CATS 76000E Series*

IN-SITE RF PERFORMANCE MONITOR AND DIAGNOSTIC SYSTEM

- **Reduces the Need for Site Visits**
- **Eliminates Manual VSWR Sweeps and Site Power Testing**
- **Performs Site Tests Any Time — Not Dependent on Maintenance Window**
- **Measures CDMA Power on Each Carrier**
- **Measures Maximum Antenna Power**
- **Finds CDMA Interfering Signals**
- **Measures Single Channel AMPS Power Allowing New Channel Additions While Site is Active and Simplifying Frequency Retunes**

*Communication Antenna Testing System

DESCRIPTION

The Narda CATS 76000E RF Performance Monitor and Diagnostics System is a cost effective in-line non-invasive system. It is three instruments in one:

RF Power Meter

Spectrum Analyzer

Antenna VSWR and Fault Analyzer

The CATS 76000E is permanently installed in each cell site with a monitoring sensor in each antenna feed line. Up to six Tx antennas and six Rx antennas can be accommodated with a single unit. The CATS 76000E system is a real time measurement tool providing immediate access to the site's RF system. Measurements can be made locally or remotely. An RS232 port is provided for local connections or remote network interface. A modem is available as an option for a telephone interface. The system can be programmed for automatic measurements and will provide alarms for out of limit parameters. This In-line measurement system eliminates the need for expensive periodic maintenance that interrupts service and necessitates the breaking of antenna feed lines.

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RF DIAGNOSTICS

The CATS 76000E can display and measure the power level of all transmitted signals on a single antenna or multiple antennas in an IS-95/97A Cell Site. All the AMPS channels and CDMA carriers can be individually measured while the site is active. (An option is available for displaying and measuring NAMPS signals)

During initial set up, the channel number of each active AMPS channel and CDMA carrier for each antenna is stored in the CATS 76000E memory. The setup data can be entered manually or from a text file, locally at the cell site or remotely. The CATS 76000E automatically steps through all stored channels and records the transmitted RF power. The system makes the measurements in accordance with user-defined program or the data can be generated on demand and displayed in a RF power versus channel number format. The standard CATS 76000E configuration can handle 200 Watts total power maximum per antenna, 15 watts maximum per AMPS channel and up to 28 channels per antenna. As many CDMA carriers as necessary can be accommodated provided the maximum combined power does not exceed 200 Watts. Power is measured at the BTS antenna feed line. Power measurement can be converted to ERP using the provided software. Options are available for up to 400 Watts per antenna feed line.

CDMA Power Measurement and Signal Display

The CATS 76000E can display any CDMA signal on any antenna and calculates the total RMS power in the signal. The signals are selected using the appropriate channel number and the information is displayed as shown in Figure #1.

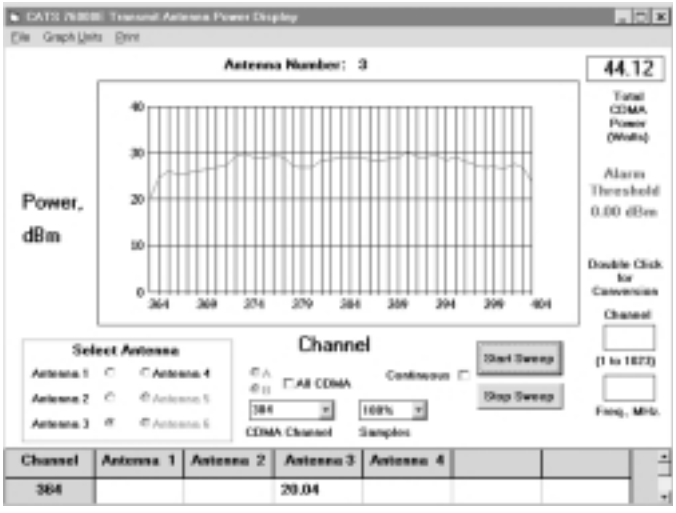

Figure 1 - CDMA Power Spectrum and Total Power

The system can also display the power in adjacent CDMA carriers and provide a convenient method of evaluating carrier power balance. The Power of each CDMA carrier can also be displayed on the virtual power meter of Figure #3. During automated meaurements, if the measured power level of any carrier falls below the stored power level for an individual antenna, an alarm is activated. The Tx Low Power form C relay latches and the Tx Low Power LED lights. The alarm status is logged.

Single Channel AMPS Power Measurement / Low Power Alarm

The CATS 76000E Series measures, displays and sets alarms for the transmitted RF power level on each active Tx AMPS Channel. During automated measurements, if the measured power falls below the stored power level for an individual channel, an alarm is activated. The Tx Low Power form C relay latches and the Tx Low Power LED lights. The alarm status is logged. Independent alarm levels are provided for voice channels and control channels on each antenna. Figure #2 shows typical AMPS power display including a CCH channel and six voice channels.

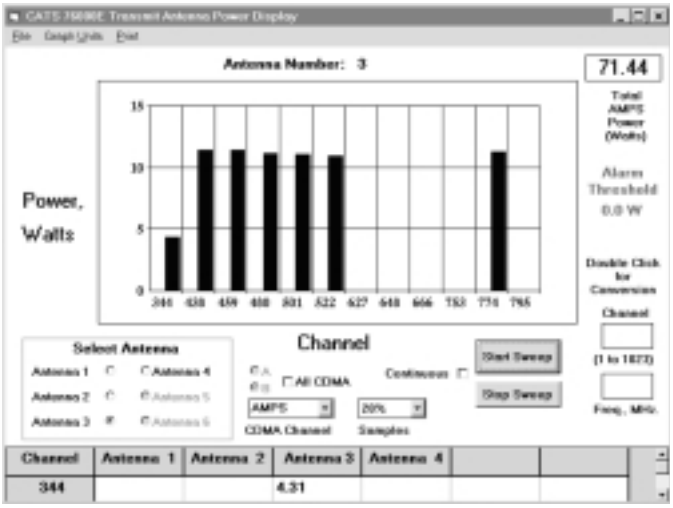

Figure 2 — Single Channel AMPS Power Measurement

The system display can be zoomed to any desired channel and the power is displayed on a virtual power meter (Figure #3) that is continuously refreshed. This display can be used for dynamic adjustment of the Tx power on each channel.

Total Antenna Power

The CATS 76000E also can measure the total composite RF power on any antenna and provide an alarm if the power level exceeds a preset limit.

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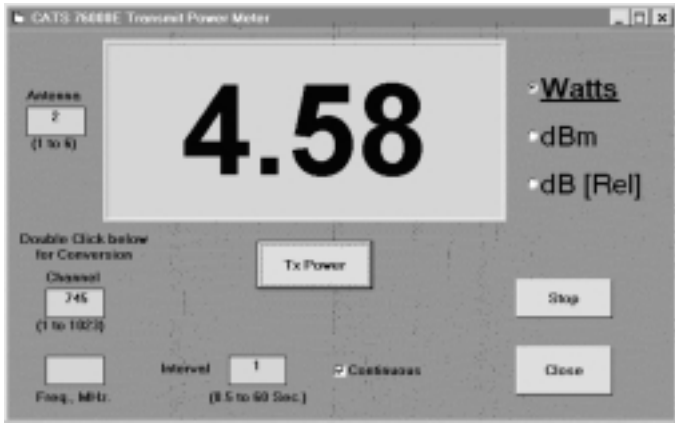

Figure #3 - Virtual Power Meter

Spectrum Analyzer

Received Signal Display and Interference Alarm

This mode of operation allows the user to profile the entire active bandwidth of an Rx antenna or a portion of that bandwidth and to scan for received signals and interfering signals. The spectrum analyzer can be used manually at any time or programmed to scan the selected Rx antennas at a programmable rate at selected times. In the programmed mode, if an undesirable signal is found, the magnitude and channel number is recorded and, if programmed, an alarm is set. For example, any received signal above -75 dBm on an inactive channel would trigger the alarm. The system also can record any signals over a predefined level (i.e.-95 dBm) on active channels and creates an activity display.

A number of scanning options are provided. Scans can be performed on demand or programmed for automatic measurement and storage. The user can zoom in on an area of interest.

Figure #4 displays received signals on a gamma sector diversity antenna. The spectrum analyzer was set to scan the complete B-Side frequency range. Active voice channels are evident on the right side of the display. The very left side is reasonably clear of signal since this is where the CDMA carriers reside.

The scan be can be easily zoomed over a narrower spectral range and refreshed to provide a continuous display as shown in Figure #5.

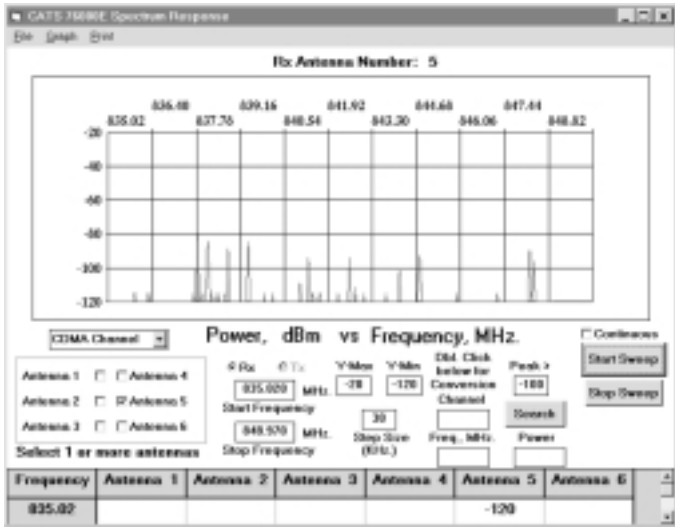

Figure #4 - Received Signals on Rx Antenna - Gamma Sector

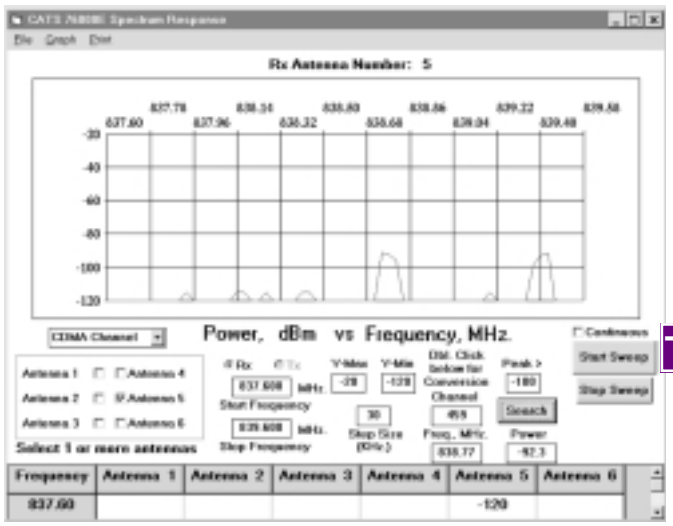

Figure #5 - Zoomed Scan - Channels - 420 to 488

CDMA Loading

The scan can be set to scan a CDMA channel only as shown in Figure #6. The noise power in the 41 channel (1.23 MHz) bandwidth is displayed in the upper right. This level is indicative of the CDMA channel loading and the ability of the system to process additional calls. In the example shown the total noise power as a result of interference at 836.8 MHz is -88.65 dBm.

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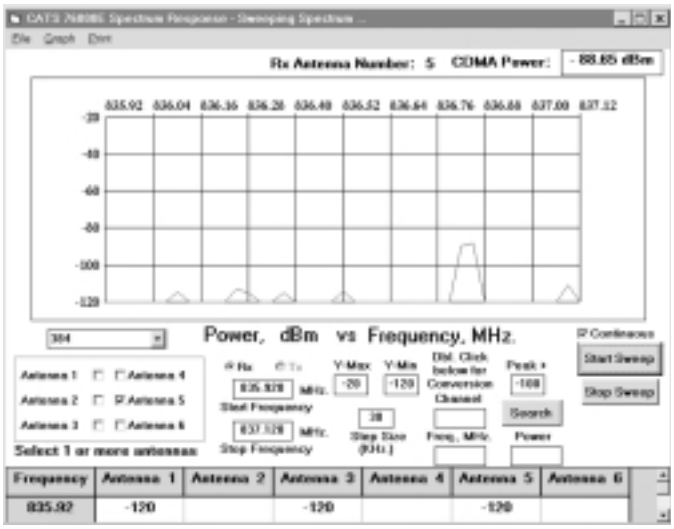

Figure 6 - CDMA Loading -gamma Sector

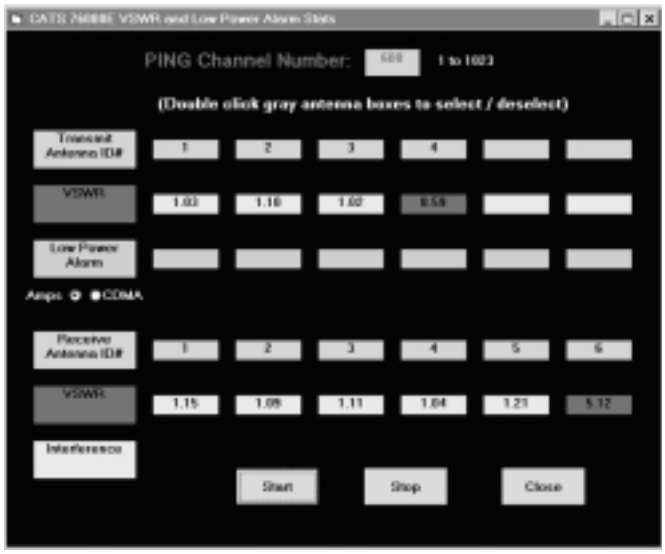

Figure 7 - Site Status Screen

Antenna Testing

The antenna monitor uses a low power synthesized signal source with a tracking receiver. The antenna VSWR is measured with a RF pulsed signal of less than 100 millisecond duration at signal level, which is nominally -20dBm on the antenna feed line. The signal is sufficiently low enough and brief such that the measurement signal is not normally discernible on the system. Unique test frequencies can be programmed for each cell site and active CDMA frequencies can be avoided. The CATS 76000E can be operated either in a single frequency measurement mode or a VSWR sweep mode. The VSWR sweep mode can be activated on-demand or from a stored measurement program.

PING Test for Emergency Diagnostics

In this single frequency mode, the VSWR measurement is made at a user defined RF test frequency. A single RF pulse is sent to the antenna via an integral coupler. The reflected power level is measured and the resulting VSWR is calculated and displayed. This low power single frequency “PING” test allows for immediate assessment of the antenna condition. The information is displayed on the status screen of Figure #7. The display also provides the status of the low power alarms. In the example shown, VSWR alarms are found on Tx #4 and Rx #6 antennas.

VSWR Sweep for Complete Characterization of Both Tx and Rx Antennas

In the VSWR sweep mode, each antenna is measured at up to 25 frequencies across the band of interest. The results are tabulated, plotted, and displayed in graphical form. The user can also export the data to a spreadsheet to create custom plots. The user can select preset frequency ranges or select their own measurement frequencies. A typical VSWR sweep is shown in Figure #8.

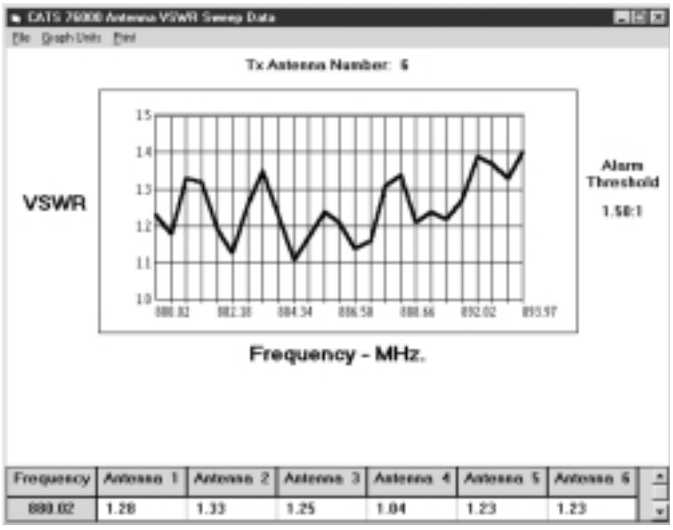

Figure 8 - Tx Antenna VSWR Sweep

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VSWR Alarms

The CATS 76000E Series VSWR alarm is activated during a programmed VSWR measurement whenever the VSWR of any antenna is measured to an excess of the user defined VSWR alarm limit setting. There are separate summary alarms for the Tx and Rx antennas. Each alarm is latching and closes a form C relay as well as activating the respective red Tx or Rx alarm light. The alarm, light and relay are reset from the Reset screen.

VSWR measurements must be initiated to verify antenna performance. The status of an individual antenna can be quickly determined by using the "PING" test and site status screen as described above.

Distance to Fault (DTF)

Distance to Fault (DTF) provides the ability to measure the distance from the CATS 76000E to an antenna feed line fault. This function is performed by taking a DFT of the swept VSWR data. Antenna fault location data are presented using the graphical display as shown in Figure #9. Both the resolution and range of the measurement can be selected.

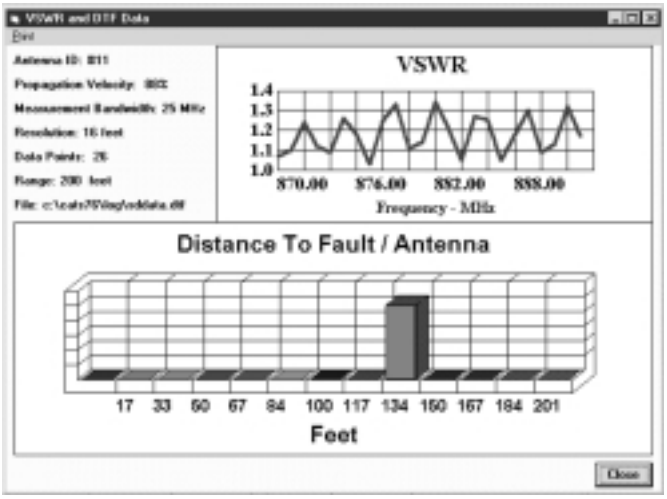

Figure 9 - Distance to Fault Display

Automatic Measurements and Data Storage

The CATS 76000E Series can automatically collect data without the user being present. The system is programmed to schedule, control and monitor VSWR measurements, antenna sweeps and the measurement of other parameters. Data is stored on a solid-state disk. Tx and Rx VSWR alarms, other alarms and associated form C relay closures occur as soon as an alarm condition is detected. The system can also be programmed to retest alarms before final relay closure. Data can be downloaded via the RS232 port, locally; through the internal modem, remotely; or a network connection. The unit can also be programmed remotely or locally.

The measurement instructions are generated through a simple point and click procedure as shown in Figure #10. In this example the CATS76000E is programmed to

- Measure VSWR on Tx Antennas Daily at 2:10 am
- Measure VSWR on Rx Antennas Daily @ 2:15 am
- Measure Individual AMPS Channels Power Daily on the Hour
- Measure CDMA Power on Channel 384 Daily @: 05 After the Hour
- Record Received Spectrum in Each Sector Daily and Hourly @ :20 After the Hour at 5 Minute Intervals for 30 Minutes

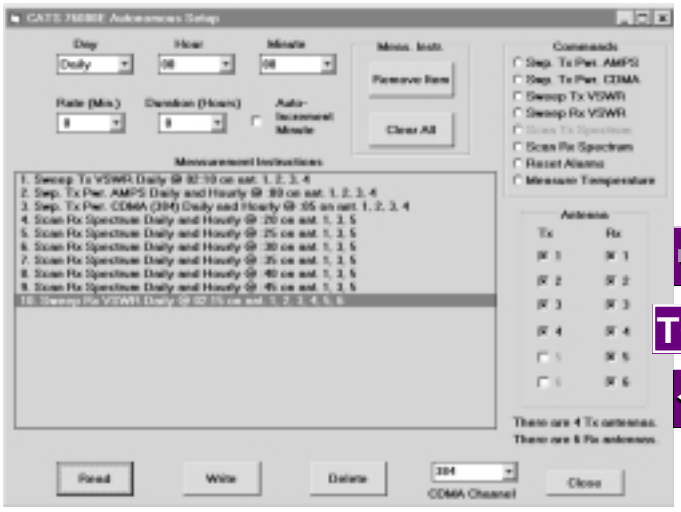

Figure 10 - Programming CATS 76000E Measurements

Downloaded Stored Data

Any data resulting from a programmed measurement can be downloaded and displayed with the supplied software. The data can be retrieved locally at the site on the service technician's laptop via the RS232 connection or remotely via the modem or network interface.

VSWR Data (VSWR Alarm Example)

VSWR records can be downloaded at any time to evaluate a problem. The site status screen of Figure #7 indicates a

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Tx VSWR alarm on Antenna TX#4. The alarm logging record screen shown in Figure #11 indicates a VSWR alarm during the programmed measurement on September 17, 1999 at 2:05 am. Figure #12 and #13 show the VSWR data recorded on September 16 and September 17, respectively. The data is presented in return loss and the high VSWR after the alarm is clearly evident.

Figure 11 - Logging Record

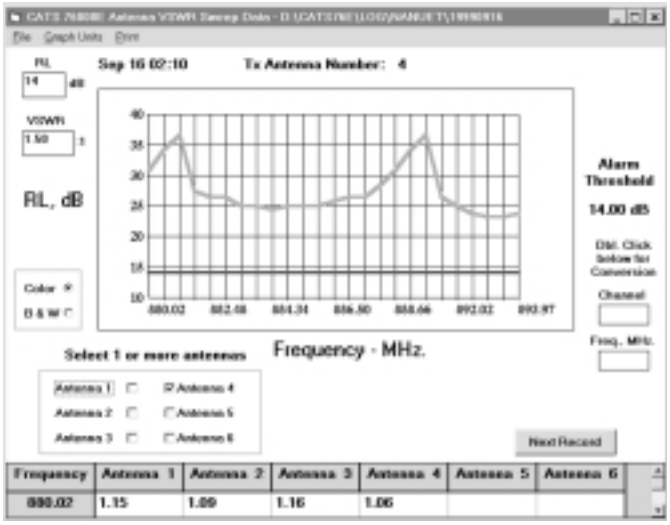

Figure 12 - VSWR Data Stored on September 16, 1999 - Before Alarm

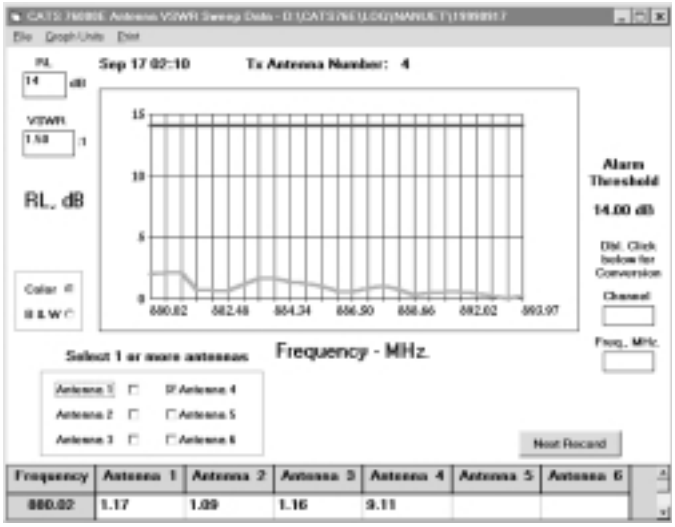

Figure 13 - VSWR Data Stored on September 17, 1999 - After Alarm

Stored AMPS and CDMA Power Measurements

Stored power measurements can be downloaded in a manner similar to VSWR data above and displayed on screens similar to those of Figures #1 and #2. Excel macros are provided for viewing and analyzing historical data.

Spectrum Analyzer Data

Stored Spectrum analyzer data scans can also be viewed directly using the user's software and Excel macros are provided for further analysis of the data. Figure #14 and #15 show histograms for scan data on the beta sector for channels 334 to 444 and channels 560 to 663, respectively. This data was recorded between 7:45 and 11:45 on September 17, 1999.

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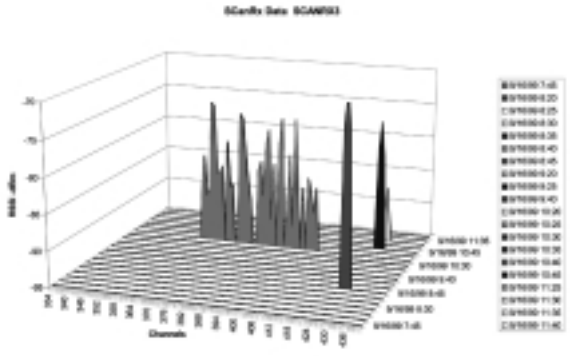

Figure 14 - Spectrum Analysis Histogram - Channels 334 to 444

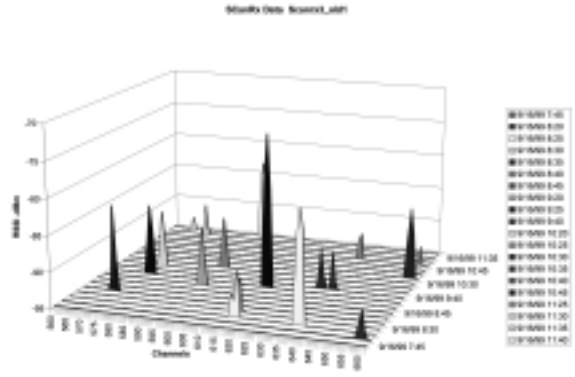

Figure 15 - Spectrum Analysis Histogram - Channels 560 to 663

Figure #16 overlays all the scanned data recorded during this measurement period on a channel group chart. This is a useful visual aid in analyzing the spectrum analyzer results.

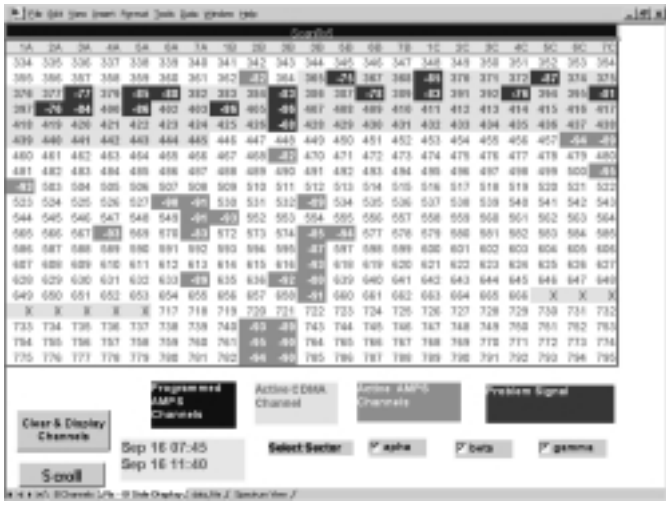

Figure 16
Spectrum Analysis Data Overlay Showing RSSI for Each Received Signal

Software and Data Analysis

Narda's user software is provided with the system to facilitate setup and use. It provides complete monitoring and setup for CATS 76000E Series products. When used either locally or remotely via modem or network, it converts the host computer to a virtual instrument for quickly measuring Power, VSWR or the signals present on the Tx and Rx antennas. The user software is an executable program that operates in a Windows 3.1, Windows 95, Windows 98, or Windows NT environment. A sample screen is shown in Figure #17.

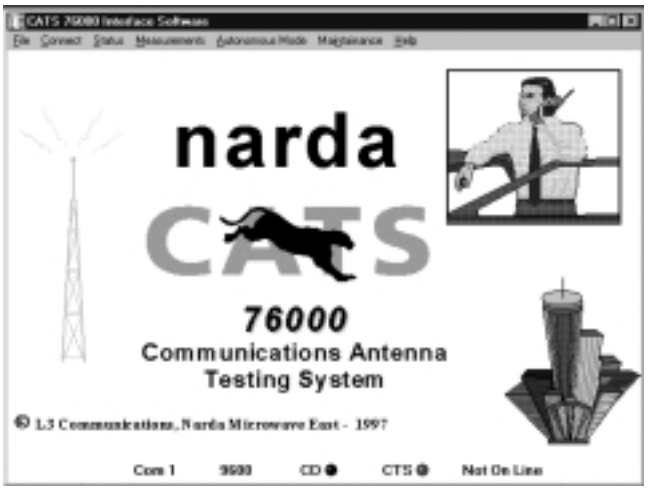

Figure 17 - Windows User Software

Simple Setup

The cell site is setup directly in the user software by simply reading input data from a text file either remotely or locally from a floppy disk. The software also provides setup screens for custom setups and setup modification.

ERP Calibration Factors

Calibration factors including antenna gain and feed line loss may also be stored in the CATS 76000E. The data can be read from a text file or input manually. These factors are then used in converting measured antenna feed line power to ERP.

Measurements On Demand

The software provides immediate access to all CATS 76000E functions and all the measurement screens shown in the preceding paragraphs. The system can be accessed from any computer, once the software is installed, either

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remotely via the modem or locally via direct connection to the RS232 port or over a network.

Trend Analysis Utilities

The software includes a number of utilities for displaying and analyzing stored data, which have been written in VBA and are intended for use with Microsoft Excel 97 or higher. Built in macros create PivotTable reports and graphical plots directly. Special macros are available for specific customer applications. Examples of current macros are shown in Figures 18, 19, and 20.

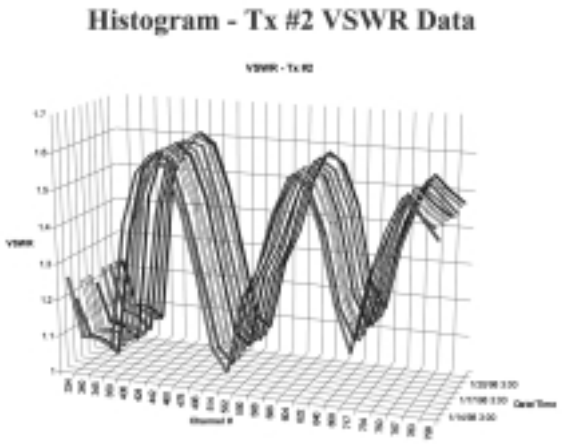

Figure 18 - VSWR Histogram

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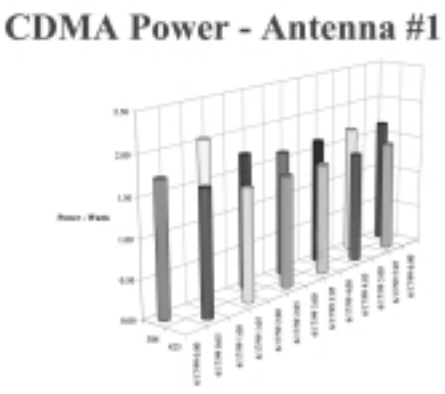

Figure 19 - Composite CDMA Power on Each Carrier vs. Measurement Time

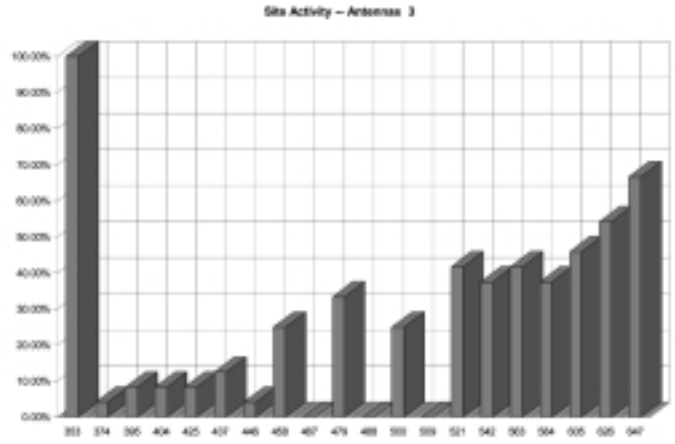

Figure 20 - AMPS Power and Channel Activity

CATS 76000E Interface

Data Interface

The CATS 76000E system has a single EIA 232D interface through which all commands and controls are directed. Set up instructions are permanently stored in EEPROM. Each unit operates in half duplex mode and responds to ASCII commands and data inquiries.

Expansion Port

An optional external RS485 interface port can be provided for custom requirements, which allow interfacing with additional CATS equipment to expand the number of antennas that can be covered.

Auxiliary Equipment Interface

An optional pair of Tx and Rx ports is provided for connecting auxiliary equipment such as test responders to selected antenna pairs. This connection uses the same coupler system used by the CATS 76000E and does not create any additional feed line loss. The desired Tx / Rx antenna pair is selected via the user software.

Network Interface

The CATS 76000E is compatible with a number of network monitoring and fault management systems Network connections can be made via the RS232 port or optional Ethernet interface.

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SPECIFICATIONS

MODEL	CATS 76263E-00
Cellular System	AMPS - CDMA
Antennas	3 Tx and 6 Rx Antennas Per Module
Maximum Tx Power Level Per Antenna	200 Watts Average ** 2.3 kW peak ** Options to 400 Watts
Alarm Threshold Range	1.5 to 3.0:1 VSWR
Tx Measurement Frequency Range	869 to 894 MHz
Rx Measurement Frequency Range	824 to 849 MHz
Insertion Loss	Tx Antennas 0.2dB Max 0.15dB typical Rx Antennas 0.3 dB Max 0.2 dB typical
Main Line VSWR	≤ 1.10 to 1
Tx Single Channel Power Measurement **Measured in Tx antenna feed line. Option to convert to ERP**	AMPS Dynamic Range per Channel - .03 to 15 Watts Minimum Channel Separation - 5 Channels Maximum Channels per Antenna 25 @ 15 Watts per Channel Total Power Per Antenna <200 Watts cw Measurement Accuracy: ±.5 dB (15 to 35°C) Typical ±1 dB (0 to 50°C) Typical Single Channel Virtual Meter Refresh Rate: 1 second.
Tx CDMA Power Measurement and Display **Measured in Tx antenna feed line. Option to convert to ERP**	Full CDMA Waveform .5 to 50 Watts /1.23 MHz (per Carrier) Composite Power Measurement Accuracy ±1.0 dB (15°C to 35°C) ±2 dB (0 to 50°C) CDMA Carriers Standard: Up to Eight Total Power Per Antenna <200 Watts cw Display Transmitted Spectrum (30 kHz Resolution) Sample Density: 100, 50, 20% Measurement Speed: 1 to 6 seconds depending on sample density Carrier Power Balance Composite Power Virtual Meter
Total Tx Power **Measured in Each Antenna Feed line**	Maximum Power – 200 Watts max. Measurement Accuracy: ±.5 dB (15 to 35°C) Typical ±1 dB (0 to 50°C) Typical Virtual Meter Refresh Rate: 1 second

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MODEL	CATS 76263E-00
Rx Signal Display	Channel Scan Mode – Normal Resolution: Resolution: 30 kHz Step Size: 30 kHz Speed: 10 channels/second Range: All 416 channels or selected regions Repetition Rate: Selectable From 5 minutes Display: RSSI vs. Frequency Display Accuracy: ±2 dB Channel Address Accuracy: ± 2 kHz Rejection: -60 dB @ ± 5 channel spacing Display Dynamic range: 70 dB Minimum Detectable Signal: @ 10 kHz RBW Single Signal: -95 dBm 10 kHz Separation: -40 dBc 30 kHz Separation: -50 dBc 100 kHz Separation -65 dBc Maximum RF Signal: -25 dBm Rx-to-Rx Antenna Port Isolation: 40 dB min. Activity Buffer and Data Storage: Programmed Storage Cumulative Activity Log For Active Channels @ >-95 dBm Alarms: Signal on CDMA Interference @>-85 dBm Levels are programmable
VSWR Measurement Test Signal	Power Level -10 dBm to -20 dBm typical Duration 100 milliseconds Maximum
Maximum Tx Power During Tx VSWR Measurement	10 Watts per channel maximum, 8 channels maximum
VSWR Measurement Range	1.2:1 to 4:1:1
VSWR Accuracy	Actual VSWR Uncertainty Limits* 1.20:1 +0.15, -0.15 1.50:1 +0.20, -0.20 2.00:1 +0.30, -0.25 2.50:1 +0.40, -0.50 3.00:1 +1.00, -0.50 *Assuming well matched receiver input
DTF Performance	Default Settings Resolution - 20 feet Range - 500 feet Options Resolution to 5 feet Range to 600 feet (Distance is calculated relative to an air dielectric)
Communications Interface **Rate** **Error Detection**	EIA 232D, Optional Internal Modem 9600 Baud Check Sum

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MODEL	CATS 76263E-00
Optional External Data Interface – Connect to Additional CATS Equipment	RS485
Optional Auxiliary RF Connection	Tx Coupling Loss: 55 dB nominal Rx Coupling Loss: 25 dB nominal
Alarms	Five Alarm LEDs and Form C Relays Tx, Rx, Low Power, System and Interference
Input Power	+20 to +28 VDC @ 2.5 Amps typical Optional External – 48 VDC Converter Available
Environment **Temperature** **Humidity**	 0 to 50°C Operating 0 to 95% RH
Mechanical	Per Outline
Connectors	All RF Ports – Type N Female RS 232 – 9 Pin D Modem – RJ11 Alarms and DC Power – 25 Pin D
Options	400 Watts Average Power per Antenna Up to 6 Tx Antennas 10 kHz Spectrum Analyzer Resolution Internal Modem Internal Ethernet Card RS485 CATS Product Interface Auxiliary RF Interface

OUTLINE DRAWINGS