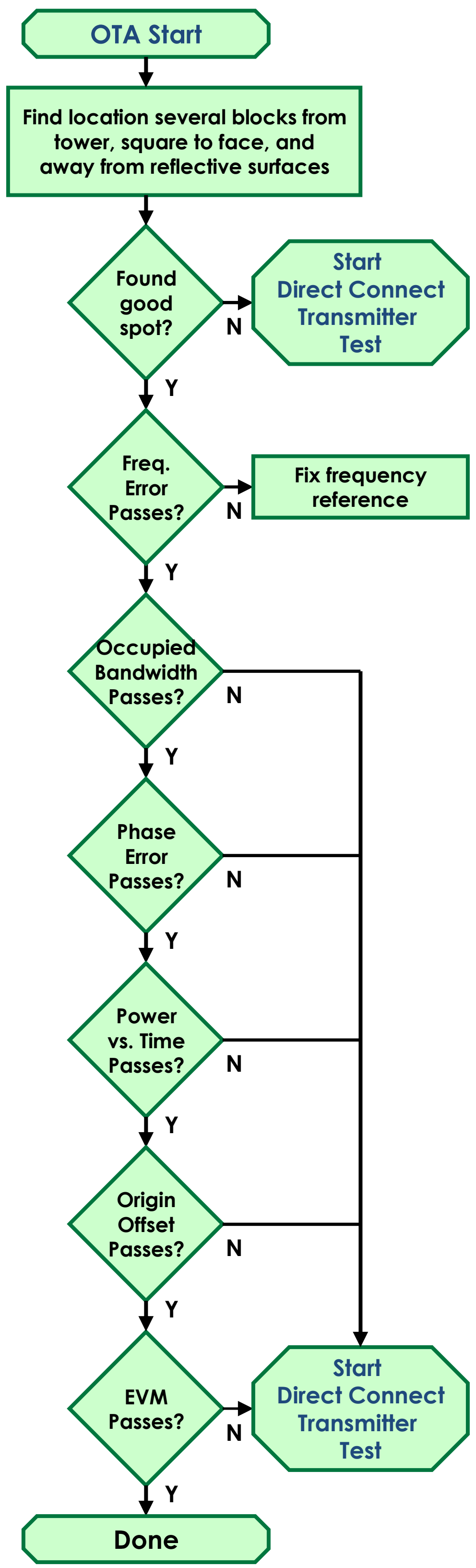
GSM/GPRS/EDGE Base Station Troubleshooting Guide – utilizing Anritsu's Handheld BTS Master™, Cell Master™, or Spectrum Master™ with Options 40/41

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

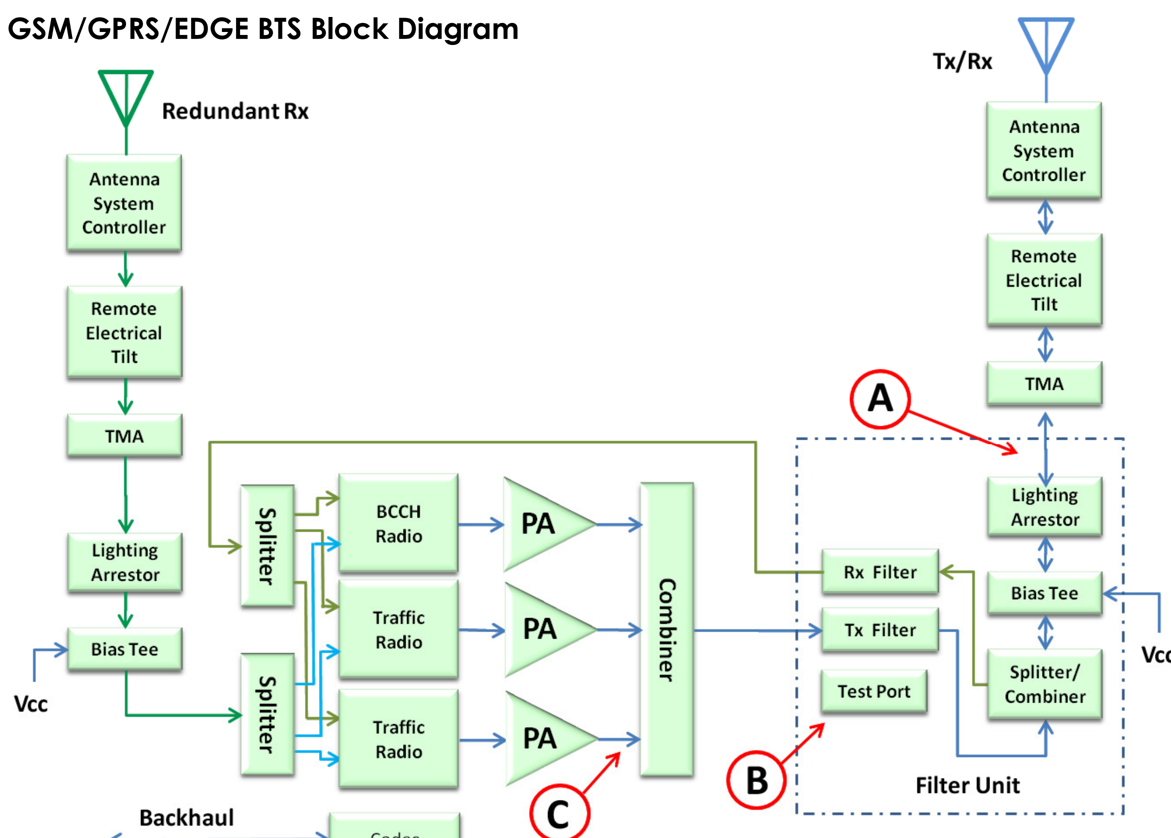
These two tables provide guidance from the first indication of a fault, a poor Key Performance Indicator (KPI), to the BTS or Spectrum Master test, and finally, to the field replaceable unit.

Key Performance Indicators vs. Test	C/I	Power	Power vs. Time (Slot)	Occ BW	Phase Error	EVM	Freq Error	Origin Offset	Rx Noise Floor
Call Blocking or Denial									
Time Slot Shortage		x	x	x		x		x	x
UL Interference	x	x							xx
Call Drop									
Radio Link Timeout	x	x	x		xx	xx	x	x	x
UL Interference	x	x		x					xx
DL Interference	xx	x	x	x	x	x	x	x	

Test vs. BTS Field Replaceable Units	Freq Ref	Radios	MCPA	Filters	Antenna	Antenna Down Tilt
Power		x	xx	x	x	
Power vs. Time (slot)		x	xx	x	x	
Occupied Bandwidth (OCC BW)		xx	x	x	x	
Phase Error		xx	x			
Error Vector Magnitude (EVM)		x	xx	x	x	
Frequency Error	xx					
Origin Offset		xx				
Carrier to Interference Ratio (C/I)		x	x	x	x	xx
Rx Noise Floor						xx

x = probable, xx = most probable

GSM/GPRS/EDGE BTS Block Diagram



Locating Over-the-Air Test Spots

To test a BTS Over-the-Air (OTA) it is necessary to find a good location. 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 good location will have a C/I ratio better than 20 dB. A directional antenna for the BTS Master will help to screen out unwanted signals and improve the OTA C/I reading.

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

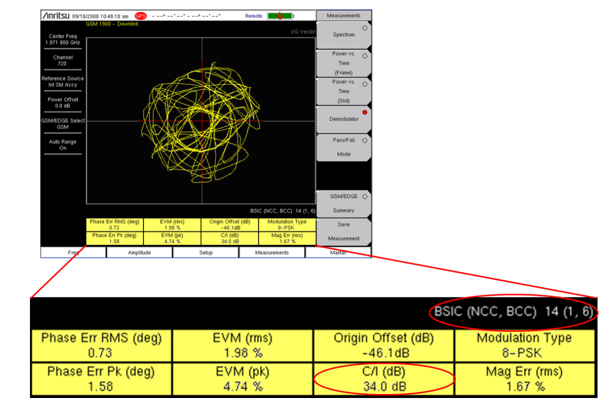
Transmitter tests can be run while hooked up to the:

- **A.** Output of the BTS (Point "A").
- **B.** Test port (Point "B") which is essentially the output of all of the amplifiers.
- **C.** Output of the power amplifiers (Point "C").

The goal of these measurements is to increase voice coverage, data rate, and EDGE capacity by accurate power settings, low out-of-channel emissions, and good signal quality. Good signals allow the cell to have better capacity and 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.

OTA Signal Quality Test
Carrier to Interference (C/I)
Base Station Identity Code (BSIC)



The **Carrier to Interference (C/I)** ratio indicates the quality of the received signal. This measurement can be used to locate a good spot for OTA testing. It also can be used to identify areas of poor signal quality.

The **Base Station Identity Code (BSIC)** gives the base station id. The **Network Color Code (NCC)** identifies the owner of the network. The **Base Station Color Code** (BCC) identifies the sector.

Guidelines:

C/I ratios for **OTA signal quality testing** should be higher than 20 dB.

C/I ratios for **coverage testing**, should be higher than10 dB over 95% of the coverage area.

BSIC, **NCC**, and **BCC** numbers should be as specified by the network operator.

Consequences:

C/I ratios under 20 dB will prevent **accurate** OTA signal quality testing. EDGE data rates will also be affected.

C/I ratios under 10 dB will cause coverage issues including dropped calls, blocked calls, and other handset reception problems.

BSIC, **NCC**, and **BCC** faults indicate coverage issues that lead to dropped calls.

Common Faults:

For **OTA signal quality testing**, the C/I ratio will vary with location. Be aware that interference or a faulty BTS may cause a low C/I.

For **coverage and BSIC issues**, check for a weak signal or excessive coverage from another sector. Check antenna down tilt, BTS power, BTS signal quality, and look for interference.

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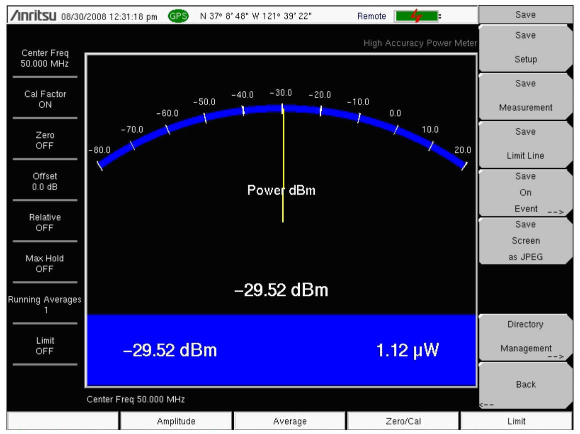
Cell Size

Power Meter Measurements
Average Burst Power



The **High Accuracy Power Meter** can measure RF power to an accuracy of ± 0.16 dB. Traffic channels may need to be changed to BCCH channels for the duration of the test.

Average Burst Power, shown to the right, can be used in-service on all channels.

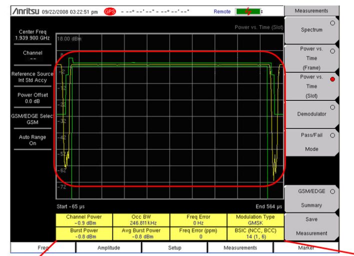
Guidelines: Most network operators set their base stations to within ±1.0 dB of specification.

Consequences: High or low values will create larger areas of cell-to-cell interference and create lower data rates near cell edges. Low values create dropouts and dead zones.

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

Guard Period Measurements

Power vs. Time (Slot)
Power vs. Tiime (Frame)



Channel Power −0.9 dBm	Occ BW 246.811 kHz	Freq Error 0 Hz	Modulation Type GMSK
Burst Power −0.8 dBm	Avg Burst Power −0.8 dBm	Freq Error (ppm) 0	BSIC (NCC, BCC) 14 (1, 6)

Power versus Time (Slot and Frame) should be used if the GSM base station is setup to turn RF power off between timeslots. When used OTA, this measurement can also spot GSM signals from other cells.

Average Burst Power is discussed to the left.

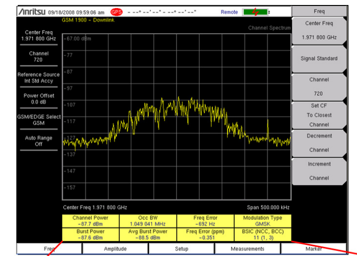
Guidelines: The GSM signal should be within the GSM mask, and EDGE signals should be within the EDGE mask. The signal's off-time must coincide with the mask.

Consequences: Violations of the mask create dropped calls, low capacity, and small service area issues.

Common Faults: Small violations of the mask during on-time indicate EVM (see EVM) issues. If the off-time misses the mask, look for radio timing issues. If a second set of off-times is visible OTA during what should be on-time, look for excessive GSM coverage.

Out-of-Channel Emissions

Occupied Bandwidth (Occ BW)
Frequency Error



Channel Power −87.7 dBm	Occ BW 1.049 041 MHz	Freq Error −692 Hz	Modulation Type GMSK
Burst Power −87.6 dBm	Avg Burst Power −88.5 dBm	Freq Error (ppm) −0.351	BSIC (NCC, BCC) 11 (1, 3)

Occupied Bandwidth is a measurement of the spectrum used by the carrier. The occupied bandwidth contains 99% of the signal's RF power.

Guideline: Occupied bandwidth should be between 230 kHz and 280 kHz for GSM signals.

Consequences: Excessive occupied bandwidth can create interference with adjacent channels or be a sign of poor signal quality, leading to dropped calls.

Common Faults: Check for proper carrier filtering and distortion caused by high amplifier power levels. Faulty radios, filters, and bad antennas can also cause occupied bandwidth problems.

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 it is GPS enabled or in GPS holdover.

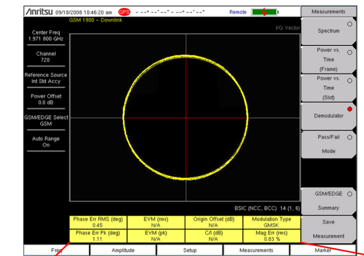
Guideline: Frequency Error should be less than ± 0.05 ppm.

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

Common Faults: First, check the reference frequency and the reference frequency distribution system. Check the backhaul and if used, the GPS.

Signal Quality Tests

Phase Error (for GSM)
Pass Fail Mode



Phase Err RMS (deg) 0.45	EVM (rms) N/A	Origin Offset (dB) N/A	Modulation Type GMSK
Phase Err Pk (deg) 1.11	EVM (pk) N/A	C/I (dB) N/A	Mag Err (rms) 0.83 %

Phase Error is a measure of the phase difference between an ideal and actual GMSK modulated voice signal. Phase Error measurements are required for the GMSK modulated signals used for GSM voice transmissions.

Guideline For GSMK signals, phase error should be:

- Less than 5% for RMS Phase Error
- Less than 20% for Peak Phase Error

Consequences: Poor signal quality leading to dropped calls, blocked calls, and missed handoffs.

Common Faults: Phase faults can be caused by distortion in the radio units or power amplifier. Trace the fault through the signal chain to find the faulty 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.

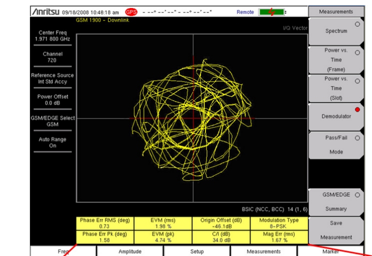
Guideline: A green "Pass" field is required for all tests.

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

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

Signal Quality Tests for EDGE

Error Vector Magnitude (EVM)
Origin Offset



Phase Err RMS (deg) 0.73	EVM (rms) 1.98 %	Origin Offset (dB) −46.1dB	Modulation Type 8–PSK
Phase Err Pk (deg) 1.58	EVM (pk) 4.74 %	C/I (dB) 34.0 dB	Mag Err (rms) 1.67 %

Error Vector Magnitude (EVM) measures the difference between an ideal and an actual 8-PSK signal. EVM measurements are required for the 8-PSK modulated signals used for EDGE data transmissions.

Guideline For 8-PSK signals, EVM should be:

- Less than 7% for EVM (rms), measured before any passive combiners
- Less than 22% for EVM (pk), measured before any passive combiners

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

Common Faults: Radio units, power amplifiers, filters and antenna system can cause EVM faults. Trace the fault through the signal chain to find the faulty Field Replaceable Unit.

Origin Offset is a measure of the DC power leaking through local oscillators and mixers. This fault lowers signal quality and is normally caused by radio units and up-converters.

Guideline: Origin Offset should be less than -30 dB for EDGE measurements.

Consequences: Origin Offset faults will lower EVM and Phase Error measurements and create higher dropped call rate.

Common Faults: Origin Offset is created in the radio units Amplifiers and passive components do not create this error.

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 on the receive channel when calls are not up.

Look first for a high received Rx noise floor by using the GSM channel power measurement on the uplink channel.

Also check for signals outside the Rx channel but still passed through the Rx filter. These 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 −100 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. This issue is often called the rusty bolt syndrome.

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