411-1333-200

Reunion

BTR 2400

Outdoor Microwave Transceiver Installation Guide

Release 1.1 July 1998

NORTEL

NORTHERN TELECOM

Reunion

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Publication history

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- Initial preliminary release of the document

About this guide

Purpose

This guide provides the information required to install and operate the BTR 2400 outdoor microwave transceiver.

The BTR 2400 is a key microwave component in the Nortel Reunion™ base station providing transmission facility for two-way digital wireless voice, data and video communications.

The BTR 2400 is one of the RF (Radio Frequency) products that constitute a Nortel Reunion™ product line. The associated products include the following types of cell site equipment:

- broadband transmitters
- broadband receivers
- broadband repeaters
- broadband transceivers

Audience

The audience for this document are those who install and operate the BTR 2400. To take full advantage of this guide, you should have a basic understanding of microwave fundamentals and know how to use microwave test equipment.

Organization

1. This Guide is divided into seven sections:

- *Product Overview* describes the BTR's components and theory of operation.
- *Pre-Installation* describes the basics of handling the equipment upon arrival.
- *Reunion Safety Standards* provide a quick review of general safety guidelines.
- *Installing the BTR 2400* explains how to physically install the transceiver.
- *BTR 2400 Maintenance* describes basic maintenance procedures to ensure that the transceiver is operating correctly.
- *BTR 2400 Diagnostic Reference Chart* provides a quick troubleshooting guide.
- *List of terms* provides a quick reference to terms and acronyms found in the guide.

Customer Support

In addition, Nortel Broadband Wireless Access (BWA) provides 24-hour customer service and technical support to ensure your service operation is trouble-free. If you have questions or need technical support, contact Nortel Broadband Wireless Access at the following telephone numbers:

- In the USA and Canada, call toll free 1 (800) 822-6355
- Outside of North America, call (204) 631-2250
- Fax (204) 631-2475

Write Nortel at:

- Nortel

  Broadband Wireless Access

  37 Stevenson Road

  Winnipeg, Manitoba R3H 0H9

  Canada

Documents to fit Your Needs

The *BTR 2400 Installation Guide* is designed to provide complete procedural and technical information needed to install, manage and operate this equipment.

Nortel Broadband Wireless Access Customer Documentation and Training's goal is to furnish concise, efficient and effective documentation that provides the customers and/or customer service personnel with the precise information required to operate and manage the specific Nortel Broadband Wireless Access equipment acquired.

To help serve you better, please identify any information that you:

- cannot find
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- think is important to include in the document

Contact us at:

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Documentation Suite

Reunion Release 1.1 has a suite of eight documents:

Reunion System Overview, 411-1343-010

Reunion System Administration Guide, 411-1343-011

Reunion Network Node Equipment Installation Guide, 411-1313-200

Reunion NIU 6050 Network Interface Unit Installation Guide, 411-1323-200

Reunion BTR 2400 Outdoor Microwave Transceiver Installation Guide, 411-1333-200

Reunion CTR 2400 Outdoor Microwave Transceiver Installation Guide, 411-1333-201

Reunion Redundancy Switching Matrix Installation Guide, 411-1313-201

Reunion DSS 1000 (Digital System Supervisor) User Guide, 411-1343-500

Contents

BTR 2400 Release 1.1

Product Overview

The BTR 2400 outdoor transceiver is a state-of-the-art broadband microwave transceiver designed to operate in the 24.25 to 24.45 GHz frequency band downstream and the 25.05 to 25.25 GHz frequency band upstream. It is a combined broadband transmitter and receiver deployed in Reunion's point-to-multipoint system.

The BTR 2400 transceiver is mounted on a pole or a building. It features a small size and low noise characteristics. The combination of digital modulation and low-loss mounting results in an efficient and low-cost installation. It has a high-stability reference oscillator.

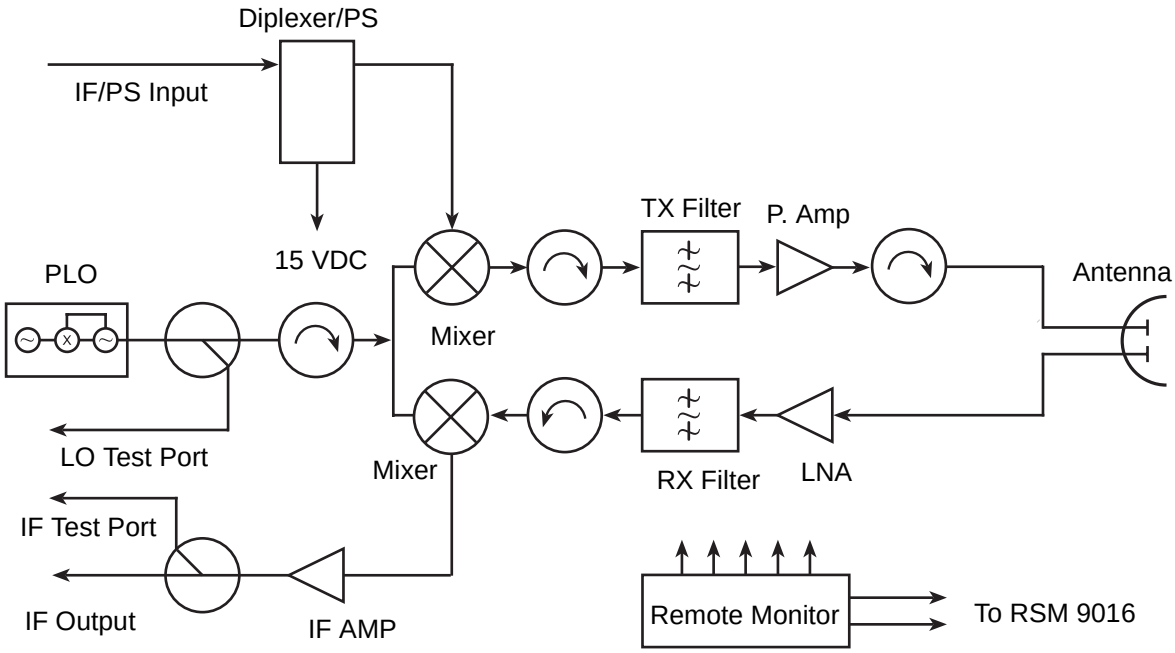
The BTR 2400 features the following attributes:

- light-weight and compact packaging designed for mounting outdoors
- solid-state upconverter and downconverter designs
- high frequency stability over a wide temperature range
- standard 60 VAC trapezoidal or 48 VDC input for use around the world

The transceiver comprises the following components:

- diplexer
- power supply
- mixers
- local oscillator
- isolators
- bandpass filters
- low noise amplifier (LNA)
- power amplifier
- antenna
- remote monitor unit
- IF amplifier

Figure 1-1
BTR 2400 Block Diagram



How the BTR 2400 Works

This section provides an overview of the theory of operation for the BTR 2400 outdoor transceiver.

Its installation on a pole or building enhances transmitting and receiving capabilities by avoiding the need for long expensive waveguide runs. This technique minimizes the power loss from waveguide attenuation, which results in a highly efficient, compact and cost-effective installation.

The high-stability reference oscillator ensures that the transmitter and receiver remain on frequency over a wide operating range, which results in a highly efficient, compact and cost-effective installation.

The radio uses a common input cable to carry the 60 VAC or 48 VDC and transmit intermediate frequencies (IFs). The power supply and the IF signals are separated by the diplexer in the radio. The radio uses a common dual pole antenna for both the transmit and receive microwave signals.

1. The BTR transceiver's input coaxial cable carries the IF signals and the power supply to the diplexer. The diplexer distributes the power to the power supply unit and interfaces with the mixer for the IF signals.
2. The 450-650 MHz transmit IF signals enter the mixer which upconverts the signals to the 24.25-24.45 GHz band for the transmit path. The received RF band is downconverted to a receive signal in the 150-350 MHz range.
3. The local oscillator (LO) provides local oscillator signal to the mixer. The LO uses a phase-locked dielectric resonance oscillator (DRO) with a temperature compensated crystal oscillator (TCXO).
4. The bandpass filters remove the undesired sideband signals, in both the transmit and receive paths.
5. The upconverted signal is fed into the power amplifier which provides the required gain to the microwave signals. The power amplifier output is connected to the antenna through the antenna mounting flange.
6. The received RF simultaneously passes through the antenna mounting flange, where the pass band is filtered and amplified by the Low Noise Amplifier (LNA). The signal is fed into the mixer path.
7. The downconverted signal is fed into the IF amplifier which provides the required gain to the IF signals. The IF amplifier's output is connected to the IF (RX) output port.
8. The remote monitor unit is monitoring the BTR 2400 working status, (temperature, RF output power, power supply voltage and local oscillator status).

There are five connectors on the outside of the transceiver case:

- The IF (TX) power supply input uses a Type N female jack
- The IF (RX) output uses a Type N female jack
- Telemetry connector uses a 6 pin military style connector
- Test Port (2) use female SMA jack

BTR 2400 Specification

Table 1: BTR 2400 Technical Specifications

TX	IF Input	RF Output
Frequency Range	450-650 MHz	24.25-24.45 GHz
P-Amp Output Level (P1)		>+30 dBm
P-Amp Output Level (IP3)		> +38 dBm
Input Impedance	50 Ohms	
Input/Output Connector	N Type Female	Antenna Mounting Flange
Input/Output VSWR	1.5:1, maximum	1:5:1, maximum
Gain (not including antenna)		28 dB, minimum
Gain vs. Temperature (-40 to +50° C)		±3.0 dB
Gain Flatness		±1.5 dB over 200 MHz BW
Out-band Spurious Emission		<-30 dBm
Frequency Stability (-40 to +50° C)		<±2 ppm

RX	RF Input	IF Output
Frequency Range	25.05-25.25 GHz	150 - 350 MHz
Nominal Input Level	- 50 dBm	
Input/Output Connector	Antenna Mounting Flange	N Type Female
Input/Output VSWR	1.5:1, maximum	1.5:1, maximum
Gain (not including antenna)		25 dB, minimum
Gain Flatness		±1.5 dB
Frequency Stability (-40 to +50° C)		<±2 ppm
Noise Figure		< 6 dB
RX Test Port		- 15 dBc

Antenna	**BTR**
Frequency	24.25-25.25 GHz
Gain	10-30 dBi
Input/output microwave connector for the antenna	WR-42
Mounting Flange Orientation	45°
Mounted on transceiver housing	WR-28 flange
Size (Height x Weight x Depth)	6" x 3" x 12"
TX / RX wave polarity	linear, orthogonal
Sectorized Angle Available	15°, 30°, 45°, 60° and 90°

Power Supply	**BTR**
Input Voltage	60 VAC or ±48-72 VDC
Input Frequency	40 - 80 Hz
Input Power	100 Watts, maximum

Environmental	**BTR**
Humidity	100% condensing
Operating Temperature	-40° to +50°C
Storage Temperature Range	-45° to +85°C

Mechanical	**BTR**
Size (Height x Width x Depth)	19.2" x 10.3" x 6.7"
Weight without brackets	35 lbs. (16KG)

Note: Use the following formula to calculate the converted frequency:

TX: $f_{\text{RF OUT}}$ (GHz) = 24.9 - $f_{\text{IF IN}}$ (GHz)

RX: $f_{\text{IF OUT}}$ (GHz) = $f_{\text{RF IN}}$ (GHz) - 24.9

BTR 2400 Component Descriptions

Diplexer / Power Supply

The diplexer separates the IF input signals and the DC power supply. The isolation between the IF path and the power supply path is more than 45 dB. There is also a transient voltage protector on the board to protect the transceiver from possible lightning damage.

The 60 VAC/48 VDC power from the diplexer is first regulated to 15 VDC, and then sent to all the modules.

Mixer

The BTR 2400 uses a third harmonic mixer. The mixer uses a 8.3 GHz local oscillator (LO) signal to convert the IF input signals to the 24.25-25.45 GHz microwave frequency band. The same LO is used to downconvert the incoming microwave signals to the receive IF frequency band.

Dielectric Resonance Oscillator (DRO)

The Dielectric Resonance Oscillator is equipped with a TCXO reference oscillator. When the DRO is phase-locked, it provides a 8.3 GHz microwave frequency with the same frequency stability as the reference crystal.

When the DRO is phase-locked, the phase-locked voltage at the test port on the DRO can vary from 3 VDC to 12 VDC depending on the chassis temperature and the input reference frequency. The voltage at the alarm test port is approximately 5 VDC.

When the DRO is unlocked, the phase-locked voltage becomes an oscillating ramp wave. The voltage at the alarm test port goes down to 0 VDC.

Isolator

Four isolators provide adequate return loss in the BTR 2400. Each isolator's maximum forward insertion loss is 0.5 dB, and its return loss is greater than 20 dB.

Bandpass Filter

The bandpass filter removes the undesired sideband elements and LO leakage, and passes the required sideband signals.

Low Noise Amplifier

The low noise amplifier (LNA) provides gain in the receive path and amplifies the received microwave signals to the mixer. The gain and noise figure of the LNA are chosen to maximize the overall dynamic range and noise performance of the BTR 2400 receiver section.

IF Amplifier

The IF amplifier provides gain in the downconverted received signals to the required level. It uses a standard CATV amplifier with 50 Ohms input and output impedance.

Power Amplifier

The power amplifier provides gain in the transmit path. It boosts the signals in the 24.25-24.45 GHz frequency range to the required level. The amplifier is a solid state amplifier that has high linearity within a high output power range.

Remote Monitor

The remote monitor unit provides an interface for remotely monitoring the BTR 2400. The unit communicates with the RSM 9016 by way of a shielded twisted pair wire cable. An operator can remotely measure and monitor RF output power (0 to 30 dBm), DRO phase voltage (0 to 15 volts), DRO phase lock alarm (0, 1), internal temperature (-40 to +80°C) and power supply voltage (15 volts). Refer the *Reunion Redundancy Switching Matrix Installation Guide*, 411-1313-201, and the *Reunion DSS 1000 (Digital System Supervisor) User Manual*, 411-1343-500.

Antenna

The BTR 2400 uses a dual pole antenna for transmitting and receiving RF signals. Physically, the antenna consists of two horns. One horn is connected to the transmit side and the other one is connected to the receiver RF input. The transmit wave and receive wave polarities are always orthogonal, allowing the maximum isolation between the TX wave and the RX wave. The TX wave polarity is defined as BTR 2400 polarity.

Pre-Installation

Prevention of Access

Allow only authorized personnel to access the equipment. Install the equipment in a restricted-access location or similar environment. Failure to prevent unauthorized user access invalidates the equipment warranty.

Unpacking Shipment

Use the following steps to unpack and inspect the shipment of Nortel Broadband Wireless Access equipment:

1. Copy adequate inventory forms
2. Check each package against the order form and packing slip to ensure that all components are received
3. Check each package for signs of damage
4. Open the package and closely inspect all components for obvious signs of damage
5. Know exactly where you are going to place the equipment, before removing them from the package
6. Carefully remove the equipment from the packaging
7. Save packing material for future use
8. Be aware of electrostatic discharge devices (ESD) requirements when handling BWA equipment

Note: For more information, refer to the Electronic Industries Association (EIA) standard, *Requirements for Handling Electrostatic-Discharge-Sensitive Devices (ESDS)*, EIA-625, as well as local and national standards.

Reunion Safety Standards

Safety and safety considerations are important while using Nortel Broadband Wireless Access equipment. The following information is provided to assist you in establishing appropriate safety practices.

Safety Disclaimer

The safety standards discussed in this guide cannot address all safety problems associated with their use or all applicable regulatory requirements. You are responsible for establishing appropriate safety and health practices and to determine the applicability of regulatory limitations before their use.

General Safety

Ensure that installation personnel are trained on CPR (Cardio Pulmonary Resuscitation), as well as on local, regional and national safety standards.

When working on Nortel Broadband Wireless Access equipment, follow these guidelines:

- Keep your work site clean and free of clutter.
- Wear close fitting clothing.
- Remove jewelry such as rings, bracelets, or watches.
- Where it is possible to dislodge small pieces, wear eye protection.
- Place equipment or cabinets on level surfaces.
- Wear a safety belt when climbing a tower and installing equipment on a tower.
- Work in pairs so that you have someone to help in case of an emergency.

Electrical Safety

Locate the main power shut-off switch controlling the equipment you are working on. This is important in the event of an accident, so you can quickly cut the power.

Disconnect all power when working on power supplies.

In an emergency (electrocution):

- shut the power off.
- have someone call for emergency medical assistance
- start CPR

Warning

Do not move in front of the antenna, nor look directly into the face of the antenna when the BTR 2400 is running.

Installing the BTR 2400

Installation is performed in three separate operations:

- adjusting antenna polarity
- installing the tower equipment
- installing the indoor equipment

Adjusting Antenna Polarity

The polarity of the transmit and receive signals at the antenna are separated by 90°. Polarity reversal is accomplished by separating the antenna from the radio and rotating 180°, as shown in Figures 1-8 and 1-9. Horizontal and vertical polarity are marked on the antenna.

Adjust the BTR antenna's polarity as follows:

Ensure that you adjust polarity at the base station prior to mounting the BTR 2400 to the pole.

Remember that you need to adjust the polarity and alignment of the associated CTR 2400s if you adjust the BTR 2400's polarity and alignment.

1. Remove the eight (8) socket head cap screws (# 8-32 UNC) on the antenna flange. There are four on top and four on the bottom of the antenna flange. Remove the lock and flat washers. See Figures 1-3, 1-4, 1-15 and 1-16.
2. Gently remove the antenna and turn it 180°.
3. Align the antenna with the two dowel pins that act as an index.
4. Place the flat washer against the antenna flange, followed by the lock washer and then the screw.
5. Use an Allen wrench # 8 to hard tighten the socket head cap screw to a maximum of 28 inch-pounds torque.
6. Complete steps 4 and 5 for all eight socket head cap screws.
7. Ensure that the screw is inserted at the top of the antenna to prevent water entering the antenna. However, loosen it halfway. The bottom screw is removed to allow condensation to drain from the antenna. See Figure 1-3.

Installing the Tower Equipment

Install the BTR 2400 microwave transceiver as follows:

The radio mounting saddle has no paint on the inside surface in order to provide a grounding.

1. Ensure that the radio mounting surface on the pole is free of paint to provide a grounding.
2. Mount the BTR 2400 to a stable pole using the supplied mounting brackets. The mounting brackets accommodate poles with outside diameters from 2.5" to 4.5". See Figures 1-4, 1-5 and 1-12.
3. There are four 1/2" 13 UNC threaded rods, along with four hex head nuts and flat and lock washers. Thread the rod into the saddle bracket, then tighten with the nut. The flat washer is against the exterior of the bracket, followed by the lock washer and then the nut.
4. Ensure connectors are facing down.
5. Install the BTR 2400 so that the fin array (heat sink) is positioned away from external barriers to allow heat dissipation through natural convection and radiation. See Figures 1-4 and 1-14.

   The BTR 2400 requires 60 VAC or 48 VDC power supply unit.
6. Connect the TX/power coaxial cable from the RPE 9000's TX female N-Type connector to the BTR's N-type IF and PS IN port.
7. Connect the RF coaxial cable from the RPE 9000's RX female N-Type connector to the BTR's N-type IF OUT port.
8. Connect the telemetry cable from the BTR 2400 to the RPE 9000's telemetry connector. There is a 300 baud modem connection between the BTR 2400, the RPE 9000 and the RSM 9016. See Figures 1-4 and 1-13.
9. Seal all connections using Coax-Seal®, cold shrink or hot shrink tubing.
10. Ground all RF cables at the recommended spacing intervals. (Refer to tower and cable manufacturers' specifications).
11. Ensure that all feed lines are securely attached to the support structure. Plan for drip (service) loops on all cables.
12. The BTR 2400 has a vertical range of motion of +10° over and -20° under the horizon, as shown in Figures 1-6 and 1-7.
13. Refer to *Outline and Installation Drawing # PO 883482* and the *Reunion Redundancy Switching Matrix Installation Guide,* 411-1313-201.

Warning

Do not turn on the power supply until the installation is complete.
After you install the equipment, check the cable.

Installing Indoor Equipment

Both the primary and the redundant BTR 2400s are connected to and switched by the RPE 9000. The RPE 9000 is connected to both the RSM 9016 and the RSM 9116. The RSM 9016 is connected to the SMMs, while the RSM 9116 is connected to the SDMs. The RSM 9016, RSM 9116, SMMs (Signal Modulator Module) and SDMs (Signal Demodulator Module) are installed in the NNE (Network Node Equipment unit). The SMMs modulate ATM cells for wireless transport, while the SDMs interface RF to digital at the base station and demodulates the QAM signal.

Install the indoor equipment associated with the BTR 2400 microwave transceiver as follows:

1. Connect the telemetry cable from the RPE 9000's telemetry connector to the RSM 9016.
2. Connect the TX/PS coaxial cable from the RPE 9000 to the RSM 9016.
3. Connect the RX coaxial cable from the RPE 9000 to the RSM 9116.
4. Refer to the *Reunion Redundancy Switching Matrix Installation Guide*, 411-1313-201.
5. Refer to site specific documentation for detailed information, such as the supplied engineer's documentation.

Figure 1-2
Block Diagram showing BTR 2400 indoor set-up

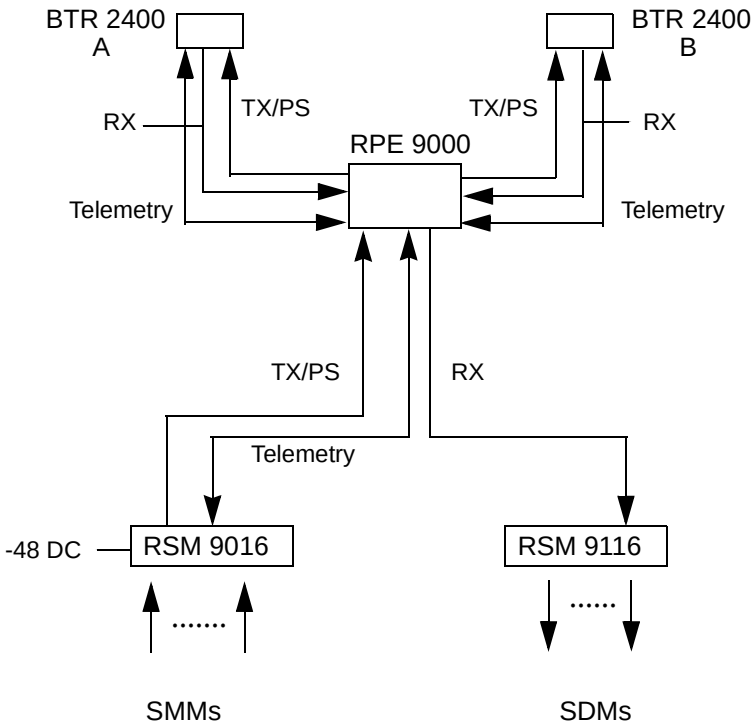


Figure 1-3
BTR 2400 Side View

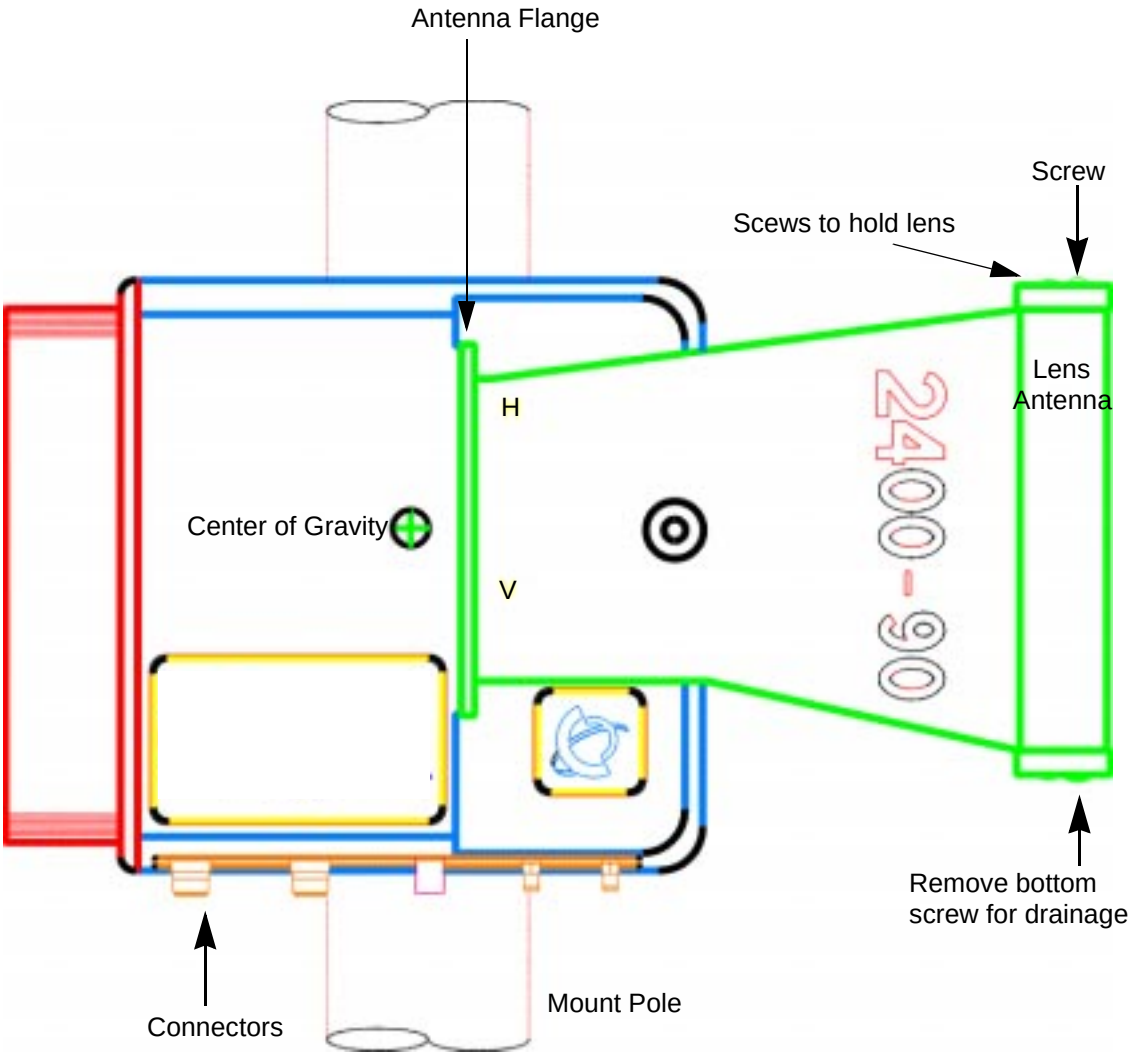


Figure 1-4
The BTR 2400 Bottom View

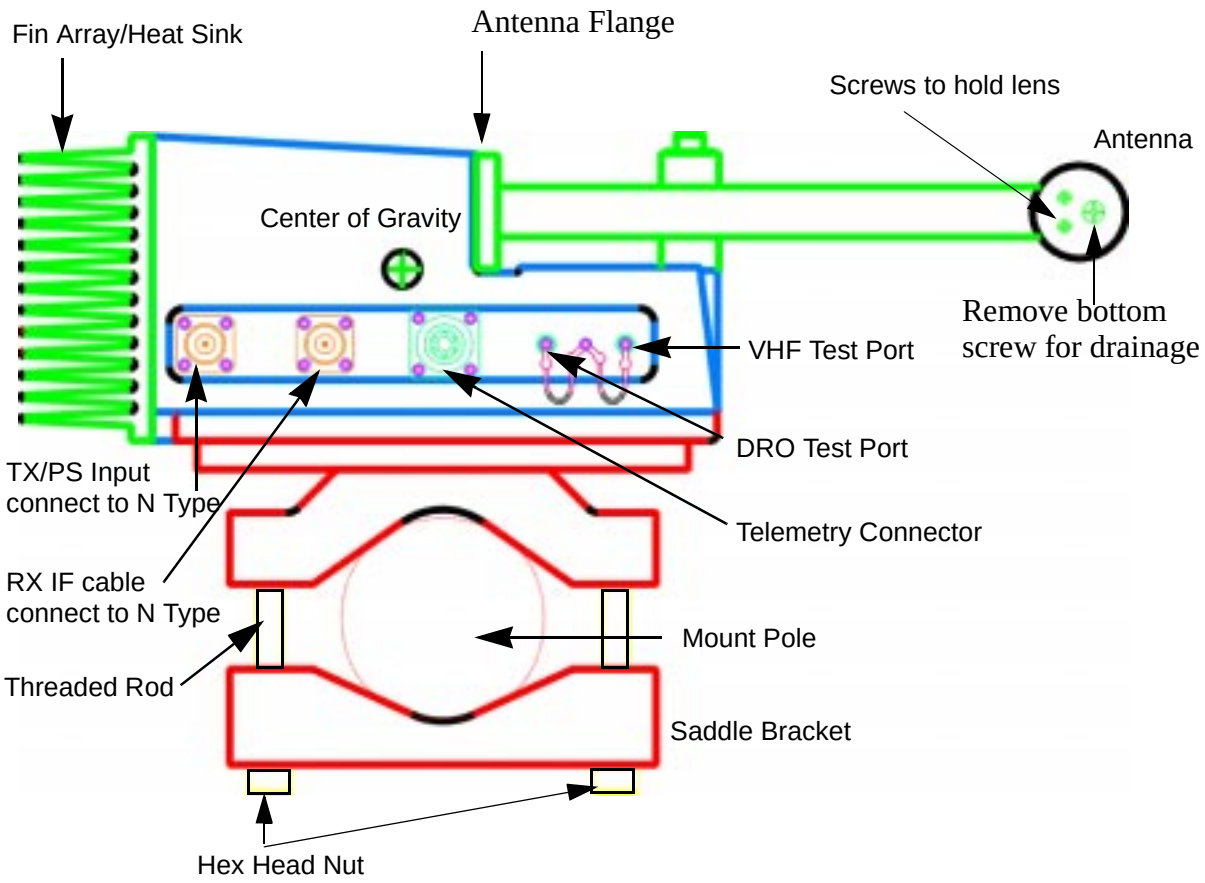


Figure 1-5
BTR 2400 Mounted to a Pole

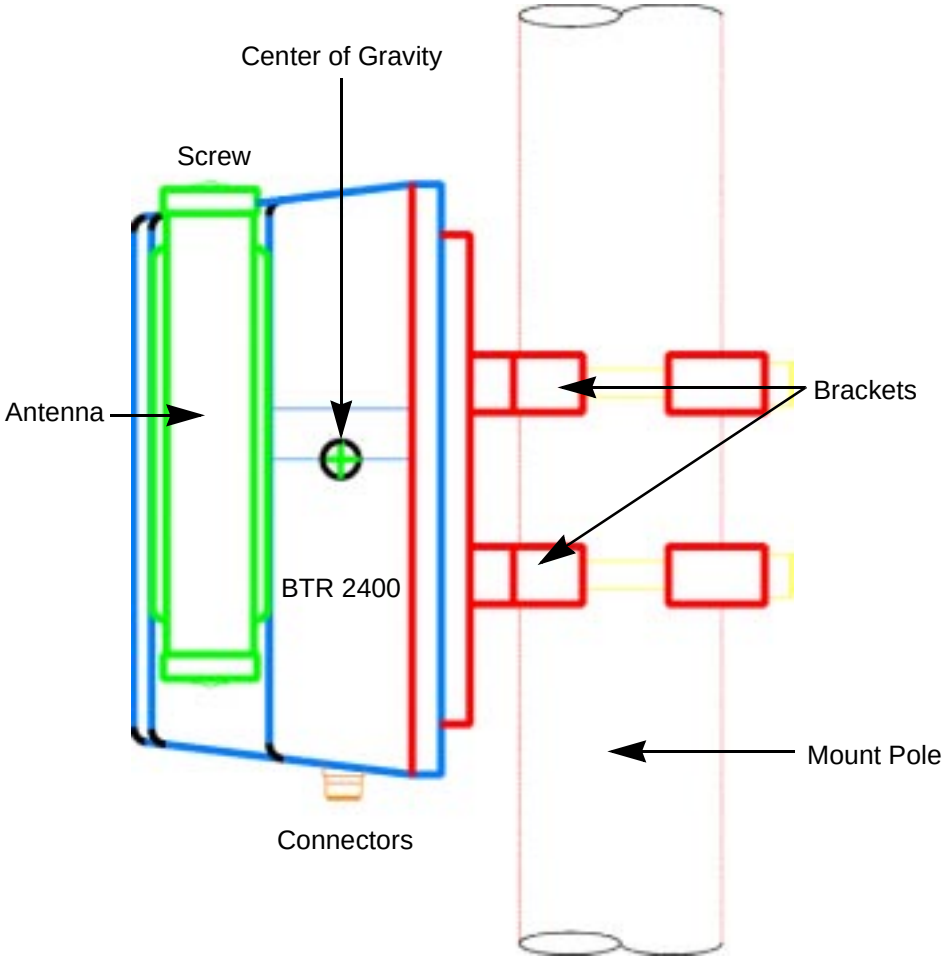


Figure 1-6
BTR 2400-Adjustment Above Horizon

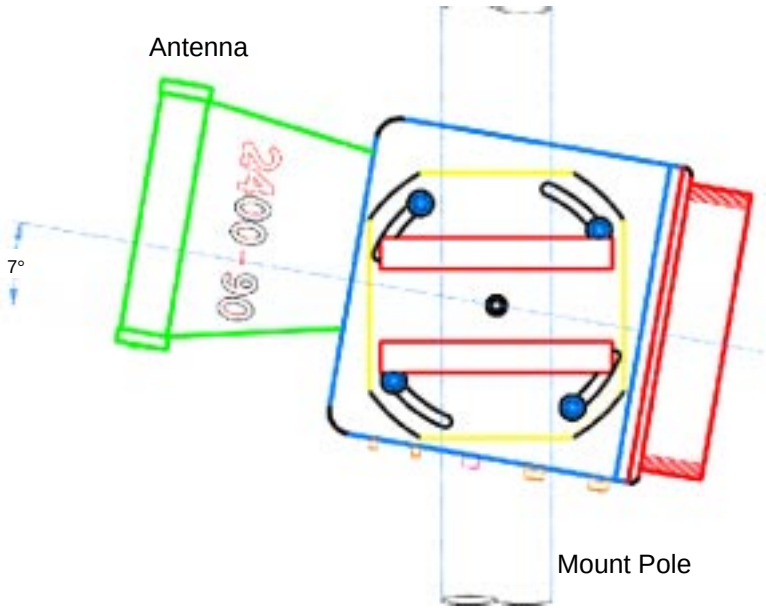


Figure 1-7
BTR 2400-Adjustment Below Horizon

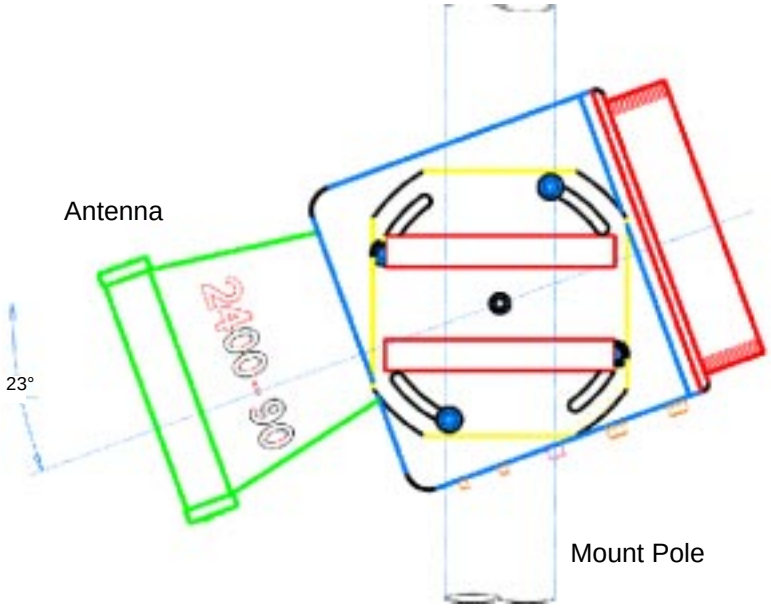


Figure 1-8
BTR 2400-Antenna Polarity

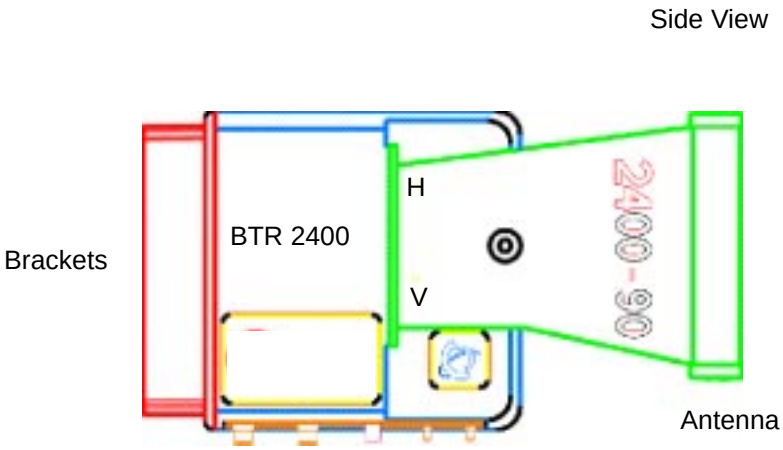


Figure 1-9
Antenna Polarity

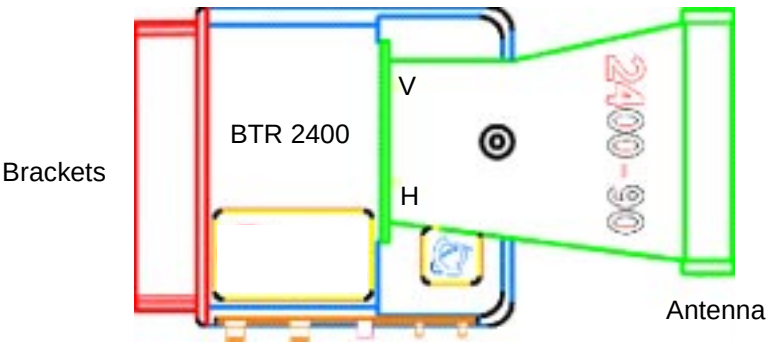
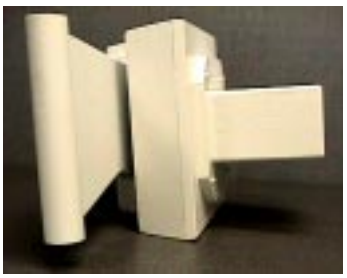


Figure 1-10
Photographs of BTR 2400 Model

Side View

Side View

Fin Array



Front View showing Antenna

Figure 1-11
BTR 2400 Prototype showing antenna

Figure 1-12
BTR 2400 Brackets

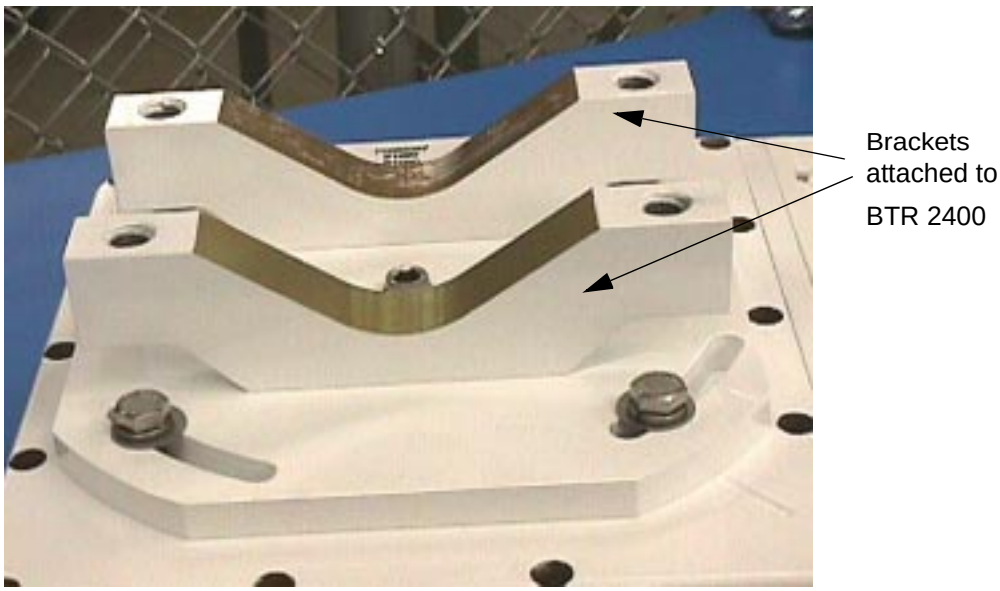


Figure 1-13
BTR 2400 Connectors -Bottom View

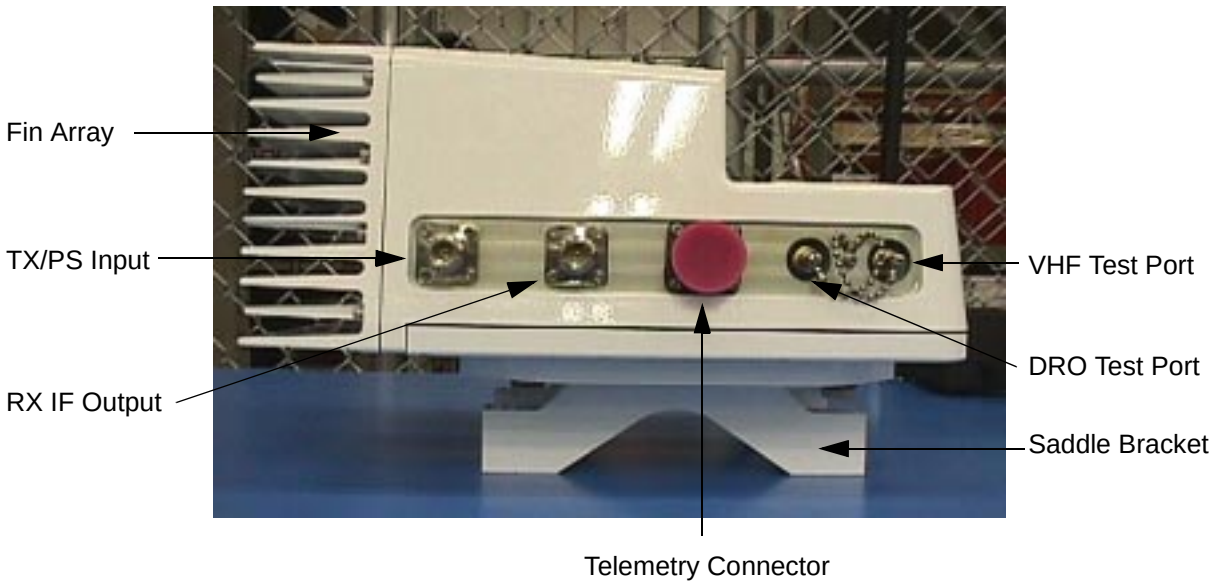


Figure 1-14
BTR 2400 Fin Array

Figure 1-15BTR 2400 Antenna Flange

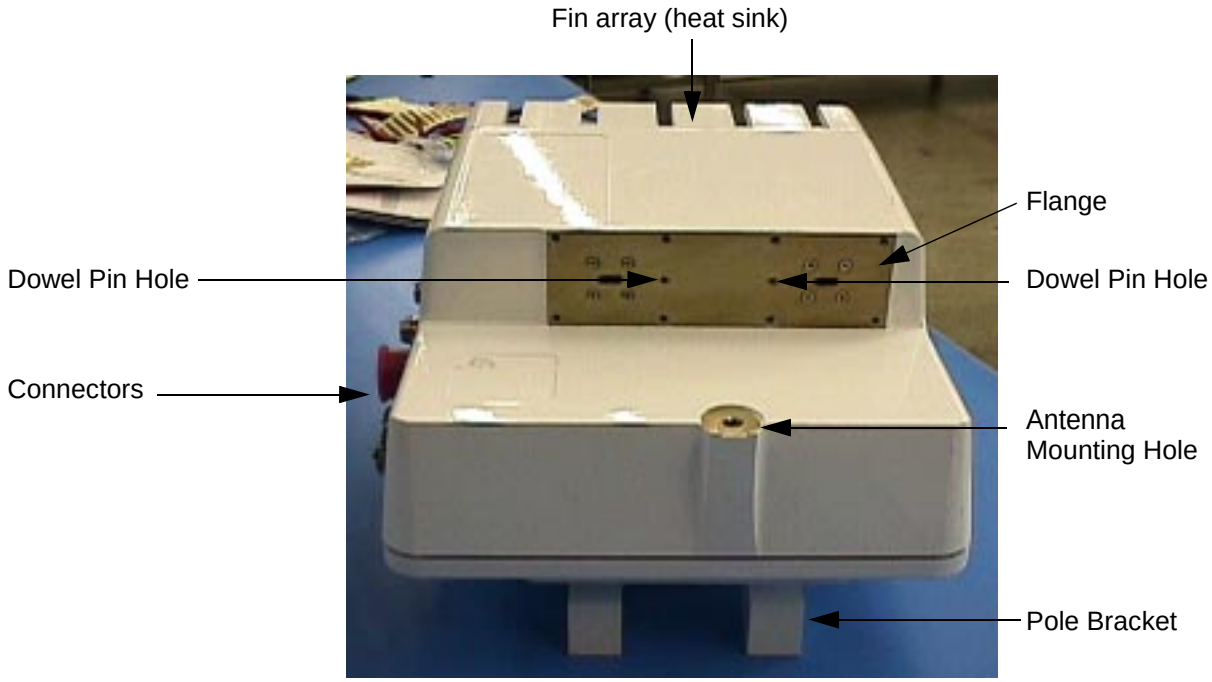


Figure 1-16
BTR 2400 Radio

BTR 2400 Maintenance

Establish a regular check procedure. This quickly identifies any problem which might develop. There are no repairable internal components in the BTR 2400. Therefore, the checks focus on the exterior features of the transceiver unit.

Mechanical Checks

Check the following mechanical areas to prevent problems:

1. Check the bolts and fasteners which hold the transceiver, waveguides, and antenna. Vibrations due to wind can cause bolts and fasteners to loosen. Verify that equipment is secure and properly mounted. If the bolts or fasteners are loose, tighten them carefully. Use lock and spring washers.
2. Check to ensure that all connections between the transceiver and antenna remain watertight. If water enters the waveguide or coaxial connections, it can cause attenuation of the microwave signals. If water is detected, call Nortel Broadband Wireless Access.
3. Visually inspect all equipment for signs of external damage. If signs of damage are detected, call Nortel Broadband Wireless Access.

Note: If you detect an unsolvable problem during the electrical and mechanical inspections, contact Nortel Broadband Wireless Access so that action can be taken to rectify the problem.

Grounding

Grounding refers to a conducting body, for example the earth, used as a common return for an electronic circuit and as an arbitrary zero of potential.

Grounding communication equipment limits voltage due to lightning, line surges or unintentional contact with higher voltage lines, by providing an alternative path. It minimizes damage to both the actual RF equipment and the indoor equipment to which it is connected.

Grounding Reunion RF equipment is critical to ensure proper system operation, as well as protection of personnel and equipment.

The BTR 2400 does not have a ‘ground point or stud.’ Its mounting to the pole serves as the ‘ground.’

Also, the cables are ‘shielded’ or armored, but do not have a ground point/ stud.

BTR 2400 Diagnostic Reference Chart

Symptom	Possible Cause	Check Procedure
Output power low	1. VHF input signal level low.	a. Check VHF signal level. b. Check coaxial cable. c. Check cable connectors. d. Check blockage (for example guano)
No power		a. Check main fuse power b. Check cable connections
If you detect any problem during the electrical and mechanical checks, contact Nortel Broadband Wireless Access so that action can be taken to rectify the problem.		

Note: Warranty void if seal is opened. This means do not attempt to remove cover.

List of terms

AC
Alternating Current

AWG
American Wire Gauge

DBMS
Digital Broadband Microwave System

DC
Direct Current

DRO
Dielectric Resonance Oscillator

EIA
Electronic Industries Association

ESD
Electrostatic Discharge

FCC
Federal Communications Commission

IC
Industry Canada

IF
Intermediate Frequency

kHz
kilohertz, one thousand hertz or cycles per second

LO
Local Oscillator

LNA
Low Noise Amplifier

LNB
Low Noise Block Downconverter

MHz
MegaHertz, one million hertz or cycles per second

NIU
Network Interface Unit

OCXO
Oven-Controlled Crystal Oscillator

PA
Power Amplifier

PS
Power Supply

QAM
Quadrature Amplitude Modulation, which entails modulating frequency

RF
Radio Frequency

RPE
Radio Power Extractor

RSM
Redundancy Switching Matrix

RSM 9016/9116
Redundancy System Monitor

SDM
Signal Demodulator Module

SMM
Signal Modulator Module

TCXO
Temperature Compensated Crystal Oscillator

VAC
Voltage Alternating Current

VDC
Voltage Direct Current (Volts Direct Current)

VHF
Very High Frequency

Reunion

BTR 2400

Installation Guide

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