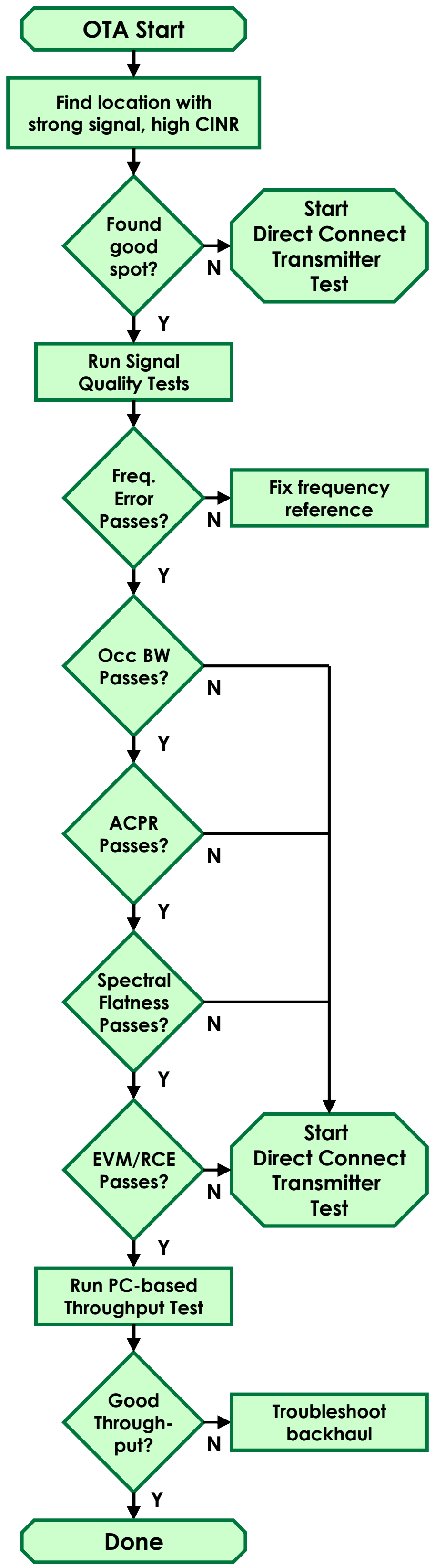
Mobile WiMAX Base Station Troubleshooting Guide – utilizing Anritsu's Handheld BTS Master™, Cell Master™, or Spectrum Master™ with Options 37/66/67

Start Here

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



Troubleshooting Hints

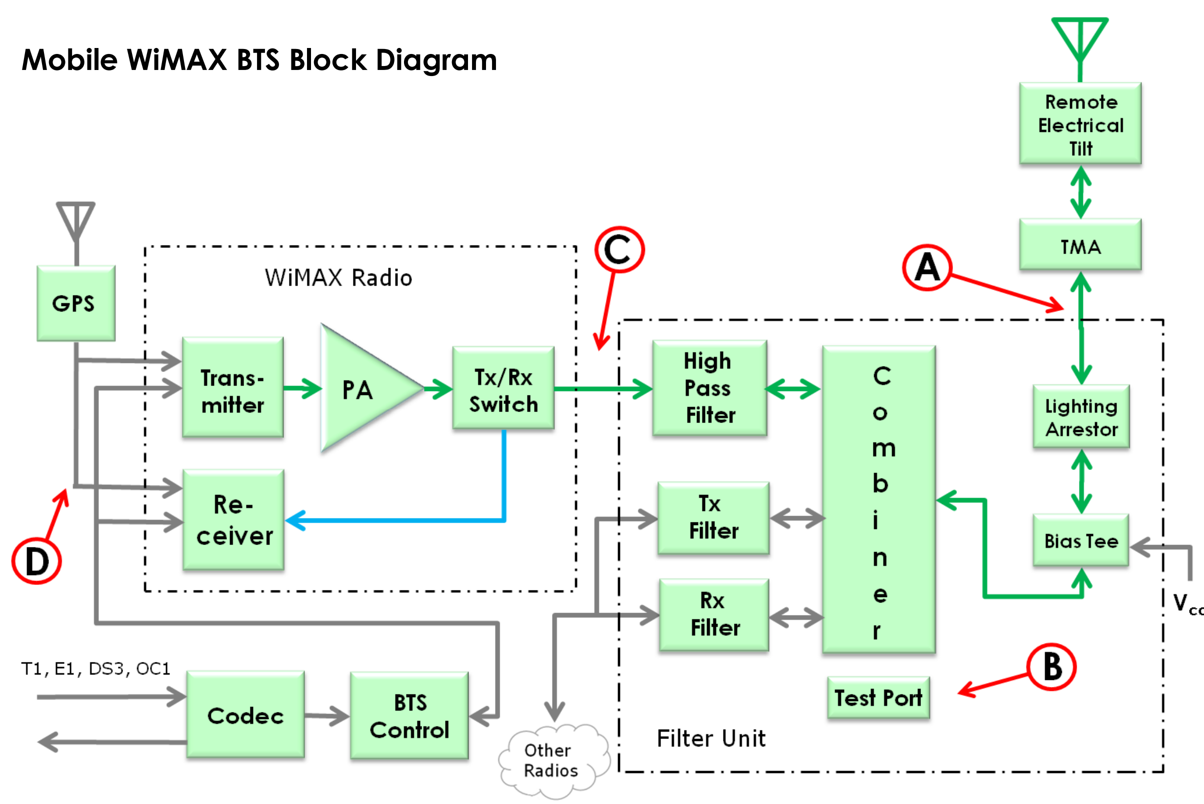
These two tables provide guidance from the first indication of a fault, a poor Key Performance Indicator (KPI), to the BTS or Spectrum Master test, and finally, to the field replaceable unit.

Key Performance Indicators vs. Test	CINR	Uplink Rx Noise Floor	Preamble Power	Spectral Flatness	ACPR & Occ BW	EVM & RCE	Freq Error
Call Blocking or Denial							
Capacity Shortage	xx	x	x	xx	x	xx	
UL Interference	x	xx					
Call Drop							
Radio Link Timeout	x	x	x	x		x	x
UL Interference		xx					
DL Interference	x		xx	x	x	x	x

Test vs. BTS Field Replaceable Units	Freq Ref	Radio	PA	Filter	Antenna	Antenna Down Tilt
Carrier to Interference Noise Ratio (CINR)		x	x	x	x	xx
Uplink Rx Noise Floor		x			x	x
Preamble Power		x	xx	x	x	
Spectral Flatness		x	xx	x	x	
Adjacent Sub-Carrier Flatness		xx			x	
Adjacent Channel Power Ratio (ACPR)		x	xx	xx	x	
Occupied Bandwidth (Occ BW)		x	x	xx	x	
EVM and RCE		x	xx	x	x	
Frequency Error	xx					

x = probable, xx = most probable

Mobile WiMAX BTS Block Diagram



Locating Over-the-Air Test Spots

To test a BTS Over-the-Air (OTA) it is necessary to find a location with good pilot dominance and low multipath.

The BTS Master can show the current sector identification, which is a handy way to make sure the signal being tested is from the desired sector when testing OTA.

To find a good OTA test site, look for a place squarely in the sector, a block or two from the tower, and away from surfaces that may reflect radio waves. A directional antenna for the BTS Master will help to screen out unwanted signals.

In some urban areas, locating a good OTA site can be difficult. In these cases, it may be quicker to hook up to the BTS for testing.

Anritsu BTS Master™
Pass/Fail screen provides status of BTS

Direct Connect Transmitter Tests

Transmitter tests can be run while hooked up to the:

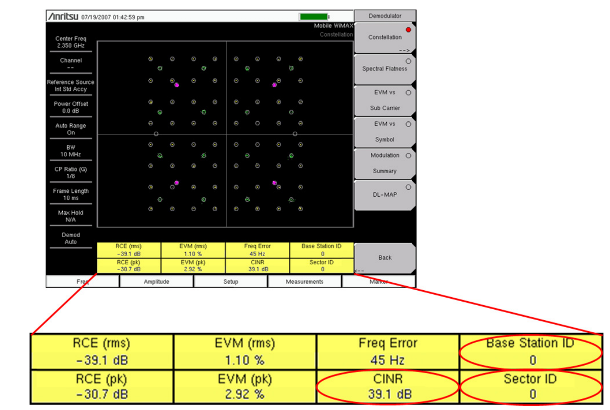
- **A.** Output of the BTS (Point "A").
- **B.** Test port (Point "B") which is essentially the output of the Multi-Carrier Power Amplifier (MCPA).
- **C.** Input to the MCPA (Point "C") if the signal is accessible
- **D.** Frequency reference system (Point "D") for carrier frequency errors

The goal of these measurements is to increase data rate and capacity by accurate power settings, low out-of-channel emissions, and good signal quality tests. 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

Carrier to Interference plus Noise Ratio
Base Station ID, Sector ID



Carrier to Interference plus Noise Ratio (CINR) is an over-the-air test that is ideal for checking received signal quality. A low CINR indicates poor signal quality and a low data rate.

Base Station ID and **Sector ID** indicate which base station and sector are being measured OTA. The strongest base station and sector are selected for measurement.

Guideline:

CINR numbers should be higher than 26 dB for OTA signal quality measurements at most data rates when in an ideal spot (several blocks from the BTS, square to a face, away from any sector boundaries, and away from reflections.) CINR number should be higher than 12 dB when near the boundary of a sector.

Base Station ID and Sector ID should indicate the sector and base station under test

Consequences:

Low CINR leads directly to low data rate, which created dissatisfied customers and lowers the capacity of the sector.

Wrong values for base station ID and Sector ID lead to dropped handoffs and island cells. If the cause is excessive overlapping coverage, it also will lead to poor CINR and low data rates.

Common Faults:

Low CINR numbers when in an ideal position indicate high multipath reflections, co-channel interference, or poor signal quality from the transmitter.

Erroneous sector and base station identification indicate either an error in base station settings, faulty base station equipment, or an issue with overlapping coverage from adjacent cells.

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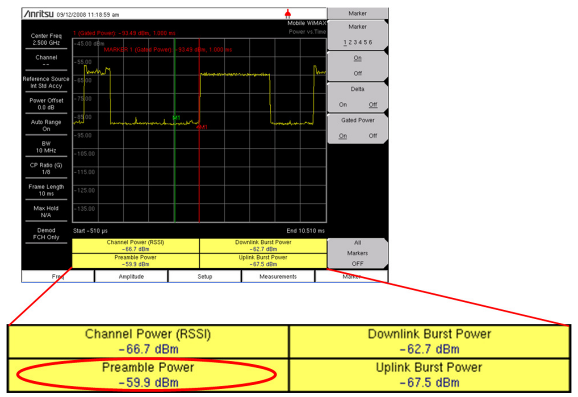
Cell Size
(Time vs. Power)
Preamble Power and RF Power



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.

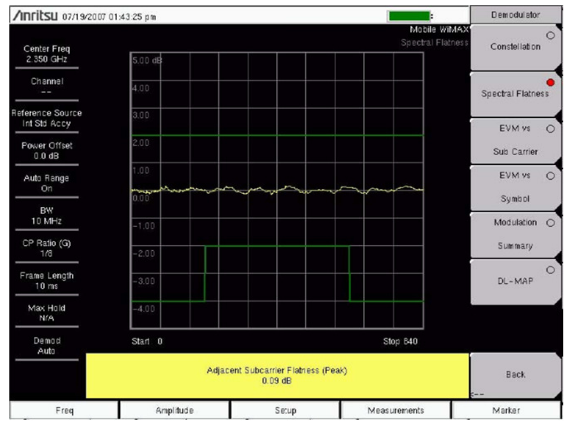
Use the high accuracy power meter for the best accuracy (± 0.16 dB).

Guidelines: Network operators specify the power levels and tolerance. While some operators accept +/- 2.0 dB, most use +/- 1.0 dB as a commonly accepted tolerance.

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, large VSWR errors, damaged connectors, and damaged antennas.

Spectral Flatness
Adjacent Sub-Carrier Flattness (Peak)



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

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.

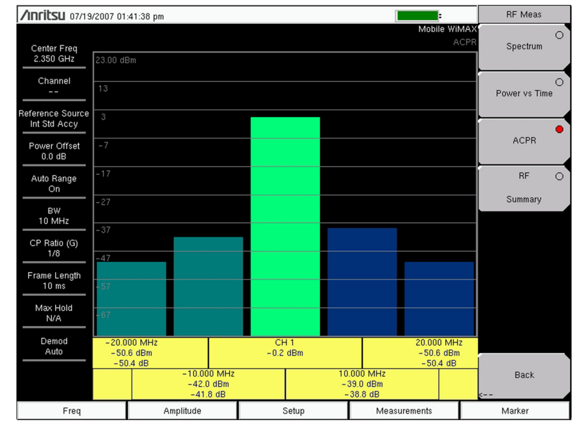
Guideline: Sub-carriers must be within the spectral flatness mask.

Adjacent subcarriers carriers must be within +/- 0.4 dB of each other.

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

Common Faults: Spectral flatness issues come from poor VSWR, filters with uneven pass-band, and amplifiers that are not flat. Adjacent sub-carrier flatness issues indicate poor sub-carrier signal generation.

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.

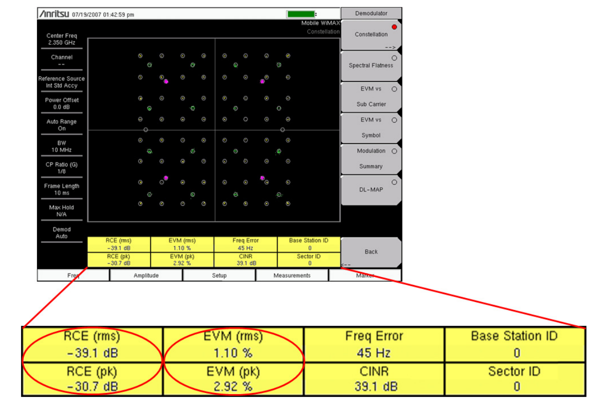
ACPR faults not only degrade the signals in neighboring channels, but also may indicate signal quality faults in the carrier under test.

Guideline: ACPR guidelines are set by local regulations. As a guideline for 10 MHz channels, -35 dBc for the adjacent channels and -45 dBc for the alternate channels are often accepted as good numbers.

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 Tx signal path for resolution. When the measurement point is before the faulty field replicable unit, the ACPR will be good.

Signal Quality Tests
Error Vector Magnitude (EVM)
Reletive Constellation Error (RCE)
Constellation Diagram



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

A known modulation is required to make these measurements, since the limit depends on the burst type, or signal modulation type, as shown below.

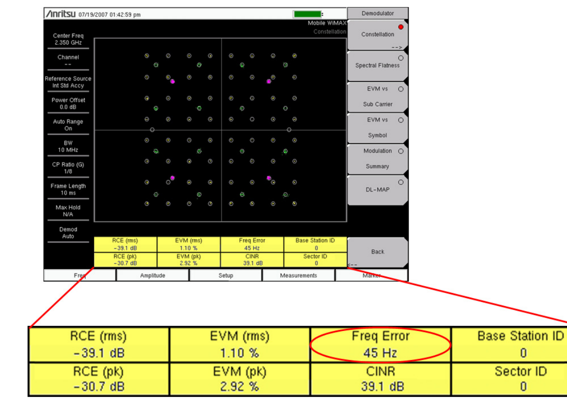
Guideline:

QPSK-1/2	-15 dB	64QAM-1.2	-26dB
QPSK-3/4	-18 dB	64QAM-2/3	-28 dB
16QAM-1/2	-20.5 dB	64QAM-3/4	-30 dB
16QAM-3/4	-24 dB		

Consequences: Low signal quality, low data rate, and low sector capacity. This is the single most important signal quality measurement.

Common Faults: Distortion in radios, power amplifier, filter, or antenna system.

Signal Quality Tests
Frequency Error
Pass Fail Mode



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 reference circuitry.

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: Calls will drop when user's equipment travels at high speed. In severe cases, handoffs will not be possible at any speed, creating island cells.

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

Uplink Rx Noise Floor

When looking for uplink interference a good first step is to check the uplink Rx Noise Floor. To do this, hookup 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 noise floor during unused uplink time. The Mobile WiMAX Gated Power vs. Time marker, shown above, is useful for this.

Also, use a test port, if present, to check for signals outside the Rx channel but still passed through the Rx filter. These sort of signals can cause receiver de-sense, lowering the cell's receive coverage.

Uplink Rx Noise Floor (continued)

Guideline: Less than approximately –80 dBm received noise floor when no calls are up.

Consequences: Call blocking, denial of services, call drops, low data rate, and low capacity.

Common Faults: Receiver de-sense from co-channel interference, in-band interference, or passive intermodulation.

Intermodulation products can cause interference and in turn may be caused by a combination of strong signals and corrosion. This corrosion can be in the antenna, connectors, or nearby rusty metal.

Occupied Bandwidth (from the Channel Power screen) is the bandwidth that contains 99% of the total carrier power.

Guideline: Less than 10.0 MHz for a 10 MHz channel.

Consequences: Excessive occupied bandwidth means excessive adjacent channel interference.

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

Constellation Diagrams can be used to check for specific signal quality errors. A simplified test signal is normally used.

Guideline: Symbol dots need to be near the template on the display.

Consequences: Errors show up as distortion, leading to lower EVM and RCE numbers.

Common Faults: Errors in phase indicate either local oscillator issues or a form of FM signal gaining ingress to the system. Errors in amplitude indicate amplifier issues. Trace the fault through the signal chain to identify the Field Replaceable Unit.

Pass Fail Mode (shown on the previous page as 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.

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

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

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