/Anritsu

Practical Tips on WCDMA Measurements

MT8222A   MS272xB
BTS Master™   Spectrum Master™

Introduction

This is a practical Wideband Code Division Multiple Access (WCDMA) measurement procedures note. The objective of this note is to present measurement tips and procedures which will help a field-based network technician or RF engineer conduct Node B measurements on WCDMA access networks.

Evolution To WCDMA

In the mid 1980's a second generation (2G) digital system known as the Global System for Mobile Communications (GSM) was introduced for mobile telephony. It significantly improved speech quality over the older analog-based systems and, as it was an international standard, enabled a single telephone number and mobile phone to be used by consumers around the world. It led to significantly improved connectivity and voice quality, as well as the introduction of a whole slew of new digital services like low-speed data. Proving to be very successful, GSM was officially adopted by the European Telecommunications Standardization Institute (ETSI) in 1991. It is now widely used in over 160 countries worldwide.

The success of GSM spurred the demand for further development in mobile telephony, and put it on an evolutionary path to third generation (3G) technology. Along the way, that development path has included 2G technologies like Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). TDMA is similar in nature to GSM and provides for a tripling of network capacity over the earlier AMPS analog system. In contrast, CDMA is based on the principles of spread spectrum communication. Access to it is provided via a system of digital coding.

In 1997 a 2.5G system called the General Radio Packet Service (GPRS) was introduced to accommodate the growing demand for Internet applications. As opposed to the existing 2G systems, it offered higher data rates and Quality of Service (QoS) features for mobile users by dynamically allocating multiple channels. GPRS installs a packet switch network on top of the existing circuit switch network of GSM, without altering the radio interface.

In 1999, the International Telecommunications Union (ITU) began evaluating and accepting proposals for 3G protocols in an effort to coordinate worldwide migration to 3G mobile networks. These proposals were known as International Mobile Telecommunication 2000 (IMT-2000). One of the most important IMT-2000 proposals to emerge was Universal Telecommunications Services (UMTS).

While GPRS is considered the first step in enhancing the GSM core network in preparation for EDGE and 3G, WCDMA is a 3G technology according to the 3GPP standard (Figure 1). It is the digital access system for the UMTS network and is today considered one of the world's leading 3G wireless standards.
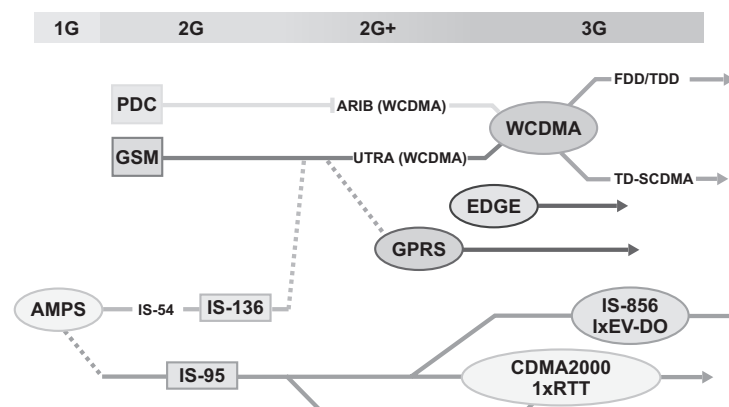

Figure 1. *Evolution of cellular technologies.*

Understanding WCDMA

WCDMA is an approved 3G technology which increases data transmission rates via the Code Division Multiplexing air interface, rather than the Time Division Multiplexing air interface of GSM systems. It supports very high-speed multimedia services such as full-motion video, Internet access and video conferencing. It can also easily handle bandwidth-intensive applications such as data and image transmission via the Internet.

WCDMA is a direct spreading technology, it spreads its transmissions over a wide, 5 MHz, carrier and can carry both voice and data simultaneously. It features a peak data rate of 384 kbps, a peak network downlink speed of 2 Mbps and average user throughputs (for file downloads) of 220-320 kbps. In addition, WCDMA boasts increased capacity over EDGE for high-bandwidth applications and features which include, among other things, enhanced security, QoS, multimedia support, and reduced latency (Table 1).

Parameters	WCDMA
Bandwidth	5 MHz
Chip Rate	3.84 Mcps
Power Control Frequency	1500 Hz up/down
Base Station Synchronization	Not needed
Cell Search	3-step approach via primary, secondary search code and CPICH
Downlink Pilot	CDM common (CPICH) TDM dedicated (bits in DPCH)
User Separation	CDM/TDM (shared channel)
2G Interoperability	GSM-UMTS handover (Multi-mode terminals)

Table 1. System performance fo WCDMA

WCDMA networks offer a number of significant benefits. They are:

- High bandwidth and low latency which contributes significantly to a higher-quality user experience and in turn increases data revenue and improves customer satisfaction.

- Support for a wide array of new and emerging multimedia services.

- Considered the most cost-effective means of adding significant capacity for both voice and data services.

- Far better integration of RF components in the base station as compared to any other radio or mobile technology. A WCDMA base station cabinet has several times the RF capacity of GSM cabinets.

- Extreme flexibility in allocating capacity to offer the optimal QoS for different traffic types.

To date, WCDMA has been adopted for 3G use as specified in the 3GPP standard by ETSI in Europe, and as an ITU standard under the name "IMT-2000 direct spread." NTT DoCoMo launched the first WCDMA service in 2001 and now has millions of subscribers. WCDMA (BTS) is also the 3G technology of choice for many GSM/GPRS operators, with dozens currently in trials. More than 100 GSM/GPRS operators have even licensed new spectrum with the intent to launch WCDMA services in the coming years.

WCDMA Basics

Unlike GSM and GPRS, which rely on the use of the TDMA protocol, WCDMA – like CDMA - allows all users to transmit at the same time and to share the same RF carrier. Each mobile user's call is uniquely differentiated from other calls by a set of specialized codes added to the transmission.

WCDMA base stations differ from some of the other CDMA systems in that they do not have to be in system-wide time synchronization, nor do they depend on a Global Positioning System (GPS) signal. Instead, they work by transmitting a sync signal along with the downlink signal.

A downlink or forward link is defined as the RF signal transmitted from the base station to the subscriber mobile phone. It consists of the RF channel, scrambling code (one per sector), an orthogonal variable spreading factor (OVSF) channel for signaling (one per call), and one or more OVSF channels for data (Figure 2). It also contains the sync signals (P-SCH and S-SCH), which are independent of OVSF and scrambling codes. The RF signal transmitted from the mobile phone is referred to as the uplink or reverse channel.
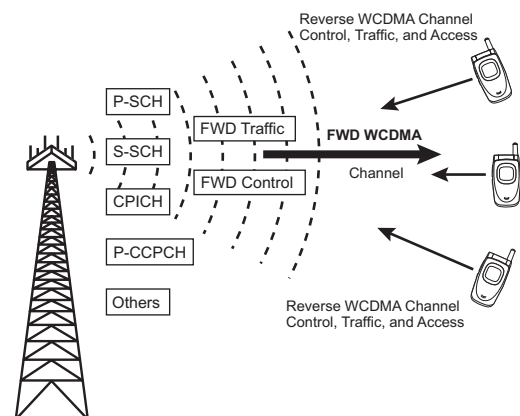

Figure 2. WCDMA channel structure

The WCDMA downlink and uplink data streams run at a constant 3.84 Mcps, are divided into time slots and grouped as frames. The frame is the basic unit of data information that the system works with in the coding, interleaving and transmitting processes.

Data transmitted via a WCDMA network – whether digitized voice or actual data – is spread using a code which is running at a 3.84 Mbps code rate. Once the transmitted data is received by the subscriber's mobile receiver, its demodulator/correlator reapplies the code and recovers the original data (Figure 3). The signal received by the mobile is a spread signal together with noise, interference and messages on other code channels in the same RF frequency slot. The interference may emanate from multiple sources including other users in the same cell or from neighboring cells.
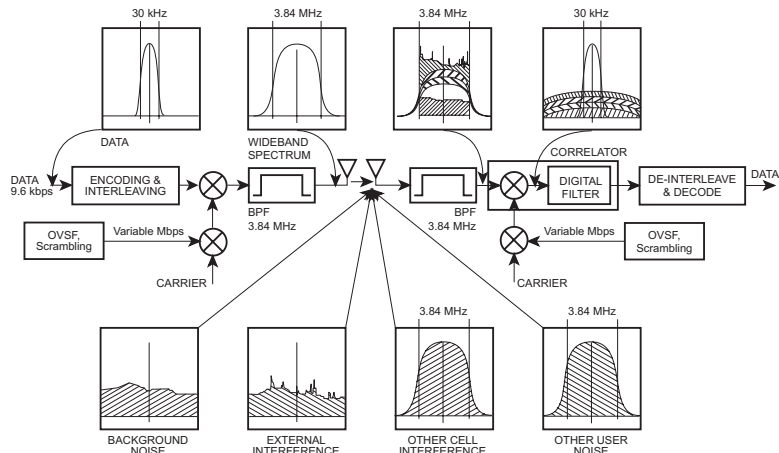

Figure 3. Signal spreading and correlation in a WCDMA base station

WCDMA has two basic modes of operation:

- Frequency Division Duplex (FDD) mode. Here separate frequencies are used for uplink and downlink. FDD is currently being deployed and is usually referred to as WCDMA.

- Time Division Duplex (TDD) mode. In this mode, the uplink and downlink are carried in alternating bursts on a single frequency.

Note that this Application Note focuses on FDD systems only.

One of the important features of a WCDMA system is its highly adaptive radio interface. WCDMA is designed to allow many users to efficiently share the same RF carrier by dynamically reassigning data rates. The spreading factor (SF) may be updated as often as every 10 ms, which in turn, permits the overall data capacity of the system to be used more efficiently.

Some of the key things to remember about WCDMA are:

- In WCDMA, the RF signal from each base station sector is "scrambled" by multiplying the data and voice channels by a unique pseudo-noise code, known as the Scrambling Code. The Scrambling Code is mixed prior to the output of a base station or the output of a subscriber's mobile unit. WCDMA base stations (Node B's) use one of 512 Scrambling Codes to uniquely identify each sector in the network.

- Adjacent base stations use the same RF frequency for spectral efficiency. WCDMA employs a frequency reuse method in which the same frequency is used at every site, with forward links separated from one another by Scrambling Codes.

- WCDMA uses channelization codes, known as OVSF codes or Spreading Codes, to uniquely identify a Dedicated Physical Channel (DPCH) user channel. At the receiver, the received RF signal passes through the correlator, that separates and identifies the code channels (pilot, signaling or user data/voice) of each WCDMA channel it sees. Other spreading code channels are used for the pilot (P-CPICH), signaling, user voice or user data. Higher user data rates can be achieved by shortening the spreading factor, thereby increasing the transmission rate.

Note that the synchronization channels, P-SCH and S-SCH, do not go through the OVSF spreading process. The OVSF codes are orthogonal codes used to separate traffic in a WCDMA signal. Any mobile phone that receives a transmitted data sequence and attempts to demodulate it using the "wrong" orthogonal code, would interpret the information as noise. The noise, when integrated over time, will net to zero. As a result, interfering signals not intended for a given mobile phone are effectively eliminated by signal processing in the mobile phone's receiver. The OVSF codes can be reused by each base station and mobile phone within the same location, since the scrambling codes identify the transmitting device.

WCDMA Versus GSM

GSM was the first digital cellular system. It uses TDMA as its air interface standard and Gaussian Modulated Shift Keying (GMSK) on the RF air interface. GSM systems in Europe operate in 900 and 1800 MHz bands, while in the United States they operate in the 800 MHz (cellular) and 1900 MHz Personal Communications Services (PCS) bands.

There are many similarities between WCDMA and GSM systems including the fact that both the GSM Base Station Subsystem (BSS) and the WCDMA Radio Access Network (RAN) provide a radio connection to the handset via the same GSM core network (Figure 4). Both are also based on the principles of a cellular radio system. The GSM Base Station Controller (BSC) corresponds to the WCDMA Radio Network Controller (RNC), while the GSM Radio Base Station (RBS) corresponds to the WCDMA RBS.
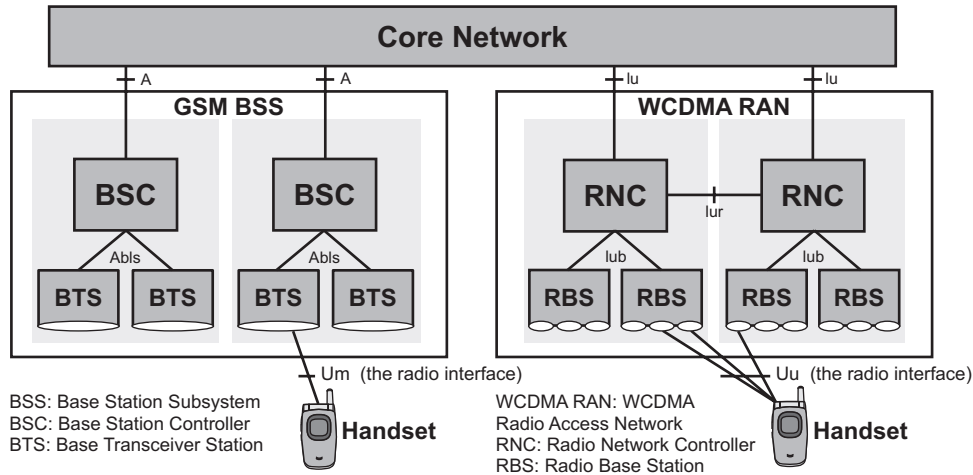
GSM/WCDMA Architecture

Figure 4. Although GSM and WCDMA are different technologies, they both share the same core network.

The significant differences between the two standards, apart from the lack of an interface between the GSM BSCs and an insufficiently specified GSM Abis-interface to provide multi-vendor operability, include the following:

- GSM uses TDMA technology with a lot of radio functionality based on managing the timeslots. WCDMA systems use CDMA technology in which both the hardware and control functions are different.

- GSM was created with voice as the primary application. WCDMA includes support for voice, high-speed packet data and multimedia applications.

- The underlying WCDMA air interface is much more performance sensitive and its operation shares many more similarities with its rival CDMA2000 than its predecessor GSM. To achieve link-level performance gains over GSM's equalization and frequency hopping techniques, WCDMA uses rake receiver technology for diversity gain.

- WCDMA employs a fast power control scheme — 1500 Hz on both the up and downlink — to deal with CDMA's inherent near-far interference issues. GSM, which features a hard capacity due to its fixed frequency reuse scheme, employs a very slow (2 Hz) power control scheme.

Understanding WCDMA Measurements

Proper characterization of complex WCDMA signals requires field technicians to measure many different types of parameters. The WCDMA measurements that can be made with BTS Master include:

- **Carrier Frequency**
  Carrier frequency is defined as the selected transmitter operating center frequency, entered by the user or calculated from the signal standard, and channel number, entered by the user.

- **Carrier Feedthrough**
  Carrier Feedthrough measures the amount of unmodulated signal that is leaking through the transmitter and is displayed in the Code Domain Power display. The WCDMA 3GPP specification does not specify Carrier Feedthrough measurement.

- **Code Domain Power (CDP)**
  CDP displays how much of the power is in each code channel (Figure 5). Power is normalized to the total power, so if a code reads –10dB, it means that the code is one tenth of the channel power. Colors are applied according to the following:
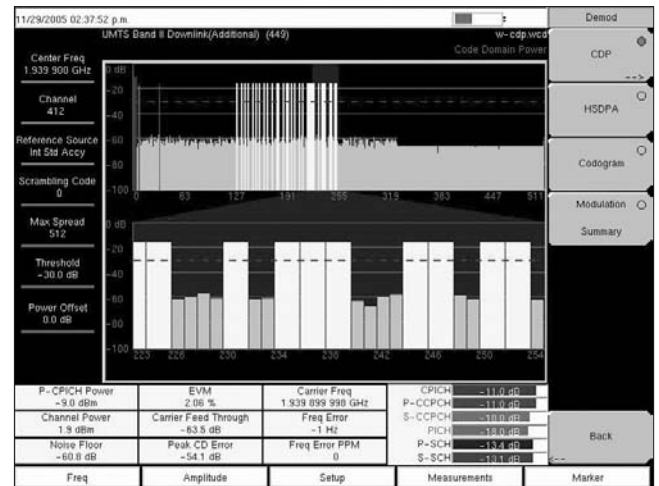

Figure 5. *CDP display example.*

Parameter	Description	Color	Viewable on Display
CPICH	Common Pilot Channel	Red	All CDP views
P-CCPCH	Primary Common Control Physical Channel	Magenta	All CDP views
S-CCPCH	Secondary Common Control Physical Channel	Cyan	All CDP views
PICH	Paging Indicator Channel	Green	All CDP views
P-SCH	Primary Sync Channel	Navy Blue	Control Channels
S-SCH	Secondary Sync Channel	Blue	Control Channels
Traffic	WCDMA Traffic	Yellow	All CDP views
Noise	Noise	Grey	All CDP views

Table 2. *Parameters description table*

Note that in the WCDMA specification, the P-SCH and S-SCH signals are not assigned spreading codes and therefore do not appear in the CDP display. The P-SCH and S-SCH signals are displayed in the control channel table. They have special non-orthogonal scrambling codes and are on 10% of the time.

- **Channel Power** is the total power transmitted in the 3.84 MHz WCDMA channel specified. Channel power measures the Node B/base station transmitting power across the entire 3.84 MHz WCMDA channel and is measured in units of dBm and Watts. For Over The Air (OTA) measurements, the channel power will vary as the signal path from the Node B transmitter to the BTS Master MT8222A varies.

- **Scrambling Code**
  According to the WCDMA specification, the scrambling code can be from 0 to 511. If the scrambling code is known, its value can be entered and the test set can decode and display the CDP of the signal. If the scrambling code is unknown, BTS Master can be set to auto scrambling (automatically detect the scrambling code) so that the test set can lock on to the strongest code to decode and display the CDP of the signal.

- **Spreading Factor (OVSF Codes)**
  According to the 3GPP standard the spreading factor can vary from 4 to 512. BTS Master can be set to a maximum spreading factor of either 256 or 512, depending upon the network requirements.

- **Frequency Error**
  Frequency error is the difference between the received center frequency and the specified center frequency. This value is tied to the external frequency or when the GPS option is installed it is tied to the internal OCXO oscillator frequency accuracy. It is typically only useful with the GPS option or a good external frequency reference.

- **Codogram**
  When codogram is selected the screen displays the changes in code power levels over time.
- **Noise Floor**
  The average power of the unused scrambling codes, displayed in CDP and OTA measurement displays.
- **Threshold**
  The active channel threshold power level can be set to indicate which code channels are considered active. Any code channels exceeding this power level are considered active traffic channels. Any code channels below this power level are considered inactive (or noise). A horizontal red line on the screen represents the threshold level. BTS Master can set this level automatically based on the received signal. The user can also opt to manually enter a value in the threshold setup menu.
- **Occupied Bandwidth** is the total integrated power occupied in a given signal bandwidth.
- **Error Vector Magnitude (EVM)** is the ratio, in percent, of the difference between the reference waveform and the measured waveform. EVM metrics are used to measure the modulation quality of a transmitter. The 3GPP standard requires the EVM not to exceed 17.5%.
- **Symbol EVM (@EVM)** is defined as the EVM for a single code channel.
- **Peak to Average Power** is the ratio of the peak power and the RMS power of the signal calculated over one frame interval and is measured in units of dB.
- **Peak Code Domain Error (PCDE)** takes the noise and projects the maximum impact it will have on all OVSF codes. PCDE is the maximum value for the code domain error for all codes (both active and inactive). Note that in the 3GPP standard, to address the possibility of uneven error power distribution in WCDMA, the EVM measurement has been supplemented with PCDE. The 3GPP standard requires the PCDE not to exceed –33 dB at a spreading factor of 256.
- **Ec** is a measurement of chip energy for CPICH.
- **Ec/Io** is the value of the pilot power compared to the total channel power.
- **Pilot Dominance** is the strength of the strongest pilot compared to the next strongest pilot from different base stations or from different sectors of the same base station. This value should be >10 dB to make good measurements.
- **Total Power** is the sum of all the scrambling codes; also called Io. It is measured in units of dBm.
- **CPICH Abs Power** is the absolute power of the common pilot channel power measured in units of dBm.
- **P-CCPCH Abs Power** is the absolute Primary Common Control Physical Channel power measured in units of dBm.
- **S-CCPCH Abs Power** is the absolute Primary Common Control Physical Channel power measured in units of dBm.
- **P-SCH Abs Power** is the absolute Primary Sync Channel power measured in units of dBm.
- **S-SCH Abs Power** is the absolute Secondary Sync Channel Power measured in units of dBm.
- **PICH** is the Paging Indicator Channel Power.

Making WCDMA Measurements

The Anritsu BTS Master MT8222A can measure WCDMA performance in one of two ways, either:

- Over The Air (OTA) with an antenna.
- Via Direct Connection of BTS Master to any Node B/WCDMA base station.

Setup

Making WCDMA measurements with BTS Master requires some initial Setup, regardless of whether the measurement will be taken Over The Air or via a Direct Connection. BTS Master must be configured to tune to the frequency being output by the base station. The user can either enter the center frequency of the channel or select the signal standard and channel. If the applicable information is not stored in the unit, Master Software Tools may be used to create the signal standard and then subsequently download it into the unit.

To set the center frequency or select the signal standard and channel number, follow these steps:

1. Switch on BTS Master. Press **Mode** to select WCDMA Signal Analyzer.

2. Press the **Freq** function hard key.

3. Press the **Center Freq** soft key.

4. Enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels will change to GHz, MHz, kHz and Hz. Select the appropriate units key. Selecting the **Enter** key has the same affect as selecting the **MHz** soft key.

5. Press the **Enter** key to set the Center Frequency. The current setting is shown on the left side of the display.

6. To select a signal standard, press the **Freq** function hard key.

7. Select the **Signal Standard** soft key.

8. Using the **Up/Down** arrow keys or the rotary knob, highlight a signal standard and press Enter to select. When a signal standard is selected, the center frequency for the first channel of the selected standard is automatically tuned.

9. Select the **Channel** soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display. The current settings are displayed on the left side of the screen.

Additional Configuration

Additional procedures for configuring BTS Master include:

Scrambling Code Setup

The BTS Master MT8222A can set up a scrambling code automatically or manually. In Auto mode the unit automatically locks on to the strongest scrambling code in the signal. To automatically set the Scrambling Code:

1. Press the **Setup** function hard key.

2. Press the **Auto Scrambling** soft key and **AUTO** to select either On or Off.

In Manual mode the desired code is manually entered and the unit looks only for that specific scrambling code. To manually set up a Scrambling Code:

1. Press the **Setup** function hard key.

2. Select the **Scrambling Code** soft key and use the keypad, the arrow keys or the rotary knob to enter the desired Scrambling Code, as shown on the left side of the screen.

3. Press the **Enter** key to set the Scrambling Code.

Maximum Spreading Factor Setup

In a WCDMA system, the number of chips per data symbol is called the Spreading Factor. In this case, the lower the spreading factor the higher the data rate. The BTS Master MT8222A can be set to 256 or 512 maximum spreading factors. To set up the maximum spreading factor:

1. Press the **Setup** function hard key.

2. Press the **Max Spreading Factor** soft key to select either 256 or 512 according to the network requirements.

S-CCPCH Spreading Factor, S-CCPCH Code and PICH Code Setup

In the 3GPP specification, two optional control channels are provided for S-CCPCH and PICH. These codes can have different spreading codes and spreading factors. In BTS Master the S-CCPCH spreading factor, S-CCPCH and PICH codes can be manually entered following these steps:

1. Press the **Setup** function hard key.

2. Select the **S-CCPCH Spread** soft key and manually enter the desired spreading factor.

3. Select the **S-CCPCH Code** soft key and manually enter the desired spreading code.

4. Select the **PICH Code** soft key and manually enter the desired spreading code.

For the most accurate results, manually enter the S-CCPCH spreading and S-CCPCH and PICH codes before making the measurement. The default values for the S-CCPCH spreading factor and S-CCPCH and PICH codes are 256, 3 and 16, respectively.

Threshold Setup

The threshold level is an advanced setting that can be set to indicate which codes are considered active. To manually set the threshold level:

1. Press the **Setup** function hard key.

2. Select the **Threshold** soft key and use the keypad, the arrow keys or the rotary knob to enter the desired threshold.

3. Press the **Enter** key to set the threshold.

Note that the default threshold level is −30 dB.

With the initial Setup complete, you are now ready to begin making WCDMA measurements.

Making Direct Connect Measurements

BTS Master can demodulate the WCDMA signal by connecting to the base station/Node B. To connect the base station/Node B directly to BTS Master, connect the power amplifier of the base station/Node B to the RF In connector of the BTS Master using a coupler or attenuator (Figure 6). Note that the maximum input damage level of the RF In port is +43 dBm. To prevent damage always use a coupler or high power attenuator.

If you choose to measure WCDMA performance using this technique, additional Setup for frequency reference and power offset is required to obtain accurate results. For example, achieving the best frequency accuracy measurements requires the use of an external reference frequency attached to the BTS Master Ext Ref In connector. The user may also use built-in GPS receiver option. Most Node B equipment have a reference frequency available on a BNC connector.

Figure 6. *Illustrated here is the connection required to make WCDMA measurements using BTS Master via direct connection to the base station/Node B.*

To configure BTS Master to use an external reference frequency:

1. Press the **Setup** function hard key.

2. Press the **Select Reference Frequency** soft key to display a list of the available reference frequencies.

3. Use the **Up/Down** arrow keys, or the rotary knob, to highlight the applicable reference frequency on the list. Press the **Enter** key to set the reference frequency.

As BTS Master locks to the source, the Reference Freq value is displayed in the user settable parameters to the left of the display.
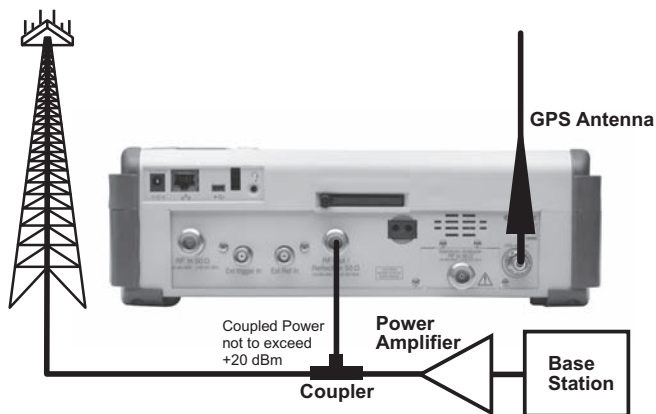
To configure BTS Master to use GPS:

1. Install the Anritsu GPS antenna to the GPS antenna connection on the BTS Master connector panel. One antenna now available from Anritsu and suitable for this purpose is the 2000-1410 Magnet Mount GPS Antenna with 5m (15 ft.) cable. Note that the GPS antenna connection on BTS Master is fitted with a reverse BNC connector to help prevent damage to the GPS circuitry. There is a DC voltage present on this connector. Never connect anything other than the Anritsu GPS antenna to this port.

2. Press the **Shift**, then **System** keys, to open the system options.

3. Press the **GPS** soft key to open the GPS menu.

4. Press the **GPS On/Off** soft key to turn the GPS feature on or off. When GPS is first turned on, the GPS icon below will be displayed in red:

When the GPS receiver is tracking at least three satellites, the GPS icon will change to green as shown:

Note that it may take as long as three minutes for the Ref Freq status to change to GPS High Accuracy in the Status menu displayed on the left side of the screen.

5. Press the **GPS Info** soft key to view the number of tracked satellites, latitude, longitude, altitude, and UTC timing information, etc...

Note that to reset the GPS, press the **Reset** soft key.

The green GPS icon with a red cross appears when GPS satellite tracking is lost. This occurs after being active (tracking three or more satellites).

Within three minutes of satellite acquisition, the reference oscillator will have an accuracy of less than 25 ppb (parts per billion). The OCXO internal standard accuracy is ±0.3 ppm. The correction factor applied to the internal OCXO allows the instrument to maintain GPS frequency accuracy for three days, even when the instrument is obstructed from receiving signals from the GPS satellites. In order to acquire data from the GPS satellites, the user must have line-of-sight to the satellites or the antenna must be placed outside with out any obstructions.

Once GPS High Accuracy is achieved, the internal reference is adjusted and will hold this adjusted value even when GPS satellites can no longer be received. This status will be indicated by "Internal High Accuracy" showing in the Status menu displayed on the left side of the screen. This improved frequency accuracy of better than 50 ppm will hold up to three days. Note: When the GPS feature is not enabled, the reference source will display either "Internal Standard Accuracy" or a user selected external reference frequency in the Status menu on the left side of the screen.

BTS Master also needs to compensate for the external attenuation using power offset to ensure accurate results. The external attenuation is caused by using an external cable or external high power attenuator. To set the power offset to compensate for external losses:

1. Press the **Amplitude** function hard key.

2. Press the **Power Offset** soft key and use the keypad, the arrow keys or the rotary knob to enter the desired offset value. Press the **Enter** key to set the Power Offset. The value entered is displayed on the left side of the screen.

Making Over The Air Measurements

The OTA method is considered the most preferable means of making WCDMA Node B measurements as it offers a more cost-effective, time-efficient approach to testing. Its proactive nature reduces the amount of time that performance degradations exist within a base station and minimizes the likelihood of a catastrophic failure. When a problem is detected, the OTA test provides insight into the cause, enabling the technician to ensure that the right tools and parts are available when the time comes to fix the problem on site.

Using the OTA test, technicians can execute a diagnostic test in less than five minutes without even getting out of their vehicles, although the vehicle should be parked close to the site. The OTA test enables field technicians to examine real-time traffic loading and power distribution, as well as to quickly see if the capacity already in place at the site is being utilized efficiently. Also, it provides field technicians with the ability to monitor hard to reach pole-top base stations.

If you chose to measure WCDMA performance Over The Air with an antenna, then additional set-up is required to obtain accurate results. To begin with, ensure that BTS Master MT8222A is not connected to the base station/Node B equipment (Figure 7). Next a Scrambling Code must be set-up, either automatically or manually, as per "**Additional Configuration**" section (page 7).

The OTA measurement screen displays the six strongest Scrambling Codes as bar graphs. Underneath the bar graphs, displayed in tabular format, are the scrambling code number, CPICH, Ec/Io, Ec and pilot dominance related to each of the strongest scrambling code. The OTA screen can be locked by pressing the **Code Lock On/Off** soft key. The Display Unit soft key is used to display the OTA bar graph by selecting CPICH or Ec/Io. The default display is CPICH. The **Sort By** soft key displays the scrambling codes sorted by Power or Code.

Figure 7. Making WCDMA measurements Over The Air requires the set-up shown here.

Note that to ensure accurate OTA measurement results in different locations, the Reset button must be pressed at each new location.

WCDMA RF Measurements

WCDMA RF measurements are Band Spectrum, Channel Spectrum, Adjacent Channel Leakage Ratio (ACLR) and Spectral Emission Mask. When making WCDMA RF measurements, you must first connect BTS Master to the base station/Node B equipment as shown in Figure 6. To make this connection, follow the direct connect procedure specified in the "**Making Direct Connect Measurements**" section (page 8).

For Band Spectrum and Channel Spectrum Measurements:

1. Follow steps 1-7 in the "**Setup**" section, then press the **Measurements** function hard key.

2. Press the **RF Measurements** soft key.

3. Press the **Band Spectrum** soft key to activate the band spectrum measurement. The red dot on the soft key indicates that it has been selected (Figure 8).

Note: To select the applicable channel, select the **Band Spectrum** soft key, Using the Band Spectrum cursor, select the desired channel and the unit will automatically display the measurements for the selected channel when the Channel Spectrum is selected.
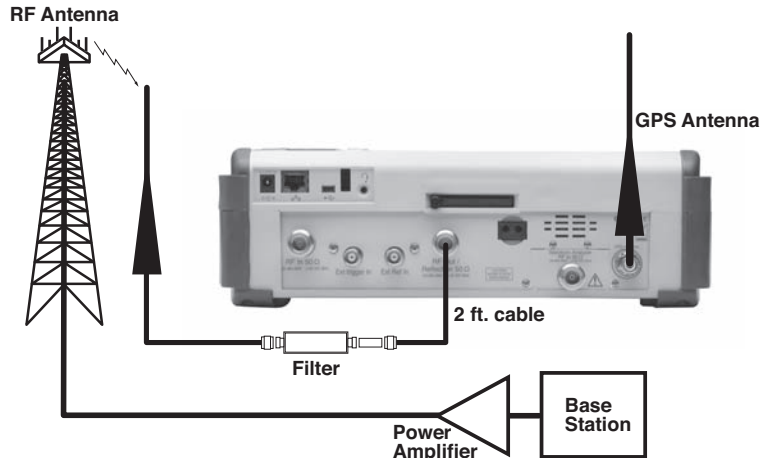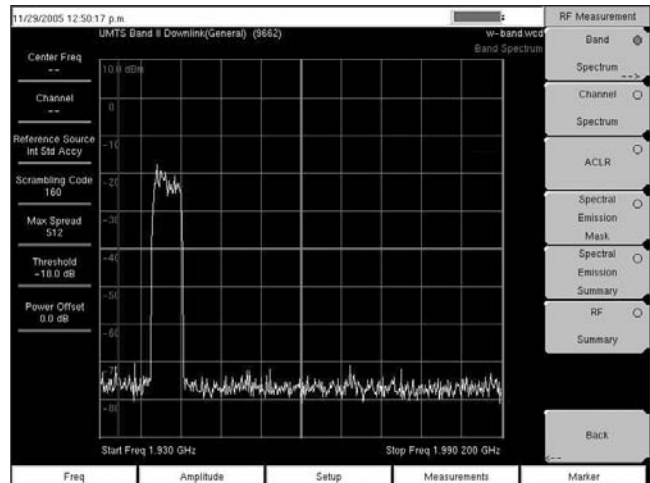

Figure 8. RF Band Spectrum example

Note that the BTS Master RF spectrum screen displays the selected channel signal, as well as the following measurements: carrier frequency, channel power in units of dBm and Watts, frequency error in units of kHz and PPM, occupied bandwidth, peak-to-average power, and noise floor measurements (Figure 9).

For ACLR Measurements:

Adjacent Channel Leakage Ratio (ACLR) is defined as the ratio of the amount of leakage power in an adjacent channel to the total transmitted power in the main channel. The BTS Master can make single channel and multi-channel ACLR measurements. In the 3GPP specification only single carrier ACLR measurement is listed. The BTS Master ACLR screen displays the main channel power and the power of two adjacent channels on each side as a bar graph. The channel spacing is –10 MHz, –5 MHz, +5 MHz and +10 MHz. The channels are color coded.
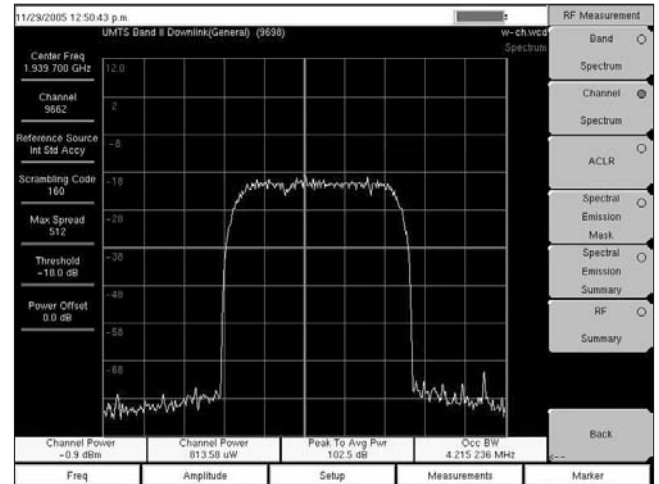

Figure 9. RF Channel Spectrum example

In the ACLR measurement mode the filtered channel power is used to determine ACLR values. It is listed as filtered on the display. In all other screens the unfiltered channel power is displayed as channel power. The 3GPP standard requires the adjacent channel power leakage ratio to be better than 45 dB at 5 MHz offset and 50 dB at 10 MHz offset.

The BTS Master can also make ACLR measurements for mulit-channel systems by measuring the main channels and the adjacent channels, from one to four channels. The ACLR screen can display up to 12 channels total. The 3GPP specification does not define mulit-channel ACLR measurement.

To make ACLR Measurements:

1. Press the **Measurements** function hard key.

2. Press the **RF Measurements** soft key.

3. Press the **ACLR** soft key to activate the ACLR measurement. The red dot on the soft key indicates that it has been selected (Figure 10).

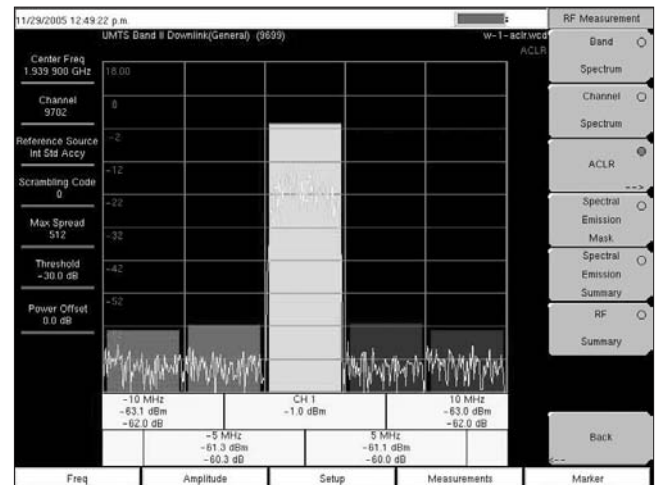4. Press the **ACLR** soft key again and select one main channel and two adjacent channels.

Multi-channel ACLR Procedure

1. Press the **Measurements** function hard key.

2. Press the **RF Measurements** soft key

3. Press the **ACLR** soft key to active the ACLR measurement. The red dot on the soft key indicates that it has been selected.

4. Press the **ACLR** soft key again and select the number of main channels as four and adjacent channels as four (Figure 11).
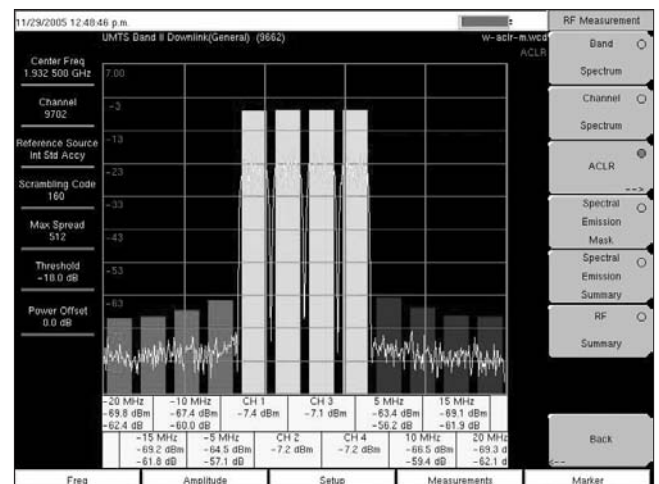

Figure 10. ACLR example

Figure 11. Multi-channel ACLR example

For Spectral Emission Mask Measurements:

The Spectral Emission Mask displays the selected signal and mask, as defined in the 3GPP specification. The mask varies depending on the input signal. BTS Master also indicates if the signal is within the specified limits by displaying PASSED or FAILED in that region. The 3GPP specification specifies four masks depending on the base station output power:

- P ≥43 dBm

- 39 ≤P <43 dBm

- 31 ≤P <39 dBm

- P <31 dBm

  Note that BTS Master MT8222A will automatically select the applicable mask, depending on the base station output power.

To make Spectral Emission Mask measurements:

1. Follow Steps 1 - 3 in the "**For Band Spectrum and Channel Spectrum Measurements**" portion of the "**WCDMA RF Measurements**" section (page 10).

2. Press the **Measurements** function hard key.

3. Press the **RF Measurements** soft key.

4. Press the **Spectral Emission Mask** soft key to activate the Spectral Emission Mask measurement (Figure 12). The red dot on the soft key indicates that it has been selected. If the signal meets the mask, the mask will turn green. If the signal does not meet the mask, the mask color will turn red for that particular frequency range. In the Spectral Emission summary table that frequency range will be displayed as failed.

5. Press the Spectral Emission Summary soft key to display the Spectral Emission summary table (Figure 13). The red dot on the soft key indicates it is selected.

Note that BTS Master displays an RF Summary screen with all the critical transmitter performance measurements listed in tabular format, without demodulating the WCDMA signal (Figure 14). The parameters featured in the RF summary table are Channel Power in dBm and Watts, Carrier Frequency, Frequency Error, Spectral emission PASS/FAIL criteria, Occupied Bandwidth, Peak to Average Power, ACLR at –10 MHz, –5 MHz, 5 MHz and 10 MHz channels.
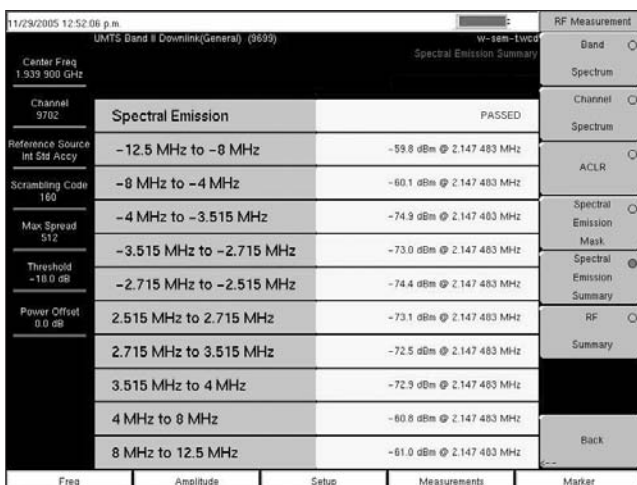

Figure 12. Spectral Emission Mask Measurement screen.
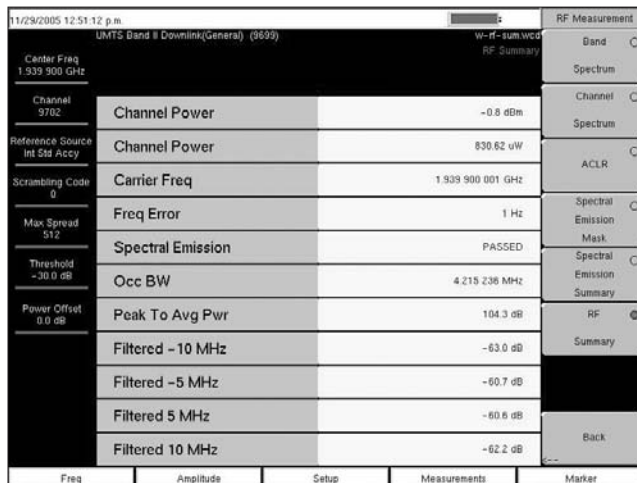

Figure 13. Spectral Emission summary table.

Figure 14. RF Summary example.

Demodulating WCDMA Signals

Demodulation is the process whereby the changes imposed on the carrier at the receiver are removed to reveal the message at the receiver. BTS Master demodulates WCDMA signals either by connecting directly to the base station/Node B equipment or Over The Air with an antenna. The demodulation results can be displayed in a CDP, Codogram or Modulation Summary Screen.

To demodulate WCDMA signals using direct connect, follow the procedure listed in the direct connect setup in the "**Making Direct Connect Measurements**" section (page 8). Then proceed as follows:

For Code Domain Power (CDP) Screen:

The CDP display includes spreading factor (OVSF codes) set to 256 or 512 and features a "zoom in" capability in which BTS Master can zoom to 32, 64 and 128 codes. The user can input the zoom code to start the zoom in from the entered OVSF codes. The demodulator also displays CPICH, P-CCPCH, S-CCPCH, PICH, P-SCH and S-SCH power in A a separate Common Control view.

For measurement results via the CDP Summary Screen:

1. Follow steps 1-9 in the "**Setup**" section (page 7) or follow Steps 1 - 3 in the "**For Band Spectrum and Channel Spectrum Measurements**" portion of the "**WCDMA RF Measurements**" section (page 10).

2. Press the **Measurements** function hard key.

3. Select the **Demodulator** soft key to activate the demodulator menu.

4. Press the **CDP** soft key to activate the CDP measurement. The red dot on the soft key indicates it is selected.

5. Press the **CDP** soft key again to activate the zoom function.

6. Press the **Zoom** soft key to select the appropriate zoom level. The Zoom key toggles between 32, 64 and 128.

7. Press the **Zoom Start** soft key to manually enter the zoom start code.

8. Press the **Back** soft key to go back to the CDP measurement. Note that the blue color block on the CDP screen represents the selected zoom codes. The same codes are displayed in the zoom screen (Figure 15).

Note that Markers can be used to read the individual code power and type of code. Markers can be activated in all the WCDMA measurements by following these steps:

1. Press the **Marker** function hard key to display the Marker menu.

2. Press the **Marker** soft key to select the appropriate marker (1-6). The underlined marker number is the currently selected marker.

3. Press the **On/Off** soft key to activate the selected marker.

4. Press the **Marker Table** soft key to display the Marker table (Figure 16). The marker table is displayed on the screen below the CDP measurements table.

Figure 15. *Code Domain Power Measurement*

Figure 16. *CDP with six markers*

Note that Markers in the CDP used to display the Symbol EVM or EVM of a specific code channel. To measure Symbol EVM, simply place the Marker on the selected code. The Marker will then display the EVM of that code (Figure 16).
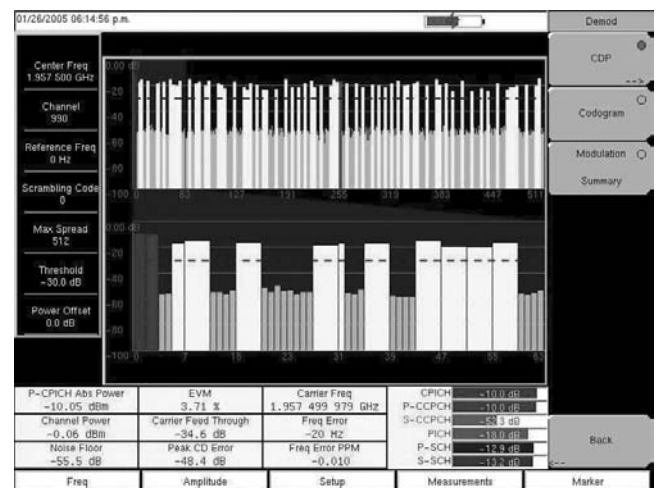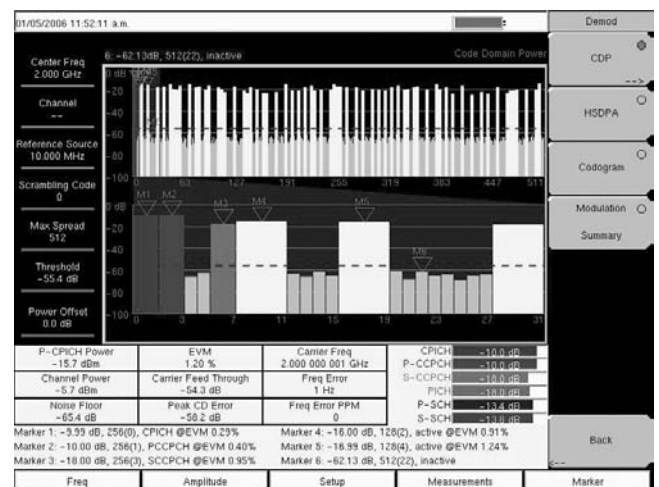
For Codogram Screen:

BTS Master's Codogram screen displays the code power levels over time via two graphs. The graph on the top of the screen displays all of the selected OVSF codes, while the graph on the bottom displays the selected OVSF zoom codes.

For measurement results via the Codogram Summary Screen:

1. Follow steps 1-9 in the "**Setup**" section (page 7) or follow Steps 1 - 3 in the "**For Band Spectrum and Channel Spectrum Measurements**" portion of the "**WCDMA RF Measurements**" section (page 10).

2. Press the **Measurements** function hard key.

3. Select the **Demodulator** soft key to activate the demodulator menu.

4. Press the **Codogram** soft key to activate the Codogram measurement.

5. Press the **Codogram** soft key to activate the zoom function and to set the time for the measurement.

6. Press the **Zoom** soft key to select the appropriate zoom level. The **Zoom** key toggles between 32, 64 and 128.

7. Press the **Zoom Start** soft key to manually enter the zoom start code.

8. Press the **Total Time** or **Single Sweep Time** soft key to set the required time.

9. Press the **Back** soft key to go back to the Codogram measurement. Note that the blue color block on the Codogram screen represents the selected zoom codes. The same codes are displayed in the zoom screen. Make sure to save the data before making any measurements, otherwise the data will be lost (Figure 17).

Over The Air Test

To monitor WCDMA performance using the OTA test, follow the general set-up and OTA measurement set-up instructions in Sections 4.1 and 4.4, respectively. Then:

1. Connect the appropriate antenna to the RF In connector.

2. Press the **Freq Function** hard key.

3. Press the **Center Freq** soft key and enter the desired frequency manually, or press the **Signal Standard** soft key and select the applicable WCDMA standard.

4. Select the **Channel** soft key and use the **Up/Down** arrow keys, the keypad or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
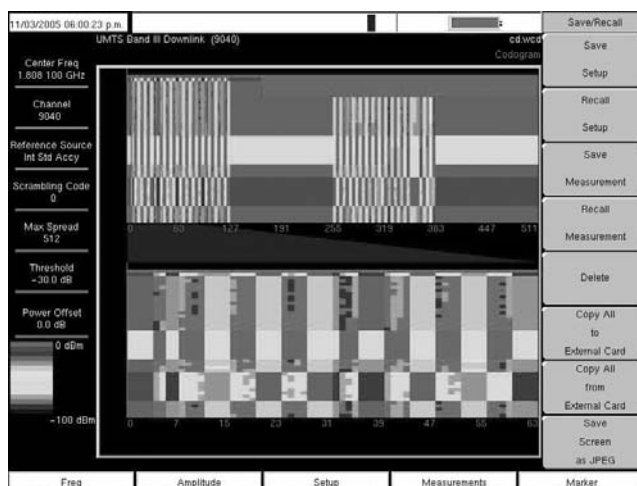

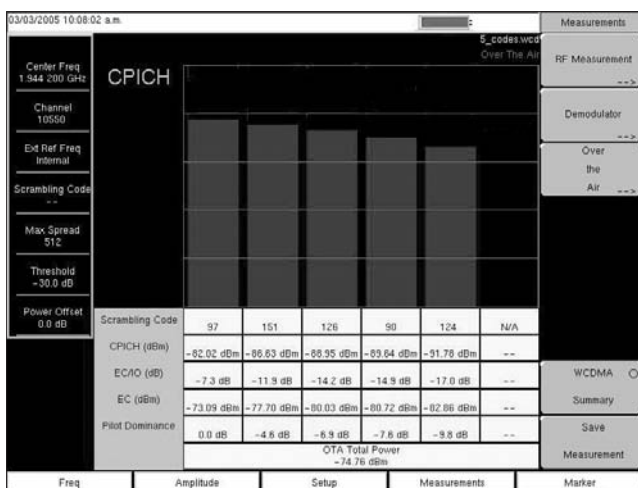*Figure 17. Codogram Measurement Screen example.*

Figure 18. OTA measurement screen

Note that instead of entering selected channel number, the desired channel can also be set by selecting Measurements, RF Measurements, and Band Spectrum. Using the Band Spectrum Cursor, select the desired channel and the unit will automatically display the measurements for the selected channel.

5. Select the **Over the Air** soft key to activate the OTA mode.

6. Press the **Scrambling Code** soft key and select **Auto** to automatically detect the six scrambling codes (Figure 18).

Note that to obtain accurate results the Reset button must be pressed to activate the OTA measurement mode in a different location.

BTS Master provides the user with a summary display of all the critical WCDMA measurements from the RF and demodulation measurements (Figure 19).

Pass/Fail Mode

Note that BTS Master MT8222A provides a Pass/Fail mode. In this mode, BTS Master saves the five test models covering all eleven test scenarios, or test conditions for base station conformance testing, specified in the 3GPP standard. Each of the five test models is specified with known characteristics, specific channels and symbol rates to characterize the measurements. Once BTS Master is connected to the base station, the base station must be set to the right test mode. BTS Master then tests the parameters listed for that particular test and displays whether or not they met the specified criteria (Figure 20).

Using Master Software Tools, custom test models can be created and downloaded into the BTS Master unit. All measurements can be selected for Pass/Fail testing including each individual codes power, spreading factor and symbol EVM (@EVM). The results are displayed in a table format with clear identification of Pass/Fail results, including the min/max thresholds and measured result.
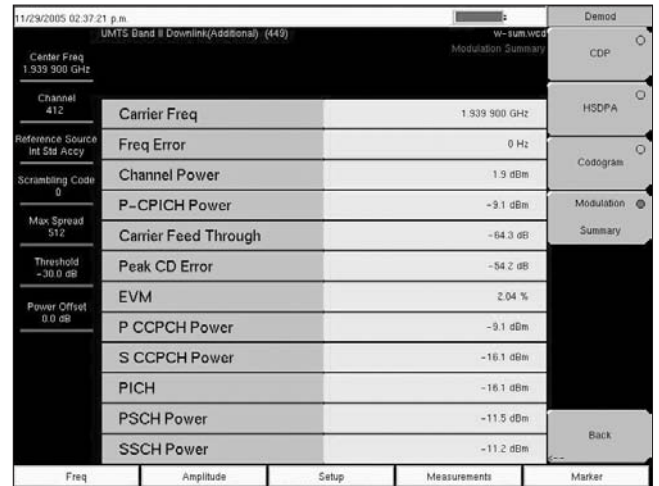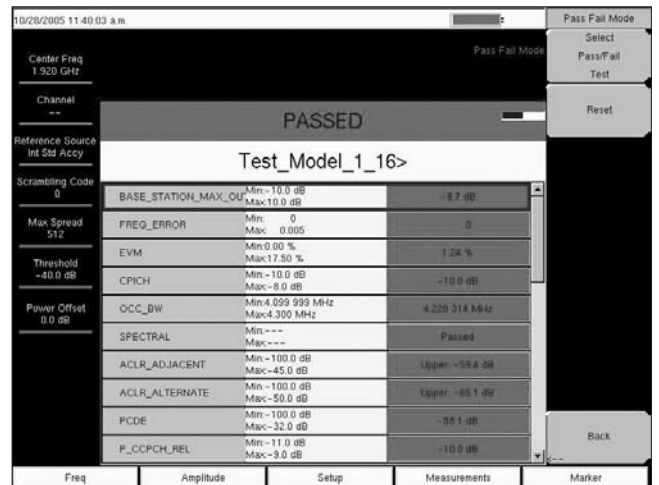

Figure 19. WCDMA Summary screen

Figure 20. Pass/Fail mode measurement screen

Conclusion

Anritsu's BTS Master MT8222A provides WCDMA measurement capabilities which enable field-based network technicians and RF engineers with a quick, ficient and cost-effective means of conducting Node B measurements on WCDMA access networks. BTS Master's support for RF measurements, demodulation and OTA measurements in WCDMA wireless networks is essential to those wanting to zero in on problems, while minimizing service disruptions and time spent off line.

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