Fixed WiMAX Base Station Troubleshooting Guide – utilizing Anritsu’s Handheld BTS Master™, Cell Master™, or Spectrum Master™ with Options 37/66/67

Start Here
Use BTS Over-the-Air (OTA) tests to spot-check a transmitter’s coverage and signal quality. Use the Direct Connect tests to check transmitter power and when the OTA test results are ambiguous.

Found good spot?

- **Test vs. BTS Field Replaceable Units**
  - Relative Constellation Error (RCE) OTA
  - Uplink Rx Noise Floor
  - Preamble Power
  - Spectral Flatness
  - Adjacent Sub-Carrier Flatness
  - Adjacent Channel Power Ratio (ACPR)
  - Occupied Bandwidth (Occ BW)
  - Relative Constellation Error (RCE) Direct Connect
  - Frequency Error

- **Anritsu BTS Master™**
  - Pass/Fail screen provides status of BTS Direct Connect Transmitter Tests

- **Locating Over-the-Air Test Spots**
  - To test a BTS Over-the-Air (OTA) it is necessary to find a location with a clean signal.
  - The BTS Master can show the current base station identification number, which is a handy way to make sure the signal being tested is from the desired source when testing OTA.

- **Relative Constellation Error (RCE) when used Over-the-Air (OTA), is a test that is ideal for checking received signal quality. A low RCE indicates poor signal quality and a low data rate.**

- **Base Station ID** indicates which base station was being measured OTA. The strongest base station at your current location is selected for measurement.

- **Guideline:** Coverage Checks: below -10 dB over 95% of the sector.

- **Consequences:** High RCE leads directly to low data rate, which creates dissatisfied customers and lowers the data capacity of the sector. RCE above -13 dBm leads to dropped calls, timeouts, and inability to register.

- **Common Faults:** High RCE numbers when in an ideal position indicate high multipath reflections, co-channel interference, and poor signal quality. Good signals allow the cell to provide a better return on investment.

The antenna is the last link in the transmission path. If hooked up at point "A", it is helpful to sweep the antenna(s) at the same time, to ensure a high quality signal.

Multiple Sector Coverage Checks

Relative Constellation Error OTA Base Station ID

- **Coverage Checks:** below -10 dB over 95% of the sector.
- **OTA Signal Quality for QPSK:** below -25 dB
- **OTA Signal Quality for 64QAM:** below -31 dB
- **Base Station ID** should accurately indicate the base station under test.

- **Consequences:** High RCE leads directly to low data rate, which creates dissatisfied customers and lowers the data capacity of the sector. RCE above -13 dBm leads to dropped calls, timeouts, and inability to register.

- **Common Faults:** High RCE numbers when in an ideal position indicate high multipath reflections, co-channel interference, and poor signal coverage. This can also indicate a transmitter fault.

- **Anritsu BTS Master™**
  - Pass/Fail screen provides status of BTS Direct Connect Transmitter Tests

- **Remote electrical connection**

- **Fixed WiMAX BTS Block Diagram**

- **Fixed WiMAX Radio**

- **GPS**

- **Transmitter/Receiver**

- **PA/ReSwitch**

- **High pass Filter**

- **Test Port**

- **Filter Unit**

- **Coding**

- **BTS Control**

- **O/E**

- **T1, E1, DS3, OC1**

- **Remote Electrical Test**

- **Lightning Arrester**

- **BiTee**

- **Filter Unit**
Cell Size (Power vs. Time) Preamble Power

Preamble Power set cell size. A 1.5 dB change in power levels means a 15% change in coverage area. Coverage is directly affected by preamble power settings.

Preamble Power can be measured in-service if the BTS has a test port.

Use the high accuracy power meter for the best accuracy (± 0.16 dB) with a test signal.

Guidelines: Network operators specify the power levels and tolerance. While some operators accept ± 2.0 dB, most use ±1.0 dB.

Consequences: High or low values will create larger areas of cell-to-cell interference and create lower data rates near cell edges. Low values affect in-building coverage.

Common Faults: Common faults include lack of amplifier calibration, radio faults, large VSWR errors, damaged connectors, and damaged antennas.

Spectral Flatness Adjacent Sub-Carrier Flatness (Peak)

Spectral Flatness is a check for un-even amplitude of sub-carriers. The overall flatness of the signal is checked by this test.

Adjacent Sub-carrier Flatness (Peak) is measured between one sub-carrier to the next. Poor flatness will give the weaker sub-carriers a high bit error rate and lower capacity.

Guideline: Sub-carriers must be within the spectral flatness mask. Adjacent sub-carriers must be within a 0.1 dB of each other, except for the pilots, which are 2.5 dB higher than adjacent carriers.

Consequences: Data will be less reliable on weak sub-carriers, creating a lower over-all data rate.

Common Faults: Spectral flatness issues come from poor radios, filters with uneven pass-band, faulty antennas, and amplifiers that are not flat. Adjacent sub-carrier flatness issues are often a signal generation fault.

Uplink Rx Noise Floor

When looking for uplink interference a good first step is to check the uplink Rx Noise Floor.

To do this, hook up to a test port, or the antenna, for the affected sector and make measurements when calls are not up.

Look first for a high received Rx noise floor by checking the channel power during unused uplink time, if it is a TDD system, or on the uplink frequency if it is an FDD system. The Fixed WiMAX Gated Power vs. Time marker, shown above, is useful for TDD systems. Also check for signals outside the Rx channel but still passed through the Rx filter. These signals lower the cell's receive coverage.

Out-of-Channel Emissions Adjacent Channel Power Ratio (ACPR) Occupied Bandwidth (Occ BW)

Adjacent Channel Power Ratio (ACPR) measures how much BTS signal gets into neighboring RF channels. ACPR checks the closest (adjacent) and the second closest (alternate) channels.

ACPR faults not only degrade the signals in neighboring channels, but also may indicate signal quality faults in the carrier under test.

Guideline: ACPR guidelines are set by local regulations. As a guideline, no more than -28 dBc for the adjacent channels and -40 dBc for alternate channels are often accepted as good limits.

Consequences: Poor ACPR can lead to interference with adjacent carriers and legal liability. It also can indicate poor signal quality which leads to low throughput.

Common Faults: Trace faults through the data path for resolution. When the measurement point is before the faulty field replicable unit, the ACPR will be good.

Occupied Bandwidth (from the Channel Spectrum screen shown in the manual) is the bandwidth that contains 99% of the total carrier power.

Guideline: Less than 3.5 MHz for a 3.5 MHz channel and 7.0 MHz for a 7 MHz channel.

Consequences: Excessive occupied bandwidth means excessive adjacent channel interference.

Common Faults: In addition to the ACPR faults, take a close look at the carrier filtering. Also check the amplifier power levels, which may be too high.

Signal Quality Tests Error Vector Magnitude (EVM) Relative Constellation Error (RCE) Crest Factor

EVM and RCE measure the difference between the actual and ideal signal. RCE is measured in dB and EVM in percent.

RCE measurements, to the guidelines below, are made when the test equipment is directly connected to the base station. A known modulation is required to make these measurements.

Guideline: 2.0 parts per million (ppm), which means:
- ±1.250 Hz at 2,500 MHz
- ±1.450 Hz at 2,900 MHz
- ±1.750 Hz at 3,500 MHz

Consequences: In severe cases communications will not be possible, causing dropped data sessions and time outs.

Pass Fail Mode (shown on the previous page on the BTS Master screen) is a way to set up common test limits, or sets of limits, for each instrument.

Guideline: A green “Pass” field is required for all tests.

Common Faults: First, check the reference frequency and the reference frequency distribution system. If a GPS frequency reference is used, check it as well.

Crest Factor (shown in the left column) is the ratio of peak to average power over the frame. A low crest factor is a symptom of inadequate amplifier headroom.

Guideline: Crest factors of 12 dB or greater are common.

Consequences: A low crest factor leads to distortion, RCE faults, and low data rates.

Common Faults: Crest factor faults are specifically linked to power amplifiers that cannot provide the required peak power. This may be caused by an amplifier fault, a low power supply voltage, or an amplifier input signal that is too high.

Consequences: Inconsistent settings between base stations, leading to inconsistent network behavior.

Common Faults: Failures come from BTS aging, hard faults, and variable standards.

Frequency Error

Frequency Error is a check to see that the carrier frequency is precisely correct. This can be checked Over-the-Air with ease, and is a quick check for the GPS driven frequency reference circuitry.

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