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Spectrum Master™

MS2721A

Benchmark Performance in a Handheld Spectrum Analyzer



User's Guide

WARRANTY

The Anritsu product(s) listed on the title page is (are) warranted against defects in materials and workmanship for one year from the date of shipment.

Anritsu's obligation covers repairing or replacing products which prove to be defective during the warranty period. Buyers shall prepay transportation charges for equipment returned to Anritsu for warranty repairs. Obligation is limited to the original purchaser. Anritsu is not liable for consequential damages.

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VxWorks Runtime License



2000-1189

WindML Target License



2000-1372

DECLARATION OF CONFORMITY

Manufacturer's Name: ANRITSU COMPANY

Manufacturer's Address: Microwave Measurements Division
490 Jarvis Drive
Morgan Hill, CA 95037-2809
USA

declares that the product specified below:

Product Name: Spectrum Master

Model Number: MS2721A

conforms to the requirement of:

EMC Directive 89/336/EEC as amended by Council Directive 92/31/EEC & 93/68/EEC
Low Voltage Directive 73/23/EEC as amended by Council directive 93/68/EEC

Electromagnetic Interference:

Emissions: CISPR 11:1990/EN55011:1991 Group 1 Class A

Immunity: EN 61000-4-2:1995/EN50082-1:1997 - 4kV CD, 8kV AD
EN 61000-4-3:1997/EN50082-1:1997 - 3V/m
ENV 50204/EN50082-1:1997 - 3V/m
EN 61000-4-4:1995/EN50082-1:1997 - 0.5kV SL, 1kV PL
EN 61000-4-5:1995/EN50082-1: 1997 - 1kV L-L, 2kV L-E
EN 61000-4-6:1994/EN61326: 1998 - 3V
EN 61000-4-11:1994/EN61326: 1998 - 1 cycle@100%

Electrical Safety Requirement:

Product Safety: The Product Complies when used with Company supplied Power
Supply (tested to EN 60950)


Corporate Quality Director

Morgan Hill, CA

1 July 2004
Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close,

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Chapter 1

General Information

Introduction

This chapter provides a description, performance specifications, optional accessories, preventive maintenance, and calibration requirements for the Anritsu Handheld Spectrum Analyzer model listed below. Throughout this manual, this instrument may be referred to as a Spectrum Master.

Model	Frequency Range
MS2721A	100 kHz to 7.1 GHz

Description

Spectrum Master is a synthesizer-based hand held spectrum analyzer that provides quick and accurate measurement results. Measurements can be easily made by using the main instrument functions: frequency, span, amplitude and bandwidth. Dedicated keys for common functions and a familiar calculator-type keypad are available for fast data entry.

Time and date stamping of measurement data is automatic. The internal memory provides for the storage and recall of more than 2000 measurement setups and more than 2000 traces. The bright daylight-viewable, high-resolution color liquid crystal display (LCD) provides easy viewing in a variety of lighting conditions. Spectrum Master is capable of up to three hours of continuous operation from a fully charged battery and can be operated from a 12 Vdc source, which also simultaneously charges the battery.

Spectrum Master is designed for monitoring, measuring, and analyzing signal environments. Typical measurements include: in-band interference, transmit spectrum analysis, plus cell site and 802.11a/b/g interference testing. A full range of marker capabilities such as peak, center and delta functions are provided for faster, more comprehensive analysis of displayed signals. Upper and lower multi-segmented limit lines are available to create quick, simple pass/fail measurements. A menu option provides for an audible alert when the limit value is exceeded.

Anritsu Master Software Tools, a PC-based software program, provides for storing measurement data. Master Software Tools can also convert the Spectrum Master display into several graphic formats.

Measurements stored in internal memory can be downloaded to a PC using the included USB or Ethernet cables. Once stored, the graphic trace can then be displayed, scaled, or enhanced with markers and limit lines. Historical graphs can be overlaid with current data using the PC mouse in a drag-and-drop fashion. The underlying data can be extracted and used in spreadsheets or for other analytical tasks.

Accessories

The following standard accessories are supplied with the MS2721A:

Part Number	Description
10580-00103	MS2721A User's Guide
61382	MS2721A Soft Carrying Case
2300-498	Master Software Tools Program CD ROM
633-44	MS2721A Rechargeable Li-Ion Battery
40-168	MS2721A AC-DC Adapter
806-62	MS2721A Automotive Cigarette Lighter 12 Volt DC Adapter
2000-1360	USB A/5-pin mini-B Cable
2000-1371	Ethernet Cable, 7 feet (213 cm)
1091-27	Type-N male to SMA female Adapter
1091-172	Type-N male to BNC female Adapter
One year Warranty (includes battery, firmware, and software)	

The following optional accessories are available for the MS2721A:

Part Number	Description
42N50A-30	30 dB, 50W, Bi-dir., DC-18 GHz, N(m) to N(f) Attenuator
34NN50A	Precision Adapter, DC to 18 GHz, 50Ω, N(m) to N(m)
34NFN50C	Precision Adapter, DC to 18 GHz, 50Ω, N(f) to N(f)
15NNF50-1.5B	Test port cable armored, 1.5 meter, N(m) to N(f), 18.0 GHz
15NN50-1.5C	Test port cable armored, 1.5 meter, N(m) to N(m), 6 GHz
15NN50-3.0C	Test port cable armored, 3.0 meter, N(m) to N(m), 6 GHz
15NN50-5.0C	Test port cable armored, 5.0 meter, N(m) to N(m), 6 GHz
15NNF50-1.5C	Test port cable armored, 1.5 meter, N(m) to N(f), 6 GHz
15NNF50-3.0C	Test port cable armored, 3.0 meter, N(m) to N(f), 6 GHz
15NNF50-5.0C	Test port cable armored, 5.0 meter, N(m) to N(f), 6 GHz
15ND50-1.5C	Test port cable armored, 1.5 meter, N(m) to 7/16 DIN(m), 6.0 GHz
15NDF50-1.5C	Test port cable armored, 1.5 meter, N(m) to 7/16 DIN(f), 6.0 GHz
12N50-75B	75Ω Adapter, 7.5 dB loss
510-90	Adapter, 7/16 DIN (f) to N(m), DC to 7.5 GHz, 50Ω

Part Number	Description
510-91	Adapter, 7/16 DIN (f)-N(f), DC to 7.5 GHz, 50Ω
510-92	Adapter, 7/16 DIN (m)-N(m), DC to 7.5 GHz, 50Ω
510-93	Adapter, 7/16 DIN(m)-N(f), DC to 7.5 GHz, 50Ω
510-96	Adapter 7/16 DIN (m) to 7/16 DIN (m), DC to 7.5 GHz, 50Ω
1030-86	Band Pass Filter, 800 MHz band, 806-869 MHz, Loss = 1.7 dB, N(m)-SMA(f)
1030-87	Band Pass Filter, 900 MHz band, 902-960 MHz, Loss = 1.7 dB, N(m)-SMA(f)
1030-88	Band Pass Filter, 1900 MHz band, 1.85-1.99 GHz, Loss = 1.8 dB, N(m)-SMA(f)
1030-89	Band Pass Filter, 2400 MHz band, 2.4-2.5 GHz, Loss = 1.9 dB, N(m)-SMA(f)
510-97	Adapter 7/16 DIN (f) to 7/16 DIN (f), 7.5 GHz
61382	Spare Soft Carrying Case
40-168	Spare AC/DC Adapter
806-62	Spare Automotive Cigarette Lighter 12 Volt DC Adapter
760-229	MS2721A Transit Case
2300-498	Master Software Tools Program CD ROM
10580-00103	Anritsu User's Guide, Model MS2721A (spare)
10580-00104	Anritsu Programming Manual, Model MS2721A
10580-00105	Anritsu Maintenance Manual, Model MS2721A
633-44	Rechargeable battery, Li-Ion
2000-1374	Dual Battery charger, Li-Ion with universal power supply
2000-1030	Portable antenna, 50Ω, SMA (m) 1.71-1.88 GHz
2000-1031	Portable antenna, 50Ω, SMA (m) 1.85-1.99 GHz
2000-1032	Portable antenna, 50Ω, SMA (m) 2.4-2.5 GHz
2000-1035	Portable antenna, 50Ω, SMA (m) 896-941 MHz
2000-1200	Portable antenna, 50Ω, SMA (m) 806-869 MHz
2000-1361	Portable Antenna, 50Ω, SMA (m) 5725-5825 MHz
2000-1358	64 MB Compact Flash Memory Module

Performance Specifications

Frequency

Frequency Range:	100 kHz to 7.1 GHz
Tuning Range:	9 kHz to 7.1 GHz
Tuning Resolution:	1 Hz
Frequency Reference:	Aging: ± 1 ppm/yr. Accuracy: ± 1 ppm ($25^{\circ}\text{C} \pm 25^{\circ}\text{C}$) + long term drift
Frequency Span:	10 Hz to 7.1 GHz plus 0 Hz (zero span)
Span Accuracy:	Same as frequency reference accuracy
Sweep Time:	Minimum 100 ms swept, 50 μs in zero span
Sweep Time Accuracy:	$\pm 2\%$ in zero span
Sweep Trigger:	Free run, Single, Video, External
Resolution Bandwidth:	(-3 dB width) 10 Hz to 3 MHz in 1-3 sequence $\pm 10\%$, 8 MHz demodulation bandwidth
Video Bandwidth:	(-3 dB) 1 Hz to 3 MHz in 1-3 sequence
SSB Phase Noise:	-100 dBc/Hz max at 10, 20 and 30 kHz offset from carrier. -102 dBc/Hz max at 100 kHz offset from carrier.

Amplitude

Measurement Range:	DANL to +30 dBm
Absolute Amplitude Accuracy:	
Power levels:	≥ -50 dBm, <35 dB input attenuation 100 kHz to 10 MHz ± 1.5 dB >10 MHz to 4 GHz ± 1.25 dB >4 to 7.1 GHz ± 1.75 dB 40 to 55 dB input attenuation 100 kHz to 10 MHz ± 1.5 dB >10 MHz to 4 GHz ± 1.75 dB >4 to 6.5 GHz ± 1.75 dB >6.5 to 7.1 GHz ± 2 dB 60 to 65 dB input attenuation 100 kHz to 10 MHz ± 1.5 dB >10 MHz to 6.5 GHz ± 1.75 dB >6.5 to 7.1 GHz ± 3 dB Preamplifier on, 0 or 10 dB input attenuation 100 kHz to 4 GHz ± 1.5 dB >4 to 7.1 GHz ± 1.75 dB

Second Harmonic Distortion (0 dB input attenuation, -30 dBm input):
-50 dBc, 0.05 to 0.75 GHz
-40 dBc, >0.75 to 1.05 GHz
-50 dBc, >1.05 to 1.4 GHz
-70 dBc, >1.4 to 2 GHz
-80 dBc, >2 GHz

Third Order Intercept (TOI) (preamplifier off)

Frequency	Typical
50 MHz to 300 MHz	>8 dBm
>300 MHz to 2.2 GHz	>10 dBm
>2.2 to 2.8 GHz	>15 dBm
>2.8 to 4.0 GHz	>10 dBm
>4.0 to 7.1 GHz	>13 dBm

0 dB attenuation, -20 dBm reference level, -20 dBm tones, spaced 100 kHz

Displayed Average Noise Level: DANL in 10 Hz RBW

Frequency	Preamplifier On		Preamplifier Off	
	Typical	Max	Typical	Max
>10 MHz to 1 GHz	-153	-151	-130	-127
>1 GHz to 2.2 GHz	-150	-149	-126	-123
>2.2 to 2.8 GHz	-146	-143	-120	-116
>2.8 to 4.0 GHz	-150	-149	-129	-126
>4.0 to 7.1 GHz	-148	-146	-121	-117

Test conditions: Input attenuation: 0 dB, RMS detection, Reference level = -20 dBm for preamplifier off and -50 dBm for preamplifier on.

NOTE: discrete spurious signals are not included in the measurement of DANL as they are covered by the residual spurious specification.

Noise Figure (derived from DANL measurement) 0 dB attenuation, 23°C: Preamp On

Frequency	Typical
>10 MHz to 1 GHz	11 dB
>1 GHz to 2.2 GHz	14 dB
>2.2 to 2.8 GHz	18 dB
>2.8 to 4.0 GHz	14 dB
>4.0 to 7.1 GHz	16 dB

Display Range: 1 to 15 dB/div in 1dB steps. Ten divisions displayed.

Amplitude Units:

Log Scale Modes: dBm, dBV, dBmv, d μ V,
Linear Scale Modes: nV, μ V, mV, V, kV, nW, μ W, mW, W, kW

Attenuator Range:	0 to 65 dB
Attenuator Resolution:	5 dB steps
Input-Related Spurious:	-60 dBc max*, (<-70 dBc typical), -30 dBm input, 0 dB RF attenuation

*Exceptions:

Input Frequency	Spur Level
1674 MHz	-46 dBc max (-56 dBc typical), 0 to 2800 MHz
>1674 to 1774 MHz	-50 dBc max (-60 dBc typical) at (F input -1674 MHz)

Residual Spurious, preamplifier off: (RF input terminated, 0 dB RF attenuation)

-90 dBm max**, 100 kHz to <3200 MHz
-84 dBm max**, 3200 to 7100 MHz

****Exceptions:**

Frequency	Spur Level
250, 300, and 350 MHz	-85 dBm max
~4010 MHz	-80 dBm max (-90 dBm typical)
~5084 MHz	-70 dBm max (-83 dBm typical)
~5894 MHz	-75 dBm max (-87 dBm typical)
~7028 MHz	-80 dBm max (-92 dBm typical)

Residual Spurious, preamplifier on: -100 dBm max
(RF input terminated, 0 dB RF attenuation)

General

RF Input VSWR: 2.0:1 maximum, 1.5:1 typical (≥ 10 dB attenuation)
Max Continuous Input: (≥ 10 dB attenuation), +30 dBm

Input Damage Level*:

≥ 10 dB attenuation, $> +43$ dBm, ± 50 Vdc

< 10 dB attenuation, $> +23$ dBm, ± 50 Vdc

* Input protection relay opens at $> +30$ dBm with 10 dB input attenuation and at approximately $+10$ to $+23$ dBm with < 10 dB attenuation

ESD Damage Level: > 10 kV 10 dB attenuation

Ext. Ref. Frequencies: 1, 1.2288, 1.544, 2.4576, 4.8, 4.9152, 5, 9.8304, 10, 13 and 19.6608 MHz at -10 to +10 dBm

Display:

Bright daylight-viewable color transmissive LCD, Full SVGA, 8.4"

Languages:

Built-in English, Spanish, Italian, French, German, Japanese, Korean, and Chinese. The instrument also has the capability to have customized languages installed from Master Software Tools.

Marker Modes:

6 Markers, 7 Modes: Normal, Delta, Marker to Peak, Marker to Center, Marker to Reference Level, Next Peak Left, Next Peak Right, All Markers Off, Noise Marker, Frequency Counter Marker (1 Hz resolution).

Sweeps:

Full span, Zero span, Span Up/Span Down in 1-2-5 increments

Detection:

Peak, Negative, Sample, RMS

Memory:

The internal memory provides for the storage and recall of more than 1000 measurement setups and more than 1000 traces. The contents of the internal memory can be copied to and from a removable Compact Flash card.

Traces:

Displayed Traces: 3 Traces with trace overlay. One trace is always the live data; two traces can be either stored data or traces which have been mathematically manipulated.

Interfaces:

Type N female RF connector

BNC female connectors for ext. reference and ext. trigger

5-pin Mini-B USB 2.0 for data transfer to a PC

RJ45 connector for Ethernet 10/100 Base-T

2.5 mm 3-wire headset connector

Size & Weight:

Size: 12 x 8 x 3 inches (305 x 203 x 76 mm)

Weight: < 6.4 pounds (2.9 kg) typical

Environmental:

MIL-PRF-28800F class 2

Operating: -10° C to 55° C, humidity 85% or less

Storage: -51° C to 71° C

Altitude: 4600 meters, operating and non-operating

Safety:

Conforms to EN 61010-1 for Class 1 portable equipment

Electromagnetic Compatibility:

Meets European Community requirements for CE marking.

Preventive Maintenance

Spectrum Master preventive maintenance consists of cleaning the unit and inspecting and cleaning the RF connector on the instrument and all accessories. Clean the Spectrum Master with a soft, lint-free cloth dampened with water or water and a mild cleaning solution.

CAUTION: To avoid damaging the display or case, do not use solvents or abrasive cleaners.

Clean the RF connectors and center pins with a cotton swab dampened with denatured alcohol. Visually inspect the connectors. The fingers of N(f) connectors and the pins of N(m) connectors should be unbroken and uniform in appearance. If you are unsure whether the connectors are good, gauge the connectors to confirm that their dimensions are correct.

Visually inspect the test port cable(s). The test port cable should be uniform in appearance, not stretched, kinked, dented, or broken.

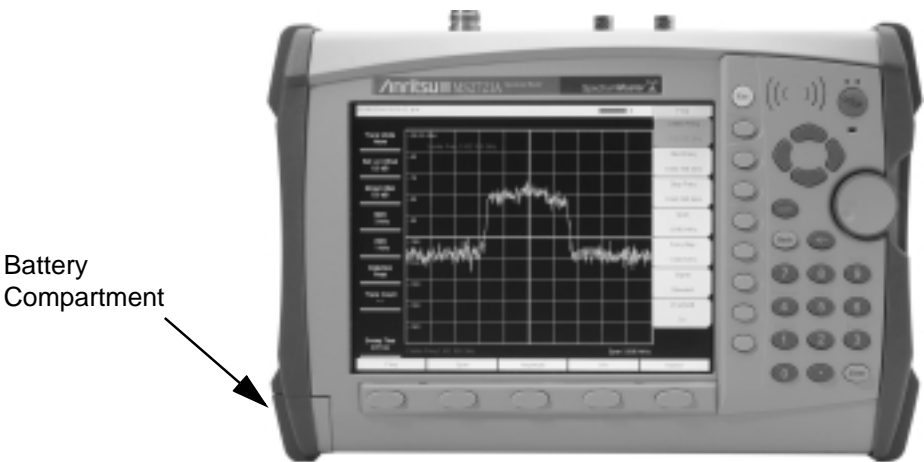
Calibration Requirements

The Spectrum Master loads factory calibration data during start-up, eliminating the need for daily calibration checks.

Although Spectrum Master does not require daily field calibration, Anritsu recommends annual calibration and performance verification by local Anritsu service centers. Anritsu service centers are listed in this chapter.

Battery Replacement

The battery can be replaced without the use of tools. The battery compartment is located on the lower left side of the instrument. Slide the battery door down, towards the bottom of the instrument, to remove it. Remove the battery pack from the instrument by pulling straight out on the battery lanyard. Replacement is the opposite of removal.



The battery supplied with the Spectrum Master may need charging before use. The battery can be charged in the Spectrum Master, using either the AC-DC Adapter (40-168) or the 12-Volt DC adapter (806-62), or separately in the optional Dual Battery Charger (2000-1374).

ESD Cautions

The MS2721A, like other high performance instruments, is susceptible to ESD damage. Very often, coaxial cables and antennas build up a static charge, which, if allowed to discharge by connecting directly to the MS2721A without discharging the static charge, may damage the MS2721A input circuitry. MS2721A operators should be aware of the potential for ESD damage and take all necessary precautions.

Operators should exercise practices outlined within industry standards such as JEDEC-625 (EIA-625), MIL-HDBK-263, and MIL-STD-1686, which pertain to ESD and ESDS devices, equipment, and practices. As these apply to the MS2721A, it is recommended that any static charges that may be present be dissipated before connecting coaxial cables or antennas to the MS2721A. This may be as simple as temporarily attaching a short or load device to the cable or antenna prior to attaching to the MS2721A. It is important to remember that the operator may also carry a static charge that can cause damage. Following the practices outlined in the above standards will ensure a safe environment for both personnel and equipment.

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Chapter 2

Quick Start Guide

Introduction

This chapter provides a brief overview of the Anritsu MS2721A Spectrum Master. The intent of this chapter is to provide the user with a starting point for making basic measurements. For more detailed information, see Chapter 3, *Key Functions* and Chapter 4, *Measurement Fundamentals*.

Turning the MS2721A On for the First Time

The Anritsu MS2721A Spectrum Master is capable of up to three hours of continuous operation from a fully charged, field-replaceable battery (see Chapter 1). The MS2721A can also be operated from a 12 Vdc source (which will also simultaneously charge the battery). This can be achieved with either the Anritsu AC-DC Adapter (Anritsu part number 40-163) or 12 Vdc Automotive Cigarette Lighter Adapter (Anritsu part number 806-62). Both items are included as standard accessories (see the list of accessories in Chapter 1).

To turn on the MS2721A, press the **On/Off** front panel button (Figure 2-1).



Figure 2-1. MS2721A On/Off Button

The MS2721A Spectrum Master takes about thirty-five seconds to complete power up and load the application software. At the completion of this process, the instrument is ready to use.

For information on making measurements with the Spectrum Master, refer to “Making a Spectrum Analyzer Measurement,” later in this chapter. For advanced applications, refer to Chapter 4, *Measurement Fundamentals*, and Chapter 5, *Field Measurements*.

Front Panel Overview

The Spectrum Master menu-driven interface is easy to use and requires little training. Hard keys on the front panel are used to initiate function-specific menus. There are five function hard keys located below the display: Frequency, Span, Amplitude, Bandwidth and Marker.

There are 21 hard keys and a rotary knob located to the right of the display. Eight of the hard keys are dual purpose, depending on the current mode of operation. The dual-purpose keys are labeled with a number on the key itself, and the alternate function printed on the panel above the key. Use the shift key to access the functions printed on the panel. The **Escape** key, used for aborting data entry, is the round button located above soft keys. The rotary knob and the keypad can both be used to change the value of an active parameter.

There are also eight soft keys to the right of the display which change function depending upon the current menu selection. The current soft key function is indicated in the active function block to the right of the display. The locations of the different keys are shown in Figure 2-2, below.

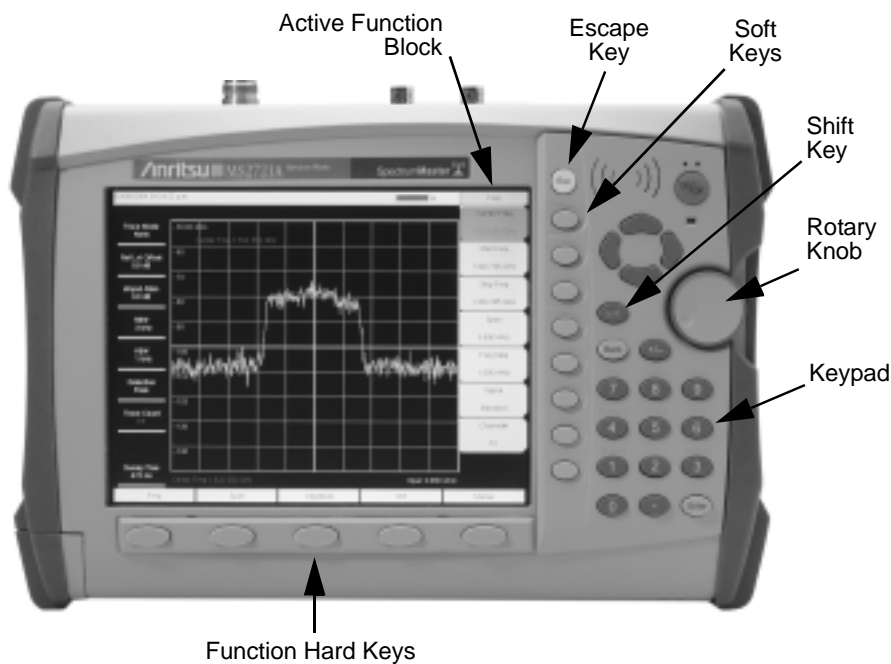


Figure 2-2. Front Panel Overview

Display Overview

Figure 2-3 illustrates some of the key information areas of the MS2721A display. Refer to Chapter 3, *Key Functions*, for more detailed key descriptions.

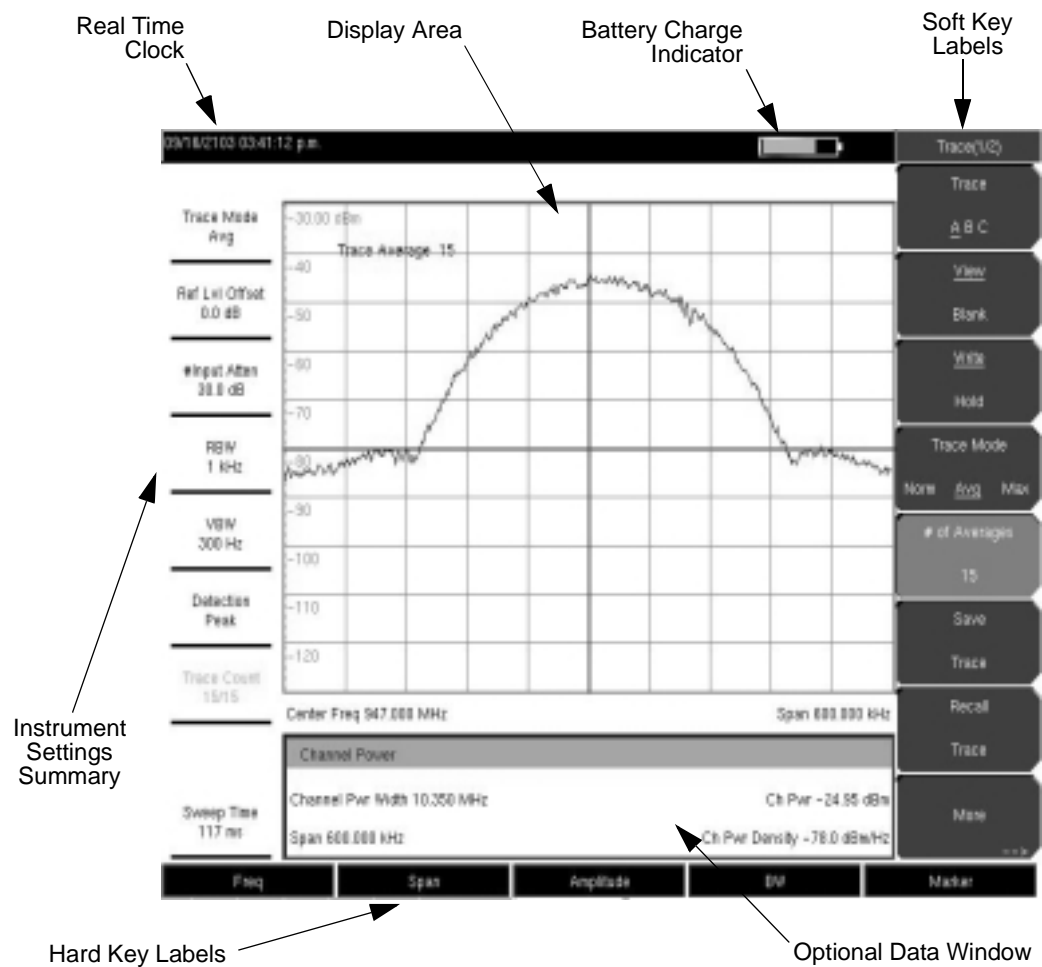


Figure 2-3. Display Overview

Test Panel Connectors

The connectors and indicators located on the test panel are shown in Figure 2-4 and described below.

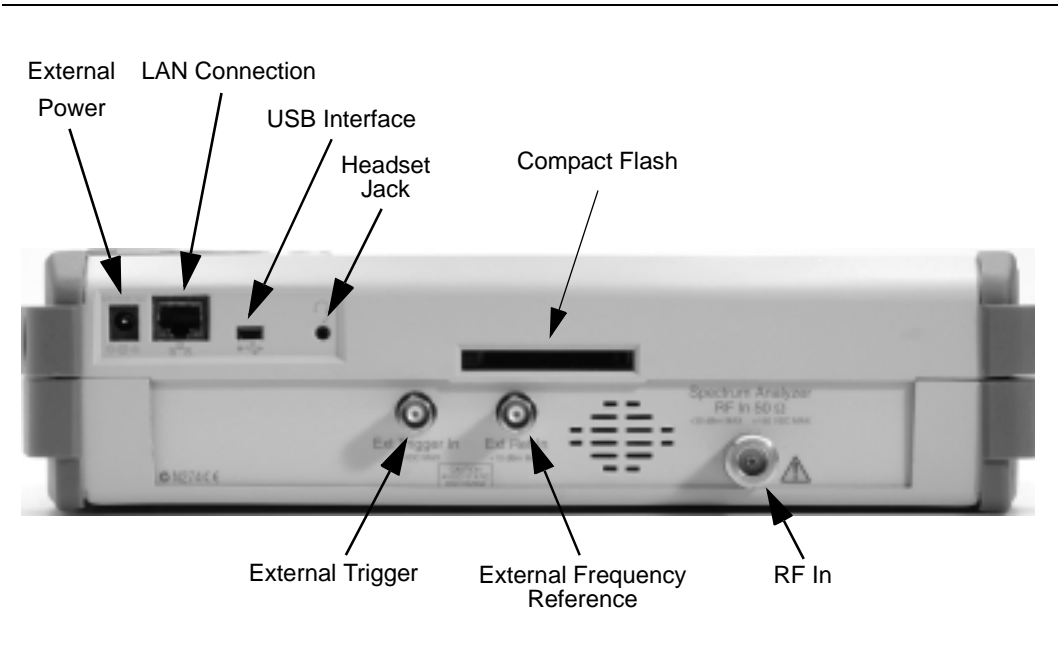


Figure 2-4. Test Panel Connectors

External Power

The external power connector is used to power the unit and for battery charging. Input is 12 to 15 Vdc at up to 5.0A. A green flashing indicator light near the power switch shows that the instrument battery is being charged by the external charging unit. The indicator is steadily illuminated when the battery is fully charged.

WARNING: When using the AC-DC Adapter, always use a three-wire power cable connected to a three-wire power line outlet. If power is supplied without grounding the equipment in this manner, there is a risk of receiving a severe or fatal electric shock.

LAN Connection

The RJ-45 connector is used to connect the Spectrum Master to a local area network. Integrated into this connector are two LEDs. The amber LED indicates the presence of LAN voltages—a live LAN connection—while the green LED flashes to show that LAN traffic is present. The instrument IP address is set by pressing the **Shift** key, then the **System** (8) key followed by the Ethernet Config soft key. The instrument Ethernet address can be set automatically using DHCP, or manually by entering the desired IP address, gateway address and subnet mask.

Dynamic Host Configuration Protocol (DHCP) is an Internet protocol that automates the process of setting IP addresses for devices that use TCP/IP, and is the most common method of configuring a device for network use. To determine if a network is set up for DHCP, connect the MS2721A to the network and select DHCP protocol in the Ethernet Config menu.

Turn the Spectrum Master off, and then on. If the network is set up for DHCP, the assigned IP address should be displayed as shown in Figure 2-5.

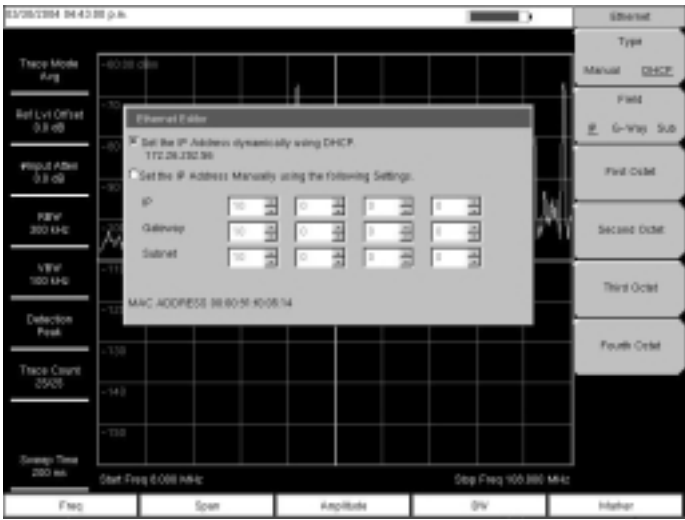


Figure 2-5. IP Address Assigned Using DHCP

USB Interface

The USB 2.0 interface can be used to connect the MS2721A Spectrum Master directly to a PC. The first time the MS2721A is connected to a PC, the normal USB device detection by the computer operating system will take place. The CD-ROM shipped with the instrument contains a driver for Windows 2000 and Windows XP that is installed when Master Software Tools is installed. Drivers are not available for earlier versions of the Windows operating system. During the driver installation process, place the CD-ROM in the computer drive and specify that the installation wizard should search the CD-ROM for the driver.

Headset Jack

The headset jack provides audio output from the built-in AM/FM/SSB demodulator for testing and troubleshooting wireless communication systems. The jack accepts a 2.5 mm 3-wire miniature phone plug such as those commonly used with cellular telephones.

Ext Trigger

A TTL signal applied to the External Trigger female BNC input connector causes a single sweep to occur. This mode is used in zero span, and triggering occurs on the rising edge of the signal. After the sweep is complete, the resultant trace is displayed until the next trigger signal arrives.

Ext Freq Ref

BNC female connector for connection of an external frequency reference or external trigger. Select the Ext Ref Freq soft key under the System menu to select the frequency of the external reference from the list presented.

RF In

50Ω Type-N female connector.

Compact Flash

Accepts a 64 MB Compact Flash Memory Module, Anritsu Part Number 2000-1358 or other commercially available equivalent.

Making Spectrum Analyzer Measurements

Required Equipment

- MS2721A Handheld Spectrum Analyzer
- Optionally, an antenna appropriate for the frequency range to be measured

Making a Measurement

To make a measurement, locate and display the signal(s) of interest by selecting the desired frequency, span, and amplitude value, as explained below.

NOTE: In most cases, information and parameters can be entered into the Spectrum Master through the keypad, the directional arrows or the rotary knob. The numerical keypad enters the information directly. The up and down arrow keys change a frequency parameter by the value entered through the Freq Step soft key (default value is 1 MHz). The left and right arrow keys change the frequency parameter by one graticule, that is, one-tenth of the total span. The rotary knob changes the frequency parameter by one pixel per step. There are 551 pixels across the screen in normal mode and 661 pixels in full-screen mode. Choose whichever method is most convenient to enter the required information.

- Step 1. Connect the input signal or antenna to the RF In test port.
- Step 2. Press the **Freq** key to display the Frequency menu.
- Step 3. To enter a center frequency, select the Center Freq soft key and enter the desired center frequency.
- Step 4. To set a specific frequency band, select the Start Freq soft key and enter the desired start frequency, then select the Stop Freq soft key and enter the desired stop frequency.
- Step 5. Press the **Span** key to display the Span menu and enter the span, or for a full span, select the Full Span soft key. Selecting a full span will override any previously set Start and Stop frequencies. For a single frequency measurement, select the Zero Span soft key.

NOTE: To quickly move the span value up or down, select the Span Up 1-2-5 or Span Down 1-2-5 soft keys. These keys facilitate a zoom-in, zoom-out in a 1-2-5 sequence.

Setting the Amplitude

- Step 1. Press the **Amplitude** key.

NOTE: To change the current measurement units, press the Units soft key and select the required units from the soft keys presented. Press the Back soft key to return to the Amplitude menu.

- Step 2. Press the Reference Level soft key and use the Up/Down arrow keys or the keypad to set the reference level. Press **Enter** to set the reference level.
- Step 3. Press the Scale soft key and use the Up/Down arrow keys or the keypad to enter the desired scale. Press **Enter** to set the scale.

NOTE: The Scale parameter cannot be changed when linear units are selected (Watts or Volts). Press the Amplitude soft key and select Auto Atten coupling of the attenuator setting and the reference level to help ensure that harmonics and spurs are not introduced into the measurements. See *Attenuator Functions* (page 4-2) for more information.

Selecting a Signal Standard

Selecting a signal standard sets the center frequency, channel spacing, integration bandwidth and span for the first channel of the selected standard. Appendix A contains a table of the signal standards available in the instrument.

To select a signal standard:

- Step 1. Press the **Freq** key to display the Frequency menu.
- Step 2. Press the Signal Standard soft key and use the Up/Down arrow keys or the rotary knob to highlight the desired signal standard. Press **Enter** to select the highlighted signal standard.
- Step 3. Press the Channel# soft key to choose the required channel. By default, if a channel number has not yet been entered, the lowest channel number for that standard is automatically selected. The channel numbers that can be selected correspond to the channel numbering schemes of the various signal standards.

Setting Bandwidth Parameters

Both resolution bandwidth (RBW) and video bandwidth (VBW) can be automatically or manually coupled to the frequency span. That is, the wider the span, the wider the RBW. The ratio of the span width to the resolution bandwidth is 300:1 by default, and if necessary, can be changed as follows:

- Step 1. Press the BW key.
- Step 2. Select the Span/RBW soft key. The current Span/RBW ratio is shown as part of the soft key label. Change the value using the keypad, the directional arrows or the rotary knob.

When auto coupling between the span and the RBW is selected, it is indicated on the left side of the display as RBW XXX, where XXX is the bandwidth value. If manual RBW coupling is selected, a "#" is shown in front of RBW on the left side of the display, and the resolution bandwidth can be adjusted independently of the span. If a non-existent resolution bandwidth is entered, the instrument will select the next higher resolution bandwidth. If a value greater than the widest RBW is entered, the widest RBW will be selected.

Auto coupling of the VBW links the video bandwidth to the resolution bandwidth, so that the wider the RBW, the wider the VBW. Auto coupling is indicated on the left side of the display as VBW XXX. If manual VBW coupling is selected, a "#" is shown in front of VBW on the left side of the display, and the video bandwidth can be adjusted independently of the RBW. If a non-existent video bandwidth is entered, the instrument will select the next higher video bandwidth. If a value greater than the widest VBW is entered, the widest VBW will be selected.

The ratio of the resolution bandwidth to the video bandwidth can be changed by pressing the **BW** key, the RBW/VBW soft key, and then using the keypad, the directional arrows or the rotary knob to set the ratio. The current value of the ratio is shown as part of the soft key label.

Setting Sweep Parameters

To set the sweep parameters, press the **Shift** key and then the **Sweep** (3) key.

Single/Continuous

When this soft key is pressed the instrument toggles between single sweep and continuous sweep. In single sweep mode, after the sweep the instrument waits in Hold mode until the Manual Trigger soft key is pressed or another triggering mode is selected.

Trigger Type

To select a specific type of triggering, press the Trigger Type soft key. Selections are:

Free Run

The default trigger type is "Free Run" in which the instrument begins another sweep as soon as one is finished.

External

A TTL signal applied to the External Trigger BNC input connector causes a single sweep to occur. This mode is used in zero span, and triggering occurs on the rising edge of the signal. After the sweep is complete, the resultant trace is displayed until the next trigger signal arrives.

Video

This mode is used in zero span to set the power level at which a sweep is initiated. The power level can be set from -120 dBm to +20 dBm. Trigger is based on the measured signal level. If no signal reaches or exceeds the trigger level, there will be no trace on the screen.

Change Trigger Position

This soft key is used in conjunction with video triggering to set the horizontal position on the display where a signal that meets the video triggering criterion will be placed. The value can be from 0% to 100%. Zero percent places the triggering event at the left edge of the screen while 100% places the triggering at the right edge of the screen. When the trigger position is any value other than 0%, the portion of the trace before the trigger event is displayed very quickly since the trace data is stored in memory. The portion of the trace after the trigger point is painted on the screen at the normal rate as the signal is swept.

Chapter 3

Key Functions

Introduction

This chapter describes the MS2721A keys and how to use them. The major sections are arranged in alphabetical order with soft key menus listed in the order they appear from top to bottom.

Amplitude

Reference Level

The reference level is the top graticule line on the display, and can be set from +30 dBm to -150 dBm. A value may be entered from the key pad, using the \pm key as the minus sign. After entering the value press the dBm soft key or the **Enter** key. The Up/Down arrow keys change the reference level in 10 dB steps, and the Left/Right arrow keys change the value by 1 dB. The rotary knob changes the value by 0.1 dB per detent.

The reference level value may be modified by the reference level offset value, discussed later in this chapter.

Scale

The scale can be set in 1 dB steps from 1 dB per division to 15 dB per division. The value can be changed using the keypad, the rotary knob or the Up/Down arrow keys.

Auto Atten On/Off

Input attenuation can be either tied to the reference level (On) or manually selected (Off). When input attenuation is tied to the reference level, attenuation is increased as higher reference levels are selected to make sure the instrument input circuits are not saturated by large signals that are likely to be present when high reference levels are required.

Atten Lvl

Input attenuation can be set from 0 to 65 dB, in 5 dB steps. Select this soft key and use the keypad, the rotary knob or the Up/Down arrow keys to change the attenuation value. When the Preamplifier is turned on, the allowed attenuation settings are 0 and 10 dB.

RL Offset

Reference Level Offset compensates for the presence of input attenuation or gain external to the instrument. Enter a positive value to compensate for an external amplifier or a negative value to compensate for an external attenuator. Use the \pm key to enter the negative sign when a negative attenuation value is being entered.

Units

Select the display units from this soft key menu:

- dBm
- dBV
- dBmV
- dB μ V
- Volt
- Watt

Press the Back soft key to return to the Amplitude menu.

Pre Amp On/Off

This soft key turns the low-noise front-end preamplifier on or off. The preamplifier lowers the noise floor by approximately 25 dB. To assure accurate measurement results, the largest signal into the instrument input when the preamplifier is turned on should be <-50 dBm.

BW (Bandwidth)

RBW

The current resolution bandwidth value is displayed in this soft key. The RBW can be changed using the keypad, the Up/Down arrow keys, or the rotary knob. The range is 10 Hz to 3 MHz in a 1-3 sequence, from 10 Hz to 30 Hz to 100 Hz, and so on.

Auto RBW

When Auto RBW is On, the instrument selects the resolution bandwidth based on the current span width. The ratio of span width to RBW can be specified using the Span/RBW soft key.

VBW

The current video bandwidth value is displayed in this soft key. The VBW can be changed using the keypad, the Up/Down arrow keys, or the rotary knob. The range is 1 Hz to 3 MHz in a 1-3 sequence.

Auto VBW

When Auto VBW is On, the instrument selects the video bandwidth based on the resolution bandwidth. The ratio of video bandwidth to resolution bandwidth can be set using the RBW/VBW soft key.

RBW/VBW

This soft key displays the ratio between resolution bandwidth and video bandwidth. To change the ratio, select this soft key and use the keypad, the Up/Down arrow keys, or the rotary knob to select a new ratio. The default ratio is 3.

Span/RBW

This soft key displays the ratio between the span width and the resolution bandwidth. The default value is 300, meaning that the span width is approximately 300 times the resolution bandwidth. The value is approximate because resolution bandwidth filters come in discrete steps while span width can be set to any value up to 7.1 GHz. To change the ratio, select this soft key and use the keypad, the Up/Down arrow keys, or the rotary knob to select a new ratio.

File

To access the functions under the File menu, select the **Shift** key, then the **File** (7) key.

Save / Recall

Selecting this soft key opens a list of save and recall function soft keys, as explained below. Press the **Back** key to return to the **File** menu.

Save Setup

Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by selecting the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the setup.

Recall Setup

This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup. Use the rotary knob or the Up/Down arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Save Measurement

Initiates a dialog box to name and save the current active trace A. The saved measurement trace can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by selecting the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the measurement trace.

NOTE: If a measurement has been previously saved, the Save Measurement dialog box will open with the previously saved name displayed. To save the new measurement with a similar name (for example, Trace-1, Trace-2, etc.) simply press the Right directional arrow and add the changes. To create a completely new name, use the keypad, the rotary knob or select the soft key for each letter.

Recall Measurement

Brings up a selection box that allows recall of a previously stored measurement trace. Use the rotary knob or the Up/Down arrow keys to highlight the saved measurement trace, and press **Enter**, the rotary knob, or the Recall soft key to select. A recalled trace may be displayed as trace A, in place of the live trace, or as trace B or C along with the live trace. Use the rotary knob or the Up/Down arrow keys to highlight the recalled trace option, and press the **Enter** key to select. Press the **Esc** key to cancel the recall.

To remove a recalled measurement trace from the screen, select the **Shift** key and the **Trace** (5) key to open the Trace menu. Use the Trace soft key to select the trace to be removed from the screen and use the View/Blank soft key to view or blank the trace. Use the Trace key to select an active trace after blanking a recalled trace.

Delete

Brings up a selection box that shows all stored setups and traces. The list shows the setup or trace name, the type (stp for a saved setup, spa for a saved trace, jpg for a JPEG file) and the date and time the information was saved. Use the rotary knob or the Up/Down arrow keys to highlight the saved information, and press **Enter**, the rotary knob, or the Delete soft key to delete. Press the Delete All soft key to delete all saved information. Press the **Esc** key to cancel the operation.

Copy All to External Card

This function copies all stored setups and measurements from the internal memory to an external Compact Flash memory card.

Copy All from External Card

This function copies all measurements and setups from an external Compact Flash memory card into the instrument internal memory.

Save Screen as JPEG

This function saves a measurement trace as a graphics file. The saved measurement can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by selecting the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the measurement after entering the file name. The file is saved in the internal memory with the specified name, with .jpg appended.

Print

The Print key can be used to save a measurement trace as a graphics file. This file can then be downloaded to a PC using Master Software Tools and printed.

Save Screen as JPEG

This function saves a measurement trace as a graphics file. The saved measurement can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by selecting the soft key for each letter.

Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the measurement after entering the file name. The file is saved in the internal memory with the specified name, with .jpg appended.

Freq (Frequency)

The tuning frequency range for the MS2721A can be entered in several different ways depending on what makes the most sense for the user or for the application. The center frequency and span can be specified, the start and stop frequencies can be entered, or a signal standard and channel number can be selected from the built-in list.

Center Frequency

Press the **Freq** key followed by the Center Freq soft key and 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 change to GHz, MHz, kHz and Hz. Select the appropriate units key. Selecting the **Enter** key has the same affect as the MHz soft key.

NOTE: When using the up and down arrows, the frequency moves in steps defined by the value entered using the Freq Step soft key.

When using the left or right arrow keys, the frequency of the active parameter moves by 10% of the current frequency span. If the instrument is in zero span, the left and right arrows do nothing.

Turning the rotary knob changes the active frequency parameter in increments of one display point for each click of the knob. There are 551 display points across the screen (661 points in full-screen mode).

Start Frequency

Press the **Freq** key followed by the Start Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a start frequency higher than the current stop frequency is entered, the stop frequency will be changed to yield a 10 Hz span.

Stop Frequency

Press the **Freq** key followed by the Stop Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a stop frequency lower than the current start frequency is entered, the start frequency will be changed to yield a 10 Hz span.

Span

Press the **Freq** key followed by the Span soft key and enter the desired span. The Span menu is used to set the frequency range over which the instrument will sweep. For the MS2721A, the span can be set from 10 Hz to 7.1 GHz. Span can also be set to zero span.

The soft key shows the current value for span in units of GHz, MHz, kHz or Hz. When the Span button is pressed, span becomes the active parameter and may be changed. Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the span frequency. If the span is changed using the Up/Down arrow keys, the span changes by the value of the Frequency Step for each key press.

Freq Step

Press the **Freq** key followed by the **Freq Step** soft key to enter the desired frequency step size. The frequency step specifies the amount by which a frequency will change when the Up/Down arrow keys pressed. The center frequency, start frequency, and stop frequency values can be changed using **Freq Step**. The active parameter will be changed by the frequency step when the Up/Down arrow keys are pressed. If **Freq Step** is the active parameter, nothing happens when the arrow keys are pressed. The frequency step size can be any value from 1 Hz to 7.1 GHz with a resolution of 1 Hz.

Use the keypad or the rotary knob to change the Frequency Step size.

Signal Standard

Use the Up/Down arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select.

When a signal standard is selected, the center frequency and span for the first channel of the particular standard is automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered. Appendix A contains a table of the signal standards that are in the instrument firmware.

Channel

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 spectrum analyzer display.

Limit

To access the functions under the Limit menu, select the **Shift** key, then the **Limit** (6) key.

Two types of limit lines can be specified, lower limit lines and upper limit lines. Limit lines can be used for visual reference only, or for pass/fail criteria using the limit alarm. Limit alarm failures are reported whenever a signal is above the upper limit line or below the lower limit line.

Each limit line can consist of a single segment, or as many as 40 segments across the entire frequency span of the instrument. These limit segments are retained regardless of the current frequency span of the instrument, allowing the configuring of specific limit envelopes at various frequencies of interest without having to re-configure them each time the frequency is changed. To clear the current limit setup configuration and return to a single limit segment starting at the current start frequency and ending at the current stop frequency, press the **Clear Limit** soft key.

Limit Upper/Lower

This soft key selects which limit line will be active for editing. The limit line that is currently selected for editing is underlined.

On/Off

This soft key turns the active limit line (upper or lower) on or off.

Limit Edit

A submenu is displayed by this soft key that allows the creation or editing of single or multi-segment limit lines. The currently active limit point is marked by a red circle on the display.

Move Limit

This soft key allows an entire single or multi-segment limit line to be moved up or down by the amount entered using the keypad, the Up/Down arrow keys, or the rotary knob. The units for this amount will be the current display units as selected under the **Amplitude** menu.

Frequency

The frequency of each point in a limit line can be individually set. When a new point is added, it takes on a value halfway between two existing points, or the stop frequency of the current sweep if there is no point higher in frequency than the one being added. See the Add Point soft key description for more details. Use the keypad, the Left/Right arrow keys or the rotary knob to change the frequency of a point.

Amplitude

The amplitude of each limit point can also be individually set. By default, when a new point is added, it takes on the amplitude that is on the limit line at the frequency where the point was added. Use the keypad, using the \pm key as the minus sign, the Up/Down arrow keys or the rotary knob to move the point to the desired value. The unit of the amplitude limit is the same as the current vertical amplitude unit. See the Add Point soft key description for more details.

Add Point

The precise behavior of this soft key depends on which limit point is active at the time the key is pressed. If the active limit point is somewhere in the middle of a multi-segment limit line, a new limit point will be added that is halfway between the currently active point and the point immediately to its right. The amplitude of the point will be such that it falls on the limit line. For example, if there is a limit point at 2.0 GHz with an amplitude of -30 dBm and the next point is 3.0 GHz with an amplitude of -50 dBm, the added point will be at 2.5 GHz with an amplitude of -40 dBm. The frequency and amplitude values of the new point can be adjusted as needed with the Frequency and Amplitude soft keys.

If the last limit point is active (assuming it is not at the right edge of the display) the new limit point will be placed at the right edge of the display at the same amplitude as the point immediately to its left.

Points may not be added beyond the current sweep limits of the instrument.

Delete Point

This soft key deletes the currently active point. The active point becomes the one immediately to the left of the point that was deleted.

Next Point Left

This soft key selects the limit point immediately to the left of the active point, making it active for editing or deletion. With each key press, the indicator of which point is active moves one limit point to the left until it reaches the left edge of the screen.

Next Point Right

This soft key selects the limit point immediately to the right of the active point, making it active for editing or deletion. With each key press, the indicator of which point is active moves one limit point to the right until it reaches the right edge of the screen.

Back

Returns to the higher-level Limit menu.

Limit Alarm

This soft key selects, for the currently active limit line, if an alarm beep will occur when a data point exceeds the limit.

Clear Limit

This soft key deletes all limit points for the currently active limit line and defaults to a single limit whose amplitude value will be selected to make it visible on the screen. The other limit line is not altered.

Marker

Press the **Marker** function hard key to open the Marker menu. The MS2721A is equipped with six markers. Any or all markers can be employed simultaneously.

Marker 1 2 3 4 5 6

Use this soft key to select the active marker. The underlined marker number is the active marker. Each press of the soft key moves the underline to the next marker number.

On/Off

This soft key turns the active marker, selected by the Marker soft key above, on or off.

Delta On/Off

This function turns on a delta marker and prompts for a delta offset frequency, either positive or negative from the frequency of the currently active marker.

Peak Search

This soft key places the currently active marker on the highest signal amplitude currently displayed on screen.

Marker Freq to Center

This soft key changes the center frequency to place the currently active marker at the center of the display.

Marker to Ref Level

This soft key causes the amplitude of the currently active marker to become the reference level, which is the top horizontal line of the display.

More Peak Options

This soft key brings up a secondary menu of soft keys for more peak searching options.

Peak Search

This soft key places the currently active marker on the highest amplitude signal currently on screen.

Next Peak Left

From the current position of the active marker, the instrument searches to the left (toward lower frequencies) for a peak signal that rises at least a certain amount above the average noise level. If no such peak is found, the marker is placed at the left end of the trace. The Peak Threshold soft key allows the user to specify the performance of peak searching.

Next Peak Right

From the current position of the active marker, the instrument searches to the right (toward higher frequencies) for a peak signal that rises at least a certain amount above the average noise level. If no such peak is found, the marker is placed at the right end of the trace. The Peak Threshold soft key allows the user to specify the performance of peak searching.

Delta Marker to Span

Sets the total span width to the value of the delta marker. If the delta marker is zero, the span is set to 10 Hz. If there is no delta marker, or the delta marker value is set to less than 10 Hz, then the span will be set to 10 Hz.

Marker Freq to Center

Sets the center frequency to the frequency of the currently active marker.

Marker to Ref Lvl

Sets the amplitude of the currently active marker to the top graticule line as the reference level.

Peak Threshold

This soft key allows the user to specify how far above the average noise floor a signal must rise before it is considered a peak.

Back

Returns to the higher-level menu.

More

Opens a submenu of further Marker options.

Marker Noise

This marker option turns the markers into noise markers with units of dBm/Hz. When this option is selected, the detection method is automatically changed to RMS and the displayed value is compensated for the noise bandwidth of resolution bandwidth filter.

Marker Table

Pressing this soft key causes a table to be displayed below the sweep window. The table is automatically sized to display all markers that are turned on. In addition to the marker frequency and amplitude, the table also shows delta frequencies and amplitude deltas for all markers that have deltas entered for them.

All Markers Off

This soft key turns off all markers.

Counter Marker On Off

Sets the frequency counter mode for all markers. Marker frequency values are normally limited in resolution to individual display pixels. Each pixel may represent multiple frequencies. Using Counter Marker in association with Marker to Peak will result in the exact frequency of the peak within the pixel to a resolution of 1 Hz.

Back

Returns to the previous menu.

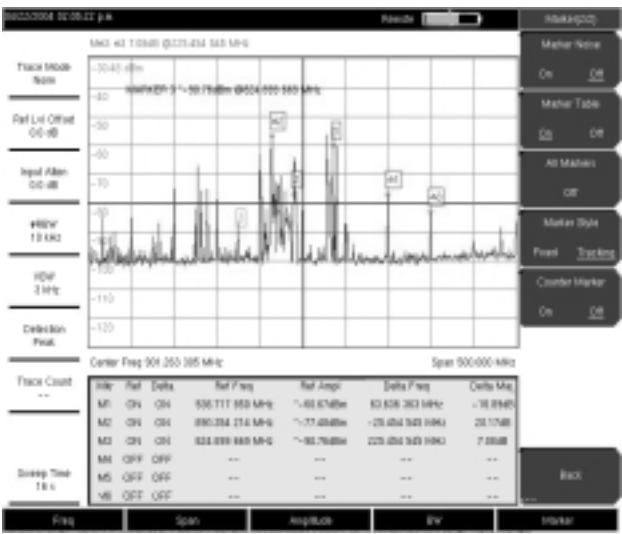


Figure 3-1. Markers

Measure

To access the functions under the Measure menu, select the **Shift** key, then the **Measure** (4) key.

Field Strength

This measurement allows the use of an antenna with known gain characteristics and measures the field strength over the frequency range of the antenna in units of dBm/meter, dBV/meter, dBmV/meter, dBμV/meter, volts/meter or watts/meter.

On Off

Turns field strength measurements on or off.

Antenna

This soft key brings up a dialog box that lists all the antennas for which the instrument has data, including both standard antennas and custom antenna that have been added using Master Software Tools. Use the Up/Down arrow keys or the rotary knob to select the desired antenna and press **Enter**.

Back

Returns to the previous menu.

OCC BW

Activates the occupied bandwidth menu. Select either % or dBc method of occupied bandwidth measurement.

Method % Down/dBc Down

Select either the % of Power (default) or dB Down measurement method as displayed in the message area.

%

Use the keypad, the directional arrow keys or the rotary knob to enter the percent of power, from 0 to 99%.

dBc

Use the keypad, the directional arrow keys or the rotary knob to enter the dBc value (0 to 120 dB).

Back

Returns to the previous menu.

Channel Power

Activates the Channel Power measurement function. Channel Power and Channel Power Density are measured based on the selection in the Units menu.

On Off

Begins or ends the channel power measurement. When the measurement is on, Ch Pwr will appear below the display. The detection method will automatically be changed to RMS Average when the measurement is started. The detection method can be modified by pressing the **Shift** and the **Sweep** keys and selecting the Detection soft key.

Center Freq

Activates the center frequency function, and sets the center frequency of the Spectrum Master for the channel power measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency.

Int BW

Sets the integration bandwidth for channel power measurement. Modifying this value automatically adjusts the channel span to maintain the same ratio. Use the keypad, the directional arrow keys or the rotary knob to enter the integration bandwidth.

Span

Sets the channel span for channel power measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the channel span.

Back

Returns to the previous menu.

ACPR

Accesses a menu of Adjacent Channel Power Ratio measurement options:

On Off

Begins or ends the ACPR measurement.

Main Ch BW

Sets the bandwidth of the main channel for ACPR measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, select the GHz, MHz, kHz, or Hz soft key to accept the frequency input. Changing this value automatically changes the adjacent channel bandwidth and channel spacing.

Adj Ch BW

Sets the bandwidth of the adjacent channels for ACPR measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, select the GHz, MHz, kHz, or Hz soft key to accept the frequency input.

Ch Spacing

Sets the channel spacing between the main and adjacent channels. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, select the GHz, MHz, kHz, or Hz soft key to accept the frequency input. This value must be greater than or equal to half of the main channel bandwidth, plus half of the adjacent channel bandwidth.

Back

Returns to the previous menu.

AM/FM Demod

The user can select AM, Narrow Band FM (300 μ s de-emphasis), Wide Band FM (50 μ s de-emphasis), Upper Sideband or Lower Sideband.

On Off

Turns AM/FM Demodulation on or off.

Demod Type

Provides soft keys to select the type of signal to be demodulated:

FM Wide Band

FM Narrow Band

AM

USB

LSB

Demod Freq

Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency of the signal to be demodulated. This frequency does not have to be within the current frequency sweep range to which the instrument is set.

Demod Time

Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the demodulation time, and press the **Enter** key to select. The demodulation time can be set from 100 milliseconds to 200 seconds. The instrument sweeps one time for every demodulation period. Sweeping pauses during the demodulation time.

Set Demod Freq to Current Marker Freq

Sets the demodulation frequency to the frequency of the current marker.

Beat Freq Osc

Sets the beat frequency of the oscillator to exactly set the demodulation frequency of USB and LSB signals.

Volume

The current volume setting is displayed on the screen. Use the Up/Down arrow keys or rotary knob to change the volume, and press the **Enter** key to select.

Back

Returns to the previous menu.

C/I

The Carrier to Interference ratio is a two-step measurement sequence that first measures the amplitude of a carrier, then, with the carrier turned off, measures the amplitude of all other interfering signals within the channel bandwidth.

On Off

Starts and stops the carrier to interference measurement.

Center Freq

Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency.

Span

Use the keypad, the directional arrow keys or the rotary knob to enter the frequency span.

Carrier Signal Type

Opens a menu to select the carrier signal type.

NB FHSS (Narrow Band Frequency Hopping Spread Spectrum)

Use this setting when the signal being measured is 802.11b.

WB FHSS (Wide Band Frequency Hopping Spread Spectrum)

Use this setting when the signal being measured is 802.11a or 802.11g.

Broadband

Use this setting when the signal being measured is a digital modulation format such as CDMA, GSM, etc.

Back

Returns to the previous menu.

Min Sweep Time

Set the minimum sweep time for the measurement.

Back

Returns to the previous menu.

Mode

To access the functions under the Mode menu, select the **Shift** key, then the **Mode** (9) key. Currently the only available mode is Spectrum Analyzer. When other modes are added to the MS2721A, they will be available for selection here.

Preset

To access the functions under the Preset menu, select the **Shift** key, then the **Preset** (1) key.

Preset

This key resets the instrument to the default starting conditions of full band sweep, 10 dBm log reference level, 10 dB/division scaling, 0 dB reference level offset, all measurements turned off and trigger set to free run.

Save Setup

Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by selecting the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the setup.

Recall Setup

This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup. Use the rotary knob or the Up/Down arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Span

The Span menu is used to set the frequency range over which the instrument will sweep. For the MS2721A, the span can be set from 10 Hz to 7.1 GHz. The Span can also be set to zero span.

Span

This soft key shows the current value for span in units of GHz, MHz, kHz or Hz. When the Span button is pressed, span becomes the active parameter and may be changed. Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the span frequency. If the span is changed by using the up and down arrow keys, the span changes by the value of the Frequency Step entered in the Frequency menu.

Span Up 1-2-5

This is a convenient way to quickly arrive at a wider span value. The first time the soft key is pressed, the span value increases to the nearest even value that starts with 1, 2 or 5. For example if the span is 1.8 MHz, pressing the soft key for the first time changes the span to 2.0 MHz, the next press takes the value to 5.0 MHz and so on.

Span Down 1-2-5

This is a convenient way to narrow the frequency span. The first time the soft key is pressed, the span value decreases to the nearest even value that starts with 1, 2 or 5. For example if the span is 1.8 MHz, pressing the soft key for the first time changes the span to 1.0 MHz, the next press takes the value to 500 kHz, then 200 kHz and so on.

Full Span

Pressing this button sets the span to cover the entire tunable spectrum of the MS2721A from 0 Hz to 7.1 GHz.

Zero Span

This soft key sets zero span. In this mode the display shows amplitude changes at a single frequency. This function is frequently used to allow the easy monitoring of power variations over time. For example, if information about the amplitude of an 802.11a access point signal is needed, the access point frequency would be set as the center frequency, resolution bandwidth would be set to a value wide enough to encompass the signal and the tester would walk around the access point usable area while the Spectrum Master records the amplitude using slow sweep.

Last Span

This soft key returns the span to the most recent span value immediately before a change was made.

Sweep

To access the functions under the Sweep menu, select the **Shift** key, then the **Sweep** (3) key.

Sweep Single/Continuous

This soft key toggles between continuous sweep and single sweep. In single sweep mode, the results of a sweep are displayed on the screen while the instrument awaits a trigger event to start a new sweep.

Manual Trigger

Pressing this soft key causes the instrument to make a single sweep when the instrument is in single sweep mode. This key has no function when the instrument is in continuous sweep mode.

Reset Sweep

This soft key stops the current sweep, clears trace averaging results, clears the maximum hold results, if selected, and restarts the sweep at the left side of the screen.

Detection

Several detection methods tailor the performance of the instrument to meet specific measurement requirements. In general, there are more measurement points across the screen than display points. The various detection methods are different ways of dealing with selecting which measurement point will be shown at each display point.

Peak

This method causes the largest measurement point to be shown for each display point, and assures that a narrow peak is not missed.

RMS

This method performs a root-mean-square calculation of all the measurement points in each display point, and is particularly useful in displaying the average value of noise.

Negative

This method causes the smallest measurement point to be shown for each display point. Typically this mode is used to help detect small discrete signals in the presence of nearly equal values of noise. The display points that contain only noise will tend to show lower amplitudes than those that contain discrete signals.

Sample

This is the fastest detection method since for each display point only one frequency point is measured. Use this method when speed is of paramount importance and the possibility of missing a narrow peak is not important.

Back

Returns to the previous menu.

Min Sweep Time

This function allows a minimum sweep time to be specified. Use the keypad, the directional arrow keys or the rotary knob to set the minimum sweep time from 50 microseconds to 4294 seconds. When using the keypad, the available time units are minutes, seconds, milliseconds and microseconds.

If the required sweep time for accurate measurement is longer than the specified minimum, then the time required for accurate measurements will prevail.

Trigger Type

Sets the type of trigger to be used.

Free Run

In this mode, a new sweep is started immediately upon completion of an old sweep. No trigger event is required to initiate a sweep.

External

A TTL signal applied to the External Trigger BNC input connector causes a single sweep to occur. This mode is used in zero span, and triggering occurs on the rising edge of the signal. After the sweep is complete, the resultant trace is displayed until the next trigger signal arrives.

Video

This mode is used in zero span to set the power level at which a sweep is initiated. The power level can be set from -120 dBm to +20 dBm. The trigger is based on the measured signal level. If no signal reaches or exceeds the trigger level, there will be no trace on the screen. This mode is used in Zero Span.

Change Trigger Position

This soft key is used in conjunction with video triggering to set the horizontal position on the display where a signal that meets the video triggering criterion will be placed. The value can be from 0% to 100%. Zero percent places the triggering event at the left edge of the screen while 100% places the triggering at the right edge of the screen. When the trigger position is any value other than 0%, the portion of the trace before the trigger event is displayed very quickly since the trace data is stored in memory. The portion of the trace after the trigger point is displayed on the screen at the normal rate as the signal is swept. This mode is used in Zero Span.

Back

Returns to the previous menu.

System

To access the functions under the System menu, select the **Shift** key, then the **System** (8) key.

Status

Pressing this soft key displays the current system status, including the operating system and firmware versions, temperatures and other details such as current battery information. Press **Esc** or **Enter** to return to normal operation.

Self Test

This soft key initiates a series of diagnostic tests that test the components of the instrument. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Self Test

This soft key initiates a series of diagnostic tests related to the performance of the spectrum analyzer. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Options

This soft key presents a menu to select application options.

Impedance 50 Ohm/75 Ohm/Other

Select either 50 ohm, 75 ohm, or other impedance value. Selecting 75 ohm selects the 7.5 dB loss of the Anritsu 12N50-75B adapter. For other adapters, select Other and enter the appropriate loss.

Ext Ref Freq

Select the frequency of the external reference from the list presented.

Back

Returns to the previous menu.

System Options

This key opens a selection of system option soft keys.

Date and Time

This soft key brings up a dialog box for setting the current date and time. Use the soft keys or the Left/Right arrow keys to select the field to be modified. Use the keypad, the Up/Down arrow keys or the rotary knob to select the date and time. Select **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Ethernet Configuration

This soft key brings up a dialog box to set the IP address of the instrument.

Type Manual/DHCP

This softkey selects whether the address will be entered manually, or supplied automatically by a network DHCP server. If Manual is selected, use the soft keys or the Left/Right arrow keys to select the field to be modified. Use the keypad, the Up/Down arrow keys or the rotary knob to enter the input. Select **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Language

This soft key brings up a selection box allowing selection from a list of built-in languages for the spectrum master displays. The languages currently available are English, French, German, Spanish, Japanese, Chinese, Korean, and Italian. In addition, a custom language may be selected if it has been defined using the Master Software Tools software and loaded into the MS2721A. The only limit regarding the number of languages that may be loaded into the instrument is the amount of space available in the memory. Select **Enter** to accept the change, or press the **Esc** key to return to normal operation without changing anything.

Brightness

The brightness of the display can be adjusted to optimize viewing under a wide variety of lighting conditions. Use the keypad, the Up/Down arrow keys or the rotary knob to select a brightness level from 1 to 10, 10 being the brightest. Select **Enter** to accept the change.

Name

Opens a dialog box to name the instrument. The unit can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by selecting the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the name.

Volume

The current volume setting is displayed on the screen. Use the keypad, the Up/Down arrow keys or the rotary knob to change the volume and press the **Enter** key to accept the change.

Reset

Opens a menu of reset and update options.

Factory Defaults

Restores the instrument to the factory default values, including Ethernet, language and brightness settings. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Master Reset

This will restore factory setting to all system parameters, including Time/Date, Ethernet, language and brightness settings. Also, all user files in the internal memory are deleted, and the original language and antenna files are restored. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Update OS Via Ethernet

Select this soft key to update the instrument operating system via the Ethernet connection. Press **Enter** to begin the update, or press **Esc** to return to normal operation without updating.

Update OS Via USB

Select this soft key to update the instrument operating system via the USB connection. Press **Enter** to begin the update, or press **Esc** to return to normal operation without updating.

Back

Returns to the previous menu.

Trace

To access the functions under the Trace menu, select the **Shift** key, then the **Trace** (5) key. The MS2721A is capable of displaying up to three traces, one with live data, and the other two either with stored data or trace math data.

Trace A, B, C

This soft key selects which trace is the active trace. The active trace is the one that is underlined. As the key is pressed, the underline advances from A to B to C and back to A.

View Blank

This soft key toggles the currently active trace to be either visible or hidden.

Write/Hold

Selects if the currently active trace will continue to sweep and be updated or to hold the current trace on screen. This is not applicable to traces B or C unless trace math involving trace A is active.

Trace Mode Norm/Avg/Max

With this soft key the function of the active trace can be modified:

Normal - the trace shows current data

Avg - the trace shows a running average of a number of traces. The number is determined by the next soft key, # of Averages.

Max - the trace shows the cumulative maximum value of each display point over many traces.

of Averages

Sets the number of traces that are used for the calculation of the average display value from 1 to 65535.

Save/Recall

Selecting this soft key opens a list of save and recall function soft keys, as explained in the **File** menu section on page 3-2.

Detection

Several detection methods tailor the performance of the instrument to meet specific measurement requirements. In general, there are more measurement points across the screen than display points. The various detection methods are different ways of dealing with selecting which measurement point will be shown at each display point.

Peak

This method causes the largest measurement point to be shown for each display point, and assures that a narrow peak is not missed.

RMS

This method performs a root-mean-square calculation of all the signals in each display, and is particularly useful in displaying the average value of noise.

Negative

This method causes the smallest measurement point to be shown for each display point. Typically this mode is used to help detect small discrete signals in the presence of nearly equal values of noise. The display points that contain only noise will tend to show lower amplitudes than those that contain discrete signals.

Sample

This is the fastest detection method since for each display point only one frequency point is measured. Use this method when speed is of paramount importance and the possibility of missing a narrow peak is not important.

Back

Returns to the previous menu.

More

A->B

Copies the contents of trace A into trace B. Doing so overwrites the previous contents of trace B.

A->C

Copies the contents of trace A into trace C. Doing so overwrites the previous contents of trace C.

B<->C

Swaps the contents of traces B and C.

A - B->C

Subtracts the value of trace B from trace A and places the results in trace C. This function is very useful for observing the changes in values of live trace A compared to a

trace stored in trace B. Display scaling can be set to a value that makes the differences easy to see.

B - A->C

Subtracts the value of trace A from trace B and places the results in trace C. This function is very useful for observing the changes in values of live trace A compared to a trace stored in trace B. Display scaling can be set to a value that makes the differences easy to see.

Full Screen

Increases size of the X-Y display by hiding the data labels on the left side of the display.

Back

Returns to the previous menu.

Chapter 4

Measurement Fundamentals

Introduction

Measurement fundamentals include the use of additional spectrum analyzer functions beyond frequency, span, amplitude and marker functions. In particular, this section focuses on resolution bandwidth, video bandwidth, sweep, and attenuator functions.

Resolution Bandwidth

Resolution Bandwidth is determined by the intermediate frequency (IF) filter bandwidth. The spectrum analyzer traces the shape of the IF filter as it tunes past a signal. If more than one IF filter is used in a spectrum analyzer, the narrowest one dominates and is considered the resolution bandwidth. The choice of resolution bandwidth depends on several factors. Filters take time to settle. That is, when a signal first appears at the input of the filter, it will take a while before the signal appears at the output. Additionally, the output of the filter will take some time to settle to the correct value, so that it can be measured. The narrower the filter bandwidth (resolution bandwidth) the longer the settling time needs to be and so the slower the sweep speed.

The choice of resolution bandwidth will depend on the signal being measured. If two closely-spaced signals are to be measured individually, then a narrow bandwidth is required. If a wider bandwidth is used, then the energy of both signals will be included in the measurement. Thus, the wider bandwidth does not have the ability to look at frequencies selectively but instead simultaneously measures all signals falling within the resolution bandwidth. Therefore, a broadband measurement would include all signals and noise within the measurement bandwidth into a single measurement.

On the other hand, a narrow-band measurement will separate the frequency components, resulting in a measurement that includes separate peaks for each signal. There are advantages to each. The ultimate decision will depend on the type of measurement required by the user.

There is always some amount of noise present in a measurement. Noise is often broadband in nature; that is, it exists at a broad range of frequencies. If the noise is included in the measurement, the measured value could be in error (too large) depending on the noise level. With a wide bandwidth, more noise is included in the measurement. With a narrow bandwidth, less noise enters the resolution bandwidth filter, and the measurement is more accurate. If the resolution bandwidth is narrower, the noise floor will drop on the spectrum analyzer display. This is because the IF filter of the analyzer has been made narrower in bandwidth, which lets in less noise. As the measured noise level drops, smaller signals that were previously obscured by the noise can now be measured.

Video Bandwidth

Spectrum analyzers typically use another type of filtering after the detector called video filtering. This filter also affects the noise on the display but in a different manner than the resolution bandwidth. In video filtering, the average level of the noise remains the same but the variation in the noise is reduced. Hence, the effect of video filtering is a "smoothing" of the signal noise. The resultant effect on the analyzer's display is that the noise floor compresses into a thinner trace, while the position of the trace remains the same.

Changing the video bandwidth (VBW) does not improve sensitivity, but it does improve discernability and repeatability when making low-level measurements. As a general rule of thumb, most field spectrum analyzer measurements are made at a video bandwidth that is a

factor of 10 to 100 less than the resolution bandwidth. In the MS2721A Spectrum Master, this ratio can be specified in the BW menu. For a resolution bandwidth of 30 kHz, the typical video bandwidth setting options are either 3 kHz or 300 Hz.

Sweep Limitations

With some spectrum analyzers, the user has control over sweep time (the elapsed time of each sweep, sometimes called scan time). An analyzer cannot be swept arbitrarily fast while maintaining its specified accuracy, but will have a sweep rate limitation depending on the resolution bandwidth, video bandwidth, and frequency range selected. The sweep rate is not usually chosen by the user but is determined by the frequency range swept divided by the sweep time. The limitation on sweep rate comes from the settling or response time of the resolution and video bandwidth filters. If an analyzer is swept too quickly, the filters do not have time to respond, and the measurement is inaccurate. Under such conditions, the analyzer display tends to have a "smeared" look to it, with the spectral lines being wider than normal and shifted to the right.

Fortunately, the Anritsu Handheld Spectrum Master is designed to relieve the user from having to calculate the sweep speed or experiment to discover a sweep speed that yields accurate results. When changing the RBW and VBW with Spectrum Master, the sweep speed automatically changes to the fastest sweep speed that will yield accurate results. The sweep speed will be faster for a wide RBW or VBW and slower for a narrow RBW or VBW. The sweep speed can also be changed manually, by pressing the SWEEP key and selecting the Min Sweep Time soft key. Enter a sweep time from 0.05 ms to 4294 seconds. If the minimum sweep time entered by the user is less than the value needed to assure accurate results, the value that delivers accurate results will be used. Regardless of the minimum sweep time setting, the Spectrum Master will never sweep faster than the RBW and VBW settings will allow. Spectrum Master is designed to assure that no uncalibrated measurement conditions will occur.

Attenuator Functions

Attenuation adjusts the hand held spectrum analyzer input attenuator. In Auto mode, as the reference level is increased, the attenuation is increased. In Manual mode, the input attenuation can be adjusted using the keypad or the Up/Down arrow keys. The attenuator range is 0 to 65 dB, in 5 dB steps. When the preamplifier is on, input attenuation can be either 0 dB or 10 dB.

Preamplifier Operation

The preamplifier can be turned on and off by pressing the **Amplitude** key, then selecting the Preamp On/Off soft key. The preamplifier has a gain of approximately 25 dB and generally will lower the noise floor by that amount. When the preamplifier is on, input attenuation can be either 0 dB or 10 dB.

Preamplifier Measurement Example

Figures 4-1 and 4-2 show the same signal with the preamplifier off and then on. Notice that when the preamplifier is turned on, the noise floor drops significantly allowing spectral regrowth components that were lost in the noise without the preamplifier to become easily visible.

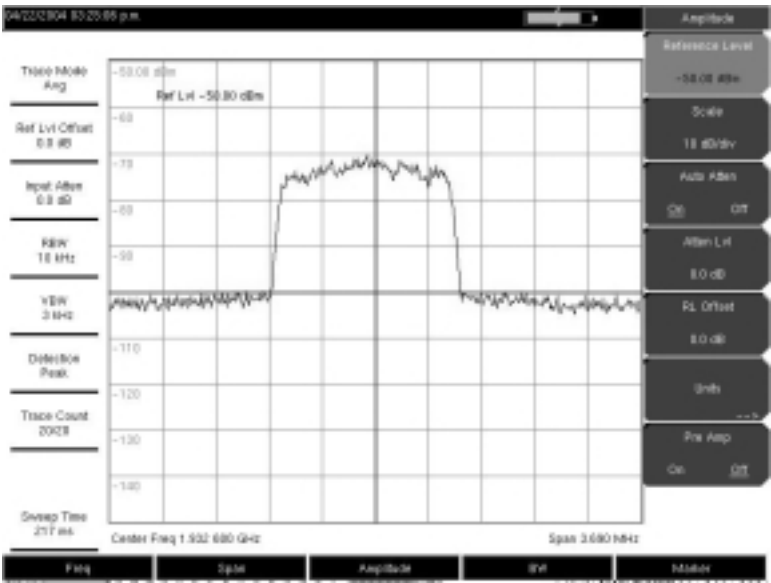


Figure 4-1. Preamplifier Off

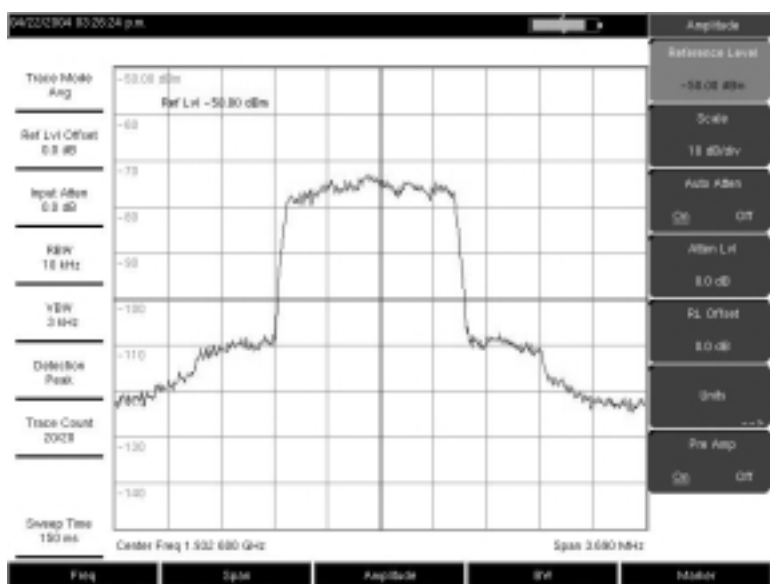


Figure 4-2. Preamplifier On

Chapter 5

Field Measurements

Introduction

There are one-button measurements built into the Spectrum Master MS2721A for field strength, occupied bandwidth, channel power, adjacent channel power ratio, and carrier to interference ratio (C/I) tests. In addition, AM/FM/SSB demodulation is available to aid in the identification of interfering signals. This chapter presents brief examples demonstrating the use of these measurements.

Occupied Bandwidth Measurement

Occupied bandwidth (OBW) is a common measurement performed on radio transmitters. This measurement calculates the bandwidth containing the total integrated power occupied in a given signal bandwidth. There are two different methods of calculation depending on the technique used to modulate the carrier.

% Down Method

The occupied frequency bandwidth is calculated as the bandwidth containing the specified percentage of the transmitted power.

dBc Down Method

The occupied frequency bandwidth is defined as the bandwidth between the upper and lower frequency points at which the signal level is a desired number of dB below the peak carrier level.

Required Equipment

- Anritsu MS2721A Handheld Spectrum Analyzer
- Test Port Extension Cable, Anritsu part number 15NNF50 - 1.5C
- 30 dB, 50 Watt, bi-directional, DC -18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30 (required if the power level being measured is >+30 dBm)

Procedure

- Step 1. Using the test port extension cable and the 30 dB, 50 watt, bi-directional attenuator (if needed) connect the MS2721A to the appropriate transmitter test port or signal source.
- Step 2. Press the **Freq** key followed by the Center Freq soft key and enter the center frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz and Hz. Select the appropriate units key. Selecting the **Enter** key has the same affect as the MHz soft key.
- Step 3. If the attenuator was connected in Step 1, press the **Amplitude** key and select the RL Offset soft key and set the reference level offset to -30 dB to compensate for the loss in the attenuator.
- Step 4. Press the **Amplitude** key then press the Reference Level soft key to set the appropriate reference level.
- Step 5. Press the Atten Lvl soft key to set the input attenuation level or leave Auto Atten set to On.
- Step 6. Press the **BW** key to set the resolution bandwidth and video bandwidth if desired.
- Step 7. Press the **Shift** key then the **Measure** (4) key followed by the OCC BW soft key. Choose the measurement method (dBc Down or % Down) by pressing the Method soft key. The selected method is underlined.

- Step 8. Press the dBc or % soft keys to adjust the settings as needed. Common values are 99% and 30 dBc.
- Step 9. Press the On/Off soft key to start the measurement. An information box will appear below the graph while occupied bandwidth measurement is on.

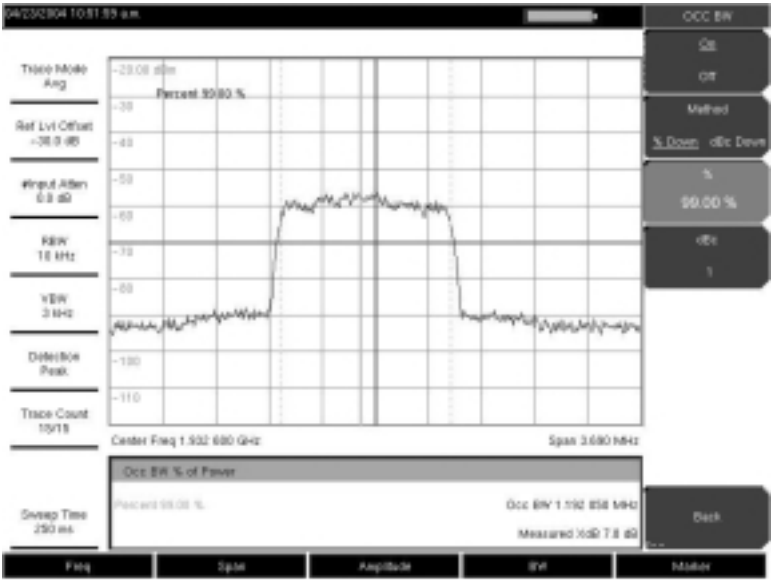


Figure 5-1. Occupied Bandwidth Results Using the % of Power Method

Figure 5-1 shows the occupied bandwidth results using the % of power method on a CDMA signal. Occupied Bandwidth is a constant measurement; once it is turned on, it remains on until it is turned off by pressing the On/Off soft key again. Occupied bandwidth is calculated at the end of each sweep.

Channel Power Measurement

Channel power measurement is one of most common measurements for a radio transmitter. This test measures the output power, or channel power, of a transmitter over the frequency range. Out-of-specification power measurements indicate system faults, which can be in the power amplifiers or in filter circuits. Channel Power measurements can be used to validate transmitter performance, comply with government regulations, or to keep overall system interference at a minimum.

Frequency and span settings for many signal standards can be automatically set by pressing the **Frequency** key and then the Signal Standard soft key. Choose the desired standard and press **Enter**. Press the Channel # soft key to enter the channel number at which the measurement is to take place.

CDMA Channel Power

The MS2721A can be used to measure CDMA signals in terms of channel power. It is important to use the proper settings to accurately measure a CDMA signal because a CDMA signal is different from a CW signal in many respects.

The following are the recommended settings for IS-95 CDMA measurements:

- CDMA Channel Bandwidth: 1.23 MHz
- Auto RBW setting: 10 kHz

- Auto VBW setting: 3 kHz

These values are set automatically when the appropriate signal standard is selected. Averaging may be used if desired.

CDMA Channel Power Measurement

Required Equipment

- MS2721A Handheld Spectrum Analyzer
- 30 dB, 50 Watt, bi-directional, DC -18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30 (required if the power level being measured is >+30 dBm)
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

- Step 1. Using the test port extension cable and 30 dB attenuator (if needed), connect the signal source to the input of the attenuator, and connect the output of the attenuator to the RF In test port of the MS2721A.
- Step 2. Press the **Freq** key followed by the Signal Standard soft key. Scroll through the dialog box using the rotary knob or Up/Down arrow keys to highlight the desired air interface standard. In this case, select CDMA US PCS - Downlink and press **Enter**.
- Step 3. Press the Channel# soft key and enter the channel number using the keypad, the arrow keys, or the rotary knob. In this case, select channel 50.
- Step 4. If the attenuator was connected in Step 1, press the RL Offset soft key and set the reference level offset to -30 dB to compensate for the loss of the attenuator.
- Step 5. Press the **Amplitude** key and select the Reference Level soft key. Set the reference level to -50 dBm.
- Step 6. Press the Scale soft key and set the scale to 10 dB/division.
- Step 7. Press the **Shift** key then the **Measure** (4) key, and select the Channel Power soft key.
- Step 8. Select the Center Freq soft key and verify that the center frequency of the Spectrum Master is set to that of the CDMA signal, 1.9326 GHz in this example. This value is automatically set when the air interface standard and channel number are selected.
- Step 9. Press the Int BW soft key and verify that the integration bandwidth is set to 1.23 MHz.
- Step 10. Press the Span soft key and verify that the span is set to 3.69 MHz.

NOTE: The integration bandwidth is defined as the frequency span in which the spectrum analyzer integrates measured power readings, while the channel span is the frequency range of the analyzer sweeps.

- Step 11. Make the measurement by pressing the On/Off soft key. The MS2721A displays the measurement results in the message area.

NOTE: Channel power is a constant measurement. Once it is turned on, it will remain on until it is turned off by pressing the On/Off key again.

GSM Channel Power Measurement

Global Systems for Mobile (GSM) communication is a globally accepted standard for digital cellular communication. There are three frequency bands allocated to GSM mobile phones, one at 850 MHz, one at 900 MHz, and another at 1800 MHz. GSM uses a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). Within each band are approximately one hundred available carrier frequencies on 200 kHz spacing (FDMA), and each carrier is broken up into time-slots so as to support eight separate

conversations (TDMA). Each channel has an uplink and a downlink, 80 MHz apart. GSM uses the Gaussian Minimum Shift Keying (GMSK) modulation method. Due to the nature of TDMA, GSM transmitters ramp RF power rapidly. If the transmitter keys on too quickly, users on different frequencies (especially those close to the channel of interest) may experience significant interference. This is one of the reasons that spurious measurements are extensively used in GSM applications.

Required Equipment

- MS2721A Handheld Spectrum Master
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

- Step 1. Using the test port extension cable, connect the signal source to the RF In test port of the MS2721A.
- Step 2. Press the **Amplitude** key and select the Reference Level soft key to set the reference level to -20 dBm. Adjust the values given in this procedure to match your measurement conditions.
- Step 3. Press the **Scale** soft key and set the scale to 10 dB/division.
- Step 4. Press the **BW** key and verify that RBW Auto and VBW Auto are On.
- Step 5. Press the **Freq** key followed by the Signal Standard soft key. Scroll through the dialog box using the rotary knob or Up/Down arrow keys to highlight the GSM900 standard for the measurement and press **Enter**.
- Step 6. Press the **Channel#** soft key and enter the channel number using the keypad, the arrow keys, or the rotary knob. For this example, select Channel 60.
- Step 7. Press the **Shift** key then the **Measure** (4) key and press the Channel Power soft key.
- Step 8. Select the Center Freq soft key and verify that the center frequency of the Spectrum Master is set to that of the GSM signal, in this case 947.0 MHz.
- Step 9. Select the Int BW soft key and enter 200 kHz for the integration bandwidth, or set the integration bandwidth appropriate for the particular application.
- Step 10. Select the Span soft key and enter 800 kHz as the channel span, or set the channel span to a value appropriate for the particular application.
- Step 11. Make the measurement by pressing the Measure soft key. The MS2721A displays the measurement results in the message area.

NOTE: Channel Power is a constant measurement. Once it is turned on, it will remain on until it is turned off by pressing the On/Off soft key again.
--

AMPS Channel Power Measurement

The MS2721A can be used to test Advanced Mobile Phone System (AMPS) base stations. These systems are narrow-band FM voice transceivers with system control functionality. The energy of the AMPS signal is represented by multiple narrow band FM channels spread over a wide frequency range. AMPS frequency allocations are within the 800 and 900 MHz cellular telephone spectrum. Each service provider can use half of the 825-845 MHz range for receiving signals from cellular phones and half the 870-890 MHz range for transmitting to cellular phones. The bands are divided into 30 kHz channels with 12 kHz maximum frequency deviation.

Required Equipment

- MS2721A Handheld Spectrum Master
- Test Port extension cable, Anritsu 15NNF50 - 1.5C
- 30 dB, 50 Watt, bi-directional, DC -18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30 (required if the power level being measured is >+30 dBm)

Procedure

- Step 1. Using the test port extension cable, and the 30 dB attenuator if needed, connect the signal source to the input of the attenuator, and connect the output of the attenuator to the RF In test port of the MS2721A.
- Step 2. If the attenuator was connected in Step 1, press the **Amplitude** key and select the **RL Offset** soft key and set the reference level offset to -30 dB to compensate for the loss in the attenuator.
- Step 3. Press the **Amplitude** key and select the **Reference Level** soft key to set the reference level to -50 dBm.
- Step 4. Press the **Scale** soft key and set the scale to 10 dB/division.
- Step 5. Press the **Amplitude** key followed by the **Auto Atten** soft key if needed to turn On auto attenuation.
- Step 6. Press the **BW** key and verify that RBW Auto and VBW Auto are On.
- Step 7. Press the **Shift** key then the **Trace** (5) key. Press the **Trace Mode** soft key as needed to select Max (maximum hold).
- Step 8. Press the **Shift** key then the **Measure** (4) key and press the **Channel Power** soft key.
- Step 9. Select the **Center Freq** soft key and set the center frequency of the Spectrum Master to that of the signal, in this example 888.852728 MHz.
- Step 10. Select the **Int BW** soft key and enter 30 kHz for the integration bandwidth.
- Step 11. Select the **Channel Span** soft key and enter 90 kHz as the channel span, or set the channel span to a value appropriate for the particular application.
- Step 12. Make the measurement by pressing the **On/Off** soft key.

NOTE: Channel Power is a constant measurement. Once it is turned on, it will remain on until it is turned off by pressing the **On/Off** soft key again.

Adjacent Channel Power Ratio

Another common transmitter measurement is that of Adjacent Channel Power Ratio (ACPR), or adjacent channel leakage power. This is defined as the ratio of the amount of leakage power in an adjacent channel to the total transmitted power in the main channel. This measurement can be used to replace the traditional two-tone intermodulation distortion (IMD) test for system non-linear behavior.

The result of an ACPR measurement is expressed as a power ratio. In order to calculate the upper and lower adjacent channel values, the MS2721A needs to know the values of four parameters:

- Main Channel Center Frequency
- Measurement Channel Bandwidth
- Adjacent Channel Bandwidth
- Channel Spacing

When a signal standard is selected from the list in the MS2721A, these four values are automatically set for that signal standard.

Adjacent Channel Power Measurement

Required Equipment

- MS2721A Handheld Spectrum Analyzer
- 30 dB, 50 watt, Bi-Directional, DC - 18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30 (if needed for the power level being measured)
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

- Step 1. Using the test port extension cable, and the 30 dB attenuator if needed, connect the signal source to the input of the attenuator, and connect the output of the attenuator to the RF In test port of the MS2721A.
- Step 2. If the attenuator was connected in Step 1, press the **Amplitude** key and select the RL Offset soft key and set the reference level offset to -30 dB to compensate for the loss of the attenuator.
- Step 3. Press the **Amplitude** key and select the Reference Level soft key to set the reference level to the appropriate reference level.
- Step 4. Press the Atten Lvl soft key to set the input attenuation level needed for the measurement. This value depends on the input power level and any external attenuator. Enter an attenuation level to achieve roughly -40 dBm at the input mixer.
- Step 5. Press the **BW** key and verify that RBW Auto and VBW Auto are On.
- Step 6. There are two ways to set the measurement parameters. If the signal standard and channel are known, press the **Freq** key and set the Signal Standard and Select Channel soft keys for the signal to be measured then skip to Step 12. If the signal standard and channel are not known, follow the procedure in Steps 6 through 11 below.
- Step 7. Press the **Freq** key, select the Center Freq soft key, and enter the desired center frequency.
- Step 8. Press the **Shift** key then the **Measure** key and press the ACPR soft key.
- Step 9. Press the Main Ch BW soft key, and enter the desired main channel bandwidth. For an IS-95 CDMA signal, enter 1.23 MHz.
- Step 10. Press the Adj Ch BW soft key, and enter the desired adjacent channel bandwidth. For an IS-95 CDMA signal, enter 1.23 MHz.
- Step 11. Press the Ch Spacing soft key, and enter the desired channel spacing. For an IS-95 CDMA signal, enter 1.23 MHz.
- Step 12. Begin making measurement by pressing the On/Off soft key. The MS2721A displays the measurement results in the message area.

NOTE: Adjacent Channel Power Ratio is a constant measurement. Once it is turned on, it will remain on until it is turned off by pressing the On/Off key again.

GSM Adjacent Channel Power Measurement

Required Equipment

- MS2721A Handheld Spectrum Analyzer
- 30 dB, 50 watt, Bi-Directional, DC - 18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30 (if required for the power level being measured)
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

- Step 1. Using the test port extension cable and 30 dB attenuator, connect the signal source to the input of the attenuator, and connect the output of the attenuator to the RF In test port of the MS2721A.
- Step 2. If the attenuator was connected in Step 1, press the RL Offset soft key and set the reference level offset to -30 dB to compensate for the loss of the attenuator.
- Step 3. Press the **Amplitude** key and select the Reference Level soft key to set the reference level to 60 dBm.
- Step 4. Press the Atten Lvl soft key to set the input attenuation level needed for the measurement. This value depends on the input power level and any external attenuator. Enter an attenuation level to achieve roughly -40 dBm at the input mixer.
- Step 5. Press the **BW** key and verify that RBW Auto and VBW Auto are On.

- Step 6. There are two ways to set the measurement parameters. If the signal standard and channel are known, press the **Freq** key and set the Signal Standard and Select Channel soft keys for the signal to be measured then skip to Step 12. If the signal standard and channel are not known, follow the procedure in Steps 7 through 12 below.
- Step 7. Press the **Freq** key, select the Center Freq soft key, and enter the desired center frequency.
- Step 8. Press the **Shift** key then the **Measure** key and select the ACPR soft key.
- Step 9. Select the Main Ch BW soft key, and enter the main channel bandwidth.
- Step 10. Select the Adj Ch BW soft key, and enter the adjacent channel bandwidth.
- Step 11. Select the Ch Spacing soft key, and enter the channel spacing.
- Step 12. Make the measurement by pressing the On/Off soft key. The detection method is automatically changed to RMS Average.

Solid vertical lines are drawn on the display to indicate the main channel. Dashed vertical lines define the adjacent channels. The MS2721A will display the measurement results in the message area.

NOTE: Adjacent Channel Power Ratio is a constant measurement. Once it is turned on, it will remain on until it is turned off by pressing the On/Off soft key again.

AMPS (TDMA) Adjacent Channel Power Measurement

Required Equipment

- MS2721A Handheld Spectrum Analyzer
- 30 dB, 50 watt, Bi-Directional, DC - 18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30 (if needed for the power level being measured)
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

- Step 1. Using the test port extension cable, and the 30 dB attenuator if needed, connect the signal source to the input of the attenuator, and connect the output of the attenuator to the RF In test port of the MS2721A.
- Step 2. If the attenuator was connected in Step 1, press the **Amplitude** key and select the RL Offset soft key and set the reference level offset to -30 dB to compensate for the loss in the attenuator.
- Step 3. Press the **Amplitude** key and select the Reference Level soft key to set the reference level to -50 dBm.
- Step 4. Press the RL Offset soft key to set the reference level offset to -30 dB.
- Step 5. Press the Auto Atten soft key and set automatic attenuation to On.
- Step 6. Press the **Freq** key, select the Center Freq soft key, and enter 835 MHz.
- Step 7. Press the **Shift** key then the **Measure** key and press the ACPR soft key.
- Step 8. Press the Main Ch BW soft key to enter the main channel bandwidth. For an AMPS signal, enter 30 kHz.
- Step 9. Press the Adj Ch BW soft key, and enter the adjacent channel bandwidth. For an AMPS signal, enter 30 kHz.
- Step 10. Select the Ch Spacing soft key, and enter the channel spacing. For an AMPS signal, enter 30 kHz.
- Step 11. Make the measurement by pressing the On/Off soft key.

The detection method is automatically changed to RMS Average. Solid vertical lines are drawn on the display to indicate the main channel. Dashed vertical lines define the adjacent channels. The MS2721A will display the measurement results in the message area.

NOTE: Adjacent Channel Power Ratio is a constant measurement. Once it is turned on, it will remain on until it is turned off by pressing the On/Off soft key again.

Out-of-Band Spurious Emission Measurement

Required Equipment

- MS2721A Handheld Spectrum Analyzer
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

- Step 1. Using the test port extension cable, connect the signal source to the RF In test port of the MS2721A.
- Step 2. Press the **Freq** key, select the Center Freq soft key, and enter the center frequency.
- Step 3. Press the **Span** key. Set the span wide enough to include the primary channel bandwidth and upper and lower channel bandwidths.
- Step 4. Press the **Amplitude** key, then press the Reference Level soft key and set the reference level to -20 dBm.
- Step 5. Press the Auto Atten soft key set the attenuation to On.
- Step 6. Press the **BW** key and use the RBW and VBW soft keys to set the resolution bandwidth to 3 kHz and the video bandwidth to 300 Hz.
- Step 7. Press the **Marker** key and press the Marker 1 2 3 4 5 6 soft key to select marker 1. The underlined number indicates the active marker.
- Step 8. Press the On/Off soft key and use the arrow keys, the keypad and the knob to move the marker over one of the spurs.
- Step 9. Compare the value of the marker to the specified allowable level of out-of-band spurious emissions for the corresponding channel transmit frequency.

Step 10. Repeat Steps 9 and 10 for the remaining spurs. Use either Marker 1 again, or choose another marker. Figure 5-2 shows a simulated out-of-band spurious signal 21.000 MHz from the carrier using a delta marker.

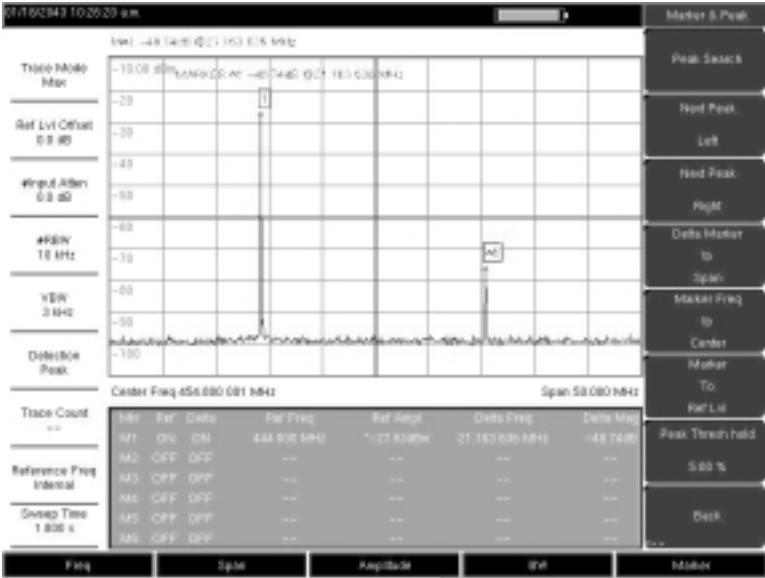


Figure 5-2. Simulated Out-of-Band Spurious Emission Measurement

In-band/Out-of-Channel Measurements

The in-band/out-of-channel measurements are those measurements that measure distortion and interference within the system band, but outside of the transmitting channel. These measurements include in-band spurious emissions and adjacent channel power ratio (also called spectral regrowth). There are stringent regulatory controls on the amount of interference that a transmitter can spill to neighboring channels. In order to determine compliance with the allowable level of spurious emissions, two parameters need to be specified:

- Measurement channel bandwidth
- Allowable level of spurious emissions

In-band Spurious Measurement

Required Equipment

- MS2721A Handheld Spectrum Analyzer
- 30 dB, 50 watt, Bi-Directional, DC - 18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

- Step 1. Using the test port extension cable and 30 dB, 50 watt, Bi-directional attenuator, connect the MS2721A to appropriate transmit test port.
- Step 2. Press the **Freq** key, select the Center Freq soft key, and enter the center frequency.
- Step 3. Press the **Span** key. Set the span wide enough to include the primary channel bandwidth and upper and lower channel bandwidths.
- Step 4. Press the **Amplitude** key and then press the Reference Level soft key to set the reference level to -20 dBm.
- Step 5. Select the RL Offset soft key to set the reference level offset to -30 dB to compensate for the loss of the attenuator
- Step 6. Press the Auto Atten soft key set the attenuation to On.
- Step 7. Press the **BW** key and use the RBW and VBW soft keys to set the resolution bandwidth to 10 kHz and the video bandwidth to 300 Hz.
- Step 8. Press the **Marker** key and press the Marker 1 2 3 4 5 6 soft key to select marker 1. The underlined number indicates the active marker.
- Step 9. Press the On/Off soft key and use the arrow keys, the keypad and the knob to move the marker over one of the spurs.
- Step 10. Compare the value of the marker to the specified allowable level of in-band/out-of-channel spurious emissions for the corresponding channel transmit frequency.
- Step 11. Repeat steps 9 and 10 for the remaining spurs. Use either Marker 1 again, or choose another marker.

Figure 5-3 shows a simulated in-band spur at 1.625 MHz from the carrier frequency. The carrier is measured by M1. The delta marker on M1 shows the signal at $f_c + 1.625$ MHz to be 60.17 dB down from the carrier. These values should be compared against the specification for the transmitter being tested.

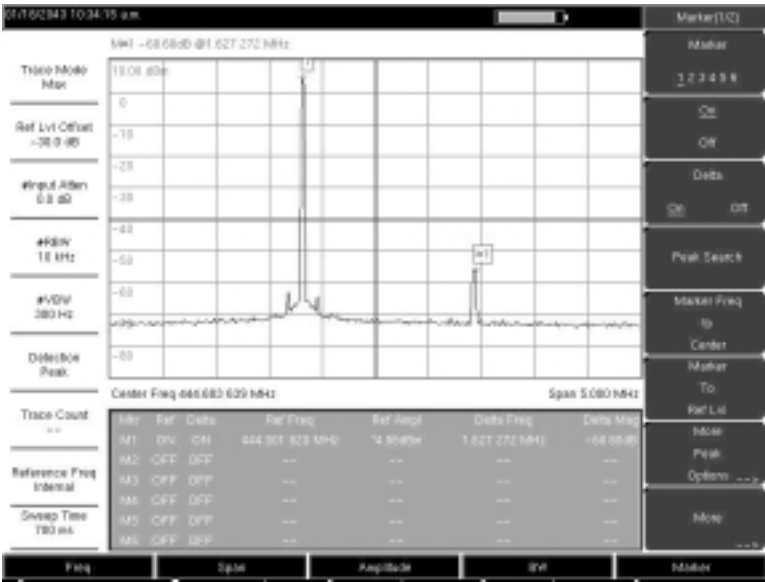


Figure 5-3. In-band Spurious Measurement

NOTE: The resolution bandwidth of a spectrum analyzer is determined by the intermediate frequency (IF) filter bandwidth. The MS2721A traces the shape of the IF filter as it sweeps past a signal. Therefore, if two equal-amplitude signals are very close to each other, the measurement result can appear to be one single response because the IF or resolution bandwidth is not small enough to resolve the two signals. Similarly, if two signals are not equal in amplitude but are very close together, the smaller signal may not be seen because it is hidden under the large response.

Field Strength

Required Equipment

- MS2721A Handheld Spectrum Analyzer
- Portable Antenna for which antenna factors or antenna gain and bandwidth data are available.

Procedure

- Step 1. Press the **Shift** key then the **Measure** key and press the Field Strength soft key.
- Step 2. Press the Antenna soft key and use the Up/Down arrow keys or the rotary knob to select the desired antenna. Press the **Enter** key to select.

NOTE: Select an antenna from the standard list available in the MS2721A, or use the Antenna Editor feature of Anritsu Master Software Tools (see Chapter 6) to define a custom antenna and upload the antenna information to the MS2721A antenna list.

- Step 3. Connect the antenna to the MS2721A.
- Step 4. Press the **Freq** key, select the Center Freq soft key, and enter the center frequency.
- Step 5. Press the **Span** key. Set the span wide enough to include the primary channel bandwidth and upper and lower channel bandwidths.
- Step 6. Press the **BW** key and verify that RBW Auto and VBW Auto are On.
- Step 7. To change the units of measurement, press the **Amplitude** hard key, then press the Units soft key and select dBm, dBV, dBmV or dBμV.
- Step 8. Select either the Volts or Watts soft key, as required. The MS2721A automatically adjusts the measurement by the antenna factors selected. Marker values will be displayed in the same units as selected for the amplitude.

Antenna Calculations

The following is a list of various antenna calculations should you find it necessary to convert from one to another:

Conversion of signal levels from W to V in a 50 ohm system:

$$P=V^2/R$$

where:

P = power in Watts

V = voltage level in Volts

R = resistance in Ohms

Note that 1 mW = 10⁻³ W and 1μV = 10⁻⁶V.

For power in dBm, and voltage in dB(μV).

$$V_{dB(\mu V)} = P_{(dBm)} + 107 \text{ dB}$$

Power density to field strength. An alternate measure of field strength to electric field is power density:

$$Pd=E^2/120\pi$$

where:

E = field strength in V/m

P = Power density in W/m

Power density at a point:

$$P_d = P_t G_r / (4 \pi r^2)$$

In the far field, where electric and magnetic fields are related by the impedance of free space:

Where P_d = power density in W/m

P_t = power transmitted in Watts

G_r = gain of transmitting antenna

r = distance from the antenna in meters

AM/FM/SSB Demodulation

The Spectrum Master built-in demodulator for AM, narrowband FM, wideband FM and single sideband (selectable USB and LSB) allows a technician to hear an interfering signal to ease identification. The demodulated signal can be heard using either the built-in speaker, or through a monaural headset connected to the 2.5-mm jack on the test panel.

Demodulation Procedure

- Step 1. Press the **Shift** key followed by the **Measure** (4) key and the AM/FM Demod soft key.
- Step 2. Press the Demod Type soft key and select FM Wide Band, FM Narrow Band, AM, USB, or LSB to match the modulation format of the signal.
- Step 3. Press the Back soft key.
- Step 4. Press the Demod Freq soft key and use the keypad or rotary knob to enter the center frequency of the signal to be demodulated. For USB and LSB signals, fine tune the signal by adjusting the Beat Freq Osc. By default the BFO frequency is set to zero, meaning that the re-injected carrier is exactly at the demodulation frequency. The Beat Freq Osc soft key allows adjustment of the beat frequency oscillator to fine tune the signal through a span of ± 10000 Hz.
- Step 5. Press the On/Off soft key to enable the measurement.
- Step 6. Press the Volume soft key and use the Up/Down arrow keys or rotary knob to change the audio volume from 0% to 100%. For most headsets a volume of 40% is adequate.
- Step 7. The Demod Time soft key sets the time the Spectrum Master will demodulate the signal. Enter a value from 100 ms to 500 seconds.

Carrier to Interference Ratio Measurement

Carrier to Interference Ratio (C/I) Measurement is a two-step process, first measuring the carrier level and then, with the carrier turned off, measuring the remaining signals and noise in the band of interest. After the two measurements are complete, the ratio of the carrier level to the noise plus interference is displayed using three assumptions:

- The interferer is a narrowband frequency hopping signal (NB FHSS)
- The interferer is a wideband frequency hopping signal (WB FHSS)
- The interferer is a broadband signal (BB).

The primary application for this type of measurement is determining the magnitude of interference problems for 802.11b, 802.11g and 802.11a access points (hot spots).

Procedure

- Step 1. Press the **Frequency** key followed by the Signal Standard soft key. Select the appropriate signal standard based on the signal to be measured and press **Enter**.
- Step 2. Press the Select Channel soft key, select the operating channel of the access point being measured and press **Enter**.
- Step 3. Press the **Shift** key followed by the **Measure** (4) key and the C/I soft key.

- Step 4. Press the **Center Freq** soft key and enter the desired frequency, unless a **Signal Standard** and **Channel** have already been selected in the **Frequency** menu.
- Step 5. If needed, press the **Span** soft key and set an appropriate span width for the signal to be measured.
- Step 6. If the signal environment includes slow frequency hopping signals, such as cordless telephones, press the **Min Sweep Time** soft key to set a sweep time of one second or more to give a good chance of capturing instances of the interfering signal.
- Step 7. Press the **On/Off** soft key and follow the on-screen prompts to complete the measurement.

<p>NOTE: Access to the transmitter is required to complete this procedure as the transmitted carrier must be turned off for the second portion of the measurement.</p>

- Step 8. After the measurement is complete, the measurement box gives results for the three different signal types. Some measurement results may show as **Error**, and this is to be expected.

The following figures show the C/I measurement steps, ready to measure the carrier, with the carrier measured, and the measurement results.

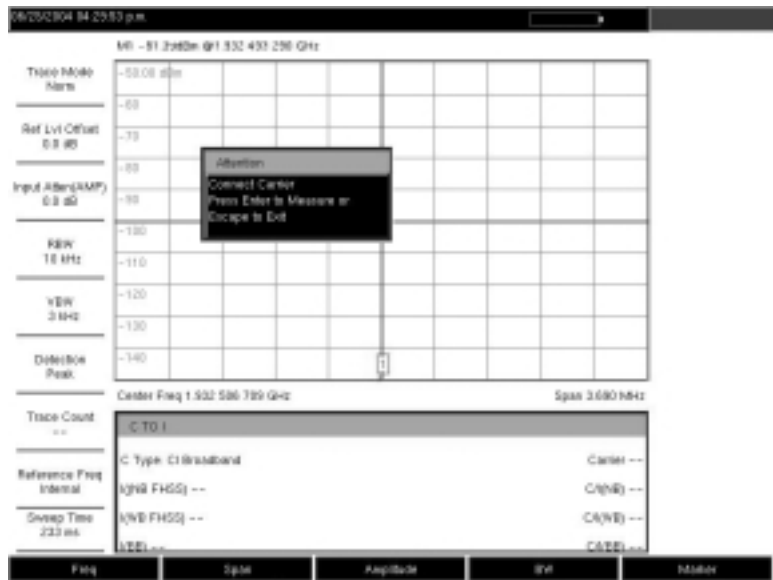


Figure 5-4. C/I Measurement, Ready to Measure the Carrier

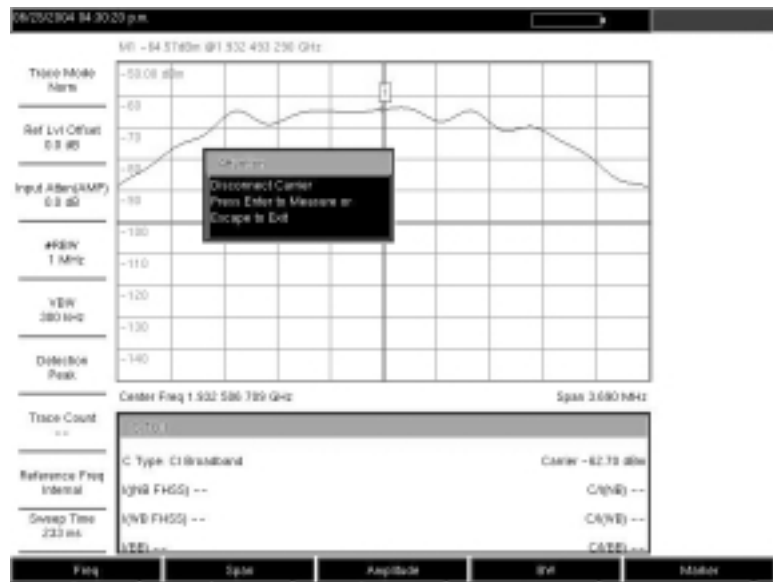


Figure 5-5. C/I Measurement, Carrier Measured

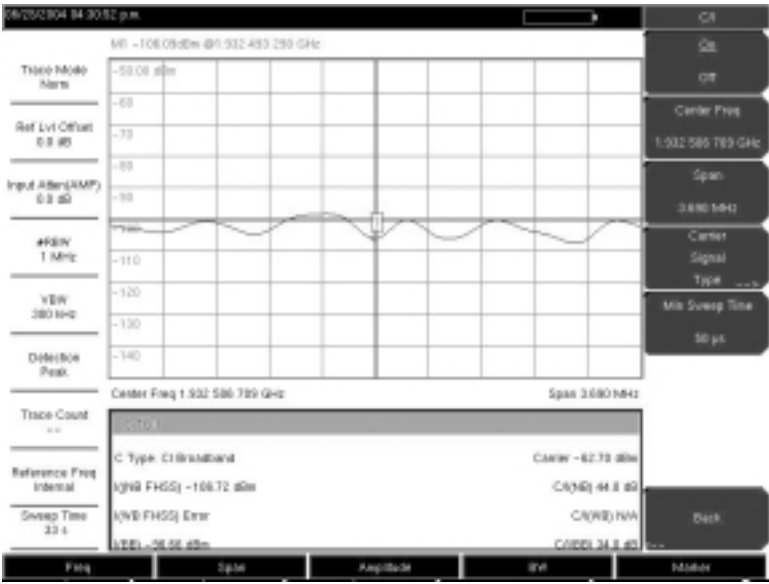


Figure 5-6. C/I Measurement, Results

Chapter 6

Master Software Tools

Introduction

This chapter provides a description of the Anritsu Master Software Tools program. Master Software Tools is a suite of Microsoft Windows 2000 and Windows XP programs for transferring saved measurements, along with markers and limit lines, to a PC display. The programs provide the capability to modify display parameters, overlay multiple traces, upload and download traces, print traces using local or networked printers, manage antenna files, create or modify language files, and convert .dat files to the new .spa format.

Master Software Tools will not function on earlier versions of the Microsoft Windows operating system as the program relies on the Windows 2000 and Windows XP .NET framework.

Features

The Master Software Tools Suite provides the following features and capabilities:

- Download measurements saved in the instrument memory to the PC for storage and analysis
- Upload measurements from the PC to the instrument memory
- Trace Overlay allows the viewing of multiple measurements on the same graph.
- Save measurements as data files (.spa file format)
- Export measurement data as text files for use in a spreadsheet (.txt and .dat file formats)
- Export measurements as graphic files (.jpg, .wmf, .bmp, and .png file formats)
- Save measurements to data files (.spa file format)
- Zoom in or out, both in frequency and in amplitude, to analyze a particular region of a trace
- Ability to modify Plot Properties
- Output measurements to a networked or local printer for hard copy records
- Create or modify antenna factor files that can be uploaded to the instrument
- Create custom language files that can be uploaded to the instrument
- Convert spectrum analyzer measurements stored by Handheld Software Tools to the new Master Software Tools .spa format

System Requirements

Minimum requirements and recommendations are:

- Microsoft Windows 2000 or Windows XP
- Intel Pentium 233 MHz microprocessor minimum (Pentium II 350 MHz or better recommended)
- 128 MB of RAM minimum (256 MB or above recommended)
- Hard disk drive with approximately 80 MB of available space (An additional 80 MB free space for storage of captured plots is recommended.)
- A USB port (USB 1.2 required, USB 2.0 recommended) or an Ethernet 10/100 T connection for communication with the instrument

Installation

To install the Master Software Tools program, insert the Anritsu Master Software Tools disk in the CDROM drive. Follow the instructions in the installation program to install the software. If the autorun feature is disabled in your computer, click on the Windows Start menu, and select Run. Type: X:\Setup.exe, where X is the drive letter of the CDROM drive, and follow the instructions in the installation program.

The readme.doc file on the disk provides updated information about the program, and the Help function provides detailed operating information from within the program.

Connection

There three methods to connect the instrument to a PC.

USB Connection

The instrument can be connected to the PC using the included USB cable (2000-1360). Connect the cable to the USB port on the computer and to the USB port on the instrument.

Ethernet LAN Connection

The instrument can be connected to a local area network (LAN) with the included Ethernet 10/100 Base-T cable (2000-1371). Connect the Ethernet cable to the RJ-45 connector on the instrument and then to the local area network. Integrated into the RJ-45 connector are two LEDs. The amber LED indicates the presence of LAN voltages—a live LAN connection—while the green LED flashes to show that LAN traffic is present.

Direct Ethernet Connection

If the instrument is to be connected directly to the PC using the Ethernet connection, an RJ-45 crossover cable will be required. Secure this cable locally.

Using Master Software Tools

To start the Master Software Tools program, double-click on the Master Software Tools desktop icon, or select Programs from the Windows Start menu and select Anritsu, then Master Software Tools to launch the program.

The first screen presented is the Anritsu Connection Manager menu.



Figure 6-1. Anritsu Connection Manager Menu

USB Connection

When using the USB cable to connect to the instrument, select the **USB** radio button in the Connection Manager and click on the **Connect** button. The message at the very bottom of the Connection Manager window will change to **Connected** when communication is established.

Ethernet LAN Connection

The Connection Manager can search the local sub-net (hub) for any connected instruments. Select the **Select from Devices on the Network** button and the drop down list will display all instruments found. Select the desired instrument from the list and select the **Connect** button in the Connection Manager window to connect. The message at the very bottom of the Connection Manager window will change to **Connected** when communication is established. The button to the right of the drop down window in the Connection Manager can be used to refresh the list of connected instruments.

When using a LAN Ethernet connection, the instrument IP address can be manually entered into the Connection Manager. To set the IP address:

- Step 1. On the instrument, press the **Shift** and **System** (8) hard keys.
- Step 2. Select the **System Options** soft key and then the **Ethernet Config** soft key.
- Step 3. Press the **Type** soft key to select either **Manual** or **DHCP**.
- Step 4. If **Manual** is selected, use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to enter the IP address, Gateway, and Subnet. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.
- Step 5. If **DHCP** is selected, enter the IP address shown on the instrument as the Ethernet address in the Connection Manager menu.
- Step 6. Select the **Connect** button in the Connection Manager window to connect. The message at the very bottom of the Connection Manager window will change to **Connected** when communication is established.

Direct Ethernet Connection

When using a direct Ethernet connection, the instrument address must be set as follows:

- Step 1. On the instrument, press the **Shift** and **System** (8) hard keys.
- Step 2. Select the **System Options** soft key and then the **Ethernet Config** soft key.
- Step 3. Press the **Type** soft key to select **Manual**.
- Step 4. Set the IP address to 10.0.0.2 using the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to enter the input. Press **Enter** to accept the changes.
- Step 5. Set the Subnet mask to 255.255.255.0 and press **Enter**.
- Step 6. On the computer click **Start, Settings, Control Panel**.
- Step 7. Double-click on **Network Connections**.
- Step 8. Double-click on the **Local Area** connection to which the instrument is connected and click on **Properties**.
- Step 9. In the scroll box select **Internet Protocol (TCP/IP)**.
- Step 10. Set the IP address to 10.0.0.1.
- Step 11. Set the submask to 255.255.255.0.
- Step 12. Click **OK** or **Close** for each window that is open.
- Step 13. Reboot both the computer and the instrument.

After the connection is established, the message **Connected to 10.0.0.2** will be displayed at the bottom of the Connection Manager window.

Along with the connection manager, the Master Software Suite menu will also be displayed.



Figure 6-2. Master Software Suite Menu

Available selections on the Master Software Suite menu are the Measurement Editor, the Antenna Editor, the Language Editor, and the Dat File Conversion tool. The following sections explain the use of each selection.

Measurement Editor

The Measurement Editor is used to view and analyze measurement traces downloaded from the instrument or stored on the PC. The measurement display window can be configured with windows for locally stored measurements, device measurements (measurements in the instrument), open measurements, and a measurement preview that can be sized and positioned as required. The push-pin icon at the top of each window can be used to lock that window in place. The size of the measurement display window can be maximized by closing all the small windows on the left.

The Measurement Editor contains the following menus and sub-menus:

File

Open Measurement - Opens a measurement file that has been saved on the local computer.

Print - Opens the print dialog box. Select the options appropriate for the system to print the selected measurement.

Save Measurement - Saves the currently open measurement.

Save Measurement As... - Saves the currently open measurement with a new file name.

Export Measurement... - Exports the measurement in the selected format, specifying the destination and size. Notice that the size of the graphics file can be specified in millimeters, inches or points. A point is 1/72 of an inch.

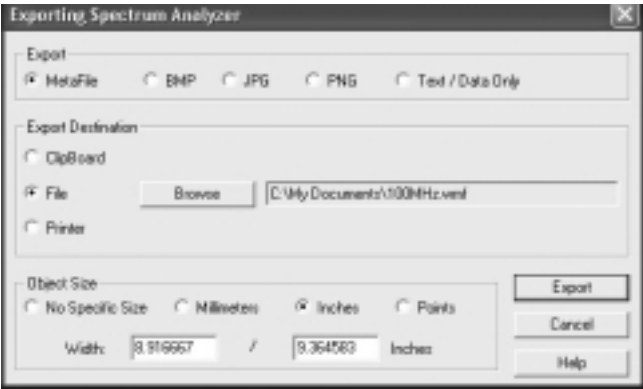


Figure 6-3. Export Measurement Menu

Close - Closes the selected measurement file.

Exit - Exits the Measurement Editor.

View

Tool Bars - Allows selection of which tool bars will be visible on the display.

Sync

Upload to Device - Sends the currently selected measurement file to the instrument.

Window

Cascade - Cascades all open measurement display windows.

Tile Horizontal - Tiles all open measurement display windows horizontally.

Tile Vertical - Tiles all open measurement display windows vertically.

Close All Traces - Closes all open measurement display windows.

Help

About - Provides current program information.

The Measurement Editor also provides the following buttons on toolbars, which can be added or removed as desired. The location of the two button bars may be changed by left-clicking the left edge of the bar and dragging the bar.

Open

Opens a measurement file that has been saved in the local computer.

Save

Saves the currently open measurement to the PC hard disk or other selected PC storage device (floppy disk drive, etc.).

Print

Opens the print dialog box.

Mouse Function

Within a measurement, the mouse can be used to zoom in on a portion of the measurement, adjust markers and limit lines, or to drag a trace from one window to another. Select the mouse function by clicking on Mouse Function at the top of the display and highlighting either Zoom/Marker/Limit or Trace Overlay.

Zoom/Marker/Limit

Zoom

To zoom in on a portion of a measurement, position the mouse cursor so as to draw a box over the area to be expanded. Press the left mouse button and drag the mouse to the right to cover the area. When the mouse button is released, the display zooms in so that the frequency range fills the horizontal axis, and the amplitude is auto-scaled so that the entire amplitude range of the selected frequency range can be seen.

To return to viewing the entire measurement, click on the Undo Zoom button at the top of the display, or click the right mouse button and select Undo Zoom.

Plot Properties

The measurement title can be changed to reflect the site name or other descriptive information. There is no built-in limit to the length of the title. The character size for the title is reduced if the title becomes longer than the width of the display area. To maintain a character size that is readable, a practical limit for the title length is about 170 characters.

Marker

To turn on or off or adjust markers, select the Marker Edit button at the top of the display, or left-click on the marker table below the measurement display. The marker table may be made visible or hidden by right clicking in the measurement window and selecting Display Marker. Clicking on any reference or delta marker state within the table will toggle the state of that marker.

Select the marker and use the checkboxes to turn the reference marker and delta markers on or off, and enter the reference frequency and delta frequency. A marker can also be dragged on screen using the mouse.

Limit Edit

The Limit Edit box can be used to set upper and lower limit lines. Select Add New Point and enter the Frequency and Amplitude. There can be up to 40 inflection points in each limit line. The upper and lower limit lines may have different numbers of points and the

points may be at different frequencies. The Display Limit Labels check box will show or hide the frequency and amplitude for each deflection point on the measurement display.

To edit a limit point, select the point in the limit table and click on Edit Point. Type in the new frequency and magnitude values and click OK. The new frequency must be between the adjacent inflection points, or the actual frequency that results from the edit will be the frequency of the closest measurement point that meets this requirement. To move an inflection point past an adjacent inflection point, delete the point that is no longer needed and add a new point where it is needed. To delete an inflection point, single-click on the table listing to be deleted and click on Delete Point.

Trace Overlay

With the mouse in Trace Overlay mode, and two or more traces open, use the left mouse button to drag a trace from one window to another. To undo the trace overlay, select the Undo Trace Overlay button at the top of the display. Up to five plots can be overlaid.

Undo Zoom

Select this button to return to viewing the entire measurement after any number of zoom operations.

Undo Trace Overlay

Select this button to undo all trace overlays.

Marker Edit

Select this button to turn on or off or adjust markers when a measurement is displayed.

Add or Remove Buttons

At the right of each row of buttons, there is a small down arrow. Clicking on this arrow brings up the Add or Remove Buttons menu. Add or remove the checkmark from each button to select which buttons will be visible.

Measurement Organization

Measurements are organized into three groups by Master Software Tools:

- Locally Stored Measurements
- Device Measurements (Measurements in the Instrument)
- Open Measurements

Shown at the bottom of the measurements list area are three buttons that are used to select which of these three choices will be shown in the measurements list.

Measurements stored in the instrument are sorted by name in alphabetical order. These measurements can be opened by either double-clicking on the measurement name or by dragging the name into the display area.

Locally stored measurements may be sorted in alphabetical order or reverse alphabetical order by clicking on the box that says "Name" above the list of trace names. Preview thumbnails of stored measurements may be seen in the preview, which by default is below the measurement list. Select a measurement to preview by doing a single left mouse click on one of the measurement names.

There are panes that show measurement information, such as the instrument settings that were used to make the measurement. A data box appears below the measurement if one of the one-button measurements was active at the time the measurement was saved.

Antenna Editor

The antenna editor allows creation and editing of custom antenna factor files for use with the instrument. The files are created with the Antenna Editor function of Master Software Tools, then uploaded to the instrument, where they become available on the antenna list.

Antenna Factors

The Antenna Factor (AF) is a common parameter of antennas used in the calculation of field strength during radiated emissions measurements, and relates the value of the incident electric or electromagnetic field to the voltage at the output of the antenna. For an electric field antenna, this is expressed as:

$$AF = \frac{E}{V_i}$$

Where:

AF = Antenna Factor, m/1

E = Electric field in Volts per meter

V_i = Voltage at the antenna terminals in Volts

It also can be shown that in a 50 ohm system:

$$AF = \frac{9.73}{(\lambda \sqrt{G_r})}$$

Where:

G_r = the gain of the receiving antenna in dB

λ = wave length in meters

Antennas used for radiated emissions testing are individually calibrated (the antenna factors can be measured directly) at all appropriate distances. The calibrations produce values that are defined as the “equivalent free space antenna factor.” The calibration procedure corrects for the presence of the reflection of the antenna in the ground plane, giving the value that would be measured if the antenna were in “free space.”

Creating a New Antenna Factor File

To create a new antenna factor file:

- Step 1. Open Master Software Tools and select Antenna Editor from the Master Software Suite window.
- Step 2. From the **File** menu, select New Antenna File. This opens a blank spreadsheet into which the frequency and gain characteristics of the antenna can be entered.
- Step 3. From the **View** menu, select either Antenna Factor (dB) or Antenna Gain (dBi) depending upon the data available from the antenna manufacturer.
- Step 4. From the **Edit** menu, select Add Antenna and enter a name for the antenna. This name will be shown in the list of antennas in the instrument.
- Step 5. From the **Edit** menu, select Insert Point (or use the keyboard shortcut Control+Insert) to add a frequency point to the table.
- Step 6. Fill in the frequency and corresponding antenna factor in dB or gain in dBi, depending on the value chosen in Step 3.
- Step 7. Continue using the Edit/Insert Point dialog until all data points have been entered. The only limitation on the number of data points is the memory to store them.
- Step 8. Save the antenna file by selecting Save Antenna File from the **File** menu and providing a name and location to save the file to a local or networked disk drive.

Editing an Existing Antenna Factor File

To edit an existing antenna factor file:

Step 1. From the **File** menu, select Open Antenna File.

NOTE: If the file exist only in the instrument, download the file to the PC and then open it.

- Step 2. If the antenna gain in dBi is known, then frequency and gain can be entered and the antenna factor is automatically calculated when the view button is pressed and Antenna Factor is selected.
- Step 3. From the **File** menu, select Save Antenna File to save the antenna data to a local or networked disk drive.

Uploading Antenna Factor Files

To upload antenna information from Master Software Tools to the instrument:

NOTE: All available antennas are transferred to the instrument at the same time. To modify only a single antenna in the instrument, first download the current antennas, then modify the appropriate antenna, then re-upload the antenna data to the instrument.

- Step 1. Connect the PC to the instrument using a USB cable or LAN connection.
- Step 2. From the **Sync** menu, select Upload Antenna File.

Language Editor

The Language Editor allows for modification of the languages already in the instrument (except English) and also provides the ability to add two custom languages to the instrument.

NOTE: Special fonts for some languages must be installed on the system in order to edit those languages. Please contact your font vendor for specifics.

Modifying or Defining a Language

The standard language files provided in the instrument may be modified, except for the default English file. In addition, there are two Custom files, in English, that may be completely rewritten in another language if desired.

For most entries, there is a limit on message length due to the need to fit the message on a soft key or in a message box. The fonts used for the onscreen messages are proportional, meaning different characters can take different amounts of space. Some creativity may be necessary to fit the words into the allotted space. Ideally, the customized language message should not take up significantly more space than the English equivalent.

Always test the customized language by uploading it into the instrument and reviewing the menus to be sure the key labels fit in the available space and are fully discernible.

To modify an existing language, or to add a Custom language:

- Step 1. Establish a connection between the instrument and the PC.
- Step 2. From the Anritsu Master Software Suite menu, select the Language Editor.
- Step 3. From the **Sync** menu in the Language Editor, select either Retrieve and Open System Language File or Retrieve and Open Spectrum Analyzer Language File. Because the file contains eight standard and two custom languages, retrieval may take 10 to 15 seconds or longer. The Language Editor screen with a language file loaded is shown in Figure 6-3.

NOTE: If the language file to be edited has previously been retrieved and saved on the PC, select Open Local Language File from the Language Editor **File** menu.



Figure 6-4. Language Editor Screen with a Language File Loaded

- Step 4. With the language file loaded, select the language to be modified by clicking on the plus sign to the left of the language name. The file tree expands to show the three groups of labels available for editing.

NOTE: Some languages require special fonts be installed on the PC. Please contact your local font vendor and install such fonts as needed.

- Step 5. Select the group of labels to be edited by clicking on the plus sign to the left of the group name. Figure 6-x shows the groups and group labels under the Italian language Parameter Name section, for example.
-



Figure 6-5. Language Editor Screen with Groups and Group Labels

- Step 6. Use the mouse or the keyboard up and down arrow keys to navigate through the list of words and phrases and edit the existing text, or enter new text, in the white text box. The right mouse button brings up a menu of editing options. When editing is complete, select the Enter button.
- Step 7. Save the modified language file locally and then upload it into the instrument.

NOTE: The files should be saved as `spa.znc` for the spectrum analyzer language file, and `system.znc` for the system language file, before uploading to the instrument.

Dat Conversion Utility

This utility is used to convert saved spectrum analyzer traces (.dat files) from an Anritsu MS2711D, MS2711B, MT8212A, S332D, S332C, or S114C to the format used by Master Software Tools. This conversion is a one-way process as there is no equivalent utility to convert newer traces to the older format. The trace files in the old format are not deleted, and the new format uses a different file name extension, .spa instead of .dat. If necessary the old traces can still be used directly with the Handheld Software Tools program.

To do the conversion:

- Step 1. Start the Measurement Conversion Utility from the Master Software Suite menu.
- Step 2. In the Source area at the top area of the window, navigate to the directory that contains the traces to be converted.
- Step 3. In the Destination area, select the directory into which the converted traces are to be placed.
- Step 4. Select the Conflicting Filenames option to be used – to keep existing, overwrite, prompt for a decision or skip the conversion of the file for which there is a conflict.
- Step 5. Select the measurement or measurements to be converted.
- Step 6. Click the Convert File button. Note that the new traces appear in the destination window.

NOTE: Before the conversion, select View to preview the file in the new format if desired.

Remote Access Tools

This program is a separate application from the Master Software Tools suite. Before running this application, be sure that Master Software Tools and Master Code Loader are not running. If Master Software Tools or Master Code Loader are running, the program will prompt the user to close them before proceeding.

With Remote Access Tools, the Spectrum Master can be remotely controlled through the USB port or a LAN connection. The Remote Access Tools software runs on a PC under Windows XP or Window 2000 only. Start Remote Access Tools by clicking on the desktop shortcut that was installed when Master Software Tools was installed, or by clicking on Start, then Anritsu and then Remote Access Tools.

When Remote Access Tools is started, a dialog box appears that has three choices.

- Connect to the instrument via a LAN connection.
- Connect to the instrument via the USB interface.
- Operate in Demo mode.

In the first two modes, once a connection to the instrument has been successfully made, the information on the computer screen mirrors what is on the screen of the instrument. In Demo mode, the on-screen information is simulated with a simulated signal at 2 GHz.

NOTE: When using a direct Ethernet connection with a crossover cable, select Ethernet and fill in the IP address of 10.0.0.2.

The instrument is controlled by using the mouse to press the buttons on the on-screen representation of the instrument.

All keypad buttons, hard keys, and soft keys can be operated remotely, except for the On/Off button and the Rotary Knob.

Master Code Loader

This program is a separate application from the Master Software Tools suite. Before running this application, be sure that neither Master Software Tools or Remote Access Tools are running. If Master Software Tools or Remote Access Tools are running, the program will prompt the user to close them before proceeding.

The Master Code Loader is used to update the firmware in the instrument. Start Master Code Loader by clicking on the desktop shortcut that was installed when Master Software Tools was installed, or by clicking on Start, then Anritsu and then Master Code Loader.

If using the Ethernet connection, enter the IP address of the instrument to be updated or select the correct instrument from the search list.

NOTE: Always connect the Ethernet cable to the instrument before turning the instrument on. If the instrument is already on, turn it off, then back on to recognize the Ethernet connection.

When using an Ethernet connection and there is more than one instrument on the network, always verify that the IP address selected is the IP address of the correct instrument to be updated. To verify the IP address, press the **Shift** and **System** (8) keys on the instrument, select the System Options soft key and then the Ethernet Config soft key to view the IP address.

If using the USB connection, connect the instrument to the computer using the USB cable supplied with the instrument.

NOTE: The USB connection can be made with the instrument on or off. If the instrument is on, the USB connection will be immediately recognized.

After specifying which instrument to update, click on the Target Version button to query the instrument.

If the version number of the target instrument is lower than the latest version, the instrument version number will be displayed in color to highlight the fact that an update is available.

To update the application package, click on the Load Now button. As new files are installed in the instrument, the name of the file is shown at the bottom of the Code Loader screen. Restart the instrument to begin using the new firmware.

To update the Operating System:

- Step 7. Ready the instrument for the update by pressing Shift, System.
- Step 8. Press System Options, Reset
- Step 9. Press either the “Update OS Via Ethernet” or “Update OS Via USB” soft key depending on how the instrument is connected to the computer.
- Step 10. Click on the “Load Now” button for the OS update.
- Step 11. Turn the instrument off and back on to complete the OS update after the Code Loader has finished installing the update into the instrument.

Appendix A

Signal Standards

Introduction

This chapter provides a list of the signal standards included in the Spectrum Master MS2721A.

Standard	Type	Where Used	Notes
802.11A	802.11	World-wide	wireless LAN
802.11B	802.11	World-wide	wireless LAN
802.11DS	802.11	World-wide	wireless LAN
802.11FH	802.11	World-wide	wireless LAN
802.11G	802.11	World-wide	wireless LAN
AMPS EIA 553 Downlink	analog	North America	Cellular
AMPS EIA 553 Uplink	analog	North America	Cellular
C 450 P Downlink			
C 450 P Uplink			
C 450 SA Downlink			
C 450 SA Uplink			
CDMA China 1 Downlink	CDMA	China	
CDMA China 1 Uplink	CDMA	China	
CDMA China 2 Downlink	CDMA	China	
CDMA China 2 Uplink	CDMA	China	
CDMA Japan Downlink	CDMA	Japan	
CDMA Japan Uplink	CDMA	Japan	
CDMA Korea PCS Downlink	PCS	Korea	
CDMA Korea PCS Uplink	PCS	Korea	
CDMA US Cell Downlink	CDMA	US	
CDMA US Cell Uplink	CDMA	US	
CDMA US PCS Downlink	PCS	US	
CDMA US PCS Uplink	PCS	US	
CDMA2000 Class 0 Cell Downlink	CDMA 2000		Cellular
CDMA2000 Class 0 Cell Uplink	CDMA 2000		Cellular
CDMA2000 Class 0 Korea Cell Downlink	CDMA 2000	Korea	
CDMA2000 Class 0 Korea Cell Uplink	CDMA 2000	Korea	
CDMA2000 Class 1 PCS Downlink	CDMA 2000		
	PCS		
CDMA2000 Class 1 PCS Uplink	CDMA 2000		
	PCS		
CDMA2000 Class 2 TACS Downlink		Europe	
CDMA2000 Class 2 TACS Uplink		Europe	
CDMA2000 Class 3 JTACS Downlink		Japan	
CDMA2000 Class 3 JTACS Uplink		Japan	
CDMA2000 Class 4 Korea PCS Downlink		Korea	
CDMA2000 Class 4 Korea PCS Uplink		Korea	
CDMA2000 Class 5 NMT 450 20 Downlink			
CDMA2000 Class 5 NMT 450 20 Uplink			
CDMA2000 Class 5 NMT 450 25 Downlink			
CDMA2000 Class 5 NMT 450 25 Uplink			
CDMA2000 Class 6 IMT 2000 Downlink			
CDMA2000 Class 6 IMT 2000 Uplink			
CDMA2000 Class 7 700 MHz Cell Downlink			
CDMA2000 Class 7 700 MHz Cell Uplink			
DCS1800 Downlink			
DCS1800 Uplink			

Standard	Type	Where Used	Notes
Digital Multimedia Broadcasting			
ETACS Downlink			
ETACS Uplink			
GSM 1800 Downlink			Includes EDGE
GSM 1800 Uplink			Includes EDGE
GSM 1900 Downlink			Includes EDGE
GSM 1900 Uplink			Includes EDGE
GSM 900 Downlink			Includes EDGE
GSM 900 Uplink			Includes EDGE
JTACS Downlink	analog	Japan	Cellular
JTACS Uplink	analog	Japan	Cellular
MATS E Downlink			
MATS E Uplink			
N AMPS IS 88L Downlink	analog	US	Cellular
N AMPS IS 88L Uplink	analog	US	Cellular
N AMPS IS 88M Downlink	analog	US	Cellular
N AMPS IS 88M Uplink	analog	US	Cellular
N AMPS IS 88U Downlink	analog	US	Cellular
N AMPS IS 88U Uplink	analog	US	Cellular
NADC IS136 Cell Downlink	analog		Cellular
NADC IS136 Cell Uplink	analog		Cellular
NADC IS136 PCS Downlink			PCS
NADC IS136 PCS Uplink			PCS
NMT 411 25 Downlink	analog	Eastern Europe & Scandinavia	
NMT 411 25 Uplink	analog	Eastern Europe & Scandinavia	
NMT 450 20 Downlink	analog	Eastern Europe & Scandinavia	
NMT 450 20 Uplink	analog	Eastern Europe & Scandinavia	
NMT 450 25 Downlink	analog	Eastern Europe & Scandinavia	
NMT 450 25 Uplink	analog	Eastern Europe & Scandinavia	
NMT 470 20 Downlink	analog	Eastern Europe & Scandinavia	
NMT 470 20 Uplink	analog	Eastern Europe & Scandinavia	
NMT 900 Downlink	analog	Eastern Europe & Scandinavia	
NMT 900 Offset Downlink	analog	Eastern Europe & Scandinavia	
NMT 900 Offset Uplink	analog	Eastern Europe & Scandinavia	
NMT 900 Uplink	analog	Eastern Europe & Scandinavia	
NTACS Downlink			
NTACS Uplink			
PCS1900 Downlink	PCS		
PCS1900 Uplink	PCS		
PDC 1500 JDC Downlink			
PDC 1500 JDC Uplink			
PDC 800 Analog Downlink			
PDC 800 Analog Uplink			
PHS Downlink			
PHS Uplink			
SMR 1500 Downlink	analog	USA	Specialized Mobile Radio (land mobile)
SMR 1500 Uplink	analog	USA	Specialized Mobile Radio (land mobile)
SMR 800 12 5 Downlink	analog	USA	Specialized Mobile Radio (land mobile)
SMR 800 12 5 Uplink	analog	USA	Specialized Mobile Radio (land mobile)
SMR 800 25 Downlink	analog	USA	Specialized Mobile Radio (land mobile)
SMR 800 25 Uplink	analog	USA	Specialized Mobile Radio (land mobile)

Standard	Type	Where Used	Notes
TACS Downlink	analog	Europe	Cellular
TACS Uplink	analog	Europe	Cellular
UMTS WCDMA Downlink	3G		
UMTS WCDMA Region 2 Downlink	3G		
UMTS WCDMA Region 2 Uplink	3G		
UMTS WCDMA Uplink	3G		

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