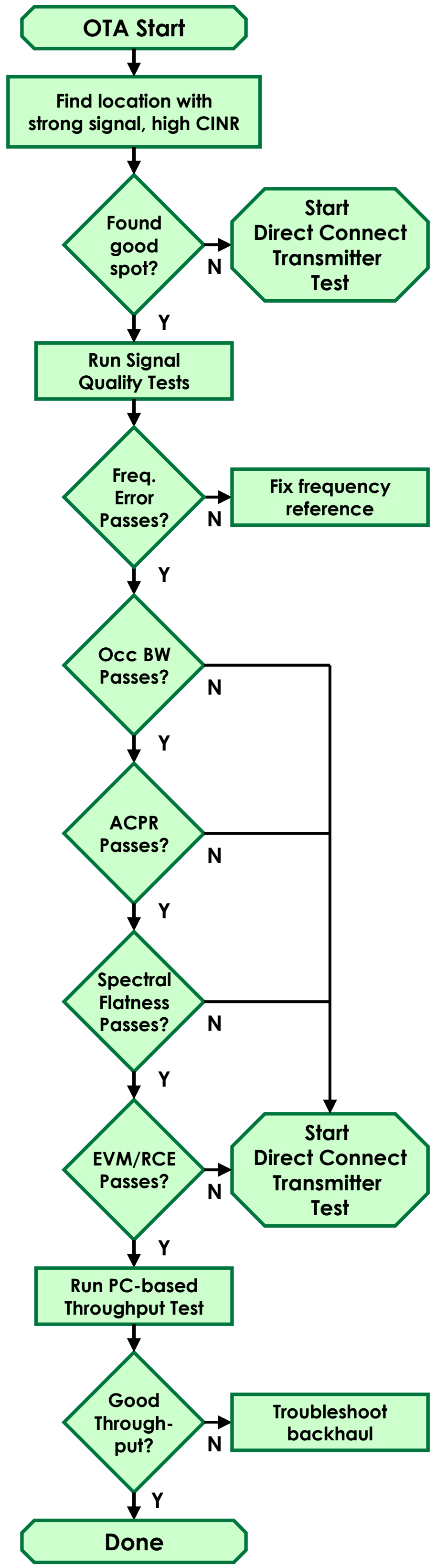
Fixed WiMAX Base Station Troubleshooting Guide – utilizing Anritsu's Handheld BTS Master™, Cell Master™, or Spectrum Master™ with Options 37/66/67

Start Here

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



Troubleshooting Hints

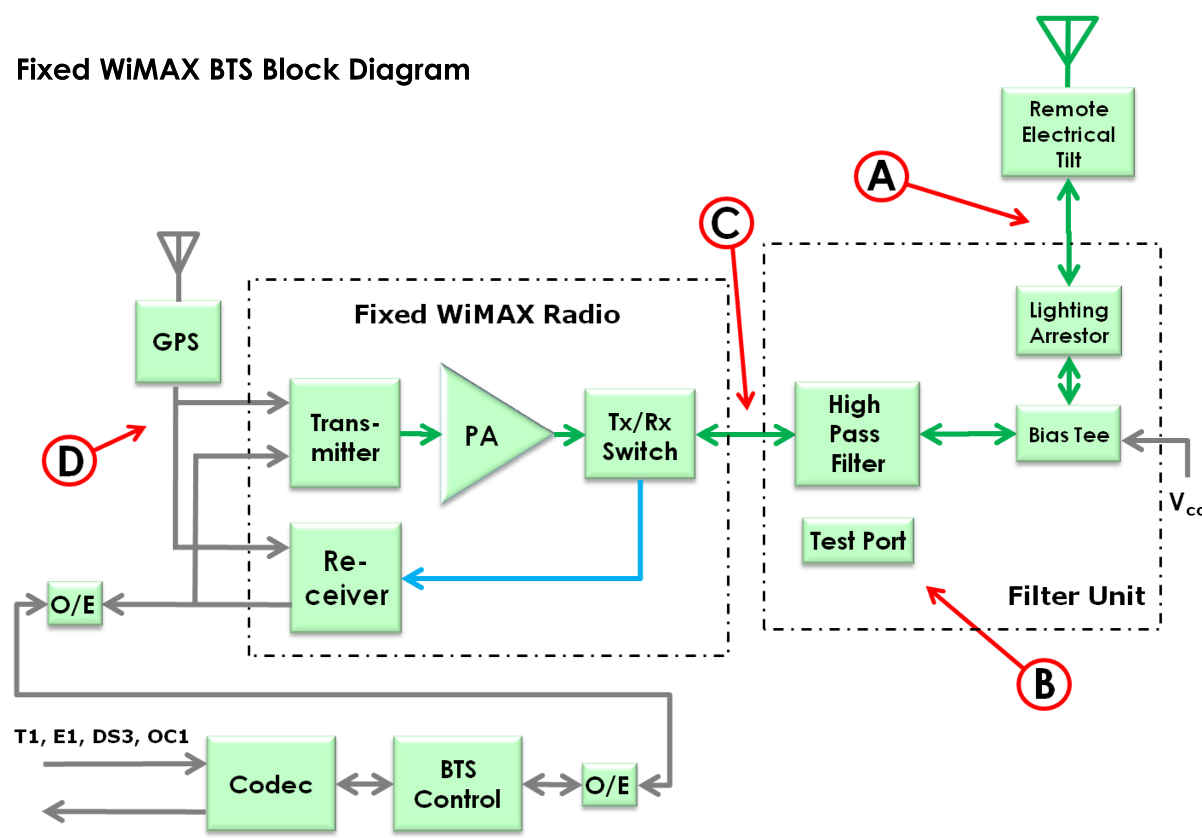
These two tables provide guidance from the first indication of a fault, a poor Key Performance Indicator (KPI), to the BTS or Spectrum Master test, and finally, to the field replaceable unit.

Key Performance Indicators vs. Test	RCE OTA	Uplink Rx Noise Floor	Preamble Power	Spectral Flatness	ACPR & Occ BW	RCE Direct Connect	Freq Error
Call Blocking or Denial							
Capacity Shortage	xx	x	x	xx	x	xx	
UL Interference		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
Relative Constellation Error (RCE) OTA		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)		xx	xx	x	x	
Relative Constellation Error (RCE) Direct Connect		x	xx	x	x	
Frequency Error	xx					

x = probable, xx = most probable

Fixed 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 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.

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.** Output from the MCPA (Point "C") if the signal is accessible
- **D.** Frequency reference system (Point "D") for carrier frequency errors

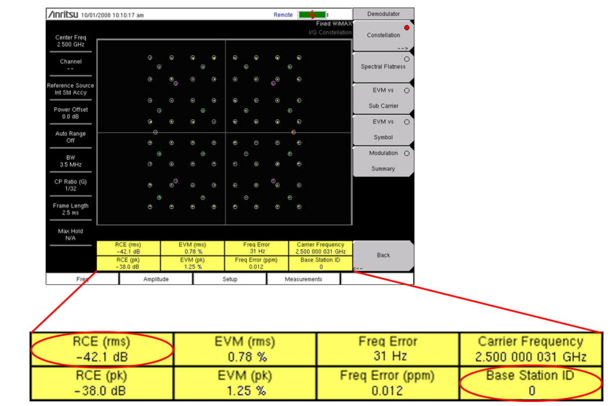
The goal of these measurements is to increase data rate and capacity by accurate power settings, low out-of-channel emissions, and good signal quality tests. Good signals allow the cell to provide a better return on investment.

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

Reletive Constellation Error OTA

Base Station ID



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 is 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.

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 created dissatisfied customers and lowers the data capacity of the sector. RCE above -13 dBm leads to dropped calls, timeouts, and inability to register.

Wrong values for base station ID lead to inability to register. If the cause is excessive overlapping coverage, it also will lead to poor RCE and low data rates.

Common Faults:

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

Wrong base station identification codes 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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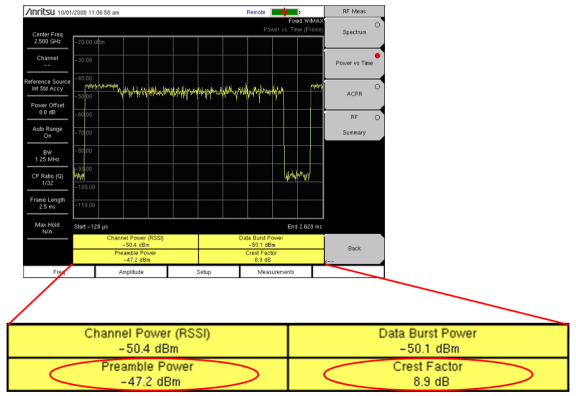
Cell Size
(Power vs. Time)
Preamble Power



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.

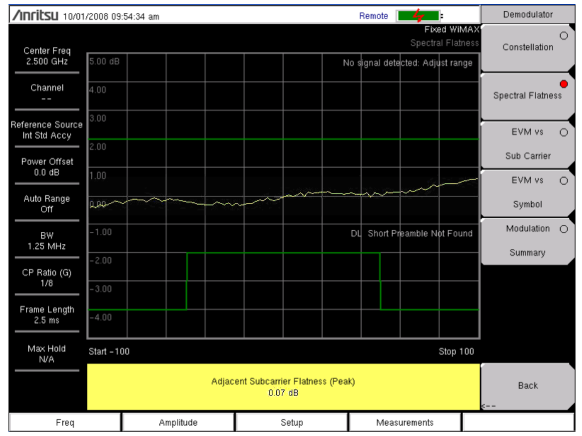
Use the high accuracy power meter for the best accuracy (± 0.16 dB) with a test signal.

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 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.

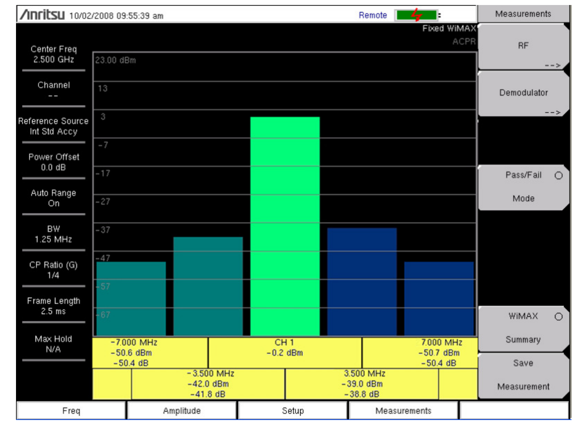
Guideline: Sub-carriers must be within the spectral flatness mask.

Adjacent subcarriers carriers must be within ± 0.1 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.

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.

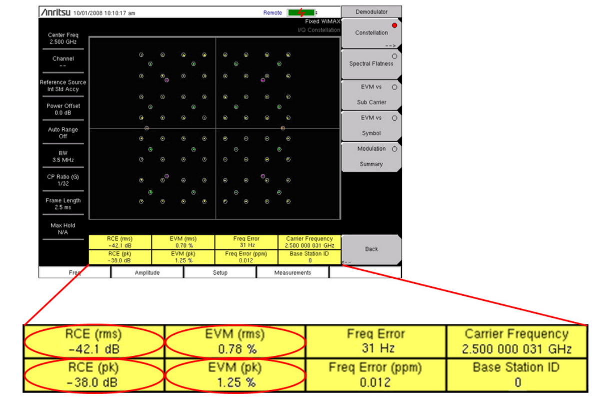
ACPR faults not only degrade the signals in neighboring channels, but also may indicate signal quality faults in the carrier under test.

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 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)
Crest Factor



RCE and **EVM** 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.

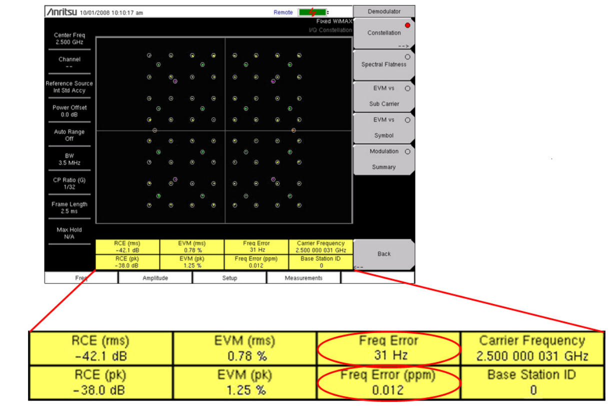
Guideline:

BPSK-1/2	-13.0 dB	16QAM-3/4	-25.0
QPSK-1/2	-16.0 dB	64QAM-2/3	-28.5
QPSK-3/4	-18.5 dB	64QAM-3/4	-31.0
16QAM-1/2	-21.5 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. Trace the fault back through the signal chain to identify the faulty Field Replaceable Unit.

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

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 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.

Uplink Rx Noise Floor (continued)

Guideline: Less than approximately –85 dBm received noise floor when no calls are up.

Consequences: Session 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 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.

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.

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.

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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