

BANTAM INSTRUMENTS

PERSONAL SPECTRUM ANALYZER
MODEL 401B



OPERATING MANUAL

PERSONAL SPECTRUM ANALYZER

MODEL 401B

Operating Manual

BANTAM INSTRUMENTS
197 South Murphy Avenue
Sunnyvale, CA 94086 USA
TEL: (408) 736-3030
FAX: (408) 904-5221
Web Site: www.BantamInstruments.com

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

DECLARATION OF CONFORMITY



Manufacturer: BANTAM INSTRUMENTS, Inc.
197 South Murphy Avenue
Sunnyvale, CA 94086
USA

We hereby declare that the equipment herein conforms to the harmonized standards of the following European Commission Directives: 89/336/EEC and 72/23/EEC

Product Name: Personal Spectrum Analyzer

Model Number: 401B

Under 89/336/EEC as amended by 92/31/EEC, and 93/68/EEC

In accordance with EN 61326:1997, Emission:

EN 61326:1997 Class B radiated and conducted emissions

In accordance with EN 61326:1997, Immunity:

EN 61000-4-2:1998 Electrostatic Discharge: ± 4 kV contact, ± 8 kV air

EN 61000-4-3:1998 Radiated Immunity: 3 V/m

EN 61000-4-4:1995 Electrical Fast Transients / Burst: ± 1 kV AC, ± 0.5 kV I/O

EN 61000-4-5:1995 Surges: ± 1 kV differential mode, ± 2 kV common mode

EN 61000-4-6:1996 Conducted Immunity: 3V

EN 61000-4-11:1994 Supply Dips and Variations: 100%

Under 73/23/EEC as amended by 93/68/EEC

In accordance with 61010-1:1993 with amendments A1 and A2 1995, Product Safety

The product complies when used with Company supplied power supply.

A handwritten signature in cursive script, reading 'Robert Bathiany', is located above the printed name.

Robert Bathiany
Vice President

December 18, 2001

Date

Chapter 1	
General Information	1
Introduction	1
Description	1
Items Included with the Model 401B	2
Options and Accessories.....	2
Battery and Charging Information.....	3
Warranty	3
Performance Specifications	4
Chapter 2	
Operating Instructions	6
Basic Controls and Connectors	6
Model 401B Front Panel	7
Contrast / Backlight (Optional)	9
Help Menus / Help Index	9
Main Menu	10
Reference Level.....	10
Scale	10
Limit Line	10
Offset	11
Frequencies.....	11
Frequency Zoom.....	12
Set Up Menu.....	13
Resolution Bandwidth	13
Video Bandwidth.....	14
Detection Mode	14
Averaging	15
Key Click.....	15
Limit Beep	15
Graticule	15
Sleep Mode.....	15
Units	16
Setting Time and Date	16
Self Test.....	16
Resetting to Factory Pre-Sets	17
Markers.....	17
Save/Recall (SAVE/RCL)	18
Hold / Resume	18
Setup Memory	18
Trace Memory	19

Chapter 3

Using the external Active Components for EMC

Pre-Compliance and Field Strength Measurements	20
Introduction	20
Selecting an External Active Device	20
Using the P101A Active E-Field Probe.....	21
Selecting an EMC Specification.....	21
EMC Pre-Compliance Measurement Example.....	22
Using the P201A Active H-Field Probe	23
Using the ANT01A Active Antenna	24
Using the PA01A Preamplifier.....	24

Chapter 4

Using the PC Enhancement Software..... **25** |

Introduction	25
Installing the PC Enhancement Program.....	25
Starting the PC Enhancement Program	25
Downloading Measurement Data from the 401B.....	26
Saving the Downloaded Data to Disk	27
Printing Downloaded Data	27
Automatic Printing from the 401B Keypad.....	28
Automatic Update of the Screen Image.....	29

Chapter 5

Remote Programming of the Model 401B..... **31** |

Introduction	31
Control Commands for the Model 401B	32
Commands for Reading Data Back from the Model 401B	35
Data Formats sent back from the Model 401B.....	36

Chapter 1

General Information

Introduction

This chapter provides basic information regarding the Model 401B Personal Spectrum Analyzer. Included are a basic description, battery and charging information, warranty, and performance specifications.

Description

The Model 401B is a handheld Spectrum Analyzer covering the frequency range of 1 MHz to 1024 MHz. It is battery operated, making it fully portable and self-contained. Its small size and light weight makes it ideal for personal bench top testing by engineers and technicians and for field service applications at remote sites.

The Model 401B has an RS-232 serial interface which can be used to download measurement data to a computer. The PC Enhancement Software supplied with the Model 401B allows measurement data to be downloaded to a personal computer and to be printed to any Windows compatible printer or stored on the hard drive for later use. The computer must have a Windows¹ 95 or later operating system. The serial interface cable is included for connection between the Model 401B and a personal computer. Instructions for operating the PC Enhancement Software is contained in chapter 4.

The Model 401B is also fully programmable through the serial interface, making it ideal for remote sensing and automated testing applications. Instructions for programming the Model 401B is covered in chapter 5.

Included with the Model 401B Personal Spectrum Analyzer is the Model P101A Active Probe. The Probe contains an internal high gain transimpedance amplifier which is powered through the input connector of the Spectrum Analyzer. The probe is calibrated in dB μ v/m from 30 MHz to 1024 MHz. The probe functions as a miniature antenna so circuits can be non-invasively measured.

The P101A Active Probe and the 401B Personal Spectrum Analyzer can be used for Electro-Magnetic Compatibility (EMC) pre-compliance testing. When using the P101A Active Probe, limit lines corresponding to FCC or CISPR EMC specifications can be displayed, making EMC pre-compliance measurements simple and straightforward.

¹Windows is a Trademark of Microsoft Corporation

Other active devices are available for use with the Model 401B, including an H-Field Probe, broadband 30 MHz to 1024 MHz Active Antenna, and a 26 dB gain preamplifier. Use of these devices, as well as the P101A Active E-Field Probe are covered in Chapter 3.

Items included with your Model 401B Personal Spectrum Analyzer

The following items are included as standard with every Model 401B Personal Spectrum Analyzer:

- P101A Active Probe
- Battery Charger (p/n 9000-0001)
- PC Enhancement Software (p/n 9000-0006)
- Serial Interface Cable (p/n 9000-0003)
- Soft Carrying Case (p/n 9000-0004)
- Operating Manual (p/n 9900-0002)
- One Year Warranty

Options and Accessories

The following options and accessories may be ordered:

Option 001	Warranty Extension to 3 years
Option 002	Backlight for use in low illumination applications
Option 003	Substitutes the ANT01A Active Antenna for the P101A Active E-Field Probe
P201A	Active H-Field Probe, 30 MHz to 1024 MHz
ANT01A	Active Antenna, 30 MHz to 1024 MHz
PA01A	Preamplifier, 26 dB gain, 1 MHz to 1024 MHz
9010-0002	Cigarette Lighter 12 VDC Adapter
9010-0003	SMA Male to BNC Female Adapter
9010-0004	Type N Female to SMA Female Adapter
9011-0001	10 dB SMA Attenuator
9011-0002	20 dB SMA Attenuator
9011-0003	30 dB SMA Attenuator
9011-0004	40 dB SMA Attenuator
9014-0001	1/4 Wavelength Antenna, 433 MHz
9014-0002	1/4 Wavelength Antenna, 868 MHz
9020-0001	SMA Male Cable, RG174A/U, 6ft (1.8m)
9020-0002	SMA Male Cable, RG174A/U, 12ft (3.6m)
9020-0003	SMA Male Cable, RG174A/U, 2ft (0.6m)
9050-0001	Transit Case for Model 401B and Accessories

Option 001 must be ordered at time of purchase. If Option 002 is ordered after time of purchase, the Model 401B must be returned to the factory for installation of the back-light. The cost of factory installation of option 002 will be higher if not ordered at time of purchase. Consult you local Bantam Instruments representative for information.

Battery and Charging Information

The Model 401B is capable of greater than 2 hours of continuous operation (1½ hours when one of the external active devices is used) from the internal rechargeable NiMH (nickel-metal-hydride) batteries, but internal power management software generally allows operation across an entire work day.

The Model 401B can be continuously powered from 100-240 VAC, 50/60 Hz line voltage using the supplied charger. While being powered, the internal batteries will also be charged, but at a lower rate. The 401B can also be powered or the batteries recharged from a 12V DC source such as a vehicle battery by using the optional 9010-0002 cigarette lighter adapter.

Use only factory supplied NiMH batteries. The use of other types of batteries may cause damage which will not be covered under the warranty. When replacing batteries, the entire set of four must be replaced at the same time. Never use batteries of varying ages.

Warranty

Bantam Instruments warrants its products to be free from defects in materials and workmanship for a period of 12 months. Under the provisions of this warranty, Bantam Instruments will repair or replace the product. This warranty, however, shall not apply to any damage caused by improper use or the application of voltages to the input connector which exceed the maximum specified limits. Please contact your local representative for information on service under this warranty.

There are no user-serviceable components inside of the Model 401B. Refer service to qualified service personnel. Do not remove the back cover of the instrument. To do so will void the factory warranty.

Performance Specifications

FREQUENCY

Frequency Range:	1 MHz to 1024 MHz
Span:	0 to 1023 MHz
Span Accuracy:	±50 ppm
Frequency Markers:	3
Marker Resolution (Frequency):	1% of span or 100 kHz
Marker Resolution (Amplitude):	0.1 dB
Marker Readout Accuracy:	1% of span or 100 kHz
Resolution Bandwidth, 3 dB:	120 kHz, 1 MHz
Video Bandwidth:	30 kHz, 300 kHz
Sweep Time, typical:	300 ms

GENERAL

Display Backlight (Optional)	Electro-luminescent
Operating Temperature Range:	0°C to 40°C
Storage Temperature:	-10°C to 50°C
Line Power:	6VA
DC Power (12-14 VDC):	0.4A max.
Dimensions, mm:	193H x 102W x 33D
Dimensions, inches:	7.6H x 4.0W x 1.3D
Weight:	1.2 lbs (0.55 kg)
Safely and Electromagnetic Compatibility:	CE Mark Compliance

AMPLITUDE

Measurement Range:	-25 dBm to -95 dBm
Displayed Average Noise Level at 120 kHz Resolution Bandwidth, typical:	-95 dBm, span <10 MHz -90 dBm, span >10 MHz
Accuracy (-30 dBm Reference Level):	±1 dB
Maximum Safe Input Level:	+23 dBm, 50 VDC
Scale:	1, 2, 5, 10, 20 dB/div
Scale Units:	dBm, dB μ V
Display Range:	7 divisions
RBW Switching Uncertainty:	1 dB
Intermods (3rds, -35 dBm signals):	-75 dBc
Harmonic Distortion (-35 dBm):	-75 dBc
Absolute Amplitude Accuracy, typical:	±2.5 dB, -25 to -70 dBm
Detection Modes:	Normal, Quasi-Peak, Peak Hold, and Average

OTHER FEATURES

Save/Recall, Setups:	20
Save/Recall, Traces:	20
RS-232 Interface Speed:	9600, 57600 Baud
RS-232 Interface Connector:	DB-9 (Female)
Stored EMC Specifications:	FCC Part 15 A/B, CISPR 11 A/B CISPR 22 A/B

Chapter 2

Operating Instructions

Introduction

This chapter covers the operating controls and interface connectors of the Model 401B Personal Spectrum Analyzer. The figure on the next page shows the Model 401B front panel and the section below identifies the function of each item.

The remaining sections of this chapter cover operation of the Model 401B such as the setting of frequencies, reference, limit lines, and scale. Markers and marker functions are also covered.

Basic Controls and Connectors:

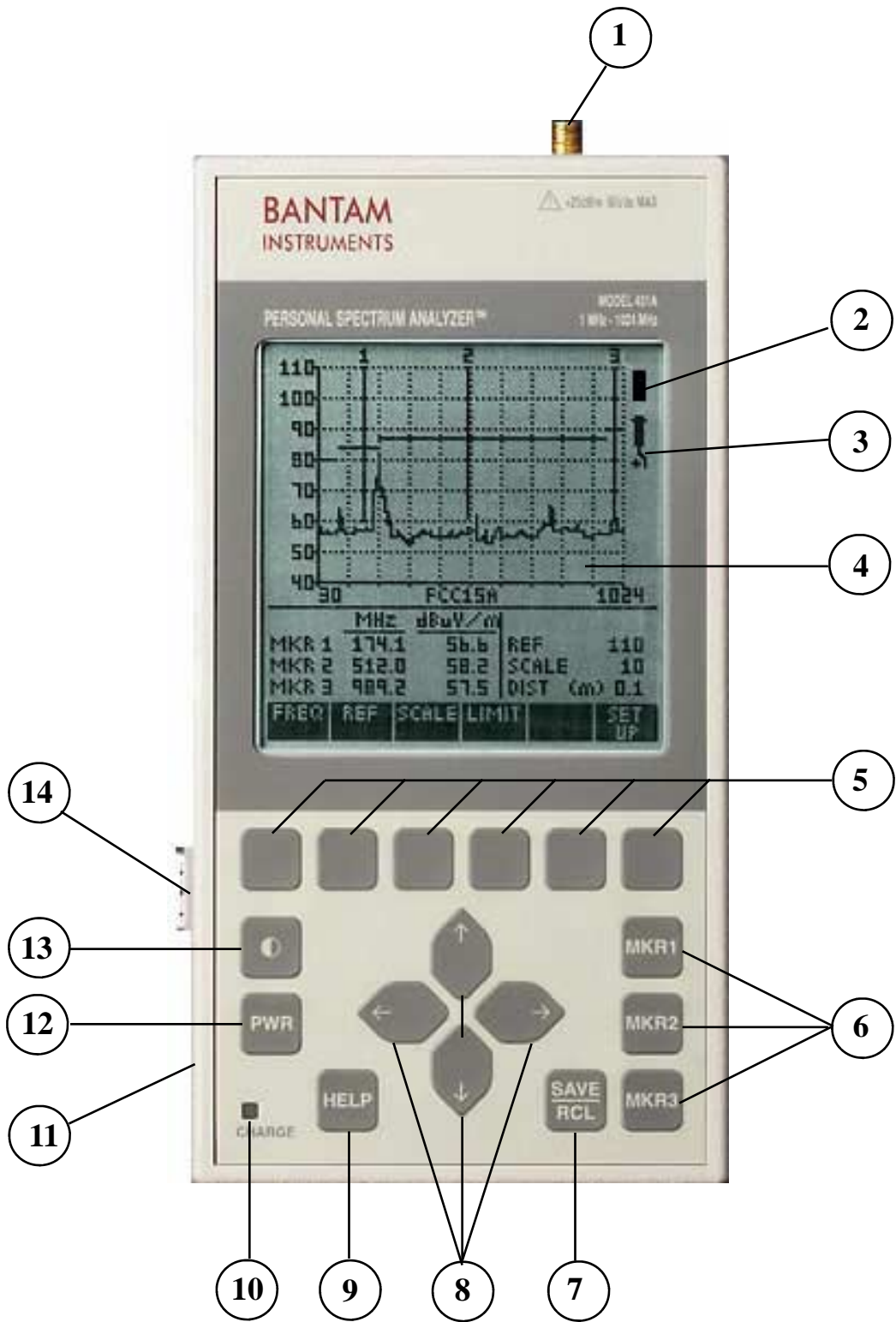
- ① **RF Input Connector.** SMA female connector. Signals to be measured enter through this connector. The Model 401B also supplies DC current to active devices such as the P101A Active E-Field Probe through this connector when the active device is selected.



CAUTION. *RF signals greater than +23 dBm (200 mW) and/or DC voltages exceeding 50 volts will cause damage to the input circuitry of the spectrum analyzer. Such damage is not covered under the warranty.*

- ② **Battery Icon.** Indicates battery charge in approximately 25% increments. When full discharge is indicated, approximately 4% of charge is remaining and instrument should be recharged immediately.
- ③ **Active Device Icon.** Indicates that external active device power is on. External active device power can only be enabled when an active device is connected to the RF input connector. If the active device is disconnected, active device power will automatically be turned off to avoid possible damage to externally connected circuits or devices.
- ④ **Liquid Crystal Display (LCD).** High resolution display for readout of measurement data and measurement parameters.
- ⑤ **Soft Keys.** The function of these six keys is indicated directly above on the Liquid Crystal Display.

Figure 1 – Model 401B Front Panel



Basic Controls and Connectors (Continued)

- ⑥ **Marker Keys.** These three keys activate and control the three markers.
- ⑦ **Save / Recall Key.** This key enables the save and recall of measurement set-ups and traces. This key also enables hard copy printout when a Personal Computer is connected to the serial interface (Number 14).
- ⑧ **Cursor Keys.** These four keys up, down, left, and right, enable the selection of parameters and the increase or decrease of measurement settings.
- ⑨ **Help Key.** Pressing this key automatically displays a help screen relating to the operation being performed by the instrument. An index of help topics can also be accessed by pressing this key.
- ⑩ **Charge Indicator.** Indicates battery charging status when an external charger is connected. Glows yellow while the batteries are being charged and green when the batteries are fully charged. The green indication will only appear when charging with the instrument turned off. The indicator will flash and the charging will terminate if the batteries are above 55°C.
- ⑪ **External DC Power Connector.** For connection of external battery charger. The Model 401B is supplied with an external 100-240 VAC 50/60 Hz charger. An optional adapter for connection to an external 12 VDC power source is available.
- ⑫ **Power On / Off Key.** Pressing this key turns the instrument on or off.
- ⑬ **Contrast Adjustment Key.** Pressing this key brings up a screen on the LCD for the adjustment of display contrast. If display is not visible due to severe misadjustment of the LCD contrast, then holding this key down for several seconds will rapidly cycle the contrast adjustment through its range and a display should be visible. The contrast can then be adjusted for an appropriate display. This key also accesses turning on or off the optional LCD backlight.
- ⑭ **Serial Interface.** DB-9 female connector. For connection to the RS-232 serial interface of a Personal Computer.



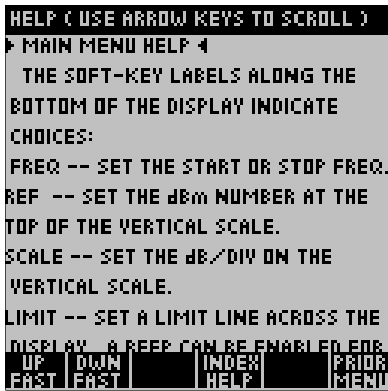
Contrast

Pressing the front panel contrast key will bring up the contrast menu shown at the left. Use the left or right front panel cursor keys to lighten or darken the display. If the display is not visible, holding down the front panel contrast key will rapidly cycle the contrast adjustment through its range. The contrast can then be adjusted for an appropriate display.



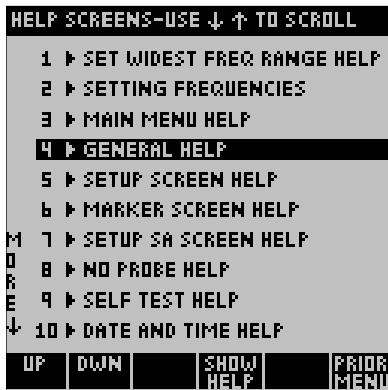
Backlight (Optional)

If Option 002 Backlight is installed, additional information will appear on the contrast menu (as shown at left) to turn the backlight on or off. If “PUSH TO TURN ON BACKLIGHT” does not appear, the backlight option is not installed in your instrument. Your 401B may be returned to the factory for backlight installation. Consult your local sales representatives for details.



Help

Help screens are accessed by pressing the HELP key on the front panel. The help screens are context-sensitive. The help information will relate to the current measurement process underway. Pressing the soft key labeled “PRIOR MENU” will return to the measurement in progress. The HELP screens may be scrolled rapidly using the soft keys or more slowly using the “Up” and “Down” cursor keys. A typical HELP menu is shown at the left.

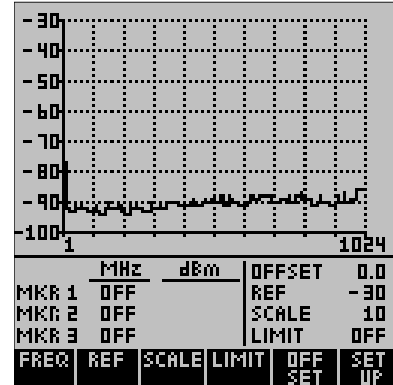


Help Index

Pressing the soft key labeled HELP INDEX, a list of topics is displayed. The appropriate help topic can then be easily selected.

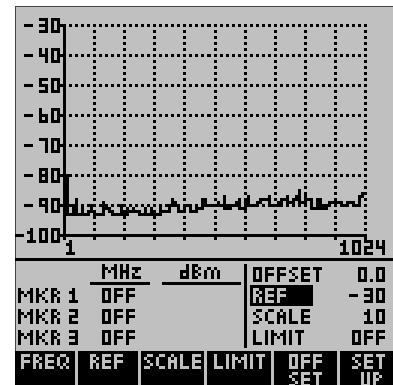
Main Menu

The Main Menu is the core menu in the operation of the Model 401B. When the instrument power is turned on, or when a stored setup or stored trace is recalled, this is the menu which is first displayed. From this menu it is straightforward to adjust measurement parameters such as Scale, Reference, Limit Line, Frequency, and to access the instrument Set-Up menus.



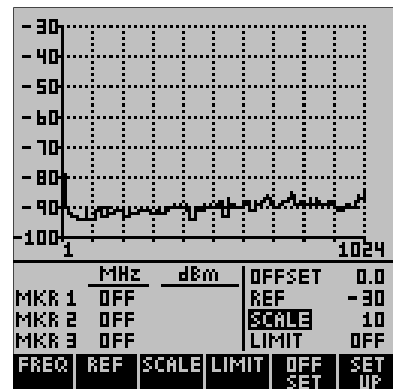
Reference Level

The Reference Level is the value associated with the top line of the graticule. In the example to the right, it is set to -30 dB which is the factory default value. To change the Reference value, press the soft key directly under “REF” at the bottom of the screen. Using the “Up” and “Down” cursor keys, the reference value can be set between +80 dB and -150 dB in 1 dB increments.



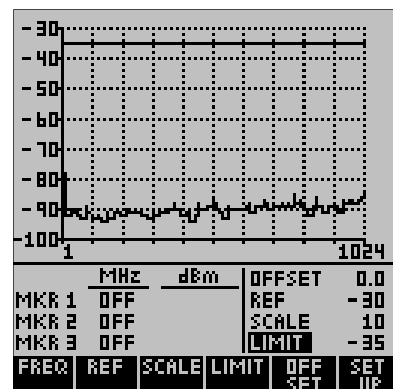
Scale

The scale is the dB per division associated with the vertical display. In the example at the right it is set to 10 dB which is the factory default value. To change the scale, press the soft key directly under “SCALE” at the bottom of the screen. Using the “Up” or “Down” cursor keys, the scale can be set to 1, 2, 5, 10, or 20 dB per division.

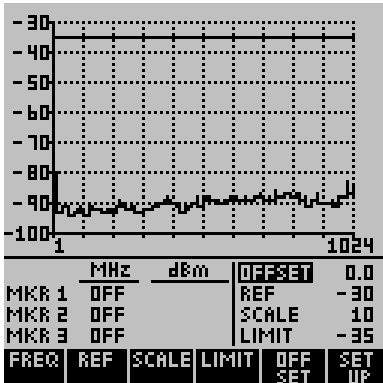


Limit Line

A Limit Line can be added as an amplitude guide for measurement data. The factory default for the Limit Line is “OFF”. To activate the Limit Line, press the soft key directly below “LIMIT” and then use the “Up” and “Down” cursor keys to set the value desired. The Limit Line can be set anywhere on the graticule in 1 dB increments. In the example at the right it is set at -35 dB. To turn the Limit Line off, press the “LIMIT” soft key again.



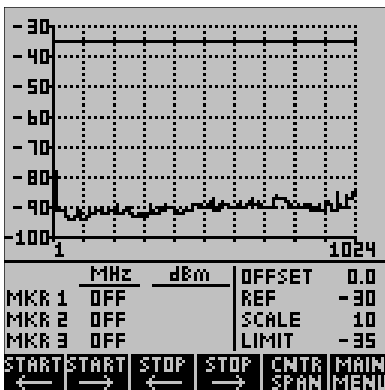
Offset



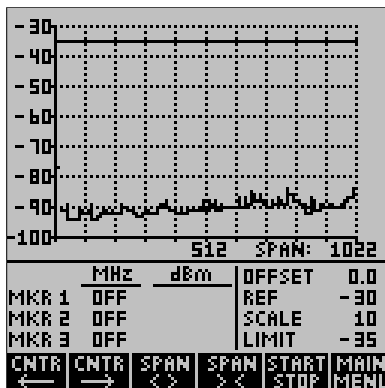
When an external amplifier or attenuator is used, it is often convenient to offset the measurement trace by the dB gain of the amplifier or dB attenuation of the attenuator. This is accomplished by pressing the OFFSET key. Positive values will move the trace upward and are used to reference the measurement to the input of the external attenuator. Negative values are used for external amplification, and move the trace downward. If no external amplifier or attenuator is used, the offset value should remain at 0. The factory preset value is 0.

Frequencies

The measurement frequency range can be adjusted by going to the Main Menu and then pressing the soft key directly under “FREQ” at the bottom of the screen. The frequency menu will come up in one of two formats, either “START STOP” or “CENTER SPAN”.



In the example at left, frequency is displayed as Start and Stop Frequency. In the example just below it, frequency is displayed as Center Frequency and Span. When in the Start / Stop frequency mode, the display mode can be changed to Center / Span by pressing the soft key directly below “CNTR SPAN”. When in the Center / Span mode, the display mode can be changed to Start / Stop by pressing the soft key directly below “START STOP”. The factory default setting is the Start / Stop mode with the full frequency range of 1 MHz to 1024 MHz.



The START STOP frequency mode is often easier to use for wide frequency scans. The CNTR SPAN frequency mode is very convenient for narrow scans, as the scanning window can easily be moved up or down in frequency by changing the center frequency.

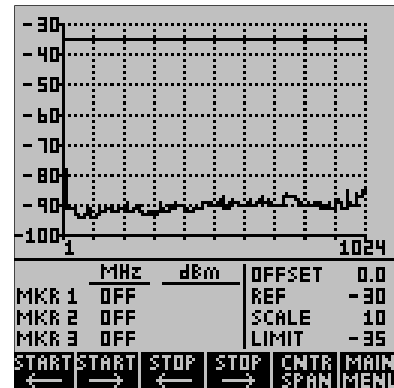
The soft keys can be used to increase or decrease the Start / Stop or Center / Span frequencies. Pressing the soft key once will make a change of 1 MHz. Holding the key down will increase the rate of frequency change.

If a large frequency change needs to be made, the cursor keys may be used. When in the Start / Stop mode, the left and right cursors control the start frequency and the up and down cursors control the stop frequency. When in the Center / Span mode, the left and right cursor keys control the center frequency and the up and down cursor keys control the span.

Frequency Zoom

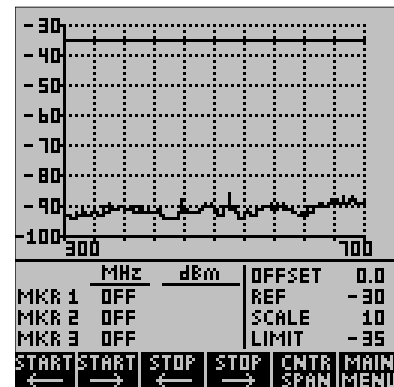
When in the Start / Stop mode, it is possible to zoom out to the full frequency range of the Model 401B and then quickly return to the original frequency range. This is very handy for making narrow band measurements and then quickly zooming out to check surrounding frequencies.

Pressing the START (left arrow) and STOP (right arrow) soft keys simultaneously quickly changes the start and stop frequencies to the full frequency range (1 MHz to 1024 MHz).



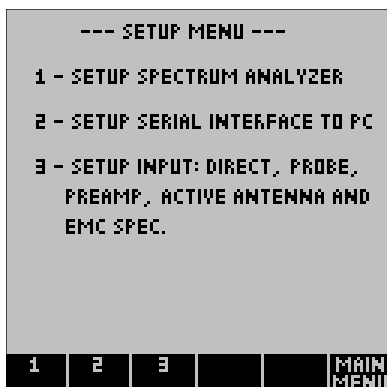
Press simultaneously to zoom out to maximum frequency range of the 401B, 1 MHz to 1024 MHz.

Pressing the START (right arrow) and STOP (left arrow) keys quickly returns to the original frequency setting.



Press simultaneously to return to original frequency range.

Set Up Menu



The Set Up menu, accessible from the Main menu, has three pages. The first page selects Spectrum Analyzer settings such as Resolution Bandwidth, Video Bandwidth, Detection Mode, Averaging, Key Click, Limit Beep, Graticule, Sleep Mode, Measurement Parameter (dBm or dB μ v), Clock and Date Setting, Self Test, and Return to Factory Defaults. This page will be discussed in this section.

The second page sets up the serial interface for communication with a personal computer (PC) using the Bantam Instruments software supplied with your Model 401B Personal Spectrum Analyzer. This is covered in Chapter 4 which discusses the operation of the Personal Computer interface software.

The third page sets up the instrument for external active devices such as the P101A Active Probe which is supplied with the Spectrum Analyzer. This is covered in Chapter 3 which discusses making pre-compliance EMC measurements with the P101A Active Probe.



Set Up Spectrum Analyzer (Set Up Menu Page 1)

In the Set Up Spectrum Analyzer menu, items shown in reverse video are the selected items. The flashing reverse video is the location of the cursor. The cursor can be moved up and down among line items by using the cursor up and down keys. The cursor can be moved left and right along the line item selections using the cursor left and right keys. When leaving this setup menu via the PRIOR MENU or MAIN MENU soft keys, the menu selections are activated.

Resolution Bandwidth

The resolution Bandwidth (RES. B/W) can be 120 kHz or 1 MHz. In the AUTO mode the instrument automatically selects the most appropriate bandwidth for the measurement.

Video Bandwidth

The Video Bandwidth (VIDEO B/W) can be 30 kHz or 300 kHz. In the AUTO mode the instrument automatically selects the most appropriate bandwidth for the measurement.

Detection Mode

Three types of detection may be selected; normal, peak, and quasi-peak.

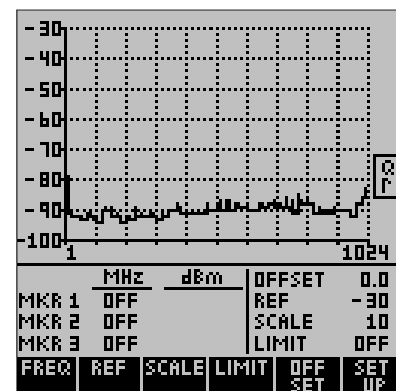
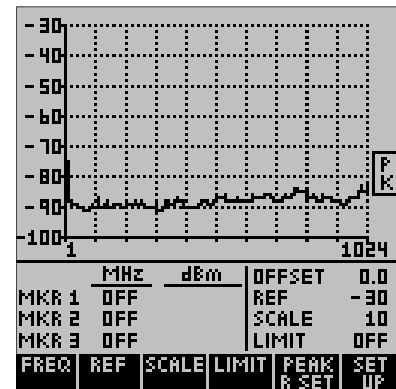
Normal Detection displays the amplitude of a signal as measured during each measurement scan.

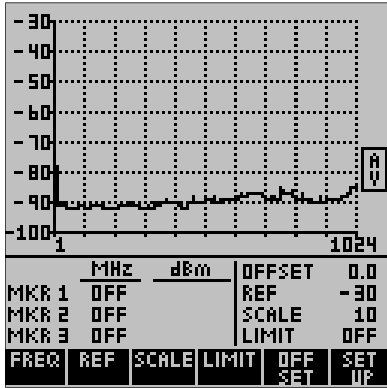
Peak Detection holds the highest amplitude of a signal from scan to scan. When peak detection is active, a small rectangle with the letters PK is displayed to the right of the graticule as shown to the right. To reset the peak detection memory, press the PEAK RESET soft key.

Quasi-peak is a detection mode which has a charge rate much faster than the discharge rate; therefore, the higher the repetition rate of the signal the higher the output of the quasi peak detector.

Quasi Peak detection is often used in EMC measurements as quasi-peak detectors weigh signals according to their repetition rate, which is a way of measuring their annoyance factor. Quasi-peak detection always gives a reading less than or equal to peak detection.

When in the Quasi Peak detection mode, a rectangle with QP in it is displayed to the right of the graticule.





Averaging

When averaging is on, the signal is averaged from trace to trace. This tends to bring signals up out of the noise so that they can be more easily measured. Averaging lowers the apparent noise as it is random. When averaging is on, a rectangle with AV will be displayed to the right of the graticule. Averaging can only be used when in the normal detection mode.

Key Click

When Key Click is on, an audible click is heard each time a front panel key is pressed.

Limit Beep

When limit beep is enabled, the instrument will beep after each sweep if the amplitude of the measurement data exceeds the limit line.

Graticule

The graticule may be turned off (OFF), display only horizontal lines (HORZ) or display both horizontal and vertical lines (H + V).

Sleep

To conserve battery power, the instrument can be set to go into a sleep mode if a button has not been pressed for a certain length of time. Time selections are 5 minutes (5 MIN), 15 minutes (15 MIN), or NEVER go into sleep mode. When in the sleep mode, pressing any key will return the instrument to the same measurement state it was previously in. When the charger is connected, the instrument does not go into the sleep mode.

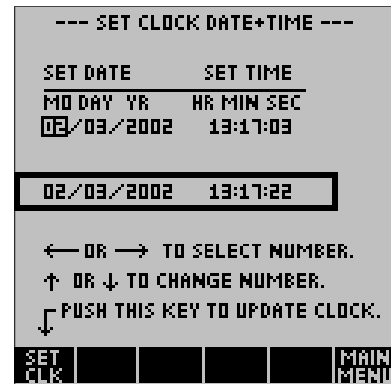
Units

Measurement display mode can be set for dBm (dB referenced to a milliwatt) or dB μ V (dB referenced to a microvolt).

Setting Date and Time

To access date and time setting, press the soft key directly below “SET DATE”. The screen at the right will appear. The date and time shown in the box at the center of the screen is that currently stored in the instrument. To change the date or time, use the cursor keys to change the settings. Exiting this menu will change the date to the new setting. Pressing the soft key under “SET CLK” will immediately reset the clock to the new time.

The clock is always in the 24 hour format. In other words, 3:00pm is displayed as 15:00. The data is always displayed in the month-day-year format.



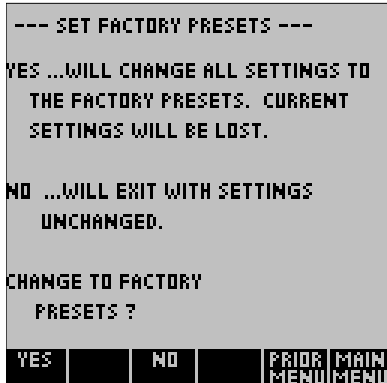
Self Test

Pressing SELF TEST will bring up the screen to the right. The instrument will conduct a self test and display the results (usually PASSED). The version of the instrument firmware is displayed along with the date, time, and internal instrument temperature. The power supply status is also indicated; either being charged from an external 12V source or powered by the internal batteries.

You will notice that this screen is also displayed for a few seconds at turn on. Each time power is activated, the instrument conducts a self test and a calibration sequence. The main menu is then displayed.



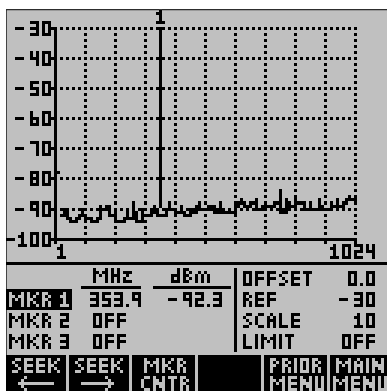
Resetting to Factory Pre-Sets



Pressing Pre-Set brings up the menu to the screen to the left. The factory default settings can be restored or the screen can be exited with settings unchanged. The factory defaults are as follows:

Frequency Range:	1 MHz to 1024 MHz
Frequency Mode:	Start / Stop
Scale:	10 dB per Division
Reference:	-30 dB
Offset:	0 dB
Limit Line:	OFF
Markers:	OFF
Resolution Bandwidth:	AUTO
Video Bandwidth:	AUTO
Detection:	NORMAL
Averaging:	OFF
Key Click:	ON
Limit Beep:	OFF
Sleep:	5 MIN
Units:	dBm

Markers



The Model 401B has three frequency markers. These markers can be accessed by pressing the front panel keys labeled MKR1, MKR2, or MKR3. A screen similar to the one at the left will be displayed. The active marker which was the last front panel key pressed is shown in reverse video (dark). It may be moved by pressing the left or right cursor keys. To turn a marker off, press the corresponding front panel marker key.

Two marker functions are built into the Model 401B. Pressing the soft key under “SEEK” will move the marker left or right to the highest amplitude signal in that direction.

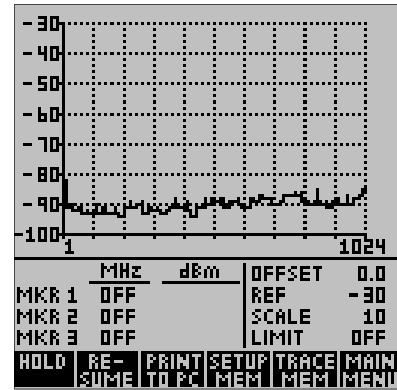
Pressing the soft key under “MKR CNTR” will change the frequency range so that the marker is at the center of the screen. If necessary, the frequency range will be narrowed to make this possible.

Save / Recall

Pressing the SAVE / RCL key on the front panel changes the soft key labels to those shown at the right.

Hold / Resume

Pressing the “HOLD” soft key stops the trace update on the screen. This is indicated by an “X” appearing under “HOLD”. To resume the trace update, press the soft key under “RESUME”.



Print to PC

Using the PC Enhancement Software supplied with the Model 401B, it is possible to make a hard copy printout of measurement data each time this button is pressed. See Chapter 4 for information on setting up this feature.

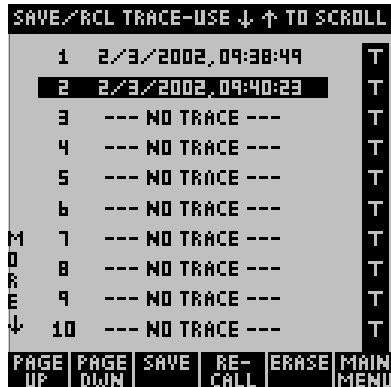
Setup Memory

Setup Memory stores the basic measurement parameters such as frequency span, reference value, scale, etc., so that the 401B can make the exact same measurement when setup is recalled. Setup Memory is accessed by pressing the soft key labeled “SETUP MEM”. The Model 401B has memory to store 20 measurement setups. Each setup in memory is identified by the measurement frequency range, reference dB value, and scale in dB per division. The soft keys labeled “PAGE UP” and “PAGE DOWN” switch between the first ten setups and the last ten. The cursor up / down keys can be used to select a specific setup.

Once a setup memory location has been selected, pressing the “SAVE” soft key will store the current setup in this location. Pressing “RECALL” will load the setup from that location into the instrument, and pressing “ERASE” will erase the contents of the location.

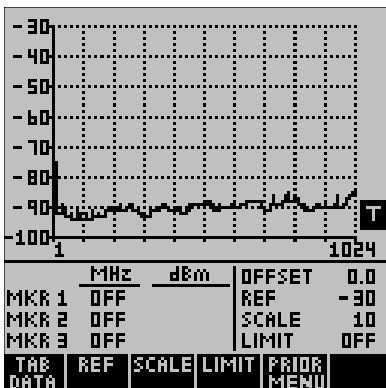


Trace Memory



Trace Memory stores just the trace, or measurement data currently being measured. Trace Memory is accessed by pressing the soft key labeled “TRACE MEM”. There is memory sufficient to store 20 traces. Each trace memory is identified by the date and time it was stored. The soft keys labeled “PAGE UP” and “PAGE DOWN” switch between the first ten setups and the last ten. The cursor up / down keys can be used to select a specific setup.

Once a specific setup has been selected, pressing the “SAVE” soft key will store the current trace in this memory. Pressing “RECALL” will load the trace in memory into the 401B, and pressing “ERASE” will erase the trace from the memory location.



When a trace is recalled, it is marked with a reverse video “T” as shown on the left. This is to show that the displayed trace is from memory; it is not current measurement data. The reference line value and scale of a stored trace can be changed; however the frequency span cannot.



Pressing TAB DATA will show tabular data about the saved measurement. Information such as Resolution Bandwidth, Video Bandwidth, whether Averaging was used, etc. can be determined.

To return to a live measurement press the soft key labeled PRIOR MENU.

Chapter 3

Using the external Active Components for EMC Pre-Compliance and Field Strength Measurements.

Introduction

This chapter describes the use of the following external Active Components with the Model 401B Personal Spectrum Analyzer:

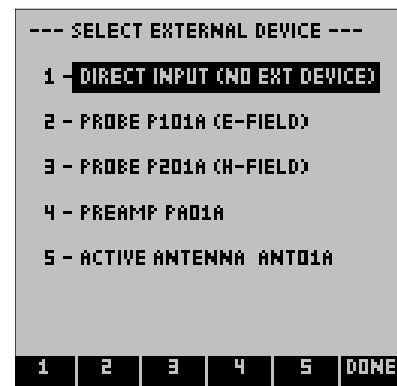
- Model P101A Active E-Field Probe
- Model P201A Active H-Field Probe
- Model ANT01A Active Antenna
- Model PA01A Preamplifier

The Model 401B is normally shipped with the P101A Active E-Field Probe. Ordering option 003 substitutes the ANT01A Active Antenna for the P101A Active E-Field Probe. The other Active Components are available as optional accessories.

The power for these active devices is supplied by the Model 401B through the SMA Female input connector. The power for the active devices is activated only when the active device is connected, so there is no danger of damage when sensitive circuits are connected to the spectrum analyzer's input connector.

Selecting an External Device

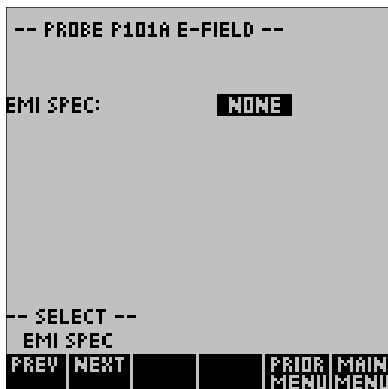
From the Main Menu press the SET UP soft key and then select number 3 – SETUP INPUT. The screen shown at the right will be displayed. The desired active device can be selected, or item number 1 DIRECT INPUT can be selected if no external active device is to be used.



Using the P101A Active E-Field Probe

The P101A Active E-Field Probe contains an internal high gain transimpedance amplifier. The probe functions as a miniature antenna so circuits can be non-invasively measured. The display is calibrated in field strength, dB μ V/m. EMC specification limit lines are stored in the memory of the Model 401B, making EMC pre-compliance measurements simple and straightforward. Connect the P101A Probe directly to the input connector of the spectrum analyzer and then select number 1, PROBE P101A (E-FIELD),

Selecting an EMC Specification



When the Probe is selected, the screen at the left appears, allowing selection of the EMI specification to be used. The default is NONE. Pressing the soft key labeled NEXT will cycle through the following seven choices:

NONE: No EMC Specification will be displayed.

FCC15A: The specification limits for FCC Part 15, Sub part A will be displayed.

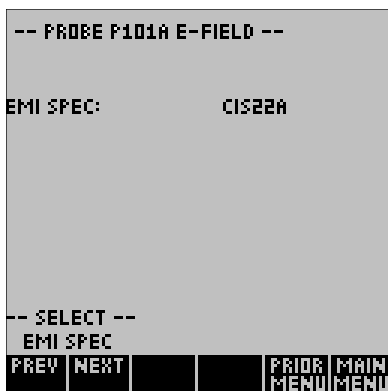
FCC15B: The specification limits for FCC Part 15, Sub part B will be displayed.

CIS11A: The specifications for CISPR 11 Class A will be displayed.

CIS11B: The specifications for CISPR 11 Class B will be displayed.

CIS22A: The specifications for CISPR 22 Class A will be displayed.

CIS22B: The specifications for CISPR 22 Class B will be displayed.



After you have highlighted the appropriate specification you are testing to, press the MAIN MENU soft key.

Pre-Compliance Measurement Example

In the example to the right, CISPR 22 Class A has been selected. Note that the Probe icon appears to the right of the graticule and the small “E” next to it indicates the it is the E-Field probe which has been selected and that it is being powered through the SMA input connector.

Note also that CIS22A appears below the graticule. This is the abbreviation used for CISPR 22 Class A. The limit lines appearing on the display are those specified by this particular specification.

The display is now in dB μ V/m and the reference line and scale have been automatically chosen for convenient display resolution. The rectangular box with QP in it indicates that Quasi-Peak detection is being used, which is the detection method specified in the FCC specification.

Note that there is one change in the soft key labels. The key which used to be labeled LIMIT is now labeled DIST, the abbreviation for distance. To make a calibrated measurement, you must enter the distance the probe is from the test device which you are measuring.

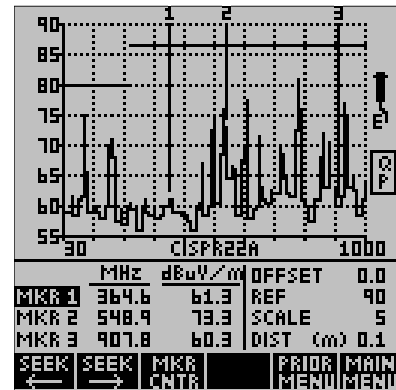
This distance must be entered in meters. The choices are 0.1 and 0.3 meters. 1.0 meters is a choice if the specification is such that an accurate measurement can be made 1 meter from the test device.

One meter is 39.37 inches, so a handy conversion table is as follows:

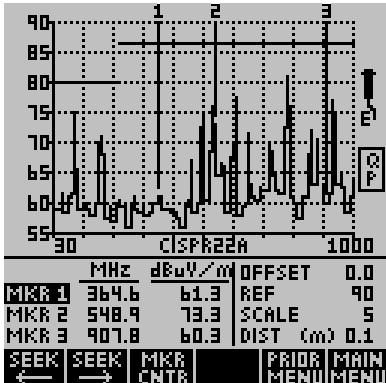
0.1 meter	approximately 4 inches
0.3 meter	approximately 12 inches (1 foot)
1.0 meter	approximately 40 inches

The distance can be entered by pressing the soft key labeled DIST and then using the up and down cursor keys to select the appropriate distance.

As can be seen on the measurement display, the worst case signal is about 9 dB below the FCC specification limit. It is very likely that when a full compliance measurement is made that the product will pass the specification. However, two things should be considered.



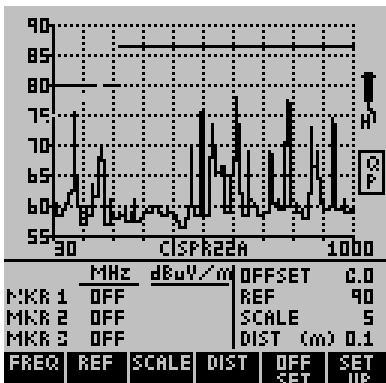
Firstly, unless you are making your measurement in an expensive screen room or at a remote location, you will probably have some interfering signals. Turn off the device under test and see what signals remain. If this signal is still present, it is from an outside source, not the device under test. If a signal or signals are interfering strongly with your measurement it may be possible to reduce them by changing the direction between your probe and test device. The probe is quite directional, so if the measurement can be set up so that the interfering signals are behind the probe, they may be less of a problem. The probe is less sensitive to signals coming from the back and the sides.



Secondly, if this signal which is measuring 9 dB below the specification is coming from your device under test, there is a small probability that you will still not pass a compliance test. Since the measurement is being made in an uncontrolled environment, there is a possibility of reflections of this signal coming to the probe and adding out of phase so as to show a smaller signal than the real signal. The lower the measured signal is below the limit line, the more likely that you will pass compliance. In this case it is quite likely to pass, but if the signal were just a couple of dB below the limit line, then it is best to consider design modifications to further reduce the signal before the compliance measurement is made.

Using the P201A Active H-Field Probe

The P201A Active H-Field Probe is similar to the P101A Active E-Field Probe but is designed to be sensitive to magnetic, rather than electric fields. It is especially valuable for measuring fields generated by high currents, inductors, transformers, and switching power supplies.



The P201A has a gold, rather than silver label so that it can be easily differentiated from the P101A E-Field probe. The icon for the H-Field probe, shown at the left, has an “H” next to the probe rather than an “E”. Operating of the H-Field Probe is identical to the E-Field probe. After selecting the probe an EMI specification is selected

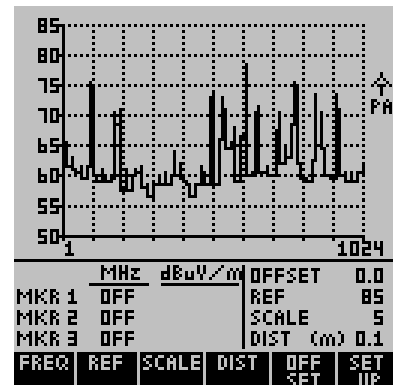
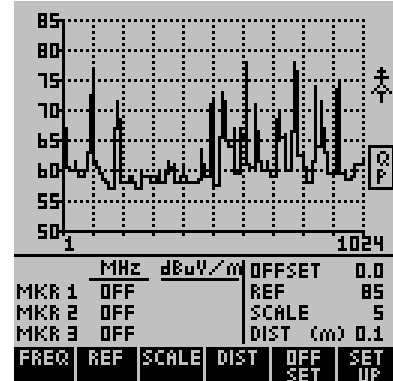
Using the ANT01A Active Antenna

The ANT01A is a broadband 30 MHz to 1024 MHz antenna with built-in amplifier. It is ideal for making Field Strength measurements. The Model 401B automatically compensates for the internal gain and antenna factor, so measurements are calibrated in dB μ V/m. When the Active Antenna is selected from the Select External Device screen, the icon shown at the right is displayed.

Using the PA01A Preamplifier

The PA01A Preamplifier has a gain of typically 26 dB and a bandwidth of 1 MHz to 1024 MHz. It is ideal for use with EMC measuring antennas and other applications where additional sensitivity is required. The Type N Male input connector interfaces directly with most measuring antennas. The 9010-0004 adapter can be used to convert the input to SMA Female if required.

When the PA01A Preamplifier is selected from the Select External Device screen, the icon shown at the right is displayed and the measurement trace is shifted by 26 dB so that measurement levels are referenced to the input of the preamplifier. It is not necessary to adjust the OFFSET. It should remain at 0 dB.



Chapter 4

Using the PC Enhancement Software

Introduction

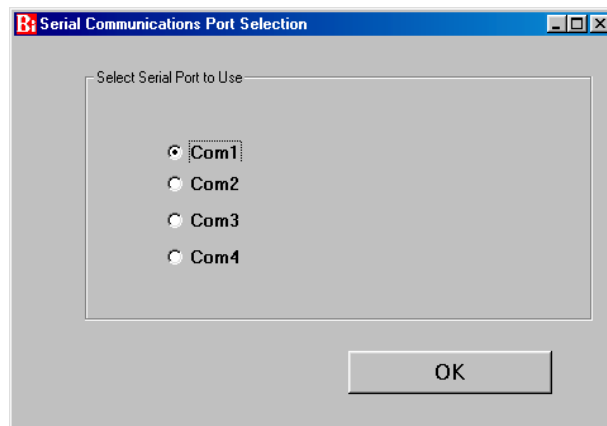
This chapter covers the installation and use of the PC Enhancement Software. This software, supplied with the Model 401B Spectrum Analyzer, allows measurement data to be downloaded to any PC operating under Windows 95 or later. Measurement data can be stored on disk within the PC or printed using any Windows compatible printer. A unique feature of this software allows data to be printed with the touch of a button on the 401B front panel without using the PC keyboard.

Installing the PC Enhancement Program

Insert the CD ROM into the computer. After several seconds the program should begin automatically installing. If this does not happen, click START located on the lower left hand corner of the Windows desktop. Select RUN from the pop up menu and then type X.SETUP.EXE, where “X” is the drive identifier for the CD ROM drive on your computer.

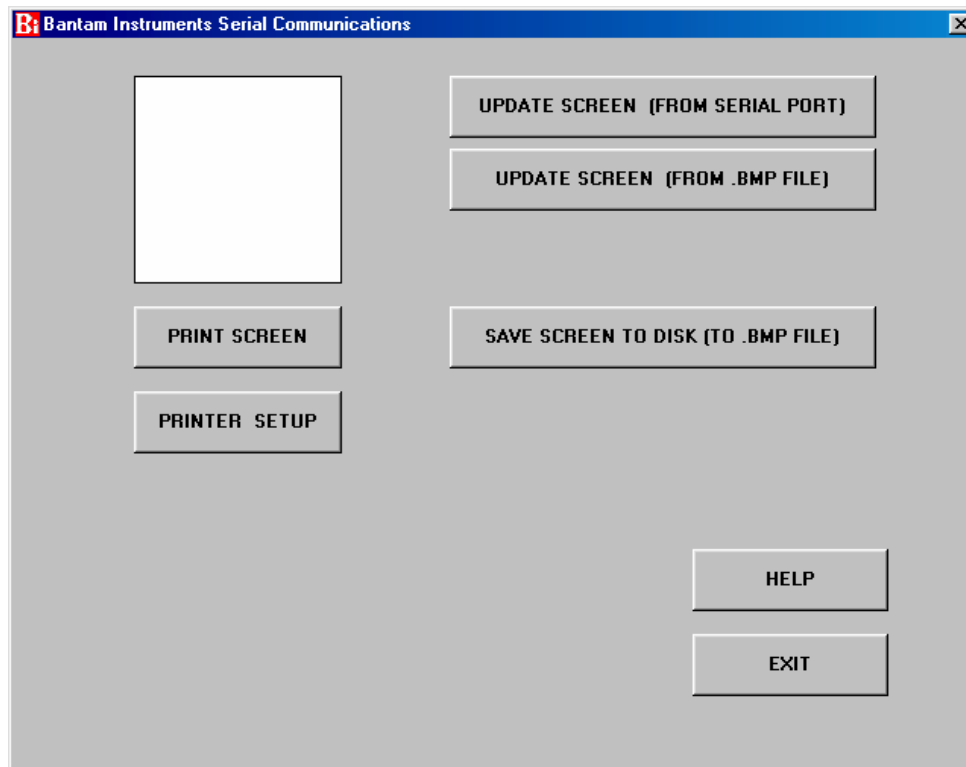
Starting the PC Enhancement Program

Connect the Model 401B Spectrum Analyzer to one of the PC RS-232 serial ports using the supplied serial interface cable. Double click on the program icon to start the program. The first screen, shown below, will ask you to indicate the RS-232 COM port you are using. Select the appropriate COM port and then press OK.



Downloading Measurement Data from the 401B

After selecting the COM port the following display will appear.



The white area in the upper left hand corner is called the "Screen". Data can be uploaded from the 401B by clicking on the button labeled UPDATE SCREEN (FROM SERIAL PORT). Clicking this button will upload whatever is present on the 401B LCD display to the Screen. The upload can take as long as five seconds depending upon the speed of the PC being used, so click just once and wait a few seconds.

If the 401B screen fails to upload to the PC, check that the serial cable is connected to both the 401B and the PC. Also check that the correct COM port was selected when the program was started. Also go to the 401B SETUP menu from the 401B Main Menu. Select soft key labeled "2" and check that the baud rate is set for 57600 and that the serial address is set to "1".

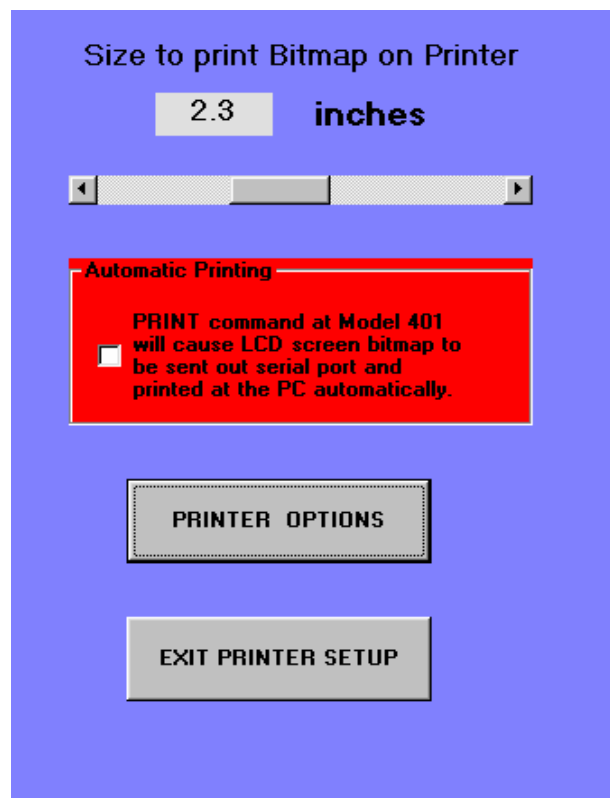
Saving the Downloaded Data to Disk

The downloaded data from the 401B can be saved to Disk by clicking on the button labeled "SAVE SCREEN TO DISK (TO .BMP FILE)". The format used is Bitmap which is compatible with most word processing, spreadsheet, presentation, and publishing software. Upon clicking on the button, you will have a choice of where to save the data and what name to place on it.

To view saved data, click on the UPDATE SCREEN (FROM .BMP FILE) and select the data to be viewed. The data will then be displayed on the program Screen

Printing Downloaded Data

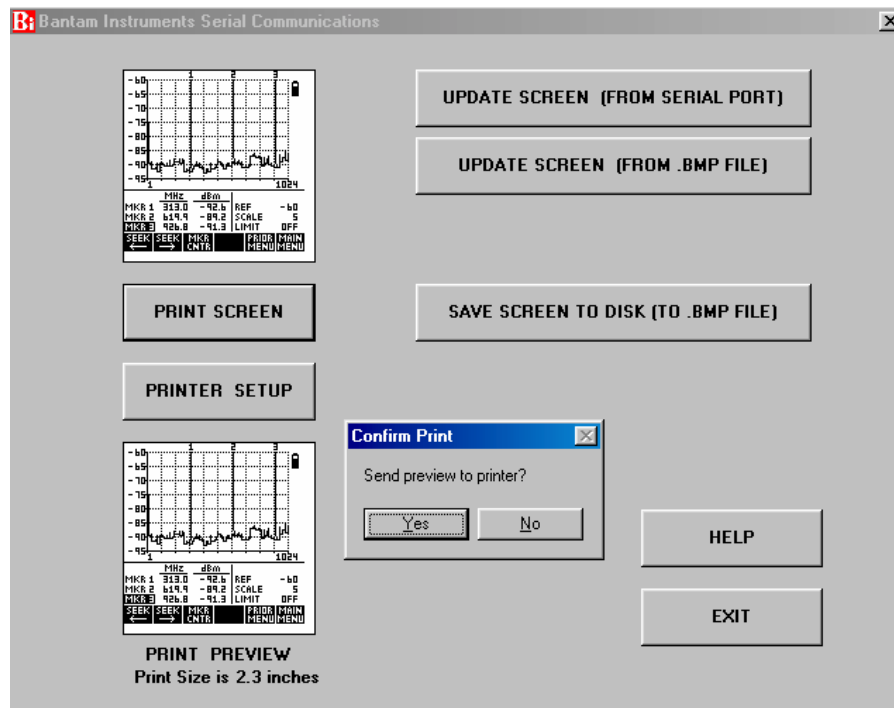
The screen can be printed at any time by clicking on PRINT SCREEN. Before doing so, click PRINTER SETUP and the screen shown below will appear.



At the top of this screen, the size of the printout can be set from a minimum of 2 inches square to a maximum of 4 inches square. The default is 2.3 inches which corresponds to a 1:1 copy of the 401B screen.

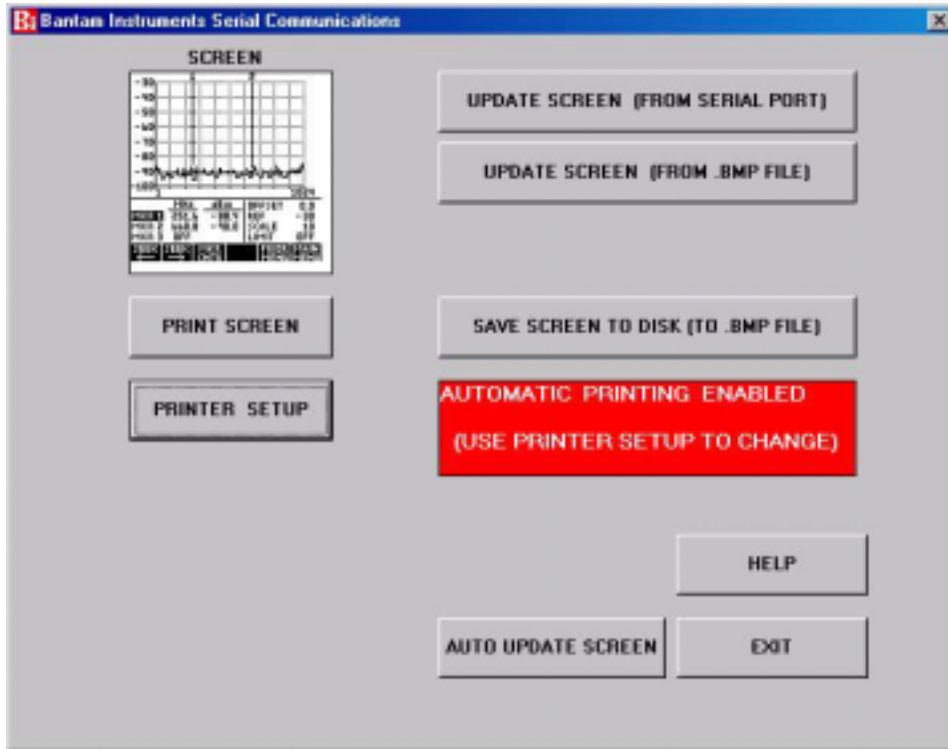
The PRINTER OPTIONS key allows selection of the printer, printer resolution, and other standard Windows printer options. Clicking on EXIT PRINTER SETUP returns to the PC Enhancement Software main display.

If the Screen is to be printed, click on the PRINT SCREEN BUTTON. A duplicate Screen will appear at the bottom left of the main display and the print size will be shown. If this is correct, press OK and the Screen will be printed.



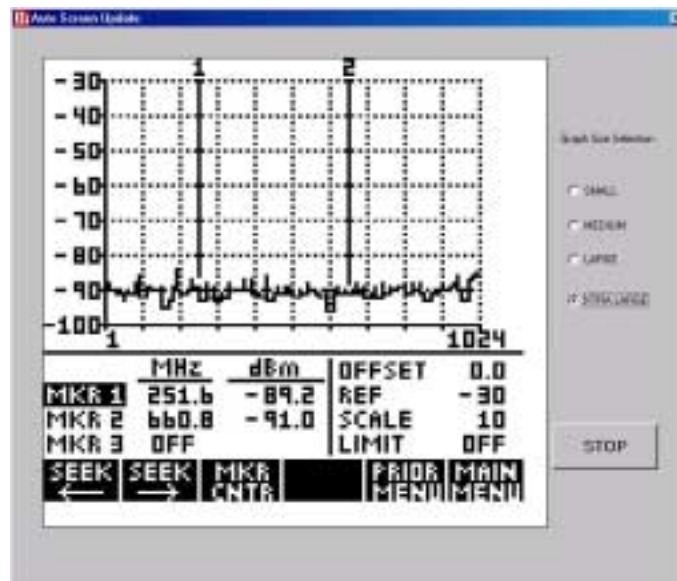
Automatic Printing from the 401B keypad

Enabling the red area labeled “automatic printing” allows a printout to be made every time the PRINT TO PC soft key on the 401B is pressed. The PRINT TO PC soft key appears when the 410B front panel SAVE/RCL key is pressed. When “Automatic Printing” is selected, the main window on the PC will appear as shown on the following illustration



Automatic Update of the Screen Image

Often it is desired for the PC to continuously update the screen image from the 401B. This is especially useful when the PC is being used to monitor measurements being made on the 401B a distance away. To activate this mode, press the AUTO UPDATE SCREEN button. The image will now be continuously updated.



On slower PCs using older versions of Windows, it is possible for the computer input buffers to occasionally overload. When this happens the update process will hesitate and the computer will emit an audible tone. As a first remedy, close any programs which are operating and not being currently used. If this does not cure the problem, simultaneously press the CTR, ALT, and DEL keys. This will activate the Windows Task Manager. Close programs here if they will not interfere with the operation of your PC.

In addition, some users may want to use a USB to RS-232 serial converter. These are inexpensive and usually have a memory to buffer bursts of incoming signal data which can overload a slow PC.

Chapter 5

Remote Programming of the 401B

Introduction

When a serial cable is connected between the Bantam 401B Spectrum Analyzer and a computer, commands can be sent to setup the instrument and to receive measurement results. This capability can be used to automate testing or to monitor the RF environment from a remote location.

All commands listed here are in ASCII characters. The first character is always the serial channel number. The default serial channel number for the Model 401B is "1". This number can be changed to "2" or "3" using the 401B SET UP menu, page 2. This capability is useful if there are two or three 401B's connected to the same computer. Next comes a three letter mnemonic which must be in CAPITAL ASCII characters. In some messages other ASCII characters will follow. Finally, every command must end with an ASCII ";" (semicolon) or a Carriage Return (ASCII 13 decimal or 0D hex).

The first commands that should be sent in every program are: REM and PRE. REM (REMOte) puts the 401B Spectrum Analyzer into a mode where it can receive other remote commands over the serial interface. The 401B front panel keys are then locked out from operation. Next, the "PRE" command returns the Spectrum Analyzer internal setup to a known state, the factory defaults or PREsets. Using the PRE command, it will not be necessary for your program to set up every measurement parameter in the Model 401B. Just the parameters which are different from the factory defaults will have to be programmed. From this state you can proceed to send out other commands. If the program works when tested it should work in a repeatable way whenever executed in the future. So always send out "REM" and "PRE" as the first two commands of every program you write.

Messages returned from the 401B Spectrum Analyzer will always begin with an ASCII "0" (ASCII zero). This is the serial address of the PC. Next comes a 3 ASCII character mnemonic followed by the data. The data will always be in ASCII characters. The message is always terminated by a Carriage Return (ASCII 13 decimal or 0D hex).

Before writing a program, the commands can be experimented with by connecting any terminal or terminal emulator (such as HyperTerminal in Windows) to the 401B Spectrum Analyzer serial port. The default setup should be 57600 baud, 8 data bits, NO parity, 1 stop bit. Confirm that you have everything connected and configured correctly by turning off power to the Model 401B and then turning power back on. You should see a sign on message on the terminal as follows:

```

Bantam Instruments 401
RAM PASSED
SELF TEST PASSED
VERSION 1.08
If message below is garbled, check baud rate setting...
401 Baud Rate is: 57600
401 Serial Addr is: 1

```

If the baud rate or serial address need to be changed, press SET UP from the Main Menu, and then select number 2. This screen then allows the serial communication port to the PC to be set up.

Control Commands for the Model 401B

Command	Description	Example Command
REF±xx	Set Display Reference in dB	1REF-30;
SCLxx	Set vertical Scale dB per division	1SCL05;
LIM±xx	Set horizontal Limit Line position in dB	1LIM-40;
F1Fxxxx	Set Start Frequency (in MHz)	1F1F123;
F2Fxxxx	Set Stop Frequency (in MHz)	1F2F987;
FCFxxxx	Set Center Frequency (in MHz)	1FCF541;
FWFxxxx	Set Scan Frequency Width (in MHz)	1FWF250;
M1Fxxxx	Set Marker 1 Frequency (in MHz)	1M1F145;
M2Fxxxx	Set Marker 2 Frequency (in MHz)	1M2F350;
M3Fxxxx	Set Marker 3 Frequency (in MHz)	1M3F742;
M11	Turn Marker 1 ON	1M11;
M10	Turn Marker 1 OFF	1M10;
M21	Turn Marker 2 ON	1M21;
M20	Turn Marker 2 OFF	1M20;
M31	Turn Marker 3 ON	1M31;
M30	Turn Marker 3 OFF	1M30;
MSLx	Marker Seek Left, where x=1, 2, or 3 (ignored if marker x if turned off)	1MSL3;

Command	Description	Example Command
MSRx	Marker Seek Right, where x=1, 2 or 3 (ignored if marker x is turned off)	1MSR2;
MTCx	Marker To Center, where x=1, 2 or 2 (ignored if marker x is turned off)	1MTC1;
RBA	Resolution Bandwidth AUTO	1RBA;
RBW	Resolution Bandwidth WIDE	1RBW;
RBN	Resolution Bandwidth NARROW	1RBN;
VBA	Video Bandwidth AUTO	1VBA;
VBW	Video Bandwidth WIDE	1VBW;
VBN	Video Bandwidth NARROW	1VBN;
DTN	Detection NORMAL	1DTN;
DTP	Detection PEAK	1DTP;
DTQ	Detection Quasi-Peak	1DTQ;
PRS	Peak Reset (when in Peak detection mode)	1PRS;
AV1	Averaging (of trace) ON	1AV1;
AV0	Averaging (of trace) OFF	1AV0;
LB1	Beep if Signal above limit line ON	1LB1;
LB0	Beep if Signal above limit line OFF	1LB0;
GOF	Graticule OFF	1GOF;
GHO	Graticule Horizontal lines only	1GHO;
GHV	Graticule Horizontal and Vertical lines	1GHV;
LL1	Limit Line ON	1LL1;
LL0	Limit Line OFF	1LL0;
PRE	PRESET to factory default values	1PRE;
REM	REMOTE mode (allow other serial commands) Keypad is locked out.	1REM;
RTL	Return to Local control (allow use of keypad)	1RTL;
DLS	Download Screen Image when signal Exceeds the Limit Line. Use Bantam program to receive. (Data will be sent at end of sweep)	1DSL;

Command	Description	Example Command
DLE	Download Spreadsheet Data (ie EXCEL) when signal exceeds the Limit Line. (Data will be sent at end of sweep)	1DLE;
SSM	Set Display to Start-Stop Mode	1SSM;
CSM	Set Display to Center-Span Mode	1CSM;
EMCxx	EMC spec displayed according to the following two ASCII decimal numbers: 00 = NONE 04 = CISPR 22B 01 = FCC 15A 05 = CISPR 11A 02 = FCC 15B 06 = CISPR 11B 03 = CISPR 22A Note that "INP" command must be issued prior to this command and probe icon must be on LCD.	1EMC01;
DSTxxx	Set Distance from Probe to DUT (to use calibrated Probe) xxx=0.1 or 0.3 or 1.0 This command is only active if an EMC specification is selected.	1DST0.3;
IND	Set RF input connector to accept DIRECT input	1IND;
1NE	Set RF Input to accept E-Field Probe. Note that if probe is not connected this command will generate an error message to be sent back: "0ERR01Error- Probe not connected"	1NE;
1NH	Set RF input to accept H-Field Probe	1NH;
1NP	Set RF input to accept Preamplifier	1NP;
1NA	Set RF input to accept Active Antenna	1NA
OFSxxx	Set Offset in dB	1OFS-17.9

COMMANDS FOR READING BACK DATA FROM THE MODEL 401B

Command	Description	Example
?SFV	Show Firmware Version	1?SFV;
?F1F	Return Start Frequency (in MHz)	1?F1F;
?F2F	Return Stop Frequency (in MHz)	1?F2F;
?REF	Return Reference for Graph (in dBm)	1?REF;
?SCL	Return Scale for Graph (in dB per div)	1?SCL;
?LIM	Return setting of the Limit Line (in dBm)	1?LIM;
?M1F	Return Marker 1 frequency (in MHz)	1?M1F;
?M2F	Return Marker 2 frequency (in MHz)	1?M2F;
?M3F	Return Marker 3 frequency (in MHz)	1?M3F;
?DSD	Download data for 100 points displayed on the LCD in Spreadsheet format (freq, amplitude).	1?DSD;
?UNT	Return the units for the vertical scale of LCD.	1?UNT;
?AM1	Return Amplitude of Marker 1	1?AM1;
?AM2	Return Amplitude of Marker 2	1?AM2;
?AM3	Return Amplitude of Marker 3	1?AM3;
ABNxx	Return Amplitude of data point xx (where xx = 00 to 99 decimal) This is the amplitude of one of the selected 100 data points points displayed on the 401	1?ABN37
?1NX	Return INPUT mode, Direct=IND, E-Field=INE, H-Field=INH, Preamp-INP, Active Antenna=INA	1?1NX;
?OFS	Return Offset value	1?OFS;

DATA FORMATS SENT BACK FROM THE MODEL 401B

<u>Command (From PC)</u>	<u>Example Response Message (from 401B)</u>
?SFV;	VERSION01.03
?F1F;	0F1F234.0
?F2F;	0F2F890.0
?REF;	0REF-30
?SCL;	0SCL10
?LIM;	0LIM-35
?M1F;	0M1F316.0
?M2F;	0M2F617.7
?M3F;	0M3F808.0
?AM1;	0AM1-85.4
?AM2;	0AM2-22.4
?AM3;	0AM3-91.9
?ABN	0ABN-44.6
?UNT;	0UNTDBM (indicates dBm) or 0UNTDBU (indicates dBuV)
?INX	0IND
?OFS	0OFS-34.4
?DSD;	0DSD*237.2,-83.8*243.8,-82.7*...*886.7,-93.8

NOTE: This data consists of 100 frequency, amplitude pairs separated by a comma and terminated by a ASCII Line Feed character (10 decimal or 0A hex). The “*” indicates where the ASCII Line Feed character is sent since it is a non-printable character. At the end of the 100 pairs is a ASCII Carriage Return (13 decimal or 0D hex) terminating the transfer.