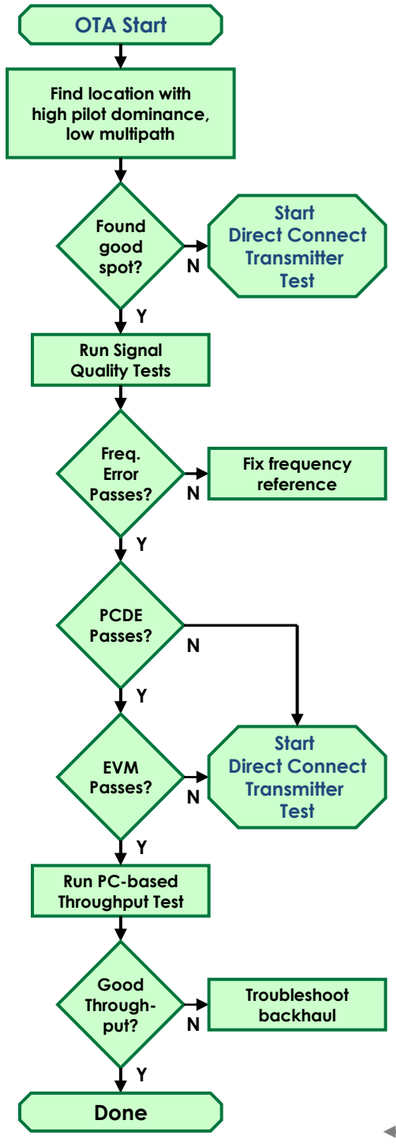
W-CDMA/HSDPA Base Station Troubleshooting Guide – utilizing Anritsu's Handheld BTS Master™, Cell Master™, or Spectrum Master™ with Options 35/44/65

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

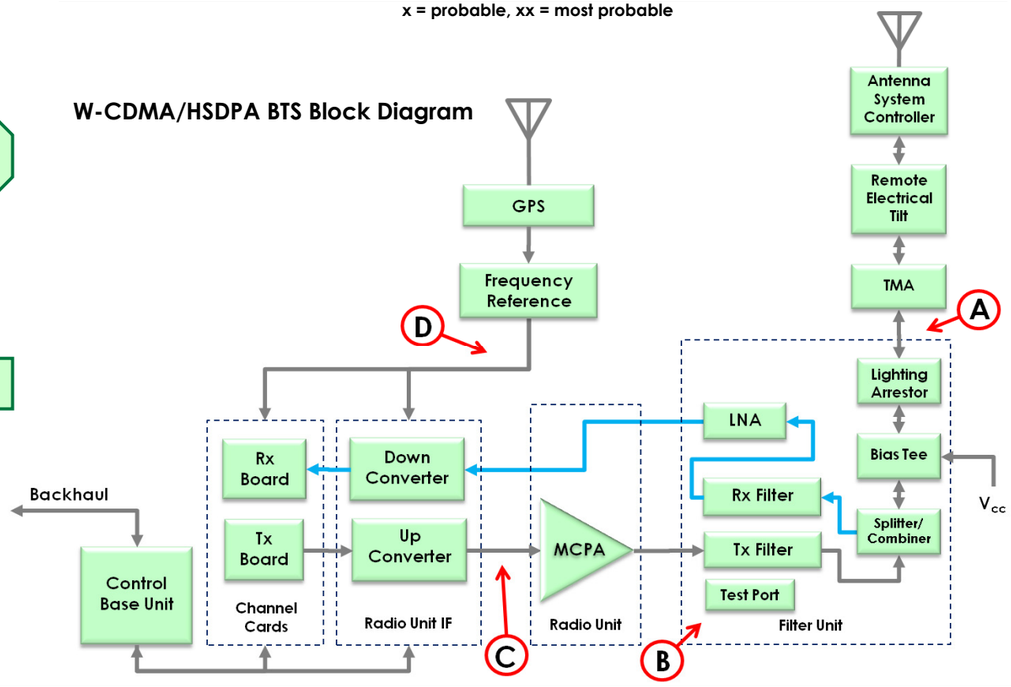
These two tables provide guidance from the first indication of a fault, a poor Key Performance Indicator (KPI), to the BTS or Spectrum Master test, and finally, to the field replaceable unit.

Key Performance Indicators vs. Test	Pilot Power	ACLR & SEM	PCDE	EVM	Freq Error	Noise Floor	Rx Noise Floor	OTA EVM or E_c/I_o	E_c	Excess Scram Codes	Multi-path
Call Blocking or Denial											
Power shortage	x		x								
Code Shortage		x	xx	xx		x					
UL Interference		x					x				
Call Drop											
Radio Link Timeout	x		x	x	x	x	x	x	x	x	x
UL Interference		x					x				
DL Interference	x		x	x	x	x		x	x	x	x

Test vs. BTS Field Replaceable Units	Freq Ref	Ch Cards	MCPA	Filter	Antenna	Antenna Down Tilt
Pilot Power			xx	x	x	
Adjacent Channel Leakage Ratio (ACLR)		x	x	xx	x	
Spectral Emission Mask (SEM)		x	x	xx	x	
Peak Code Domain Error (PCDE)		xx				
Error Vector Magnitude (EVM)		x	x	x	x	
Frequency Error	xx					
Noise Floor		x	x			
OTA EVM or E_c/I_o		x	x	x	x	x
E_c			x			xx
Excess Scrambling Codes			x			xx
Multipath						x

x = probable, xx = most probable

W-CDMA/HSDPA 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 pilot dominance and multi-path measurements are ideal for this task. OTA testing requires a pilot dominance higher than 10 dB and a multipath number less than 0.3 dB.

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:

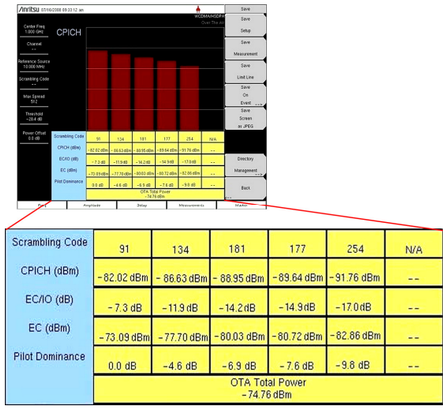
- **A.** Output of the BTS (Point "A").
- **B.** Test port (Point "B") which is essentially the output of the Multi-Carrier Power Amplifier (MCPA).
- **C.** Input to the MCPA (Point "C") if the signal is accessible.
- **D.** Frequency reference system (Point "D") for carrier frequency errors.

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

Scrambling Code, E_c/I_o, E_c, Pilot Dominance



Scrambling Code	91	134	181	177	254	N/A
CPICH (dBm)	-82.02 dBm	-86.63 dBm	-88.95 dBm	-89.64 dBm	-91.76 dBm	--
EC/IO (dB)	-7.3 dB	-11.9 dB	-14.2 dB	-14.9 dB	-17.0 dB	--
EC (dBm)	-73.09 dBm	-77.70 dBm	-80.03 dBm	-80.72 dBm	-82.86 dBm	--
Pilot Dominance	0.0 dB	-4.6 dB	-6.9 dB	-7.6 dB	-9.8 dB	--
OTA Total Power -74.76 dBm						

Scrambling codes indicate which sectors are present at the current location. Too many strong sectors create pilot pollution.

E_c is a measure of pilot power Over-the-Air. It is often used to check coverage levels. It should be highest near the tower, declining to a minimum level at the handoff point.

E_c/I_o indicates the quality of the signal from each scrambling code.

Guidelines:

Scrambling Codes: 3 or fewer codes, within 15 dB of the dominate code, over 95% of the coverage area.

E_c: Should be higher than -88 dBm over 97% of the coverage area.

E_c/I_o: Should be higher than -9 dB over 95% of the coverage area.

Pilot Dominance: Higher than 10 dB for OTA signal quality testing.

Consequences:

Scrambling Codes: Low data rate, low capacity, and excessive soft handoffs.

E_c: Call drop, low data rate, and low capacity.

E_c/I_o: Low data rate and low capacity.

Common Faults:

Scrambling Codes: Antenna down tilt, pilot power, and repeaters.

E_c: Antenna down tilt, pilot power, building shadows, and other obstructions.

E_c/I_o: Antenna down tilt, damaged antennas, pilot power, and co-channel interference.

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Single Sector Coverage Checks

Multipath

Multipath #	1	2	3	4	5	6
Tau	-4.06 µs	-9.06 µs	-6.98 µs	-14.54 µs	-16.08 µs	-1.06 µs
Tau (chips)	-17.25	-34.70	-30.55	-58.25	-63.75	-6.75
Distance	1346.75m	2771.54m	2381.14m	4547.65m	4977.05m	547.65m
RSCP	-12.8 dBm	-13.4 dBm	-13.9 dBm	-14.1 dBm	-14.1 dBm	-14.6 dBm
Rel Pwr	0.1 dB	-0.6 dB	-1.1 dB	-1.3 dB	-1.3 dB	-1.8 dB
Multipath Power 1.0 dB						

Multipath measurements show how many, how long, and how strong the various radio signal paths are. Multipath signals outside tolerances set by the cell phone or other UE devices become interference.

Guideline: Limits are set by User Equipment (UE) needs. Multipath signals within -15 dB of the strongest signal should be within the time range the UE can deal with and be numerically equal to, or fewer than, the UE's fingers.

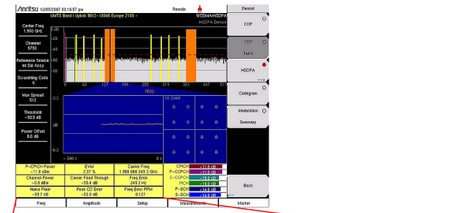
OTA signal quality testing requires a multipath power less than 0.3 dBm.

Consequences: The primary issue is co-channel interference leading to dropped calls and low data rates.

Common Faults: Buiding shadows, antenna tilt, and repeaters.

Cell Size

BTS Power and Pilot Power



P-CPICH Power -11.8 dBm	EVM 2.37 %	Carrier Freq 1.950 000 249 3 GHz
Channel Power -0.8 dBm	Carrier Feed Through -59.4 dB	Freq Error 249.3 Hz
Noise Floor -59.7 dB	Peak CD Error -53.0 dB	Freq Error PPM 0.127

Pilot Power sets cell size. A 1.5 dB change in power levels means approximately a 15% change in coverage area.

Pilot power is an in-service measurement if the BTS has a test port.

Use the high accuracy power meter for the best accuracy (+/- 0.16 dB).

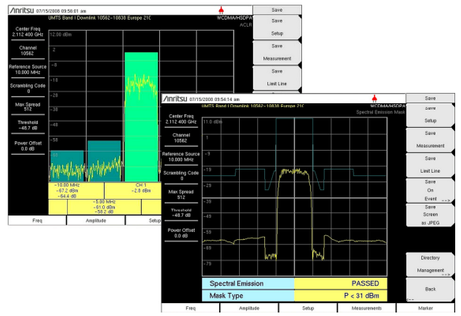
Guideline: The signal should be within +/- 2.0 dB of specification under normal conditions.

Consequences: High values will create pilot pollution. High or low values will cause dead spots/dropped calls and cell loading imbalances/blocked calls.

Common Faults: The first thing to check is the MCPA calibration followed by large VSWR faults and damaged connectors.

Out-of-Channel Emissions

Adjacent Channel Leakage Ratio (ACLR)
Multi-Channel ACLR
Spectral Emission Mask (SEM)



ACLR measures how much of the carrier gets into neighboring RF channels. ACLR, and multi-channel ACLR, check the closest (adjacent) and second closest (alternate) RF channels on both single carrier and multi-carrier W-CDMA signals.

Guidelines: -45 dBc for the adjacent channels, -50 dBc for the alternate channels.

In certain regions of the world, for Local Area (low power) base stations, the adjacent channel should be -8.0 dBm (for Band I, Band IX and Band XI) or +2.0dBm (for Band VI).

Consequences: The BTS will create interference for neighboring carriers. This is also an indication of low signal quality and low capacity, which can lead to blocked calls.

Common Faults: First, check the Tx filter, then the MCPA and the channel cards. Also, the antenna system can generate intermodulation due to corrosion.

SEM checks closer to the signal than ACLR does. It also is sensitive to absolute power levels. Regulators in many countries require regular measurements of spectral emissions.

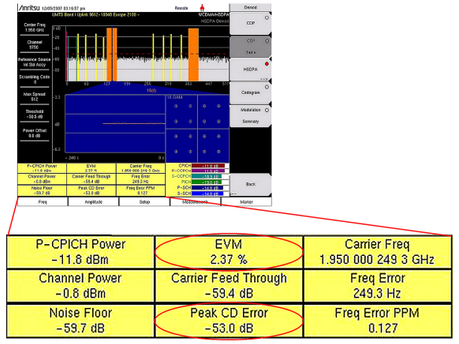
Guideline: Must be below mask. Received power levels matter so be sure to use the right external attenuation value.

Consequences: Failing this test leads to interference with neighboring carriers, legal liability, and low signal quality.

Common Faults: Check amplifier output filtering first. Also look for intermodulation distortion or spectral re-growth.

Signal Quality Tests

Error Vector Magnitude (EVM)
Peak Code Domain Error (PCDE)



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EVM is the ratio of errors, or distortions, in the actual signal, compared to a perfect signal. EVM applies to the entire signal.

Symbol EVM for each code is available on the marker measurements and in the Code Domain Power Table view.

Guideline: ≤17.5 % when transmitting a composite signal using only QPSK modulation.

≤12.5 % when transmitting a composite signal that includes 16 QAM modulation.

≤8.0 % when transmitting a composite signal that includes 64 QAM modulation.

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

Common Faults: EVM faults can be caused by distortion in the channel cards, power amplifier, filter, or antenna system.

Peak Code Domain Error is a measure of the errors between one code channel and another. Errors on individual code channels likely originate on the channel cards.

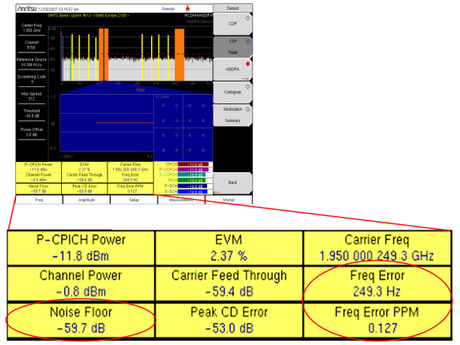
Guideline: -33 dB or less at a spreading factor of 256.

Consequences: Dropped calls, low signal quality, low data rate, low sector capacity, and blocked calls.

Common Faults: Check the channel cards first, particularly if EVM passes.

Signal Quality Tests

Frequency Error
Noise Floor



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Frequency Error is a check to see that the carrier frequency is precisely correct.

The BTS Master can accurately measure Carrier Frequency Error OTA if the instrument is GPS enabled or in GPS holdover.

Guideline: Frequency Error should be less than:

Wide Area BTS:	+/- 0.05 ppm
Medium Range BTS:	+/- 0.1 ppm
Local Area BTS:	+/- 0.1 ppm

Consequences: Calls will drop when mobiles travel at higher speed. In some cases, cell phones cannot hand off into, or out of the cell.

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

Noise Floor is the average level of the visible noise floor. This will affect EVM and PCDE.

Guideline: -35 dB, or lower, is a typical limit.

Consequences: Dropped calls, low signal quality, low data rate, low sector capacity, and blocked calls.

Common Faults: A high noise floor can be caused by cross talk in the channel cards, co-channel interference, and high EVM.

Rx Noise Floor

When looking for uplink interference a good first step is to check the Rx Noise Floor. To do this, hookup to a Rx test port, or the Rx antenna, for the affected sector and make measurements when calls are not up.

Look first for a high received Rx noise floor by using the W-CDMA RF channel power measurement on the uplink channel.

Also, use the spectrum analyzer to check for signals outside the Rx channel but still passed through the Rx filter.

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 PIM).

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