control Red Solid On – the module is not operational, the fans are not spinning Solid Off – the module is not receiving power from the PWM
Hot-Swap	Blue	Hot-Swap Ready Indicator Solid ON – the module is deactivated and can safely be extracted Long Blink - module activation in progress Short Blink - module deactivation in progress Solid Off – the module is activated and unsafe for extraction

3.8 PSU - Power Unit (PSU)

The PSU provides regulated DC power to the base station power module (PWM) and/or the outdoor remote radio headend (RRH).

NOTICE

Complete installation, operation, and maintenance information is provided in the original equipment manufacturers (OEM) documentation supplied with the product. Read all information in these manuals carefully before installing and operating this equipment.

3.8.1 Module Description

The PSU can be configured to provide one or two channels of regulated 48 VDC power. The PSU features redundant inputs, allowing power to be supplied from two independent 240 VAC sources. The PSU can also be configured in a redundant output configuration with an optional second rectifier module installed for each DC output. When two rectifier modules are installed and operating normally, the failure of one module will not affect the DC power output for that channel.

Mounting Shelf

The Power Monitoring and Control module and rectifier modules mount in the PSU shelf. This 2U assembly is suitable for installation in a standard 19 inch TELCO rack.

Figure 9: Phy - PSU: Integrated Power Supply Unit

Rectifier Modules

Each rectifier is powered by one or two 240 VAC supplies, and provides a single 48 VDC output. Up to four rectifier modules can be installed in redundant pairs. All rectifier modules are supervised by the Power Monitoring and Control Module.

Figure 10: Phy - PSU: Rectifier Module

Monitoring and Control Module

All rectifier input and output voltages are supervised locally by the Power Monitor and Control Module. The base station supervises the PSU remotely using an Ethernet connection to the module.

Figure 11: Phy - PSU: Power Monitor and Control Module

3.8.2 PSU Module Wiring

All PSU wiring connections are located inside the PSU chassis. The PSU features a front pull-out shelf providing access to all terminal blocks.

NOTICE

Power input cables should have the following minimum ratings:

16 AWG/2 conductors, copper stranded, shielded, -40 C to 90 C, 8 mm (0.31 in) O.D.

3.8.3 Front Panel Interface

The following ports and controls are provided:

Table 17: Phy - PSU: Front Panel Interface

Label	Type	Description
[none]	LCD Display	Display system status messages.
USB	USB	The USB port is used only for factory diagnostics.
↑	Push-to-make	Up button to control the LCD display.
↓	Push-to-make	Down button to control the LCD display.
↵	Push-to-make	Enter button to control the LCD display.

3.8.4 Rear Panel Interface

The following ports and controls are provided:

Table 18: Phy - PSU: Rear Panel Interface		
Label	**Type**	**Description**
CAN1	RJ-45, 8P8C	CAN controller Port 1 and 2.
CON1	Mini Power, 10 pin	Alarm I/O connections.
CON2	RJ-45, 8P8C	Ethernet connection to base station (TCM module).
CON3	DB-15P	Battery connections
CON4	DB-15P	Battery connections
CON5	DB-15S	System connections

3.8.5 LED Indicators

The PSU module has the following front panel LED indicators:

Table 19: Phy - PSU: Mini Pack Power Module LEDs		
Label	**Color**	**Description**
	Green	Power on
	Yellow	Minor Alarm
	Red	Major Alarm

3.8.6 Hot-Swap states LED Indicators

The base station chassis supports redundant hot-swappable power modules. To ensure operation of the base station is not interrupted, the defective power supply can be replaced while the alternate power supply is installed and powered on.

Table 20: BS Maint. L Hot-Swap States and LED Indications		
BLUE LED	**Mode**	**Description**
N/A	Module Not Installed	The module is not present in the system (extracted or waiting to be extracted).
On	Module Inactive	Module is powered on and initializing.
Slow Blink	Module Activation Requested	Detected handle closed – waiting for activation by shelf manager.
Off	Module Active	Module is fully operational
Fast Blink	Module Deactivation Requested	Detected handle opened – waiting for deactivation by shelf manager.

3.9 Grounding and Surge Protection

3.9.1 Base Station Chassis and Modules

- A ground lug is provided on the base station chassis (cooling module) for connection to earth ground.
- Individual base station modules are grounded through the chassis backplane.

3.9.2 Outside Radio Module and Cabling

- A lug is provided on the RRH (Remote Radio Headend) for connection to earth ground.

3.9.3 Installation Environment

- The base station mounting rack must be properly grounded.
- External AC and/or DC power sources must be properly grounded.
- Power and signal cables running between the indoor and outdoor equipment must be bonded to ground at recommended intervals.

Important: Grounding connections are provided on all Redline base station and radio equipment. It is the user's responsibility to install proper grounding to protect against power surges and accumulated static electricity. The base station equipment must be installed in accordance with the local electrical codes: correct installation procedures for grounding of the transceiver unit, mast, lead-in wire and discharge unit, location of discharge unit, size of grounding conductors and connection requirements for grounding electrodes.

3.10 Antenna Systems

The base station supports multi-channel SISO, MIMO Matrix A (STC), and MIMO Matrix B (2x2 DL, Collaborative MIMO UL). The system also implements Maximal Rate Combining (MRC) diversity on uplink channels (when MIMO Matrix B is not used). A selection of 60^{o} to 360^{o} antennas are available for the 2.5 GHz and 3.5 GHz ranges.

4 CLI Interface

The base station can be monitored and configured using the Command Line Interface (CLI) commands. This section describes the procedures for establishing a local console or Telnet connection, the CLI command structure, and descriptions of individual CLI commands.

The base station CLI operates in modes. This feature simplifies usage by grouping related commands together under a specific level. After changing to the desired mode, the user does not need to preface each command with the full pathname.

4.1.1 Physical Connections

Local management is performed through the TCM serial/console interface (**Serial 2**). Remote management can be performed through the TCM Ethernet port (**Ethernet 1**) or Gigabit Ethernet port (**GbE**).

The following diagram illustrates the management connection to the base station.

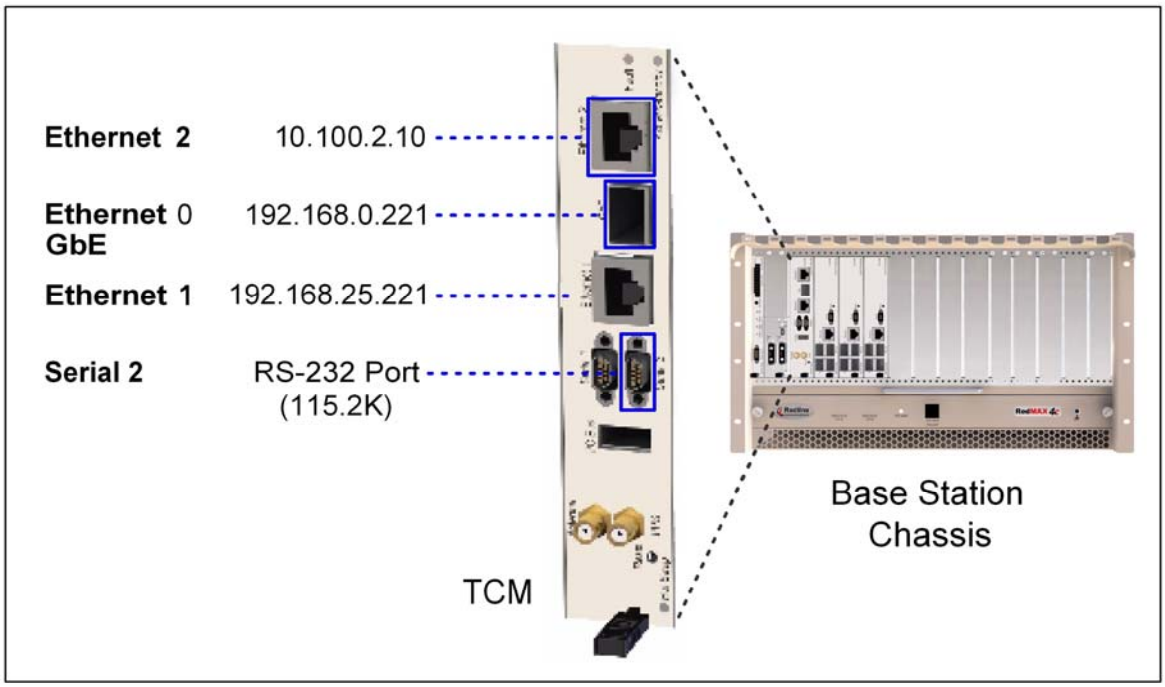


Figure 12: CLI - Management Terminal Connections

Table 21: Phy - Base Station Default IP Addresses		
Port	**IP Address**	**Description**
Ethernet 2	10.100.2.10	Connect the Redline supplied Ethernet cable (R4C-04) to the TCM board Ethernet 1 port. Terminate the other end of this cable to a computer or network.
GbE	192.168.0.221	Connect the Redline supplied Ethernet cable (R4C-05) to the TCM board GbE port. Terminate the other end of this cable to a computer or network.

Table 21: Phy - Base Station Default IP Addresses		
Ethernet 1	192.168.25.221	Out-of-band management
Serial 2	N/A	Connect the Redline supplied serial console cable (R4C-03) to the TCM board Serial 2 port. If the host does not have a serial connector, use an RS-232-to-USB converter. Settings: Baud rate: 115200; Data bits: 8; Flow Control: None; Parity: None; Stop Bits: 1

4.1.2 User Names and Passwords

The base station is shipped from factory with the following default user names and passwords. It is suggested that during commissioning, the system administrator should perform a system audit and assign new user names and passwords to all accounts.

Table 22: Phy - Base Station Default Usernames and Passwords		
Account	**Username**	**Password**
Administrator	Cli	Cli

4.1.3 Telnet Connection

Type telnet followed by the IP address for the selected system access port and press ENTER. Enter the account and password when prompted.

Example for GbE port:

telnet 192.168.25.221 [ENTER]

cli [ENTER]

cli [ENTER]

Result:

Copyright (c) 2006-2007 Redline Communications Inc.

http://www.redlinecommunications.com

SC1000>

Telnet Logout: To exit from the telnet session, type quit [ENTER].

4.1.4 SSH Connection

SSH login:

To begin an ssh session, type ssh followed by the IP address for the selected system access port and press ENTER. Type the account and password when prompted.

Example:

ssh cli@192.168.25.221 [ENTER]

cli [ENTER]

Result:

Copyright (c) 2006-2007 Redline Communications Inc.

http://www.redlinecommunications.com

SC1000>

SSH logout: To exit from an ssh session, type exit then press ENTER.

5 Operational Notes

5.1 Synchronization

In TDD mode, the base station and the subscribers transmit at the same frequency, and require precise base station synchronization (timing between downlink and uplink bursts) to minimize potential interference and ensure good performance. The IEEE 802.16 standard calls for the use of global positioning system (GPS) receivers to provide the precise time reference for synchronization of WiMAX networks.

5.2 Examples of 3-Sector Configurations

The modularity of the base station, combined with the OBSAI capabilities, provides a wide selection of configuration options to meet the requirements and budget of the network carrier.

5.2.1 No Redundancy

This deployment scenario provides maximum economy without redundancy. In this configuration, failure of the TCM or PWM module will cause the system to be unavailable. Failure of a BBM will result in a loss of service for the affected sector. Failure of a sector radio will revert to SISO for the affected sector or a loss of the sector (based on the type of failure).

Table 23: 3-Sector with No Redundancy

Module	Quantity	Failure Mode	System Action
PWM	1	Failure of PWM	System unavailable
TCM	1	Failure of TCM	System unavailable
BBM	1	Failure of BBM	Sector unavailable
RRH	3	Failure of one RF PCB	Sector reverts to SISO
		Failure of digital PCB	Sector unavailable

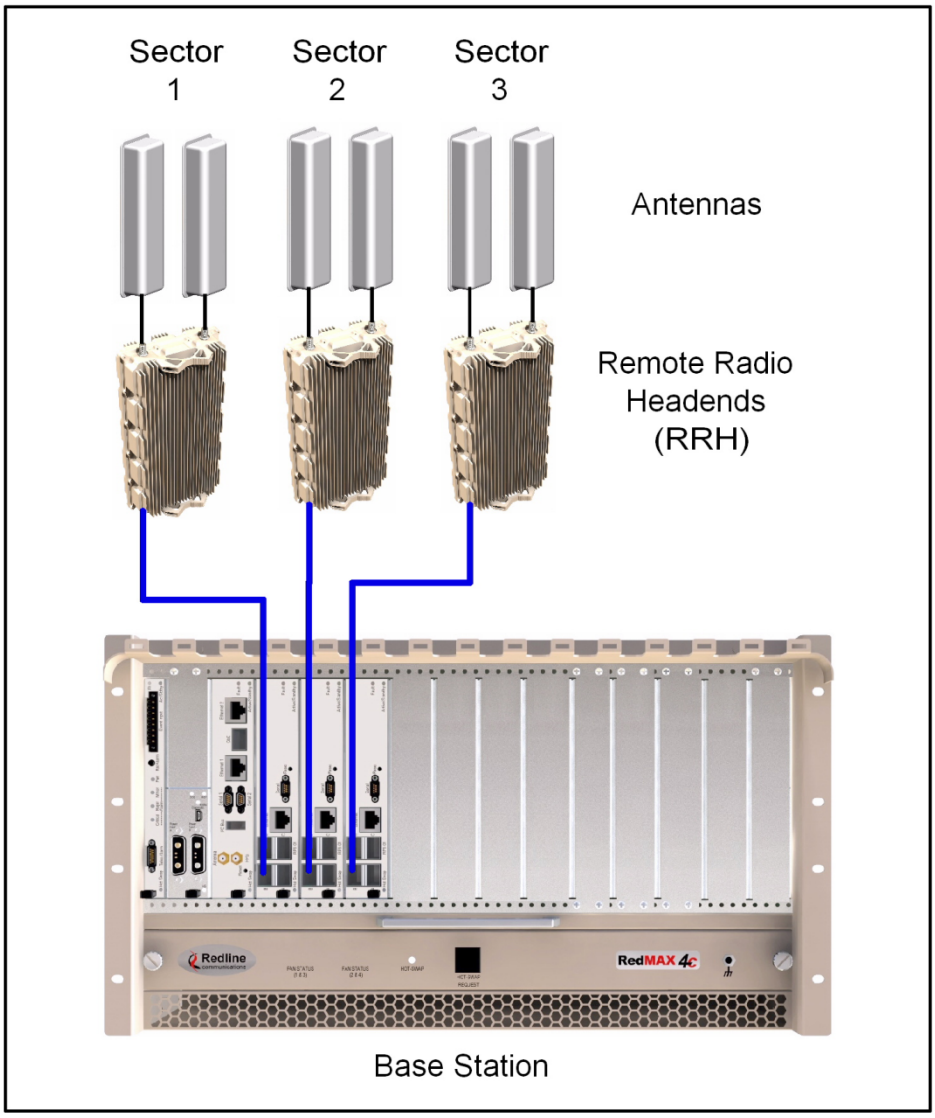


Figure 13: 3-Sector No Redundancy

5.2.2 Basic Redundancy

Basic redundancy is provided by adding standby transport, clock and control (TCM) and power (PWM) modules. Baseband-radio link redundancy is achieved by installing a standby BBM module with optical interface cables connecting to each sector RRH.

In this configuration, failure of a PWM or TCM module will switch to the dedicated standby. If any single BBM fails, the system will switch to the standby BBM module. If any single RFHE RF component fails the radio will operate in SISO mode for that sector.

Table 24: 3-Sector with Basic Redundancy + Standby BBM

Module	Redundancy	Failure Mode	System Action
PWM	1+1	Failure of active PWM	Switch to standby PWM
TCM	1+1	Failure of active TCM	Switch to standby TCM
BBM	Up to 4+1	Failure of one active BBM	Switch to standby BBM
RRH	Not provided.	Failure of active RFHE	Revert to SISO operation

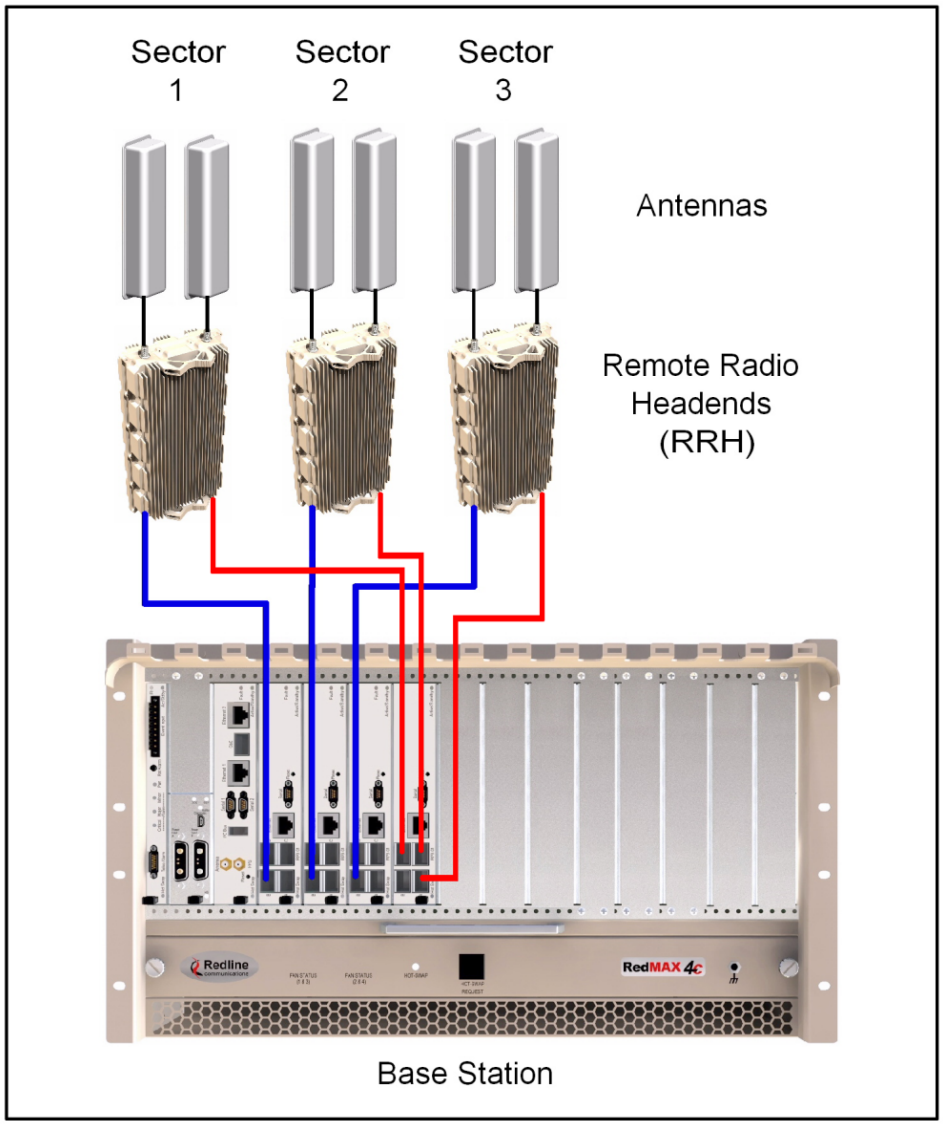


Figure 14: 3-Sector Basic Redundancy

6 Troubleshooting

6.1 Factory Default Settings

The table lists some important factory default settings for the base station chassis.

Table 25: Troubleshooting - Factory Default Settings

Setting	Sub	Field	Value
Ethernet Interface		Management	Via Data port (integrated)
Management Interface Eth 1		IP Address	192.168.25.221
Wireless Interface	RF	Frequency	
Wireless Interface	RF	Reference RSSI	-69 dBm
Wireless Interface	RF	Tx Power	36 dBm
Wireless Interface	PHY	Channel size	5 MHz
Wireless Interface	PHY	Guard Interval	1/8
Wireless Interface	PHY	Number of Symbols in DL	29
Wireless Interface	PHY	Number of Symbols in UL	18
Wireless Interface	MAC	Adaptive DL/UL Ratio	Disabled
Wireless Interface	MAC	Cell Range Km	5
Wireless Interface	MAC	DL Ratio	54
Wireless Interface	MAC	Frame Duration	5 msec
Wireless Interface	MAC	Synchronization Mode	Free Run
Admin Login		Login Password	admin admin
Guest login		Login Password	guest guest

*Based on 3.4 - 3.6 GHz RRH (radio).

6.2 Recovering a Lost IP Address

Use a serial cable to access the base station serial console. The configuration of the serial port should be 115,200 bps, no parity, 8 data bits, and 1 stop bit. Use the CLI commands to restore the IP address to a known value.

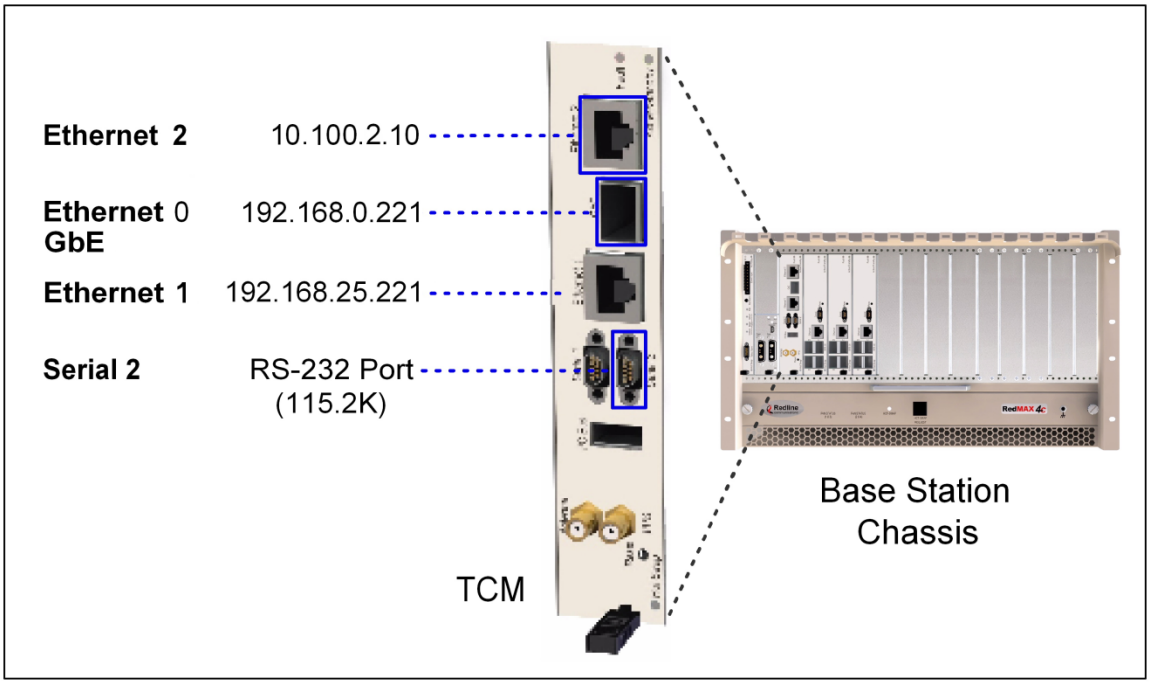


Figure 15: Op - Management Terminal Connections

6.3 System Log Messages

Table 26: Troubleshooting - Event Log Messages	
Log Message	Description
Input Overdrive	The RRH raises an alarm if the IQ TX stream is causing an input overdrive.
TX Gain Failure	The RRH monitors the transmit gain and raises an alarm if the gain is outside the programmable gain limits.
Frequency Lock	The RRH monitors the lock status of all PLL's and raises an alarm if an out of lock alarm occurs for a programmable time threshold.
TX Pre-distortion alarm	The RRH monitors the digital pre-distortion system and raises an alarm if a failure is detected, e.g. TX-SRX correlation failure etc.
RX Failure Alarm	The RRH monitors the RX performance and raises an alarm if a RX failure is detected.
Temperature Alarm	The RRH monitors the internal temperature of critical sub-assemblies and raises an alarm when a temperature exceeds a programmable threshold.
Software Download	The RRH raises an alarm if a new SW image download fails. Unit continues to operate with the previous software image.

7 Appendices

7.1 System Technical Specifications

Table 27: Spec.: Base Station	
Capacity:	Scalable from one to six sectors
MAC:	Cell-based PMP deployment 802.16e-2005 compliant PMP 802.16e-2005 IP CS Ethernet CS QoS: UGS, RT-VR, ERT-VR, NRT-VR, BE
PHY:	IEEE 802.16e-2005 S-OFDMA (WiMAX MTG compliant) Dynamic Time Division Duplex (TDD) 512/1024 FFT 3.5, 5, 7, 10 MHz (125 KHz channel center resolution) MRC Receive Diversity PUSC, FUSC, AMC 2x3 permutation Dynamic Adaptive Modulation (bi-directional) Auto-select modulation: QPSK, 16 QAM, 64 QAM Auto-select coding: 1/2, 2/3, 3/4, 5/6 Channel Coding: Convolutional Turbo Codes (CTC), multiple repetitions Chase Combining Hybrid ARQ with CTC MIMO: Matrix A (STC), Matrix B (2x2 downlink, Collaborative MIMO uplink)
Interfaces - Logical:	Management: HTTP (Web server), Telnet (CLI) R1: Base station over-the-air to CPE (IEEE 802.16e-2005) R3: Core Network Interface R6: ASN connectivity
Interfaces - Physical:	Management: 10/100 Ethernet (RJ-45), RS-232 (Sub DB-9) Radio: OBSAI RP3-01 optical interface Synchronization: 1 PPS TTL (GPS satellite clock) WAN: Copper: 10/100/1000Base-T Optical: 1000Base-X, 10/100/1000Base-T
Redundancy:	N+1 for baseband module 1+1 for radio, control, and power modules
Encryption:	Message Authentication Code Mode (CMAC) 802.16 Authorization Policy Support PKMv2 Support EAP-based authorization Cryptographic suites: CCM-Mode 128-bit AES TEK encryption: 128-bit AES
Management:	Full management by Redline RMS (SOAP/XML)
Network Attributes:	Transparent bridge 802.1Q VLAN 802.1p network traffic prioritization

Table 27: Spec.: Base Station	
	DHCP client pass-through
Power Requirements:	-48 VDC (Auto-sensing 18-60 VDC) Optional 120/240 VAC (Auto-sensing 90 - 264 VAC 50/60 Hz)
Power Consumption:	280 W for single sector without redundancy 1410 W for fully redundant six-sector configuration.
Reliability (MTBF):	Availability: 99.999% Base Station: > 400 000 hours (estimated) Base Station modules: >400 000 hours (estimated)
Standards/Compliance:	EMC: ETSI EN 301 489-1, EN 301 489-4, EN 55022/CISPR 22 Safety: IEC 60950-1, EN 60950-1, UL 60950-1; FCC: CFR 47, Part 15, Part 27
Dimensions:	19” rack mount 6U MicroTCA Shelf 482.6 x 266.7 x 237 mm (19.00 x 10.50 x 9.33 in) W x H x D
Operating Temperature:	0 C to +40 C (up to 90% humidity non-condensing) > 40 C for 5 hours (+55 C max.)
Storage Temperature:	-5 C to +45 C (Δ15 C/hr, 10-95% humidity non-condensing)
Weight:	12.5 kg (27.5 lb) empty, with fan tray 19 kg (42 lb) fully equipped
Power Cable:	16 AWG/2 conductors, copper stranded, shielded Max. allowable cable signal loss: 8 VDC
Optical Cable:	BBM to RRH: 50/125 UM Fiber Optic, Type OFNR, -40°C to +75°C Outdoor Rated – 7 mm (0.28 in) OD. X 91 m (300 ft) max. length Max. allowable cable signal loss: 8 dB
RF Jumper Cable	2 meter (6.5 ft) LMR-400 coaxial cable. Maximum allowable cable signal loss: 0.5 dB
GPS Antenna Cable	15 meter (50 ft) RG-59 coaxial cable. Refer to manufacturers recommendations for cable types and maximum allowable cable signal loss.

Table 28: Spec.: Transport, Clock & Control Module (TCM)	
Module:	Transport, Clock & Control Module (TCM 1000)
OBSAI Function:	Transport and Control & Clock Function
Dimensions:	Double Width-Full Height Advanced Mezzanine Card (AMC) 29 x 150 x 180 mm (1.14 x 5.90 x 7.08 in) W x H x D
Functions:	Classify traffic from core network and distribute to air interface Aggregation of traffic from air interface to core network Shelf control functionality (OAM&P) System clock (Stratum 3 holdover of max +-0.37 ppm per 24 hrs)
Interfaces:	Core network data transport port up to GbE with GBIC (SFP Gigabit Interface Converter) or 10/100/1000 (SFP copper adapter) Core network management port (10/100 Ethernet) GPS synchronization input port Operator serial console port (RS-232) Operator network console port (10/100 Ethernet)
Opt. Redundancy:	1 + 1
Hot-Swappable:	Yes

Table 29: Spec.: Baseband Module (BBM)	
Module:	Baseband Module (BBM 1000)
OBSAI Function:	Baseband Block
Dimensions:	Double Width-Full Height Advanced Mezzanine Card (AMC) 29 x 150 x 180 mm (1.14 x 5.90 x 7.08 in) W x H x D
Functions:	WiMAX 802.16e-2005 modem (one BBM per sector)
Interfaces:	Optical SFP port to RRH Operator local console port (RS-232) Operator network console port (10/100 Ethernet)
Opt. Redundancy:	N + 1 per 3 sectors
Hot-Swappable:	Yes

Table 30: Spec.: SFP Module – Copper
The LCP-1250RJ3SR-S is 3.3V copper small form-factor plug-able (SFP) transceiver. It offers full duplex 1000Mb/s Ethernet by transporting data over standard CAT 5 UTP cable (category 5 unshielded twisted pair), with RJ-45 connection. It takes signals from both CAT 5 UTP cable and the SFP SerDes interface. The system host (MAC) must enable SGMII auto-negotiation while LCP-1250RJ3SR-S is operated to setup the partner linking at one speed of 10/100/1000Mbps by 1000Base-T auto-negotiation. - Compatible with specifications for IEEE 802.3z/Gigabit Ethernet - Compliant with MSA specifications for Small Form Factor Pluggable (SFP) Ports - Hot-Pluggable SFP footprint - Compliant with industry standard RFT electrical connector and cage - EEPROM with serial ID functionality - Auto-Negotiation follows IEEE 802.3u Clause 28 (1000BASE-T) and Cisco SGMII Spec. - Compatible with the Cisco specification of SGMII interface. - LCP-1250RJ3SR-S supports SGMII interface without clock on MAC side - Gigabit PHY device is integrated internally - Internal PHY IC is configurable by host system software via SFP 2-wire-interface

Table 31: Spec.: SFP Module – Fiber
Single Wavelength Transceiver 4 Gigabit Short-Wavelength SFP Transceiver (FTRJ8524P2xNy) FTRJ8524P2xNy SFP transceiver is compatible with the Small Form Factor Pluggable MSA, and Gigabit Ethernet and Fiber Channel. - Up to 4.25 Gbps bi-directional data links - Hot-pluggable SFP footprint - Built-in digital diagnostic functions - 850 nm Oxide VCSEL laser transmitter - Duplex LC connector - Up to 500 m on 50/125 µm MMF, 300 m on 62.5/125 µm MMF - Extended operating temperature range: -20°C to 85°C

Table 32: Spec.: Power Module	
Module:	Power Module (PWM 380/760)
OBSAI Function:	Power
Dimensions:	Single Width-Full Height Advanced Mezzanine Card (AMC) 29 x 75 x 180 mm (1.14 x 2.95 x 7.08 in) W x H x D
Functions:	Power for the base station chassis modules and the fan chassis PWM 380 -- 380 Watts PWM 760 -- 760 Watts
Interfaces:	DC input: -48 VDC AC input: 120/240 VAC (optional)
Opt. Redundancy:	1 + 1
Hot-Swappable:	Yes

Table 33: Spec.: Cooling Module (CM)	
Module:	Cooling Module (CM)
Dimensions:	431.8 x 44.5 x 196.9 mm (17 x 1.75 x 7.75 in) W x H x D Integrated in chassis
Functions:	Forced air cooling (four fans in tray) Monitor fan operation and report alarm conditions (signaling and LEDs)
Interfaces:	Alarm signaling to the TCM (via the backplane).
Hot-Swappable:	Yes

7.2 Data Cable Specifications (Optical and Copper)

Table 34: Phy - BBM: Data Cable Specifications	
Optical	50/125 UM Fiber Optic, Type OFNR, -40°C to +75°C Outdoor Rated – 7 mm (0.28 in) OD. X 91 m (300 ft) max. length Max. allowable cable signal loss: 8 dB
Copper	Standard CAT 5 UTP for data link up to 100 m (330 ft).

7.3 PSU - Power Supply Unit

Table 35: Spec.: PSU Power Shelf Specifications	
AC Input	
Voltage:	2 x AC feeds (85-300 VAC 1 ph)
Frequency:	45 to 66 Hz
Surge protection:	Internal fuses (L & N) Disconnect above 300 VAC
Monitoring	
Local operation:	Menu driven software via keypads and LCD or PC
Remote operation:	Eltek PowerSuite via modem or Monitoring via Eltek WebPower (WEB Interface, SNMP protocol and email)
Alarm output:	6 relays
DC Output	
Voltage:	48 VDC
Power:	3.2 kW (66.7A at 48 VDC)
DC Distribution Options	
No. of Load breaker:	Up to 10 mini MCB type (2-30A)
No. of Battery fuse:	Up to 4 MCB type (60A)
Programmable LVD:	LVBD: 125 A Optional LVLD: 80A Connection options in blocks of 2 breakers (2-8, 4-6, 6-4 or 8-2)
Connections	
System extractable from frame for easy access	
Battery connection:	Screw terminals (up to 35 mm^2 lug)
Load:	MCB connections Terminal blocks (up to 4 mm^2)
Alarm connection:	Terminal blocks (up to 1.5 mm^2)
Other Specifications	
Isolation:	3.0 KVAC – input and output 1.5 KVAC – input earth 0.5 KVDC – output earth
Operating temp:	-40 to 75°C (-40 to 167°F)
Storage temp:	-40 to 80°C (-40 to 176°F)
Dimension:	19” mounting (446 mm + brackets) 2U height and 250 mm depth
Rec. cabinet depth:	300 mm min.
Weight (excl. rectifiers:	Approx. 4.38 Kg (9.66 lbs)
Applicable Standards	
Electrical safety:	IEC 60950-1 UL 60950-1
EMC:	ETSI EN 300 386 V.1.3.2 (telecommunication network) EN 61000-6-1 (immunity, light industry) EN 61000-6-2 (immunity, industry) EN 61000-6-3 (emission, light industry) EN 61000-6-4 (emission, industry)
Environment:	ETSI EN 300 019-2 ETSI EN 300 132-2

Table 36: Spec.: PSU Power Module Specifications	
AC Input	
Maximum Current:	Input: 4.9 A RMS maximum at nominal input and full load Earth leakage: 1.7 mA at 250 VAC/50 Hz
Power Factor:	0.98 at 30% load or more
THD:	3.1% (230 VAC) 2.1% (115 VAC)

Input Protection:	Transient protection Mains fuse in both lines Disconnect above 300 VAC
DC Output	
Nominal output:	53.5 VDC
Float/Boost range:	48 – 57.6 VDC
Standby test range:	43.5 – 48 VDC
Output Power:	800 W at nominal input / 350W at 85 VAC
Maximum Current:	16.7 Amps at 48 VDC and nominal input
Current Sharing:	±5% from true average current between modules
Static voltage regulation:	±1.0% from 5% to 100% load
Dynamic voltage regulation:	±5.0% for 25-100% load variation, regulation time < 10 ms
Hold up time:	> 20 ms; output voltage > 43.0 VDC at 80% load
Ripple and Noise:	< 100 mV peak to peak, 20 MHz bandwidth < 2 mV RMS psophometric
Output Protection:	Overvoltage shutdown Blocking diode Short circuit proof High temperature protection
DC Output	
Efficiency:	Typ. 91% at 60-100% load
Isolation:	3.0 KVAC – input and output 1.5 KVAC – input earth 0.5 KVDC – output earth
Alarms:	Low mains shutdown (<85 VAC) High temperature shutdown Rectifier Failure Overvoltage shutdown on output Low voltage alarm at 43.0V CAN bus failure
Warnings:	Rectifier in power derate mode Remote battery current limit activated Input voltage out of range, flashing at overvoltage Loss of CAN communication with control unit, stand alone mode
Visual indications:	Green LED: ON, no faults Red LED: rectifier failure Yellow LED : rectifier warning
Operating temp:	-40 to 75 C (-40 to 167°F) Derating above 55 C linear to 450W at +65 C
Storage temp:	-40 to 80 C (-40 to +176°F)
Cooling:	1 fan (front to back airflow)
Fan Speed:	Temperature and current regulated
MTBF:	> 300, 000 hours Telcordia SR-332 Issue I, method III (a) (T ambient : 25°C)
Acoustic Noise:	< 45 dBA at nominal input and full load
Humidity Operating:	5% to 95% RH non-condensing
Storage:	0% to 99% RH non-condensing
Dimensions:	42.5 x 88.9 x 250 mm (1.67 x 3.5 x 9.84”) (W x H x D) Weight 1.08 kg (2.38 lbs)
AC Input	
Voltage:	2 x AC feeds (85-300 VAC 1 ph)
Frequency:	45 to 66 Hz
Surge protection:	Internal fuses (L & N) Disconnect above 300 VAC
Monitoring	
Local operation:	Menu driven software via keypads and LCD or PC
Remote operation:	Eltek PowerSuite via modem or Monitoring via Eltek WebPower (WEB Interface, SNMP protocol and email)

Alarm output:	6 relays
Visual indication:	Green LED – System ON Yellow LED – Minor alarm(s) Red LED – Major alarm(s) LCD – system status messages
Connections	
Battery connection:	Screw terminals (up to 35 mm^2 lug)
Load:	MCB connections Terminal blocks (up to 4 mm^2)
Alarm connection:	Terminal blocks (up to 1.5 mm^2)

7.4 System Throughput

The base station uses TDD (Time Division Duplexing) for system uplink transmissions, employing a single frequency for both the base station and the subscriber. The PMP downlink is a broadcast medium shared and received by all subscribers in the sector. Transmission priorities are adjustable during provisioning of WiMAX subscribers.

For each channel bandwidth (3.5, 5, 7, and 10 MHz), there are six possible modulation and coding combinations. In the following tables, the Ethernet throughput is the rate that can be achieved after burst overhead and acquisitions times are removed.

Table 37: Spec.: RedMAX 4C Physical Layer Throughput to CPEs (Mbps)

	Throughput (Mbps) per Sector							
	3.5 MHz Channel		5 MHz Channel		7 MHz Channel		10 MHz Channel	
Modulation/ Code	**DL**	**UL**	**DL**	**UL**	**DL**	**UL**	**DL**	**UL**
BPSK 1/2	0.7	0.4	1.0	0.5	1.4	0.7	2.0	1.1
QPSK 1/2	1.4	0.7	2.0	1.0	2.9	1.5	4.0	2.1
QPSK 3/4	2.2	1.1	3.0	1.6	4.3	2.2	6.0	3.2
16 QAM 1/2	2.9	1.4	4.0	2.1	5.8	2.9	8.1	4.3
16 QAM 3/4	4.3	2.1	6.0	3.1	8.6	4.4	12.1	6.4
64 QAM 2/3	5.8	2.8	8.1	4.1	11.5	5.8	16.1	8.5
64 QAM 3/4	6.5	3.2	9.1	4.7	13.0	6.6	18.1	9.6
64 QAM 5/6	7.2	3.5	14.4	7.3	10.1	5.2	20.2	10.6

Note: PUSC, Excludes RTG & TTG; includes all layer 2 overhead,
Assumptions: 60:40 traffic split, 5 msec frame, cyclic prefix = 1/8.

7.5 Power Requirements

The DC wide mouth power supply supports from -18 VDC to -60 VDC. The optional AC power supply is auto-sensing in the 90 to 132 V and 180 to 264 V ranges.

Table 38: Spec.: RedMAX 4C Power Dissipation (Watts)								
	Sectors without Redundancy				Sectors with Redundancy & Diversity			
Modules	**1**	**3**	**4**	**6**	**1**	**3**	**4**	**6**
BBM	50	150	200	300	100	200	300	400
TCM	30	30	30	30	60	60	60	60
Cooling Module	50	50	50	50	100	100	100	100
RRH	150	450	600	900	150	450	600	900
Total	**280**	**680**	**880**	**1280**	**410**	**810**	**1060**	**1460**

7.6 Heat dissipation (Shelf)

Table 39: Spec.: Heat Dissipation for SC-1000 Shelf (IDU) in BTU/Hour								
	Sectors without Redundancy				Sectors with Redundancy & Diversity			
Modules	**1**	**3**	**4**	**6**	**1**	**3**	**4**	**6**
BBM	170	510	680	1020	340	680	1020	1360
TCM	100	100	100	100	200	200	200	200
Fan Tray (CU)	170	170	170	170	170	170	170	170
Total	**440**	**780**	**950**	**1290**	**710**	**1050**	**1390**	**1730**

7.7 Heat dissipation (Remote Radio Head)

Table 40: Spec.: Heat Dissipation for RRH (ODU) in BTU/Hour								
	Sectors without Redundancy				Sectors with Redundancy & Diversity			
Modules	**1**	**3**	**4**	**6**	**1**	**3**	**4**	**6**
RRH	400	1200	1600	2400	400	1200	1600	2400
Total	**400**	**1200**	**1600**	**2400**	**400**	**1200**	**1600**	**2400**

7.8 RF Sensitivity

The RF sensitivity is provided in the following tables.

Table 41: Spec.: RedMAX Receive Sensitivity (dBm)						
Modulation/Code	Receive Sensitivity					
	2.496-2.696 GHz Band		3.3-3.5 / 3.4-3.6 / 3.6-3.8 GHz Band			
	5 MHz Channel	10 MHz Channel	3.5 MHz Channel	5 MHz Channel	7 MHz Channel	10 MHz Channel
QPSK 1/2	-99.5	-96.5	-101.0	-99.5	-97.9	-96.5
QPSK 3/4	-96.1	-93.1	-97.6	-96.1	-94.5	-93.1
16 QAM 1/2	-93.8	-90.8	-95.3	-93.8	-92.2	-90.8
16 QAM 3/4	-89.7	-86.7	-91.2	-89.7	-88.1	-86.7
64 QAM 2/3	-85.5	-82.5	-87.0	-85.5	-83.9	-82.5
64 QAM 3/4	-84.4	-81.4	-85.9	-84.4	-82.8	-81.4
64 QAM 5/6	-82.5	-79.5	-84.0	-82.5	-80.9	-79.5

7.9 Single Omnidirectional Node Station

A single omnidirectional node base station can use one RF channel and one omnidirectional type antenna. The capacity of the base station is dependent on the channel size and is equivalent to one single channel.

Table 42: Spec.: Op - Total TDD Ethernet Throughput per Sector				
	Channel Bandwidth (Mbps)			
Modulation Mode	3.5 MHz	5 MHz	7 MHz	10 MHz
QPSK ½ CTC, 6x	0.3	0.4	0.6	0.8
QPSK ½ CTC, 4x	0.6	0.8	1.1	1.6
QPSK ½ CTC, 2x	1.1	1.6	2.2	3.1
QPSK ½ CTC, 1x	2.2	3.1	4.5	6.2
QPSK ¾, CTC	3.3	4.7	6.7	9.4
16 QAM ½ , CTC	4.1	6.2	8.2	12.5
16 QAM ¾ , CTC	6.7	9.3	13.4	18.7
64 QAM ½, CTC	6.7	9.3	13.4	18.7
64 QAM 2/3, CTC	8.9	12.4	17.9	25.0
64 QAM ¾, CTC	10.0	14.0	20.1	28.1

7.10 Spectral Efficiency

The RF spectral efficiency is provided in the following tables.

Table 43: Spec.: RedMAX 4C Spectral Efficiency (5 MHz / 10 MHz)				
	Rates (Mbps)		Bit Efficiency (Bits/Hz)	
Modulation	Over-Air	Eth Net	Over-Air	Eth Net
64 QAM 3/4	22.9 / 45.7	14.1 / 28.1	4.6 / 4.6	2.8 / 2.8
64 QAM 2/3	22.9 / 45.7	12.5 / 25.0	4.6 / 4.6	2.5 / 2.5
16 QAM 3/4	15.3 / 30.4	9.4 / 18.7	3.1 / 3.0	1.9 / 1.9

16 QAM 1/2	15.3 / 30.4	6.2 / 12.5	3.1 / 3.0	1.2 / 1.3
QPSK 3/4	7.6 / 15.3	4.7 / 9.4	1.5 / 1.5	0.9 / 0.9
QPSK 1/2	7.6 / 15.3	3.1 / 6.2	1.5 / 1.5	0.6 / 0.6
BPSK 1/2	3.9 / 7.6	1.6 / 3.1	0.8 / 0.8	0.3 / 0.3

7.11 GPS Synchronization

Important: To minimize inter-sector RF interference, synchronization must be used to coordinate RF transmissions of base stations.

The IEEE 802.16 standard calls for the use of GPS (Global Positioning System) receivers to provide the precise time reference for synchronization of WiMAX networks. Operating in TDD mode, the base station and the subscribers transmit at the same frequency, and require precise synchronization between downlink and uplink transmissions. Proper coordination of these activities is required to minimize interference and ensure the best overall system performance.

The base station uses the GPS 1 PPS signal to set the frequency of the TCM onboard clock. This TCM reference clock is used when broadcasting a radio frame synchronization signal to all BBM and RRH modules. If the 1 PPS signal becomes unavailable at any base station, that TCM enters 'holdover mode' to maintain the highest accuracy until the GPS signal can be restored.

GPS reference clock systems require that a receiver be placed at each base station and that the GPS antenna have line-of-sight satellite access. Ideally, a GPS antenna should be mounted on a rooftop with a full 360º view of the sky, but often an antenna mounted on the side of a building or a tower with a 180º view of the sky is adequate.

The base station provides the following synchronization schemes.

Model 1 (Standard) – External GPS Unit

The GPS component is an integrated GPS receiver/antenna module. Signal input is through an RS-232 cable connected to the Serial 1 port on the TCM front panel. Recommended for short cable runs (~20m).

Figure 16: Spec.: External GPS Clock

Table 44: Spec.: External GPS Unit Specifications	
Mechanical	
Dimensions	60 mm dia. x 34.2 mm H
Weight	50g
Connector	RS232: DB9F
Mounting	¾" Thru hole or Mast bracket
Shock	Vertical axis 50G, other axis 30G
Vibration	3 axis sweep = 15 minutes (10-200 Hz log sweep)
Environmental	
Operating Temp	-40 to +85 C
Storage Temp	-45 to +85 C
Humidity	95% max (non-condensing)
Electrical	
Voltage	+/-25 V
Current	<100 mA
Antenna Response	
Frequency	1575.42 MHz
Gain	@ 90 3 dBic @ 20 -2.0 dBic
Polarization	Right Hand Circular
Axial Ratio	@ 90 4 dB @ 20 6 dB
Out-of-band rejection	+/- 20 MHz: 10 dB +/- 30 MHz: 32 dB
GPS Performance	
Frequency	L1, 1575.42 MHz
Channels	12 channels parallel
Sensitivity	-146 dBm (min. tracked signal)
Position Accuracy	< 30 meters SPS
Time to First Fix	Autonomous start < 90 sec Cold start < 45 sec Warm start < 7 sec Re-acquisition < 1 sec
Serial Protocol: RS232	NMEA messages 4800 baud: GGA5, VTG, GSA, GSV on UTC second 57,600 baud: GGA5, GSA, GSV, RMC, on UTC second
1 PPS	
Resolution	+/- 31 nanoseconds
Accuracy	50 nanoseconds
Reporting	Proprietary NMEA message TG format

Model 2 – Embedded GPS Daughterboard)

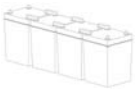
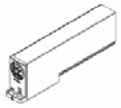
The GPS component is a daughter card on the TCM module. Signal input is through an RJ-59 RF cable from the GPS antenna to the Antenna input (SMA) on the TCM front panel. Recommended for short cable runs (up to 22m).

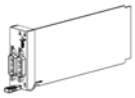
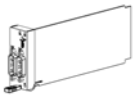
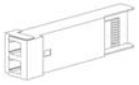
Figure 17: Spec.: Internal GPS Clock

Table 45: Spec.: Internal GPS Unit Specifications	
Physical	
Dimensions	66.3 mm L x 32.1 mm W x 8.5 mm H (2.6” L x 1.3” W x 0.33” H)
Weight	Approx 12.5 grams (0.4 ounce)
Environmental	
Operating Temp	–40 C to +85 C
Storage Temp	–55 C to +105 C
Vibration	0.008 g2/Hz 5 Hz to 20 Hz 0.05 g2/Hz 20 Hz to 100 Hz –3 dB/octave 100 Hz to 900 Hz
Humidity	5% to 95% R.H. non-condensing, at +60° C
Altitude	–400 to 18,000 m max
Electrical	
Prime Power	+3.3 VDC ±0.3 VDC
Power Consumption	GPS board only: 350 mW @ 3.3 V
Ripple Noise	Max 50 mV, peak to peak from 1 Hz to 1 MHz
Antenna Fault Protection	Short-circuit/open detection and protection
Interface	
Connectors	I/O: 8-pin (2x4) 2 mm Male Header
	RF: Right-angle SMB (SMA optional)
Serial Port	1 serial port (transmit/receive)
PPS	3.3 V CMOS-compatible TTL-level pulse, once per second Rising edge of the pulse synchronized with GPS/UTC

Table 45: Spec.: Internal GPS Unit Specifications	
Protocols	TSIP @ 9600 baud, 8 bits NMEA 0183 v3.0 @ 4800 baud, 8 bits
Accessories	
Rooftop Antenna	Bullet III, TNC (F) 3.3 VDC with 30 dBi gain. or Bullet III, F 5 VDC with 35 dBi gain
Transition cable	SMB to F
Rooftop Antenna Kits	3 or 5 VDC
Performance	
General	L1 (1575.42 MHz) Frequency, C/A Code, 12-channel, parallel-tracking receiver, DSP-based
Update Rate	TSIP @ 1 Hz; NMEA @ 1 HZ
Accuracy	Horizontal Position: <6 meters (50%), <9 meters (90%)
	Altitude Position: <11 meters (50%), <18 meters (90%)
	Velocity: 0.06 m/sec
	PPS: within 15 ns to GPS/UTC (1 Sigma) <5 ns with quantization error removed
Acquisition	Reacquisition: <2 sec. (90%)
	Hot Start: <14 sec (50%), <18 sec (90%)
	Warm Start: <41 sec (50%), <45 sec (90%)
	Cold Start: <46 sec (50%), <50 sec (90%)
Sensitivity	Acquisition –136 dBm
	Tracking –141 dBm
Operational (COCOM) Limits	Altitude 18,000 m
	Velocity 515 m/s

7.12 Base Station Part Numbers

Order Code	Image	Description
R4C-BBM-00001		MIMO capable base band modem with single optical SFP for RRH connection.
R4C-CFB-PL100		Amphenol fiber cable assembly for BBM to RRH connection. Multimode outdoor fiber optic cable. Amphenol PT connector on RRH side and LC connector on BBM side. Length 100 ft
R4C-CFB-PL300		Amphenol fiber cable assembly for BBM to RRH connection. Multimode outdoor fiber optic cable. Amphenol PT connector on RRH side and LC connector on BBM side. Length 300 ft
R4C-CPW-L0100		16 AWG/2 Conductors, Copper Stranded, Shielded DC power cable with Amphenol-lite connector on RRH side. Another side not connectorized. Length 100 ft
R4C-CPW-L0300		16 AWG/2 Conductors, Copper Stranded, Shielded DC power cable with Amphenol-lite connector on RRH side. Another side not connectorized. Length 300 ft
R4C-CRF-11021		Amphenol RF Jumper assembly. LMR-400 coaxial cable with two N-male connectors. Length 6.5 ft
R4C-GPS-TR00S		Trimble Resolution T daughter card for TCM.
R4C-GPS-TRB00		Trimble Bullet III GPS antenna, 35 dB gain with TNC-female connector
R4C-GPS-TRC15		15m of RG59 TNC-male to SMB-male for Trimble Resolution T timing module.
R4C-PWM-EB000		Eltek battery backup kit
R4C-PWM-ER800		Eltek 800W power rectifier module
R4C-PWM-ESH01		Eltek power shelf with controller unit and single 800W power rectifier module
R4C-SLF-AI00S		uTCA shelf Air Impedance Plate Prevents horizontal heat transfer between modules
R4C-SLF-AL000		Alarm module for uTCA shelf

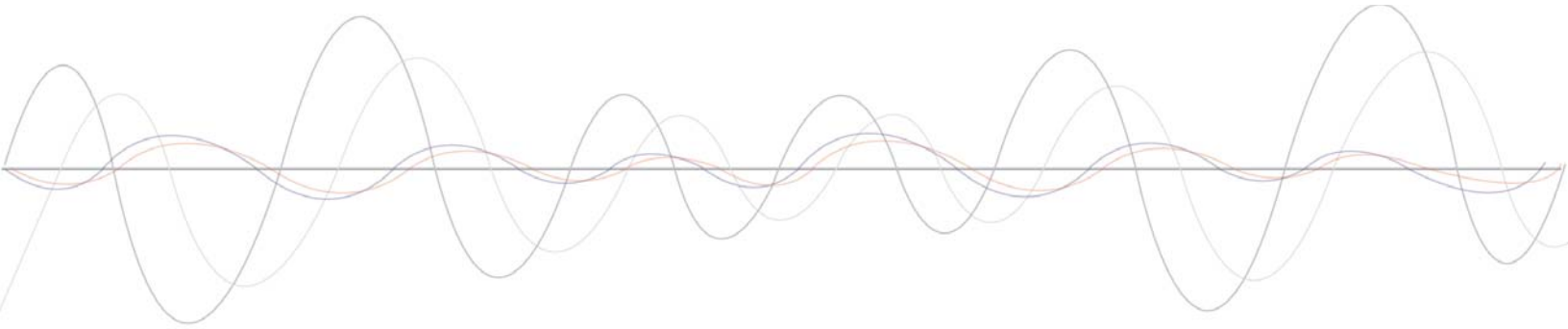
R4C-SLF-FL00S		uTCA shelf Fill Plate
R4C-SLF-FN00S		uTCA shelf Fan Tray
R4C-SLF-FT00S		uTCA shelf Filter Tray
R4C-SLF-PW380		-48 VDC, 380W power module for uTCA shelf with 3 ft DC cable
R4C-SLF-PW720		-48 VDC, 720W power module for uTCA shelf with 3 ft DC cable
R4C-SLF-uTCA0		PICMG-Compliant uTCA shelf with cooling unit includes: (Shelf, Fan Tray, Filter Tray, Back Plate, Nine Fill Plates, Air Impedance Plate). Power & alarm modules are not included.
R4C-TCM-01SFP		CAT5 10/100/1000 Mbps Ethernet, replaceable SFP equipped with RJ-45 connector
R4C-TCM-10SFP		Optical 1000 Mbps Ethernet, replaceable SFP equipped with LC optical connector
R4C-TCM-G0001		Transport, control and clock card equipped with integrated Trimble Resolution T timing module
REM-D00-3500M		Gemtek 3500 MHz MIMO capable outdoor CPE for 3.4 – 3.6 GHz frequency band. Only data capable.
RPM-D00-2500M		Gemtek 2500M MIMO capable indoor CPE for 2.5 – 2.7 GHz frequency band. Only data capable.
RPM-DP0-2500M		Gemtek 2500M MIMO capable indoor CPE for 2.5 – 2.7 GHz frequency band. Data and phone capable. Equipped with two analog phone line connections.

8 Abbreviations

8P8C	8 Position 8 Contact
AAA	Authentication, Authorization and Accounting
AC	Alternating Current
AES	Advanced Encryption Standard
AMC	Advanced Mezzanine Card
ARQ	Automatic Repeat Request
ASN	Access Service Network
ASP	Application Service Provider
AWG	Application Working Group
Base-T	Baseband Twisted Pair
BBM	Baseband Modem
BE	Best Effort
BFW	Broadband Fixed Wireless
BPSK	Binary Phase Shift Keying
BRAS	Broadband Remote Access Server
BS	Base Station
BTU	British Thermal Unit
C/A Code (GPS)	Coarse Acquisition
CAN	Controller Area Network
CAT / UTP	Category / Unshielded Twisted Pair
CCM	Control and Clock Module
CEC	Canadian Electrical Code
CFR	Code of Federal Regulations
CINR	Carrier to Interference-plus-Noise Ratio
CLI	Command-line Interface
CM	Cooling Module
CMAC	Cipher-based Message Authentication Code
COCOM	Complete Communication (Round Rock, TX)
CPE	Customer Premises Equipment
CPRI	Common Public Radio Interface
CS	Communications Slot
CSN	Connectivity Service Network
CTC	Convolutional Turbo Codes
dB	Decibel
DB connector	Database Bus connector
DB-15P	D-subminiature size B – 15 Pins
dBm	Decibels per milliwatt
DC	Direct Current
DHCP	Dynamic Host configuration Protocol
Dia	Diameter
DL	Down Link
DSCP	Differentiated Services Code Point
DSP (GPS)	Domain Specific Part
D-sub	D-subminiature
EAP	Extensible Authentication Protocol
EB	Excess Burst
EMC	Electro Magnetic Compatibility
EMMC	Enhanced Module Management Controller
EMS	Element Management System
EN	Engineering Notice
ERT-VR	Extended Real Time Variable Rate
ERT-VR	Extended Real Time – Variable Rate Service
ESD	Electrostatic Discharge
ETSI	European Telecommunications Standard Institute
FCC	Federal Communications Commission
FDD	Frequency Division Duplex
FFT	Fast Fourier Transform
FTR	Federal Telecommunications Recommendation
FUSC	Fully Used Sub-Channel / Sub-Carrier
FWA	Fixed-Wireless Access
G	Gravitational acceleration
GbE	Gigabit Ethernet
GBIC	Gigabit Interface Converter
GGA	
GPS	Global Positioning System
GSA	Global mobile Suppliers Association
GW	Gateway
HA	Home Agent
HO	Hand Over
HS	Hot Swap
HSMA	Hardware System Management Activity
HTTP	Hypertext Transfer Protocol

I/O	Input/ Output
IC	Integrated Circuit
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IPMI	Intelligent Platform Management Interface
IQ TX	Input Queuing Transmission
ISP	Internet Service Provider
KVAC	Kilovolts Alternating Current
KVDC	Kilovolts Direct Current
L & N (fuse)	Live & Neutral
LC	Link Control
LCD	Liquid Crystal Display
LCP	Link Control Protocol
LED	Light-Emitting Diode
LMR	Land Mobile Radio
LVBD	Low Voltage Battery Disconnect
LVD	Low Voltage Disconnect
MAC	Media Access Control
MAN	Metropolitan Area Network
MCB	Main Circuit Breaker
MIBs	Management Information Bases
MIMO	Multiple Input Multiple Output
MMF	Multimode Fiber
MOS	Metal Oxide Semiconductor
MRC	Maximal Rate Combining
MS	Mobile Subscriber
MSA	Metropolitan Statistical Area
MTBF	Mean Time Between Failure
MTG	Mobility Task Group
NBI	Northbound Interface
NEC	National Electric Code
NMEA	National Marine Electronics Association
NMS	Network Management System
NRT-VR	Non-Real Time – Variable Rate Service
NRT-VR	Non-Real-Time Variable Rate
NSP	Network Service Provider
NWG	Network Working Group
OAM&P	Operation, Administration, Maintenance and Provisioning
OBSAI	Open Base Station Architecture Initiative
OBSAI RP3	Open Base Station Architecture Initiative Reference Point 3 Specification
OD	Outside Diameter
OFDMA	Orthogonal Frequency Division Multiple Access
OFNR	Optical Fiber Non-conductive Riser
OOS	Out-of-Service Signaling
OP	Operation/Operational
OSS	Operations Support System
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PHY	Physical Layer
PICMG	PCI Industrial Computer Manufacturers Group
PKM	Privacy Key Management
PLL	Phase-Locked Loop
PMP	Point to Multipoint
PMP	Paging Message Processor
PPM	Parts per Million
PPS	Packet Per Second
PSU	Power Supply Unit
PT	Payload Type
PUSC	Partially Used Sub-Carrier
PWM	Power Module
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RDY	Ready
RF	Radio Frequency
RF IC	Radio Frequency Integrated Circuits
RFHE	Radio Frequency Head-End
RFT	Radio Frequency Transmitters
RH	Relative Humidity
RJ-45	Registered Jack-45
RMC	Remote Management Console
RMS	Resource Management System
RMS	Redline Management Suite
RRH	RRH - Remote Radio Headend
RS-232	Recommended Standard 232
RSS	Really Simple Syndication
RSSI	Relative Signal Strength Indicator
RTG	Receive/transmit Transition Gap
RT-VR	Real Time –Variable Rate

SC1000	Sector Controller 1000
SELV	Separated or safety extra-low voltage
SerDes	Serializer / Deserializer
SFP	Small Formfactor Pluggable
SGMII	Serial Gigabit Media Independent Interface
SIP	Session Initiation Protocol
SISO	Single Input Single Output
SLA	Service Level Agreement
SMA	SubMiniature version A
SMA connector	SubMiniature version A connector
SMB	SubMiniature version B
SNMP	Simple Network Management Protocol
SNMP MIBs	Simple Network Management Protocol Management Information Bases
SOAP	Simple Object Access Protocol
SPS	Single Pull Station
SPST	Single-Pole, Single-Throw
SRX	Sampling Receiver
SSH	Secure Shell Protocol
STC	Space–Time Coding
TBD	To Be Defined/ Developed
TCA	Threshold Crossing Alerts
TCM	MicroTCA Carrier Hub ?
TCM	Transport, Clock & Control Module
TCP	Transmission Control Protocol
TDD	Time Division Duplexing
TDM	Time Division Multiplexing
Telco	Telephone Company
THD	
TMF	Transport Multiplexing Function
TNC (antenna)	Threaded Neill-Concelman
TOS	Type of Service
TS	Telecommunications Standard
TSIP	Trimble Standard Interface Protocol
TTG	Transmit/receive Transition Gap
TTL	Time To Live
TX	Transmission
UDP	User Datagram Protocol
UGS	Unsolicited Grant Service
UL	Up Link
UM (Fiber Optic)	Micrometer (Micron)
USB	Universal Serial Bus
UTC	Universal Time Coordinator (Coordinated Universal Time)
VAC	Voltage Alternating Current
VCSEL	Vertical Cavity Surface-Emitting Laser
VDC	Voltage Direct Current
VLAN	Virtual Local Area Network
VoD	Video on Demand
VOIP	Voice over IP
VTG (serial)	Virtual Technology Gateway
WEEE Directive	The Waste Electrical and Electronic Equipment Directive
WiMAX	Worldwide Interoperability for Microwave Access
XML	Extensible Markup Language



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