**Troubleshooting Hints**

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

<table>
<thead>
<tr>
<th>Key Performance Indicators vs. Test</th>
<th>Sync Power</th>
<th>BS Power</th>
<th>Occupied BW, ACLR, &amp; SEM</th>
<th>EVM (pk)</th>
<th>EVM (rms)</th>
<th>Freq Error</th>
<th>Rx Noise Floor</th>
<th>OTA EVM</th>
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<tbody>
<tr>
<td>Call/Session Blocking</td>
<td>x</td>
<td>x</td>
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<td>Power shortage</td>
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<td>Resource Block shortage</td>
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<td>UL Interference</td>
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<tr>
<td>LTE Interference</td>
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**Test vs. BTS Field Replaceable Units**

<table>
<thead>
<tr>
<th>Freq Ref</th>
<th>Signal Generation</th>
<th>MCPA</th>
<th>Filters</th>
<th>Antenna</th>
<th>Antenna Down Tilt</th>
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**Locating Over-the-Air Test Spots**

To test an eNodeB Over-the-Air (OTA) it is necessary to find a location with good Sync Signal (SS) dominance. The SS dominance measurements are ideal for this task. OTA testing requires SS dominance readings higher than 10 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 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 connect to the BTS for testing.

**Multiple Sector Coverage Checks**

**Sync Signal Power, Dominance, Cell ID, and EVM**

- **Sync Signal (SS)** affects cell size. SS is also used OTA to check coverage. It should be highest near the tower, declining to a minimum level at the handoff point.
- **Dominance**: The strength of the strongest SS compared to the others.
- **EVM** indicates the quality of the received signal. In this screen, EVM is measured on the PBCH signal, so as to not be affected by traffic.

**Cell, Group, and Sector ID**: Identifies the source of the OTA signals detected.

**Guidelines**:

- **Dominance**: Higher than 10 dB for OTA signal quality testing.
- **EVM**: Should be lower than 17.5% when Dominance is over 10 dB.

**Consequences**:

- **Poor Dominance**: Poor spot to test the BTS OTA. May be a result of excessive coverage, which will result in a loss of system capacity due to excessive co-channel interference.
- **Poor EVM**: Call drops, call blocking, low data rate, and low capacity.

**Wrong Cell, Group or Sector ID**: Dropped handoffs and island sectors.

**Common Faults**:

- Antenna down tilt, damaged antennas, control channel power settings, and co-channel interference.

**Direct Connect Transmitter Tests**

Transmitter tests can be run while connected to the:

- Output of the eNodeB (Point “A”).
- Test port (Point “B”) which is essentially the output of the Multi-Carrier Power Amplifier (MCPA) or the input to the receiver, depending on the timing.
- Input to the MCPA (Point “C”) if the signal is accessible
- 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 generate more revenue and provide a better return on investment.

The antenna is the last link in the transmission path. If connected at point “A”, it is helpful to sweep the antenna(s) at the same time, to ensure a high quality signal.
Channel Spectrum Occupied Bandwidth

The transmitter’s signal should be centered in the display, which indicates that the proper RF channel has been chosen. This display is also useful when looking for gross RF problems such as a low or missing signal.

Occupied Bandwidth measures the width of the frequency spectrum occupied by the transmitter’s signal. The Occupied Bandwidth contains 99% of the signal’s power.

Guideline: The defined LTE Occupied Bandwidths are 1.4, 3.0, 5.0, 10, 15, and 20 MHz.

Consequences: Excessive Occupied BW results in interference with neighboring carriers, dropped calls, and low capacity.

Common Faults: The Tx filters, MCPA, Signal Processing, and antennas may contribute to Occupied Bandwidth faults.

Rx Noise Floor

When looking for uplink interference a good first step is to check the Rx Noise Floor. To do this, check the Power vs. Time measurement.

The Transmit Off Power level both shows and measures co-channel interference when connected to an antenna port. Another good idea is to use the spectrum analyzer to check for signals outside the Tx/Rx band but still passed through the Tx/Rx filter.

Rx Noise Floor Threshold is set at 75 dBm. Rx Noise Floor can be tuned in the Rx noise floor settings.

Guideline: Less than approximately –80 dBm. This level varies with the TD-LTE RF channel bandwidth.

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

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

Tx Test MIMO Verification

Tx Test measurement can be used OTA to verify low co-channel interference, MIMO operation, OTA EVM and frequency error. It is particularly useful for Remote Radio Head (RRH) installations where it’s difficult to get direct access to the transmitters. However, it can also be used in direct connect configuration to verify each MIMO transmitter. The MIMO indicator verifies which transmitter is connected.

Guideline: OTA as a quality indicator - One cell ID detected at measurement position (use directional antenna) or at least 20 dB dominance, RS Delta power < 3 dB, EVM < 10%. Frequency Error < 0.0 Hz (GPS). Measure at installation, track changes.

Consequences: Poor or no MIMO operation will result in poor throughput, low sector capacity, dropped and blocked calls. Low dominance means high co-channel interference with similar consequences.

Common Faults: Disconnected or misconnected (inter-sector cross connections) MIMO transmitters, faulty power amplifiers, poor antenna installation.

Power vs. Time Timing Error

Timing Error is a measure of how well eNodeB’s and TD-LTE base stations are synchronized.

Transmit Off Pwr is a measure of the received power when the eNodeB is not transmitting. See the Rx Noise Floor section for details.

Guideline: Timing Error maximum values will be determined by experience. However, a value of 10% of the shortest guard period, or 100 micro-seconds, is approximately right.

Consequences: Excessive timing error leads directly to co-channel interference with neighboring eNodeB’s and TD-LTE base stations.

Common Faults: Poor GPS signal or a faulty timing distribution system.

Out-of-Channel Emissions

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

ACLR and SEM are used to measure how much of the transmitted signal leaks into adjacent channels. ACLR is used to look for error conditions further away, and SEM is used to look for error conditions closer to the carrier.

ACLR and SEM checks the closest (adjacent) and second closest (alternate) RF channels on TD-LTE signals.

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

Consequences: The eNodeB 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 the 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 Error Vector Magnitude (EVM)

EVM is the ratio of errors, or distortions, in the actual signal, compared with a perfect signal. EVM, in this screen, measures the PBCH, if there is no data traffic, and the PDSCH if there is traffic.

EVM is the single most important signal quality measurement.

Guideline: 17.5% for QPSK modulation, 12.5% for 16 QAM modulation, and 8% for 64 QAM modulation when measured while connected to the eNodeB.

Consequences: Poor EVM leads to dropped calls, low signal quality, low data rate, low sector capacity, and blocked calls.

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

OTA Testing, with Google Maps, allows analysis of signal quality at a particular location, or series of locations. This is a good way to find coverage and interference problems.