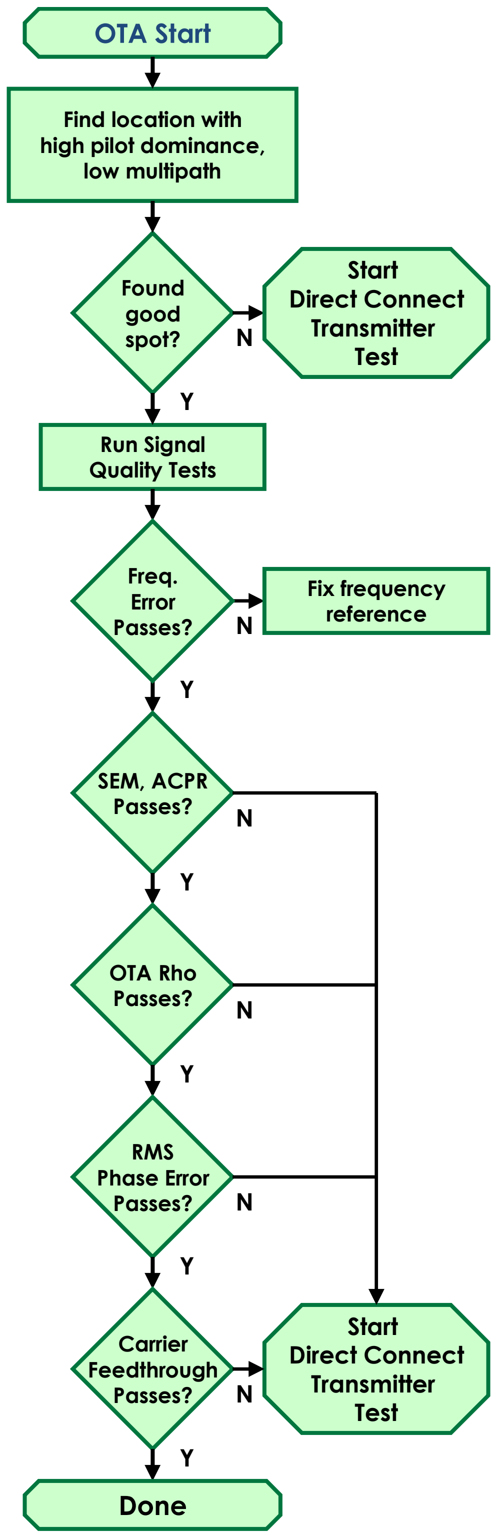
CDMA2000 1X Base Station Troubleshooting Guide – utilizing Anritsu's Handheld BTS Master™, Cell Master™, or Spectrum Master™ with Options 35/44/65

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

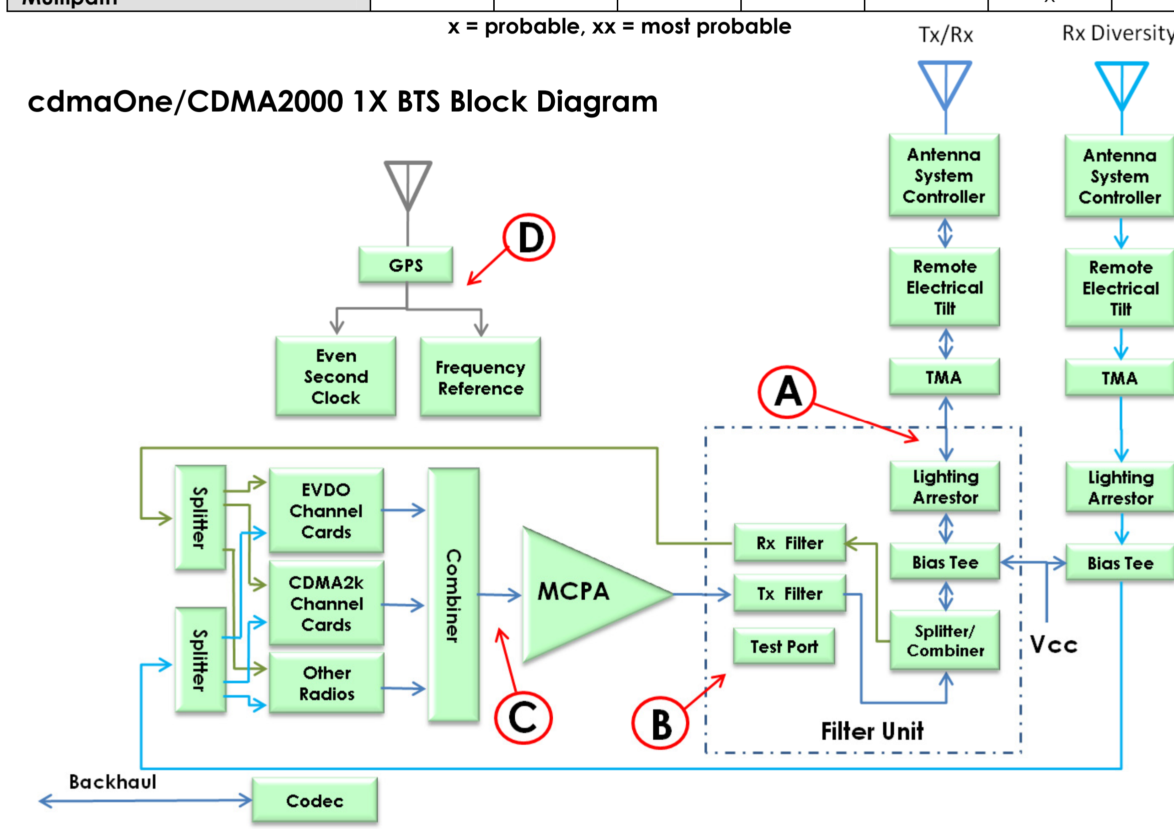
These two tables provide guidance from the first indication of a fault, a poor Key Performance Indicator (KPI), to the BTS or Spectrum Master test, and finally, to the field replaceable unit.

Key Performance Indicators vs. Test	Pilot Pwr	ACPR & SEM	Rho	RMS Phase Error	Freq Error	Carrier Feed-through	Code Noise Floor	Rx Noise Floor	Ec/Io	OTA Pilot Power	Excess PN Codes	Multi-path
Call Blocking/Denial												
Power shortage	x								x	xx		
Code Shortage		x	xx	x			xx		x	x		
UL Interference		x					x	x				
Call Drop												
Radio Link Timeout	x		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	x	x

Test vs. BTS Field Replaceable Units	Freq Ref	Ch Cards	MCPA	Filter	Antenna	Antenna Down Tilt	Uplink Inter-ference
Pilot Power			xx	x	x		
Adjacent Channel Power Ratio		x	x	xx	x		
Spectral Emission Mask		x	x	xx	x		
Rho		x	xx	x	x		
RMS Phase Error		xx	x				
Frequency Error	xx						
Carrier Feedthrough		xx					
Code Noise Floor		x	x				x
Rx Noise Floor		x		x	x	x	xx
Ec/Io			x		x	xx	x
Pilot Power OTA			x			xx	
Excess PN Codes			x			xx	
Multipath						x	

x = probable, xx = most probable

cdmaOne/CDMA2000 1X 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:

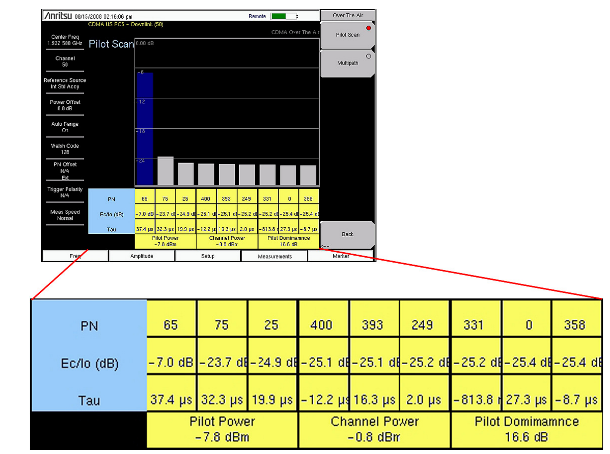
- **A.** Output of the BTS (Point "A").
- **B.** Test port (Point "B") which is essentially the output of the Multi-Carrier Power Amplifier (MCPA).
- **C.** Input to the MCPA (Point "C") if the signal is accessible.
- **D.** Frequency reference system (Point "D") for carrier frequency errors.

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

The antenna is the last link in the transmission path. Antennas can distort an otherwise clean signal. This can be spotted by checking for return loss or VSWR with an antenna sweep.

Multiple Sector Coverage Checks

Pilot Scaner, OTA Pilot Power, E_c/I_o, Pilot Dominance



Pilot Scanners indicate which pilots, identified by PN code, are present at the current location. Too many strong pilots create pilot pollution.

OTA Pilot Power indicates signal strength of the dominant code.

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

Pilot Dominance measures how much stronger the strongest PN code is relative to the others.

Guidelines:

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

OTA Pilot Power: Should be higher than -93 dBm over 95% 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:

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

OTA Pilot Power: Call drop, low data rate, and low capacity.

E_c/I_o: Low data rate and low capacity.

Common Faults:

Antenna down tilt and BTS pilot power settings affect **all measurements** in this category. **OTA Pilot Power** and **E_c/I_o** are also affected by building shadows. In addition, **E_c/I_o** is affected by antenna damage, poor BTS Rho, and co-channel interference.

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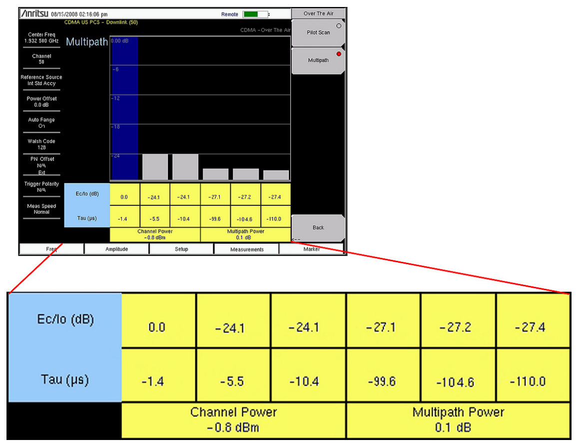
Single Sector Coverage Checks

Multipath



Multipath measurements show how many, how long, and how strong the various radio signal paths are, for the selected PN Code. 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.

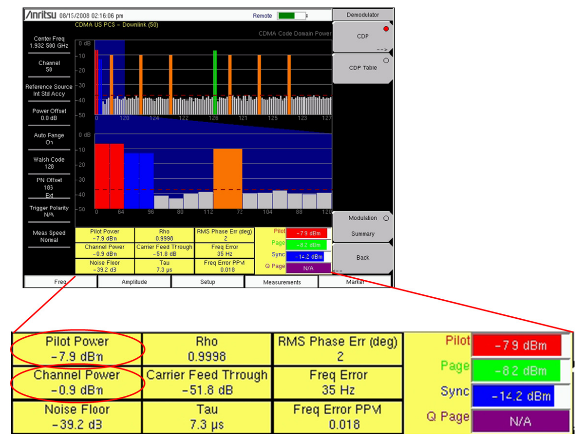
OTA signal quality testing requires a multipath power less than 0.3 dBm

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

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

Cell Size

BTS Power and Pilot Power



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

Channel Power is measured using a test signal. For the best accuracy, use the high accuracy power meter (+/- 0.16 dB) when setting power with a test signal.

Guideline: Pilot Power and Channel Power are typically set to within +/- 1.0 dB of specification.

The standard allows BTS power to be as far off as +2.0 dB and -4.0 dB from specification during extreme environmental conditions but this is not ideal.

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. Next, look for large VSWR faults and damaged connectors.

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 cdma2000 RF channel power measurement on the uplink channel.

Also, use the spectrum analyzer and a Rx 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, a reduction in receiver sensitivity that effectively lowers the cell's receive coverage.

Rx Noise Floor (continued)

Guideline: Less than approximately –90 dBm received noise floor when no calls are up.

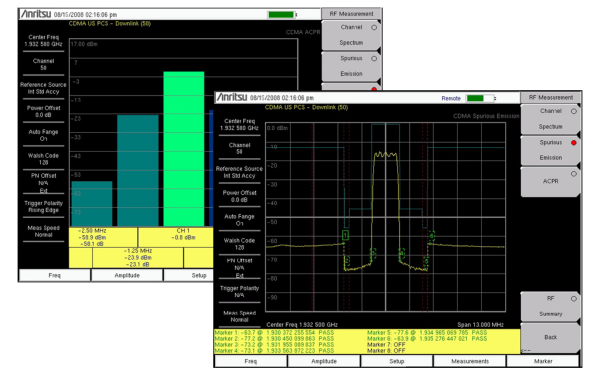
Consequences: Call blocking, denial of services, call drops, low data rate, and low capacity.

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

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. This issue is often called the rusty bolt syndrome.

Out-of-Channel Emissions

Spectral Emission Mask (SEM)
Adjacent Channel Power Ratio (ACPR)
Multi-Channel ACPR



SEM is a way to check out-of-channel spurious emissions near the carrier. These spurious emissions both indicate distortion in the signal and can interfere with other carriers in the adjacent channel.

This test is required by a number of regulatory agencies around the world.

Guideline: Must be below the mask. Power levels matter so be sure to enter the external attenuation value into the BTS Master and use full power on the BTS.

For the most accurate testing, use a test signal as defined in the standard.

Consequences: Check amplifier output filtering first. Also look for intermodulation distortion, spectral re-growth and ACPR faults

Common Faults: First, check the Tx filter, then the MCPA and the channel cards. Antenna system corrosion will also affect ACPR.

ACPR measures how much of the carrier gets into neighboring RF channels. ACPR, and multi-channel ACPR, check the closest (adjacent) and second closest (alternate) RF channels for single and multicarrier signals.

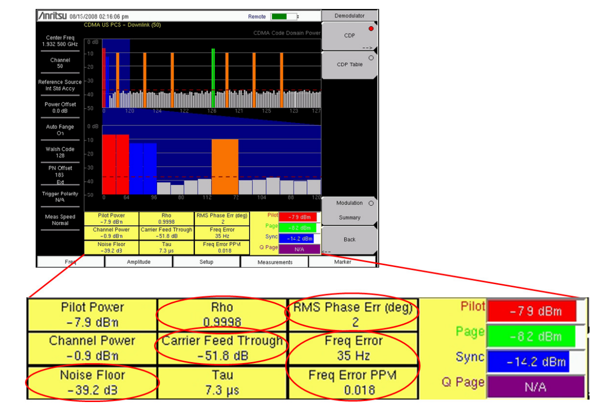
Guidelines: Typical values are -45 dBc for the adjacent channels and -62 dBc for the alternate channels.

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. Antenna system corrosion will also affect ACPR.

Signal Quality Tests

Rho
RMS Phase Error



Rho is a measure of modulation quality. It measures the amount of power that is correctly transmitted. A Rho of 1.000 indicates a perfect signal.

Rho is the primary signal quality test for cdma2000 base stations.

Guidelines: 0.912 for a pilot only signal when directly connected to the BTS. OTA Rho measurements will likely be lower.

For Radio Configuration 10 only, Rho should be 0.985, or 0.97 if the radio channel center frequency is within 750 kHz of the edge of the band.

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

RMS Phase Error is a measure of signal distortion caused by frequency instability. Any changes in the reference frequency or the radio's internal local oscillators will cause problems with phase error.

Guideline: 3 degrees or less is typical. This is measured with a test signal and while attached to the BTS.

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

Common Faults: Phase instability originates with the frequency reference and local oscillators. Check the channel cards and up-converters. Also look for stray FM signals in the BTS.

Signal Quality Tests

Frequency Error
Carrier Feedthrough
Noise Floor & Overhead Channels

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 +/- 0.05 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, 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.

Carrier Feedthrough is a measure of how much un-modulated signal leaks through the mixers in the radios and up-converters. This leakage directly lowers Rho.

Guideline: A typical limit is -25 dBm. Specific models of base stations may require limits as high as -19 dBm.

Consequences: Lower Rho, lower capacity, and a lower effective cell size which results in more dropped calls.

Common Faults: Carrier Feedthrough faults are confined to mixers, which are found in the up-converters and channel cards.

Noise Floor is the average level of the visible code domain noise floor. This will affect Rho.

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 if OTA, and low Rho.

Overhead Channels should be set at specific levels or mobiles will have difficulty registering.

Guideline: in dB below total test signal power
Pilot -7.0 dB
Paging -7.3 dB
Sync -13.3 dB
Tolerance: +/- 0.5 dB

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