Avantron 2000 Series Portable Spectrum Analyzer

Avantron AT-2000R/RQ User Manual

Version 4.0
(preliminary)

Avantron Technologies, Inc.
The OTHER Spectrum Analyzer
Company the MSOs Trust

CONTENT

INTRODUCTION **6**

WELCOME 6
AT-2000R/RQ SPECIFICATIONS 8
CATV Measurement Specifications *10*
Digital Measurement QAM 64/256 Specifications *12*
Available Options for 2000 Series *13*
Windows PC Software for 2000 Series *13*
Optional Accessories for 2000 Series *14*
ACCESSORIES 15
A.C. Charger/Power Supply *15*
RECEIVING & UNPACKING 15
WARRANTY INFORMATION 17

GETTING STARTED **18**

INITIAL CHECKOUT 18

UNDERSTANDING THE AT-2000R/RQ **19**

AUTOCALIBRATION 19
AT-2000R/RQ'S ON-LINE HELP 19
FRONT-PANEL KEYS 20
Menu Keys *20*
Soft-Keys *20*
Key Description (Push Buttons) *21*
MAIN MENU - SOFTWARE FUNCTIONS 23
Standard Functions and Icons *24*
Optional Functions and Icons *24*
Optional CATVPAK Functions and Icons *25*

BASIC AT-2000R/RQ FUNCTIONS **26**

DEFAULT INSTRUMENT SETTINGS 26
Preset *26*
STORING TO MEMORY 26
Store Records *26*
Store Settings *27*
Recall Stored Records *28*
Recall Stored Settings *28*
Superimpose On A Live Trace *29*
Erasing Records And Settings *30*
PRINTING 30
Printing Reports And Screens *30*
Print Screen Method *31*
Print Multiple Records *31*
DATA COMMUNICATION 32
COMM - RS-232 Serial Interface *32*
Upgrading Firmware *32*
AT-2000R/RQ User Files *33*
Avantron WinCom for Windows *34*
Avantron WinRemote for Windows *35*
ETHERNET 10BASE-T INTERFACE - RJ-45 (OPTIONAL) 36

Configuring IP Address ... *36*
Other TCP/IP Parameters ... *38*
SETUP - USER PREFERENCES ... 40
Set-up Screen ... *40*
User Parameters ... *40*
Custom Screen Colours ... *43*
Channel Plan Set-up ... *44*

USING AVANTRON'S AT-2000R/RQ SPECTRUM ANALYZER ... 46

MAIN CONTROL KEYS & MENUS ... 47
Frequency ... *47*
Span ... *48*
Zero Span ... *48*
Resolution Bandwidth (RBW) ... *49*
Sweep Time (SWT) ... *49*
Video Bandwidth (VBW) ... *50*
Amplitude ... *50*
Sensitivity Measuring Low-Level Signals ... *50*
Markers ... *51*
PRECISION FREQUENCY COUNTER ... 52

CATVPAK - AUTOMATED CATV MEASUREMENTS (OPTIONAL) ... 53

DIGITAL CHANNEL POWER ... 53
FREQUENCIES AND LEVELS ... 54
TV Channel Mode ... *54*
Multi Carrier Mode ... *54*
AUTOTEST ... *55*
DISTORTION MEASUREMENTS ... 56
Hum Modulation Measurement ... *56*
Combined C/N, CTB and CTB ... *58*
Carrier-To-Noise (C/N) ... *59*
Composite Triple-Beat (CTB) ... *62*
Composite Second Order (CSO) ... *63*
IN-CHANNEL FREQUENCY RESPONSE ... 66
DEPTH-OF-MODULATION ... 66
Depth Of Modulation With VITS ... *67*

QAM 64/256 - DIGITAL MEASUREMENT ANALYZER (OPTIONAL ON AT-2000R) ... 68

INTRODUCTION TO DIGITAL MEASUREMENTS ... 68
Quadrature Amplitude Modulation ... *69*
DOCSIS and J.83 ANNEX B ... *69*
TESTING QAM SIGNALS ... 72
Pre and Post Bit Error Rate (BER) ... *73*
Modulation Error Ratio (MER) ... *74*
Estimated Noise Margin (ENM) ... *75*
Error Vector Magnitude (EVM) ... *75*
CONSTELLATION DISPLAY ... 76
Zoom Mode ... *76*
STATISTICS GRAPH DISPLAY ... 77
Error Statistics ... *77*
ADAPTIVE EQUALIZER DISPLAY ... 78

BAS-1 BI-DIRECTIONAL ALIGNMENT (OPTIONAL) ... 79

MODEL BAS-1 HEADEND UNIT ... 79
MODEL AT402P 2 CARRIER GENERATOR ... 80
OPERATING BAS-1 OPTION ON AT-2000R/RQ ... 80

Setting FSK Receive Frequency *81*

NON-INTERFERING RF SWEEP SYSTEM (OPTIONAL) **82**

INSTALLING SWEEP SYSTEM 83
NORMALISING SWEEP RESPONSE 85
OPERATING SYSTEM SWEEP 86
Sweep Display Selections *86*

AVANTRON SERVICE AND SUPPORT **88**

AT-2000R/RQ MAINTENANCE 88
RF Connector Replacement *88*
Battery Pack Replacement *88*
TECHNICAL SUPPORT 89
RETURNING EQUIPMENT TO AVANTRON 90

GLOSSARY OF TERMS **92**

INDEX **94**

Avantron AT-2000R/RQ User Manual

Introduction

Welcome

The Avantron Spectrum Analyzer Model **AT-2000R/RQ** is a portable, battery operated RF Spectrum Analyzer which will prove itself to be an invaluable, multifunction tool for broadband RF testing. This is due to its inherent broad input range, high sensitivity, and advanced circuit design characteristics. You may perform daily testing and preventative maintenance as well as locate faults and perform trouble shooting.

The Model **AT-2000R/RQ** is a "designed for the field" portable instrument. The base function is an advanced digital spectrum analyzer, which also may optionally include features required for CATV and other broadband testing. One-button measuring of signal levels with various correction factors for different modulation types, measurement of Carrier-to-Noise Ratio, Composite Second and Composite Triple Beat distortions as well as Hum Modulation and QAM digital measurements. An integrated Frequency Counter can measure any CW, AM, FM or Television signals. Avantron has skillfully combined many unique features and functions in a single state-of-the-art microprocessor controlled instrument. This combination of laboratory grade test functions in a designed for the field package allows the user to virtually go anywhere, and rapidly align any broadband RF network while instantaneously be able to monitor system performance with documentation capability, all in a single, portable and lightweight instrument.

The analyzer has simple and straightforward controls that allow for quick measurements with repeatable tests. The analyzer can function with “Smart Modes” which automate tests and procedures. Fully automated Test & Measurement functions allows the operator to complete tests on multiple frequencies or channels within minutes and store all the results in non-volatile memory as an individual record. Records may be directly printed out from the Model **AT-2000R/RQ** to a standard parallel printer or may be downloaded to a PC with Avantron’s file transfer and data manager software.

A spectrum analyzer enables you to view the performance of your entire RF system at a glance or single carrier or channel for close scrutiny. Troubleshooting for extraneous signals and or interference is easy with the graphical color spectral displays and you may perform these tests virtually anywhere, because the Model **AT-2000R/RQ** is lightweight and runs on an internal, sealed, rechargeable lead-acid battery. System testing and maintenance are easier than ever, because the effects of system adjustments

may be observed instantly and precisely. The Model **AT-2000R/RQ** also enables you to listen to signals at the center frequency in zero span with the built-in AM/FM demodulator. This is an invaluable aid in identifying interfering signals and ingress.

The Model **AT-2000R/RQ** ensures you of speed and accuracy when taking measurements. At power up, the analyzer automatically performs a self-check on internal components and is ready in seconds. It constantly monitors internal temperature as well as battery level, with warnings for out of calibration conditions. This automatic and continual monitoring with stored calibration curves ensure always consistent and precise digital measurements within the specified limits

AT-2000R/RQ Specifications

Note: All specifications apply over the standard 0°C to + 50°C operating temperature range, after a minimum of 2 hours of storage within the operating temperature range, if the unit is not fully at ambient temperature. The **AT-2000R/RQ** meets all it's specifications within 1 minute after it is turned on, providing that the **AT-2000R/RQ** is within the one year calibration cycle. Avantron's unique AutoCal feature assures accuracy by periodically self-testing itself and triggering a non-obstructive calibration, as required.

FREQUENCY

Frequency range ---------- 1 MHz - 1 GHz
Frequency Reference:
- Aging ---------- ± 1 PPM/Yr
- Temperature Stability ---------- 1 PPM (0ºC to 50ºC)

Frequency counter:
- Accuracy ---------- ±1 PPM ± 1count
- Resolution ---------- 10 Hz

Stability (Noise sidebands offset from CW signal) ---------- 85 dBc @ ± 10kHz

SPAN

Frequency Span:
- Range ---------- Variable from Max Span 1000 MHz to 100 kHz & Zero Span.
- Accuracy ---------- ≤ 2 PPM

Sweep Time:
- Range ---------- 3mS, 6mS, 15ms, 30mS, 100mS, 300mS, 1000mS, 3000mS
- Stability ---------- ≤ 2 PPM

Sweep Trigger ---------- Automatic (Sweep Mode only), Free Run, Linelock and TV Frame.

Resolution Bandwidth:
- Range ---------- 1 MHz, 300 kHz, 30 kHz & 10 kHz
- Accuracy ---------- ± 5%
- Selectivity (60 dB/3dB Ratio) ---------- 5.3:1, 3:1, 2:1, 2:1

Video Bandwidth:
- Range ---------- 1 MHz, 100 kHz & 10 kHz

AMPLITUDE

Response Flatness ---------- ± 0.75 dB (5 - 1000 MHz)
Sensitivity ---------- -65 dBmV to +65 dBmV
Level accuracy ---------- ± 0.75 dB @ 25°C
Level resolution ---------- 0.1 dB
Impedance at RF input ---------- 75 ohm
Input Return Loss ---------- > 16 dB (>10 dB attenuation)
Maximum safe input ---------- + 68 dBmV

Noise figure ---------- 10 dB max. 0 dB attenuation
Spurious free dynamic range ---------- > 70 dB

Vertical scale ---------- 10, 5, 2 dB/Division

Input attenuator ---------- 0 - 65 dB in 5 dB steps
Internal calibrator ---------- 38.5 MHz @ -5 dBmV
Temperature Readout Range ---------- 40ºC to 100ºC ±1.5ºC

Display type ---------- TFT Active Matrix Color LCD
Display size ---------- 162.5 mm (6.4 inches)

POWER

Battery type ---------- Rechargeable lead acid, 12 Volt 5 Ah.
Charger Type ---------- Battery Charger 12 Volt 2 A
Charge Time ---------- Approx. 3 hours
Operating Time ---------- Approx. 2.5 hours

Temperature range:
Operating ---------- 0°C to +50°C
Non-operating ---------- -20°C to +55°C

Size ---------- 304.8mm x 177.8mm x 355.6mm
(12"W x 7"H x 14"D)
Weight (w\battery) ---------- 8.6 Kg (19.6 pounds)

CATV Measurement Specifications

Channel Selection ---------- Frequency, Channel Video or Channel Audio
Channel Plans ---------- 4 custom plans, NTSC, PAL or other. Maximum of 250 positions.
Tuning Range ---------- 1 MHz to 1 GHz
TV Channel amplitude range ---------- -40 dBmV to +65 dBmV ± 0.75dB for S/N > 30dB

TV Visual Frequency:
Accuracy ---------- Carrier Frequency, ± 1 PPM
Resolution ---------- 10 Hz

Visual/Aural Delta Frequency:
Range ---------- 1 - 10 MHz
Accuracy ---------- ± 200 Hz
Resolution ---------- 10 Hz
Visual/Aural Delta Amplitude ---------- ± 0.75 dB for S/N > 30 dB

Digital Carrier Measurement
Amplitude Range ---------- -30 to +60 dBmV
Resolution ---------- 0.1 dB
Absolute Accuracy ---------- ± 1.5 dB
Bandwidth Range ---------- 200 kHz to 200 MHz

FM Deviation:
Range ---------- ± 150 kHz
Accuracy ---------- ± 2 kHz, 1 - 75 kHz, ± 5 kHz to 150 kHz

HUM/Low Freq. Disturbances:
Modes ---------- CW or Video (In-Service)
Range ---------- 1 - 10 %
Accuracy ---------- ± 0.5 % from 1 to 5 %, ± 1 % from 5 to 10 %

Modulation Depth
AM Range ---------- 40 to 95%
Resolution ---------- 0.1%
Accuracy ---------- ± 1.5% (C/N > 40 dB)
Signal type ---------- Use VITS line with white reference

In-Channel Response
Range ---------- ± 10 dB
Resolution ---------- 0.1 dB
Accuracy ---------- ± 0.25 dB
Signal type ---------- Use VITS line with full amplitude multiburst signal

Carrier-to-Noise Ratio

Optimum Range ---------- 0 dBmV to +10 dBmV with 0 dB Attenuation

Maximum C/N ---------- 60 dB with ± 1 dB accuracy, 65 dB with ± 3 dB accuracy

Resolution ---------- 0.1 dB

CSO/CTB

Optimum Range ---------- -4 dBmV to +4 dBmV with 0 dB Attenuation

Maximum ---------- CSO/CTB 64 dB with ± 1.5 dB accuracy 71 dB with ± 4 dB accuracy Resolution 0.1 dB

Note: C/N, CSO and CTB specifications Without Preselector & 77 Channel Loading

Digital Measurement QAM 64/256 Specifications

Modulation

Modulation Type ---------- 64/256 QAM (DUS-031, ITU-T J.83 Annex B)
Constellation Display ---------- Size: 64 and 256 QAM
Full constellation with zoom capability.
Adaptive Equalizer Display ---------- Number of Taps: 8 feed-forward; 8 feedback.
Scale ---------- +10 to -40 dBc.
Mask ---------- DVB.

Digital Carrier Average Power Measurement

Amplitude Range ---------- -30 to +35 dBmV or -30 to +60 dBmV with pre-selector Resolution 0.1 dB
Absolute Accuracy ---------- ± 1.5 dB
Bandwidth Range ---------- 200 kHz to 200 MHz

Adjacent Channel Power

Difference Amplitude Range ---------- +10 to -25 dB.
Accuracy ---------- ±2.1 dB
Display Vertical Scale ---------- 20 to 40 dBmV, -65 to -5 dBm

Modulation Error Ratio (MER)

Range ---------- 22 to 35 dB.
Accuracy ---------- ±1.5 dB
Error Vector Magnitude (EVM) Range ---------- 1.2 to 4.1%.
Accuracy ---------- ±0.4% over 1.2 to 2.0% range; ±0.8% over 2.1 to 4.1% range

Average Bit Error Rate (BER), Before R-S Decoding

Range ---------- 1.0×10^{-9} to 1.0×10^{-4}.
User-selectable Time Period ---------- 1 to 60 minutes.

Estimated Average Bit Error Rate (BER), After R-S Decoding

User-selectable Time Period ---------- 1 to 60 minutes.

Estimated Noise Margin

Range ---------- 1 to 12 dB
Accuracy ---------- +/- 1.5 dB

Data Logging

User-selectable Time Period ---------- 1 to 60 minutes.
Errored Seconds.
Severely Errored Seconds.

Symbol Rate

Range ---------- 5.057 to 5.360 Msymb/s.

Available Options for 2000 Series

AT2CATVPAK	CATV Measurement Option Carrier measurement, Precision frequency counter, In service HUM, C/N, CSO and CTB, Digital Channel Power.
AT2SWPFW	Field unit, Low Level Non-Interfering Forward Sweep only. (Requires Headend Sweep Reference Generator Model **AT-2000G**)
RBAS1	Software option for Return path balancing (Requires Model **AT-BAS-1** Bi-directional 2 carrier Return Alignment Headend unit and a portable 2 carrier signal generator such as Model **AT-402P**)
AT2VIDOUT	Baseband NTSC video output
AT2HCBAT	High capacity battery Kit (provides 1 hr additional operating time, approx. 3.5 hr)
AT2NETR	10BASE-T Network connection (RJ45) for **AT-2000R/RQ**
AT2CAL3YR	3 Year Calibration Program
AT2W-EXT-R	**AT-2000R/RQ** Extended Warranty option (additional 1 year for a total of 3 years)
AT-2000G	1GHz Low Level Non-Interfering Forward Sweep Reference Generator
AT-BAS-1	Bi-directional 2 Carrier Return Alignment Headend Unit (Specify 2 Input Frequencies from 5 to 50 MHz, and Telemetry Data Out > 50 MHz)
AT-402P	Portable 2 Carrier Signal Generator56 dBmV Max Out, 20 dB adjustment, Freq. range (5 - 108 MHz)

Windows PC Software for 2000 Series

A99026010	WinCom - Data Management Software Includes Disks and User Manual (1 license per PC)
A99026020	WinRemote - Remote Control Spectrum Analyzer Software Includes Disks and User Manual (1 license per PC)

Optional Accessories for 2000 Series

PV1	Quite Line Inserter for in-service distortion testing
PSC2000	2 Amp Battery Charger/AC Power Supply for **AT-2000R** (110/60)
PSC2220E	2 Amp Battery Charger/AC Power Supply for **AT-2000R** (220/50)
PSC2004	4 Amp Battery Charger/AC Power Supply for **AT-2000RQ** (110/60)
PSC2224E	4 Amp Battery Charger/AC Power Supply for **AT-2000R/Q** (220/50)
A90093030	Model BTA Bucket Truck Adapter
A91001252	**AT-2000R** Replacement battery 12V 5 A/h
A91001270	**AT-2000R/RQ** Replacement High Capacity battery 12V 7 A/h (Requires AT2HCBAT)
A65000909	Serial Cable for PC connection DB9 to DB9
A99025600	Padded Protective Soft Case for **AT-2000R/RQ**
AT2CASE	Hard transport protective case for **AT-2000R/RQ**

Accessories

A.C. Charger/Power Supply

Depending on the application, one of two battery chargers may be supplied. For 120 VAC applications, the power supply/battery charger is rated at 120 VAC, 50/60 Hz primary and 12 VDC at 2.0 Amperes. For 220/240 VAC applications, the power supply/battery charger is rated at 240 VAC, 50 Hz primary and 12 VDC at 2.0 Amperes. Using a power supplies/chargers with a lesser or greater rating may damage the power supply/battery charger and the Model **AT-2000R/RQ**. Please contact Avantron if you need to power the AT-2000R/RQ from other than an already approved source.

CAUTION:

The external power jack can receive power either from the provided Power Supply/Battery Charger or the DC vehicle cord. The Power Supply/Battery Charger is capable of supplying sufficient current to both power the unit and charge the battery (the charge time will be lengthened if the unit is operating). The DC external power source (vehicle battery) should be capable of providing a minimum of 2 Amperes at 12 VDC. Due to the nature of the power supplies and battery charger in the unit, an input voltage below 12 VDC can draw excessive current and damage the internal circuitry. The (3A) three Ampere fuse in the DC vehicle cord will prevent damage to the Model AT-2000R/RQ. Any attempts to power the Model AT-2000R/RQ from an external power source other than the provided Power Supply/ Battery Charger or the provided DC power cord may result in poor operation or damage to the Model AT-2000R/RQ.

Receiving & Unpacking

The Model **AT-2000R/RQ** Spectrum Analyzer is carefully packed at the factory, using a specially designed shipping container, to prevent damage during transit.

The shipping container must be inspected prior to accepting delivery. If any exterior damages are present, notify the transport carrier immediately. Avantron is not responsible for damage caused during shipping.

Carefully open the shipping container without destroying it. Remove the equipment and once again, inspect it for damage. Test the **AT-2000R/RQ** operation using the procedure listed in the ***INITIAL CHECKOUT*** section. If damage or defects are discovered, notify your Avantron representative for instructions on how to proceed. If the equipment has to be returned to an Authorised Avantron Service Center, carefully repackage it in the original shipping container.

The original Avantron shipping container and packing materials should be saved for possible future use, they are useful for long term storage, and protecting the equipment if the analyzer must be moved long distances.

Warranty Information

AVANTRON products are warranted against defects in materials and workmanship for a period of 2 years from date of sale. AVANTRON agrees to repair or replace any assembly or component found to be defective under normal use during this period. The obligation under this warranty is limited solely to repairing the instrument which proves to be defective within the scope of the warranty when returned to the factory. Transport costs to the factory is to be prepaid by the customer.

AVANTRON assumes no liability for secondary charges or consequential damages and, in any event, AVANTRON's liability for breach of contract, shall not exceed the purchase price of the products shipped and against which a claim is made.

Any application recommendation made by AVANTRON for the use of its products are based upon tests believed to be reliable and accurate, but AVANTRON makes no warranty for the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorised to represent or assume for AVANTRON any liability in connection with the sale of our products other than set forth herein.

Repairs and/or calibration is typically completed in 5 to 10 working days. Shipping costs are paid by the factory only when returning equipment to a customer following warranty repair. It is the responsibility the customer to notify the factory technical support persons prior to shipping products for servicing, since many times problems may be solved over the telephone, saving the user more precious time and shipping costs. AVANTRON maintains regular office hours from 8:00 AM to 5:00 PM eastern time, Monday through Friday. A toll free 800 number and e-mail address for technical and sales support are provided below:

North America Toll Free: (800) 297-9726
E-mail address for Sales or Technical Support: info@avantron.com

Typical warranty on our products covers all parts and labour, as well as software and required hardware updates. The warranty period starts from the day the equipment is delivered, however, AVANTRON extends a grace period of 60 days after the end of the official warranty period to cover any contingencies. Please note that the warranty period for rechargeable batteries is three months.

Getting Started

Initial Checkout

The Model **AT-2000R/RQ** Spectrum Analyzer was inspected, and passed all final operational and quality control tests prior to being carefully packed for shipment. The **AT-2000R/RQ** should be activated as soon as possible after receipt, to verify that it operates in accordance with the specifications listed in this above manual.

The default settings when shipped from the factory are the following;

Mode:	Spectrum Analyzer
Span:	Full span (5MHz-1GHz)
Resolution Bandwidth:	1MHz
Sweep Time:	30 milliseconds
Amplitude:	30 dB of input attenuation.

To check out the operation of the Spectrum Analyzer, follow these steps:

1. Turn the unit on.
2. When the unit has passed it's initial self-test and calibration, it will display the spectrum analyzer screen with the factory set defaults. (see above).
3. If the unit finds an error in the self test it will display error messages on the screen during the boot-up sequence.
4. If the main electronics passed the boot-up self test but there is an RF error in self calibration, then the **AT-2000R/RQ** will display a "uncal" message below the Avantron logo at the bottom left corner of the screen.
5. Press **[MENU]** the time, date, temperature and battery voltage will display across the top of the screen.
6. Using the Rotary Knob or Arrow Keys, select the FREQUENCY COUNTER function (Single Carrier mode) and apply a stable CW RF signal of known frequency and level, such as 40 MHz. @ +10 dBmV .
7. Press **[ENTER↵]** to activate the frequency counter.
8. Verify that the frequency and level displayed is precise.
9. If the frequency and level is correct, the **AT-2000R/RQ** is functioning normally.

Understanding the AT-2000R/RQ

This section will help you to become familiar with the front panel keys and the general operation of the Model **AT-2000R/RQ**. You will find detailed description of the front panel and an explanation on the use of features.

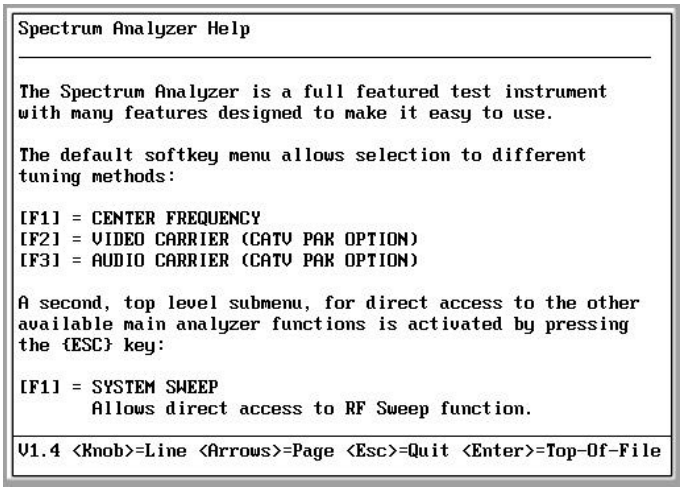
AutoCalibration

The **AT-2000R/RQ** automatically calibrates itself to the current ambient temperature, and then monitors that temperature as the testing is completed. It is fully calibrated to traceable standards and includes built in computer generated calibration data in non-volatile memory.

AT-2000R/RQ's On-Line Help

Context related help screens can be called up any time during the operation of the instrument. This feature offers the user an operators handbook at the touch of a finger.

When performing tests in a particular mode, the **HELP** system is continuously available to assist the user with step by step instructions. Throughout the operation of the **AT-2000R/RQ**, the **HELP** system can offer tips and reminders as well as detailed descriptions of each menu function.



To access help, select the **[HELP?]** function key. The spin knob scrolls the text line-by-line, while the arrow keys scroll page-by-page. The **[ENTER ↵]** key allows you to return to the start of the text. Press **[ESC]** to end **HELP?** and return to the previous mode of operation.

Front-Panel Keys

Menu Keys

The blue keys labelled FREQ, SPAN, AMPL are all examples of front-panel keys which access menus of functions that are displayed along the right side of the display. These menus are called soft-key menus.

Figure 1 - Model **AT-2000R/RQ**

Soft-Keys

The soft-keys are the six push buttons arranged vertically and located on the right side of the colour LCD screen. The function for each key corresponds to the description displayed on the on screen menu along the right. The soft-key menu, which will vary depending on the test mode of the analyzer and will allow for certain changes, such as for different levels of testing or options within the selected mode. Depending on the selected mode of operation, some of the soft-keys will also permit direct access to other test modes without the necessity of returning to the main menu, as a time saving feature. Although the soft-key function keys are not labelled, these keys are also known as F1 (top key) to F6 (bottom key).

Key Description (Push Buttons)

POWER - Use to turn the unit's power on or off.

MENU

MENU - Access Main Menu screen. Provides direct access to various test options and setup functions.

FREQ

FREQUENCY - Accesses frequency tuning either by entering frequency direct (MHz), using the video or audio channel number.

SPAN

SPAN - Access variable span, resolution bandwidth (RBW) ,and sweep time (SW) settings.

AMPL

AMPLITUDE - Access amplitude related functions; Attenuator, Reference Level, Vertical Scale and Reference Offset.

MARK

MARKERS - Access horizontal and vertical markers for indicating level and frequency references. Also activates dB/Hz function .

TRACE

TRACE - Access signal processing functions; digital average 1, digital average 2, Peak Hold or No Average.

PREV MODE

PREVIOUS MODE - Allows to return to the previous measurement mode and instrument settings.

1 QZ# 2 ABC 3 DEF
4 GHI 5 JKL 6 MNO
7 PRS 8 TUV 9 WXY
± 0 SPACE ,

ALPHA NUMERIC KEYS - Use alpha-numeric keys for entering frequency, channel, span, etc. If an entry from the numeric keypad does not coincide with an allowed function value, the analyzer defaults to the nearest allowable value.

FUNCTION

FUNCTION KEY - Located to the right of LCD display provides soft-key menu selections. Top key is [F1] to bottom [F6]

STORE

STORE - Press to store test data or the instrument setup. Store documented measurements and trace records in non-volatile memory for later viewing, printing or transfer to PC compatible computer..

RECALL

RECALL - Press to access RECALL menu and select [F1] RECALL RECORDS to retrieve stored records for viewing, printing or superimpose on live trace for comparing. Press [F2] RECALL SETTINGS to activate previously stored instrument setups.

PRESET

PRESET - Press to clear current instrument settings and return to factory default settings.

HELP ?

HELP - Access context related help screens which can be viewed during the operation of the instrument

PRINT

PRINT - Press to print the screen's contents directly to a parallel type printer. You may choose Epson compatible or HP Laserjet™ compatible print driver modes in the setup parameters.

COMM

COMMUNICATIONS - This function key enables the built-in communications software to download and upload files , by using a standard RS-232C connection.

ESC

ESCAPE - Press to back out of menu or soft-key function selections.

MEM +

MEMORY + Allows operator to temporarily store a screen trace in a temporary memory. You may use to compare a live trace to the one in temporary memory. This trace may also may be saved **STORE** volatile memory, if desired by using the key.

MEM C

MEMORY CLEAR - Used to clear the trace in temporary memory , or one that was recalled, and removes it from the screen display.

BKSP

BACKSPACE Press within a keyboard command to delete or correct preceding characters.

ENTER ↵

ENTER - This key is used to confirm and save all entries or commands.

CURSOR - Up Arrow key moves items upwards or towards the right hand side.

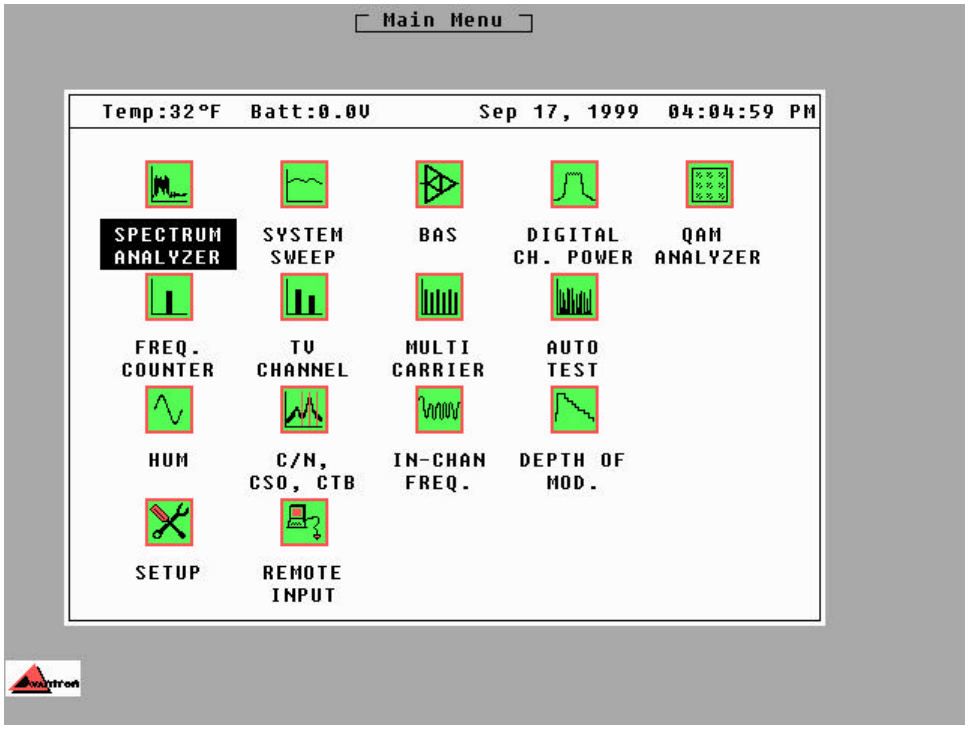
CURSOR - Down Arrow key moves items downwards or towards the left hand side.

KNOB - The rotary spin knob allows continuous change of values of many functions that change in increments only such as center frequency, reference level, and marker position. Clockwise rotation of knob increases values.

Main Menu - Software Functions

The **[MENU]** key accesses the Model **AT-2000R/RQ** Main Menu screen. In the center of the screen are icons with text description for each available function mode and selected for direct access to various test options and setup functions. The rotary spin knob or the arrow keys may be used to scroll through the icons and use the **[ENTER↵]** key to select the function.

At the top left of the screen the display shows the external Temperature in degrees Celsius or Fahrenheit, depending on the selection of US or International settings in Date/Time parameters. The battery voltage is displayed at the top center of the screen. The day/date and time are displayed at the top right of the screen.



Standard Functions and Icons

Spectrum Analyzer
Full function 1 to 1 GHz Spectrum Analysis

Freq. Counter
Allows the selected center frequency to be measured with better than 1kHz precision. The Amplitude in dBmV is also displayed.

Setup
Allows the user to upload either stored Records Database file or a choice of several other configuration files (Channel Plans, Colors etc…) to the Avantron Model **AT-2000R/RQ** spectrum analyzers.

Remote
Allows the user to download or retrieve either Records Database file or a choice of several other configuration files (Channel Plans, Colors etc…) from the Avantron Model **AT-2000R/RQ** spectrum analyzers for storage on the PC.

Optional Functions and Icons

System Sweep
Used in conjunction with Avantron's Digital safe, Low-Level Non-Interfering Sweep System provides the user with a true view of broadband frequency response. (SWP option)

BAS
Activates internal BAS telemetry receiver for bi-directional system alignment. Functions with Avantron Model **AT-BAS-1 -** Headend Bi-directional Alignment System

Digital Ch. Power
The average power of digitally modulated carriers such as 64 and 256 QAM can be easily and accurately measured. This function supports the latest digital technologies and is simple to use, allowing you to set center frequency and channel bandwidth.

QAM Analyzer
The built-in digital demodulator makes it possible to measure in-service 64/256 QAM digital signals. Displays Constellation with zoom capabilities, Adaptive Equalizer Display, Pre and Post Bit Error Rate (BER), Modulation Error Ratio (MER), Error Vector Magnitude (EVM)

Optional CATVPAK Functions and Icons

TV Channel
Allows the selected TV Channel to be measured with better than 200Hz resolution. The Amplitude in dB is also displayed.

Multi-Carrier
The display allows quick RF amplifier setup by scanning up to 6 user selected reference carriers. The markers function in this mode and can be used to measure deltas in level. This is a convenient feature to determine RF amplifier tilt (slope) and gain settings.

Auto Test
Allows the selected tagged Channels listed in the active channel lineup to be measured with better than 200Hz resolution. The Amplitude in dBmV is also displayed.

Hum
Allows the Hum Modulation Distortion to be measured. Result is in peak to peak percent and dBc (decibels below carrier level).

C/N, CSO, CTB
This unique TEST option is a feature that integrates 3 measurements into one. C/N, CTB and CSO are performed separately or simultaneously combined to reduce the number of signal interruptions on a CATV system. This feature is very practical and useful for FCC type proof-of-performance testing.

In-Channel Freq.
In-Channel Frequency Response are measured quickly, accurately and in-service using multiburst test signal in VITS lines of a video channel.

Depth of Mod.
The video depth of modulation screen provides percent modulation in both graphical and precise numeric format. Test signals transmitted on the VITS of program video provides a standard to calibrate the video depth of modulation.

Basic AT-2000R/RQ Functions

Default Instrument Settings

Preset

The light-grey with red lettering **[PRESET]** key resets the **AT-2000R/RQ** to a known default state.

The Model **AT-2000R/RQ** is factory set to default to the Spectrum Analyzer mode with full span (1000 MHz), Resolution Bandwidth of 1 MHz, Sweep Time of 30 ms and 30 dB of input attenuation.

Storing To Memory

Microprocessor power adds expanded storage capabilities. Measurements, traces and instrument settings are stored as records in non-volatile memory for later viewing, printing or transferring to PC compatible computer.

Ease-of-use and time saving being a primary objective, the Model **AT-2000R/RQ** allows you to store measurement records as well as instrument settings. Up to 100 measurement records and 64 instrument settings can be stored and later selected from the RECALL RECORDS or RECALL SETTINGS directory listing when needed.

By storing and recalling measurement and/or instrument test settings, time savings can be realised by the test and maintenance personnel. This time savings directly translates to cost savings and therefore, the equipment will tend to pay for itself, more quickly with improved staff efficiency.

Store Records

The STORE interface is simplified by reducing the number of keystrokes required to store a measurement. A SITE ID and COMMENT field has been provided so that the user can enter specific information which will be saved along with the measurement results records. To store the record simply press the **[STORE]** key on front panel and then from the on screen menu select the **STORE RECORDS** (F1) function. Give this record a unique ID (8 char. max.),

by using the alphanumeric keypad (or optional keyboard, if unit has been installed with this option). After entering your ID press the **[ENTER↵]** key, at this point a comment box will appear where you can enter some additional information (max. 40 char.).

Each stored record will contain full front panel settings and information that was entered in the ID and COMMENT fields, as well as time, date, external temperature, user ID, and last calibration date. The stored records can be accessed by using the **[RECALL]** key on the front panel and selecting from the on screen menu **RECALL RECORDS** (F1).

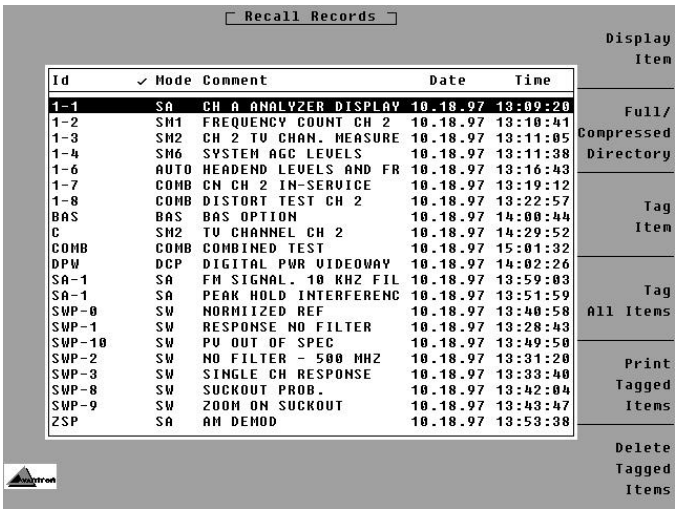
Store Settings

Complete Model **AT-2000R/RQ** instrument settings may be stored. Storing settings is very simple. Set up the instrument to make the desired test with the desired frequency or channel position along with span, attenuator settings, bandwidth adjustment etc. necessary to make the specific measurement and store those settings by pressing the **[STORE]** key, and then from the on screen menu select the **STORE SETTINGS** (F2) function. Give this setting a unique ID (8 char. max.), by using the alphanumeric keypad (or optional keyboard, if unit has been installed with this option). After entering your ID press the **[ENTER↵]** key, at this point a comment box will appear where you can enter some additional information (max. 40 char.).

Each stored setting will contain full front panel settings, and information entered in the ID and COMMENT fields, as well as the time and date. The stored settings can be accessed by using the **[RECALL]** key on the front panel and selecting from the on screen menu **RECALL SETTINGS** (F2).

Selecting a stored setting instantly prepares the Avantron for a specific measurement. This feature simplifies repetitive measurements and can assist in creating company wide standards for individual measurements being performed by various users.

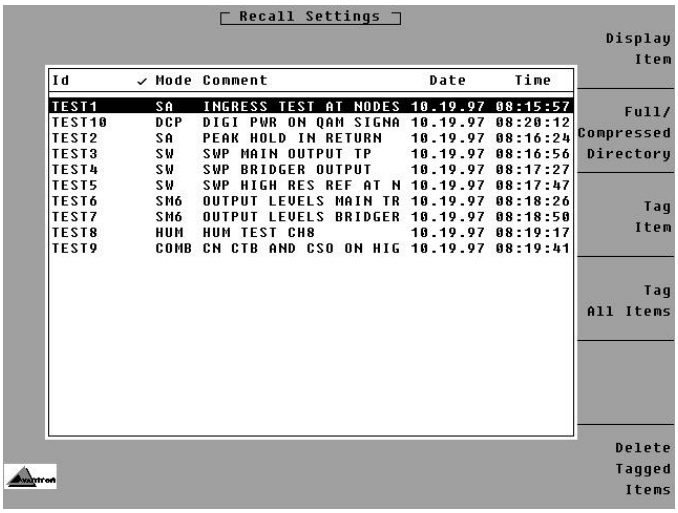
Recall Stored Records



To recall any stored record for viewing and printing, access the **RECALL RECORDS** directory, by pressing the **[RECALL]** key on the front panel and from the on screen menu select **RECALL RECORDS** (F1) then use the spin knob or arrow keys (Pg Dn↓ - Pg Up↑) to scroll through the stored records in the directory, as well as any that may have been compressed.

To view a record on the screen, select **DISPLAY ITEM** (F1). Records that were stored using the *AUTOTEST* (ATCATVPAK option required) function on the Main Menu can be recalled on screen and scanned channel by channel. To view the results of each signal carrier, select **EXPLORER** (F5) from the on screen menu and use either the spin knob or arrow keys to scroll through the information.

Recall Stored Settings



Recalling settings is just as easy as storing them. You may select them by pressing the **[RECALL]** key and then by selecting **RECALL SETTINGS** [F2]. The various settings are indicated by their user defined alphanumeric designations and may be recalled simply by highlighting them with the spin knob or arrow keys and then pressing the **[ENTER↵]** key. If **Display Item** (F1) is pressed then only the settings parameters will be displayed.

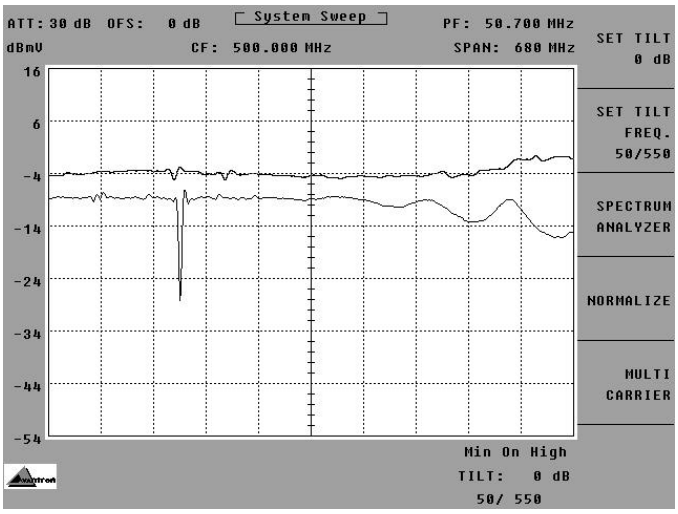
Recalling a stored setting instantly prepares the Model **AT-2000R/RQ** with the exact same previously stored settings such as Attenuator, Span, Frequency etc…

If there are many settings or records stored using the same site **ID** name, it won't take long before the on screen directory fills up. One way to help minimise this, is to select this function from the on screen menu **Full / Compressed Directory** (F2). What this does, is that it displays only the first item of all identical **ID's.** As an example, if there were ten tests performed under one **ID**, instead of showing all ten, only the first will appear, if this function is used. This allows to display more of a variety of records or settings. To de-compress just press (F2), and all will be displayed on the screen. To scroll through files on screen use the spin knob for other pages use arrow keys (Pg Dn↓ - Pg Up↑).

Superimpose On A Live Trace

The **AT-2000R/RQ** allows a stored trace to be Recalled and superimposed on a live trace for comparing. This powerful feature is extremely helpful when aligning the system response and analysing different RF signatures.

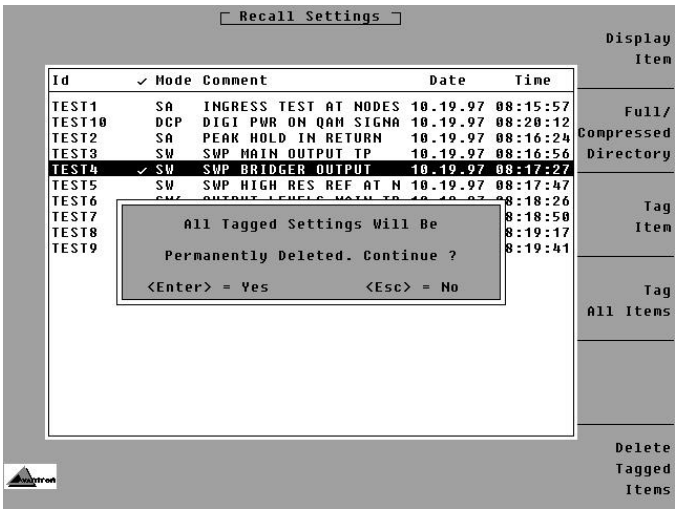
The Recall/Superimpose function will work in all the **AT-2000R/RQ** operating modes. The superimposed trace will appear in a specific colour on the screen.



To superimpose a trace, press on the **[RECALL]** key on the front panel and then from the on screen menu select **RECALL RECORDS** (F1). Using either the spin knob or arrow keys (Pg Dn↓ - Pg bUp↑) you can scroll through the records and select the proper trace to be displayed. With the trace highlighted press the **[ENTER↵]** key to display. To clear the superimposed trace simply press the light blue **[MEM C]** key on front panel.

Erasing Records And Settings

Stored records or settings that are no longer needed or that have been transferred or printed, should be erased to free up memory for adding new records. To delete only a few records, use the spin knob to scroll through the on screen records or the arrow keys (Pg Up ↑- Pg Dn ↓) to access records on the other pages. Tag the highlighted record by selecting from the on screen menu **Tag Item** (F3) key. If you wish to delete all records from memory, select from the on screen menu **Tag All Items** (F4)



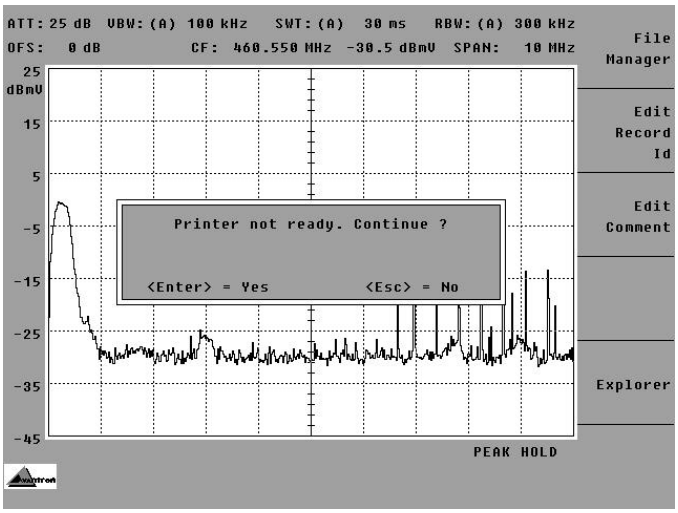
A prompt will question you (Do You Wish to Delete All Tagged Records?). Press[ENTER ↵] **to continue or** [ESC] **to cancel the operation. A second prompt will confirm that (All Tagged Records Will Be Permanently Deleted. Continue?), you now have one last chance to press**[ESC] **to cancel operation or** [ENTER ↵] **will continue and delete tagged items.**

Printing

Printing Reports And Screens

Documenting CATV proof of performance testing using the Model **AT-2000R/RQ**.

The **AT-2000R/RQ** supports 2 printer drivers, a standard EPSON compatible, which works well with most types of dot matrix and ink jet printers. The second driver is for laser printers emulating the



HP Laser standard. For printer selection see section **4.2 User Parameters – Printer Type (Epson/HP).**

Connecting the **AT-2000R/RQ** to a compatible printer is simple. Simply connect a printer cable to the 25 pin connector port, which is located on front panel behind the drop down door, and the printer. Some printers may not function properly.

Print Screen Method

This method is convenient if only a few traces are to be printed at any one time. To print the screen all that has to be done is to press the **[PRINT]** key. An error message will appear if there are any problems either with the printer configuration or cable connection. If a message (fig. 8) does appear please verify if proper printer was selected.

Print Multiple Records

To use this method, you will first have to access the records. Access to the records is by pressing the **[RECALL]** key on the front panel. From the on screen menu, choose **RECALL RECORDS** (F1). Using the spin knob to scroll through the records that are on the screen, or by using the arrow keys (Pg Dn↓ - Pg Up↑) to access other pages. Tag the ones you want to print by pressing the **Tag Item** (F3) key, or by pressing the **Tag All Items** (F4) key all the stored records will be printed when the **Print Tagged Items** (F5) key is pressed. If a message (fig. 8) does appear please verify if proper printer was selected.

Documentation is a critical step for proof-of-performance or FCC Testing and Compliance. CATV Systems are required to maintain a copy of the proof-of-performance results in a FCC public inspection file for five years. In addition to the data from all required tests and test procedures used, proof-of-performance documentation must include all pertinent information about the test equipment being used for the measurements. The Avantron report headers have been designed to include the model and serial number, last factory calibration date of the instrument as well as the all basic information such as DATE, TIME, TEMPERATURE, COMPANY NAME and USER NAME..

Data Communication

COMM - RS-232 Serial Interface

The Model **AT-2000R/RQ** has a standard RS232 communications serial port interface. A 9 pin "D" type connector is located in the front panel connector compartment, behind the drop down door.

Activating the **[COMM]** function will set the Model **AT-2000R/RQ** as a file server, allowing you to access the contents of the non-volatile memory as if it were a disk drive on a PC. Avantron's software must be installed on a PC and executed before communications can be made with the **AT-2000R/RQ** through a standard null modem cable.

When the transfer has been completed, press the **[ESC]** key to exit the server mode and return the **AT-2000R/RQ** to the normal mode of operation. The maximum rate for serial communications is 57,600 baud.

This manual covers the Model **AT-2000R/RQ** functions and operation only. Consult the documentation accompanying the Avantron software for more information on using serial communications features.

Upgrading Firmware

WinCom features a function that simplifies the process of upgrading your Avantron 2000 series instruments. By pressing the **Comm** function button on the keypad will put the **AT-2000R/RQ** in communication mode.

Avantron provides firmware update files on disk or they can downloaded from our web site at www.avantron.com. A password is required to access the download section that is obtained by contacting Avantron customer support.

The firmware file has the extension **".udf"**. When **Upgrade Firmware** is selected from the communications menu, a dialog box will appear and you select location of the firmware file and double-click on it to start the upgrade procedure.

AT-2000R/RQ User Files

The following files are formats available on Avantron **AT-2000R/RQ** spectrum analyzer products. All instrument files have the "**.bin**" file extension and can be downloaded or uploaded to and from the instruments. Below is a short description of each file and its purpose.

Records.bin
This is the database where all measurement records and traces are stored.

Settings.bin
The settings database contains stored instrument setups. Using the same settings files are multiple units helps speed up measurements in the field and provides some consistency on the measurements even though they are done by different technicians each using their own **AT-2000R/RQ** spectrum analyzer.

Plans.bin
Contains channel plans for NTSC, PAL or other world standards.

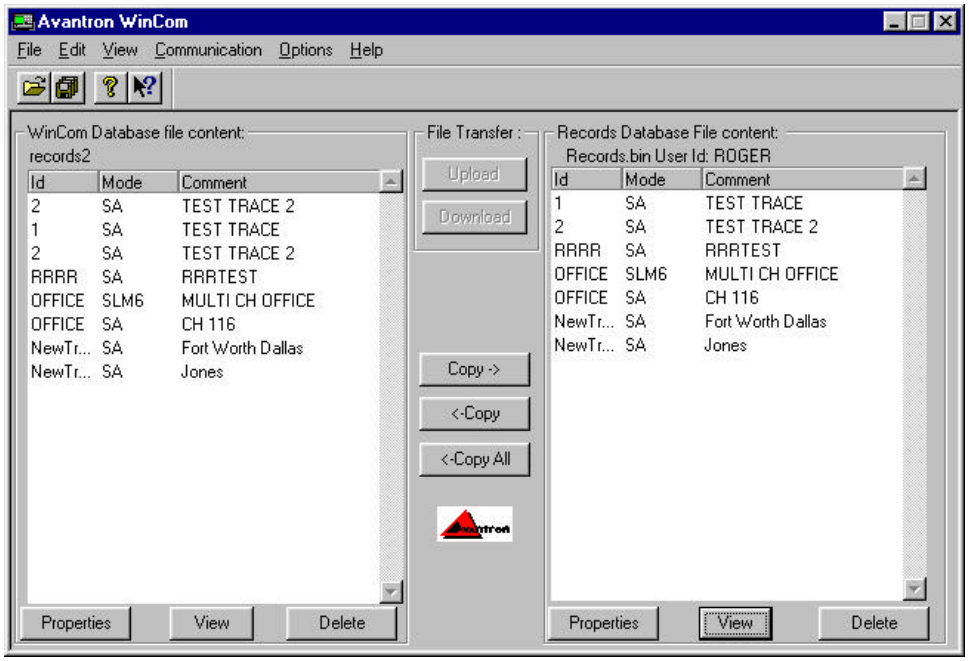
Colors.bin
This file that contains the customized color settings used on the Avantron **AT-2000R/RQ** spectrum analyzer.

Param.bin
This file contains user preferences on Avantron **AT-2000R/RQ** spectrum analyzer.

Avantron WinCom for Windows

To use **Avantron WinCom**, you must retrieve a Records Database file which can then be transferred to a **WinCom** Database, a PC based database file. Retrieving measurement data from Avantron instruments requires that you establish a communication connection with an Avantron Model **AT-2000R/RQ** spectrum analyzer.

A Records Database file is where you store your measurement data information on an Avantron instrument and is limited to 100 records or traces. A **WinCom** Database is a Windows PC based file that supports unlimited number of records or traces. The information that you record about your measurement traces includes date, time, instrument serial number, user name, company name, temperature, instrument calibration date etc…



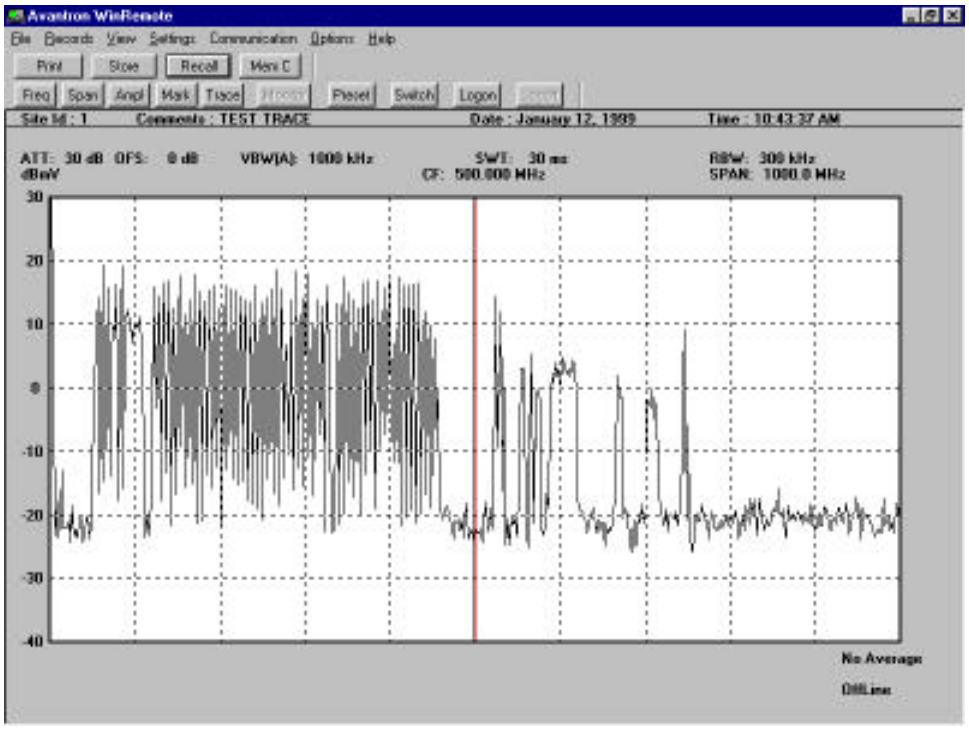
Avantron WinRemote for Windows

The Avantron **WinRemote** software was designed to help you take full advantage of the measurement capabilities of the Avantron 2000 series spectrum analyzer products.

The Avantron **WinRemote** gives you remote control spectrum analyzer access to the **AT-2000R/RQ** spectrum analyzer units. With the Avantron **WinRemote** you can fully control the spectrum analyzer functions such as center frequency, span, resolution bandwidth settings etc…

Operation has been kept similar to the operation of the Avantron **AT-2000R/RQ** spectrum analyzer whenever it was possible. If you know how to operate your Avantron **AT-2000R**/RQ spectrum analyzer, you know how to use the Avantron **WinRemote**.

Avantron **WinRemote** will allow you to store and view record traces, and also export the measurement data to the Windows clipboard (in BMP format). Avantron **WinRemote** capabilities make it easy to display and analyze information on your PC. After collecting the data, the Avantron **WinRemote** enables you to analyze and print the measurement traces.



Ethernet 10BASE-T Interface - RJ-45 (Optional)

Configuring IP Address

When delivered with the Ethernet option, every 2000 series analyzer has a pre-configured default IP Address. This IP Address is **192.0.1.200**.

When using a 2000 series analyzer in a Network without a gateway, it is necessary to configure it's IP Address to have the same base address as the Network.

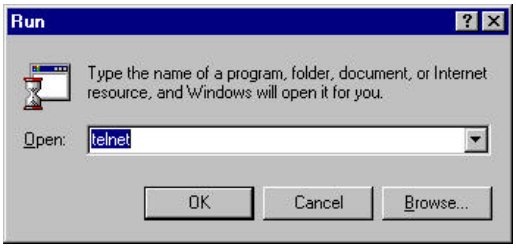
Here are the steps to follow to modify the IP Address of the **AT-2000R/RQ** spectrum analyzer:

1. Connect the analyzer to one of your hubs or directly to your PC's network card with an inverted RJ45 cable.

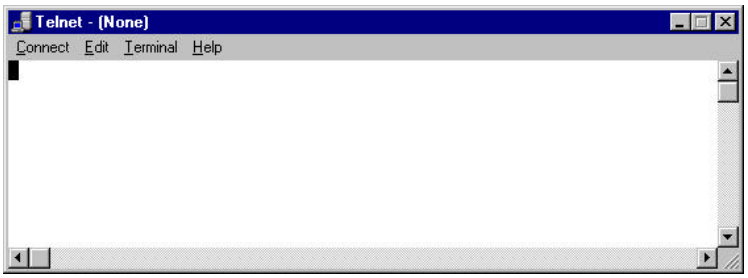
2. Configure your computer on the same hub or with the direct inverted cable to have the same base address as the analyzer, but to have a different IP Address. For example, you can use the Address 192.0.1.10

3. From the start menu, select RUN

4. Type telnet in the dialog box, as shown below.

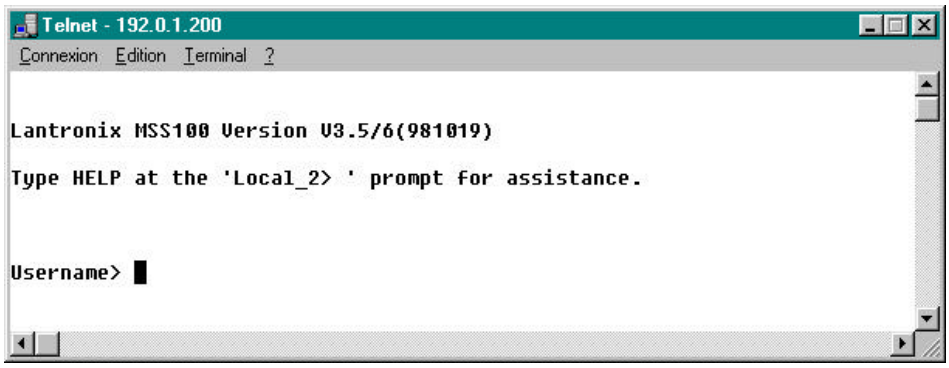


5. Click ok. The telnet program and it will open. Looking like the figure below.



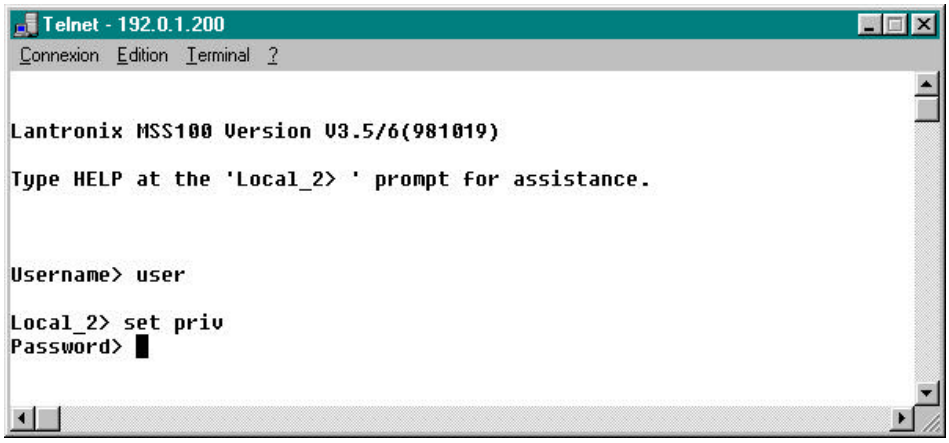
6. Select Connect-> Remote System from the menu, The following dialog box should appear.

7. Type in the default IP address of the **AT-2000R/RQ** spectrum analyzer (192.0.1.200) and click Connect. The following screen will appear.



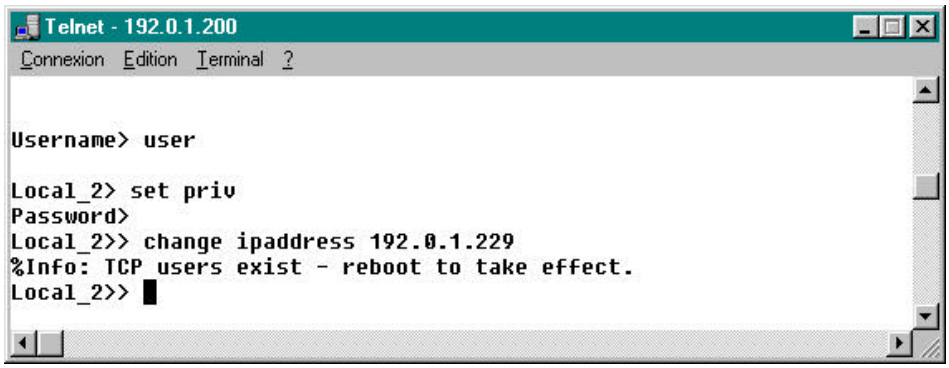
8. Type in any username, the name is not important, in the next screen, you will see we typed the name **"user"**.

9. Type the command **"set priv"** which will enable you to configure the Network Interface card of the **AT-2000R/RQ**. The screen should now look like the one shown below.



10. At the password prompt, enter the default configuration password, which is "system". The password will not be echoed on screen. After the password will have been entered, the command prompt should change from a single > to a double >>, as shown below :

11. You are now authorised to change the Network Interface card settings. Enter the command **"change ipaddress** [IP address]" where [IP address] will be the new IP Address of the **AT-2000R/RQ**. In the example below, the IP Address was changed to **192.0.1.229**



As noted on screen, the IP address will be changed only upon rebooting the **AT-2000R/RQ**.

Other TCP/IP Parameters

In order to provide complete flexibility to introduce your **AT-2000R/RQ** Spectrum analyzer in your network, there are a few other parameters the user has access to via TELNET as described below.

Subnet Mask: This mask allows the server to decide at connection time whether a given TCP/IP host is part of the local network segment so that packets can be

routed properly. A default subnet mask is created automatically when the IP address is configured, but can be overridden. **EX: CHANGE SUBNET MASK 255.255.255.0**

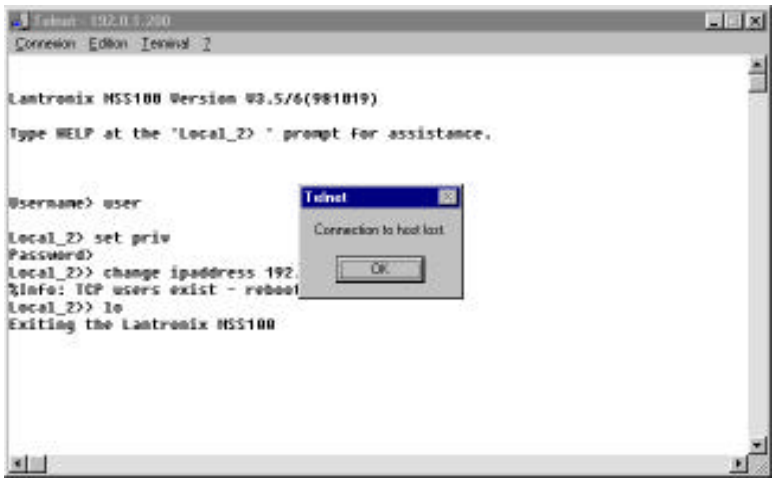
Name Resolution: Hosts on TCP/IP networks generally have a text hostname and a numeric IP address. The network interface module of the 2000 series analyzer can resolve text host names into the numeric equivalents needed for most connections, provided that a DNS (domain name server) has been configured. **EX: CHANGE NAMESERVER 192.0.1.167**

A default **domain name** can also be configured for the purpose of name resolution. When a user types a host name, the network interface module will add the domain name and attempt the connection. **EX: CHANGE DOMAIN "badger.incorp.com"**

Gateway: TCP/IP networks rely on gateways to transfer network traffic to hosts on other networks. The network interface module will learn which hosts are gateways for the local network by listening to broadcasted IP routing packets, or it can be explicitly told which hosts are gateways. **EX: CHANGE GATEWAY 192.0.0.66.**

Once all of your parameters have been entered, follow the steps below.

1. Enter the Command **"lo"** (Logout). The following screen should appear



2. Reboot the **AT-2000R/RQ** by switching it off for at least 30 seconds.

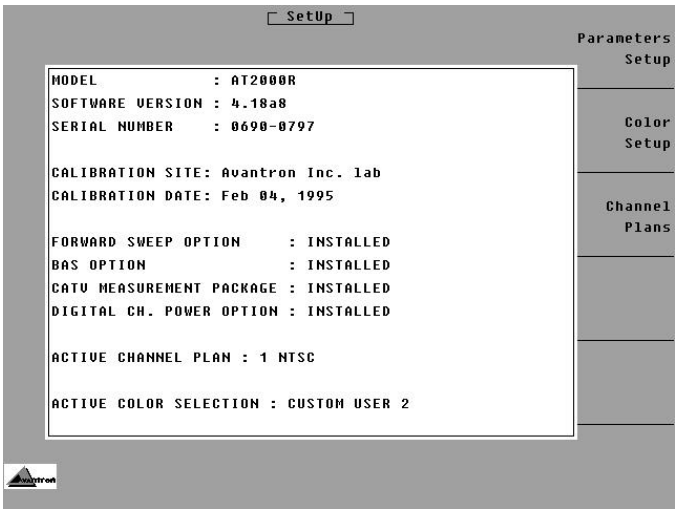
3. Don't forget to set the same IP address settings of the PC computer being used to communicate with the **AT-2000R/RQ.**

Setup - User Preferences

The Model **AT-2000R/RQ** initial settings can be customised according to individual user requirements. The two main items that are user-defined are system [F1] **PARAMETERS**, and screen display [F2] **COLORS**. If the optional CATV MEASUREMENT PAK is installed, a third item will appear in the SETUP mode, [F3] **CHANNEL PLANS**. Access to SETUP is done from the MAIN MENU. If not already in the **MAIN MENU** simply press the **[MENU]** key on the front panel, and select **SETUP**. The **SETUP** screen will then appear (fig. 9).

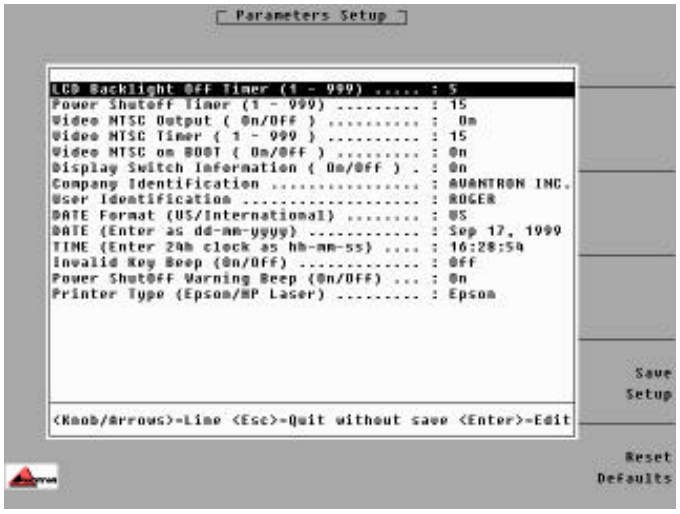
Set-up Screen

The SETUP screen displays important information about your Model **AT-2000R/RQ,** such as Model and Serial numbers, software version, calibration date and time as well as all installed options. Additional information includes certain user preferences such as the active channel plan (optional CATV PAK required) and the active colour setting.



User Parameters

The Model **AT-2000R/RQ** has many user-defined preferences known as PARAMETERS. To change any of the parameters, scroll through the menu using the spin knob, when the desired parameter is highlighted press **[ENTER↵]**, this will allow you to make the necessary changes. After you have terminated, simply choose from the on screen menu **Save Setup** (F5) to store the parameters. The PARAMETER screen displays information about the preferences set on the Model **AT-2000R/RQ** such as LCD Power Down Delay and Power Off delay, Beep On/Off preferences as well as the type of printer driver and date format selected.



LCD Backlight off Timer:
Set LCD power down delay time in minutes. Enter 999 to disable the feature. The LCD power down feature conserves battery power. (DEFAULT VALUE IS 5 MINUTES)

Power off Timer:
Set Power off delay time in minutes. Enter 999 to disable the feature. The Power off feature helps conserve battery charge by powering off the Model **AT-2000R/RQ**. All active settings are saved during Power Off so that when the unit is powered on again, the settings are exactly the same as when it powered off. You may continue to operate the unit by pressing any key or rotating the knob in either direction, thus restarting the countdown. The countdown is automatically reset at any key press or knob rotation. (DEFAULT VALUE IS 15 MINUTES)

Video NTSC Output (On/Off):
Turn On or Off the Video NTSC output.

Video NTSC Timer :
Set Video NTSC output off delay time in minutes.

Video NTSC on Boot (On/Off):
Set Video NTSC output in the ON position when unit starts up (boots)

Display Switch Information (On/Off):
For use in remote control applications which use a testpoint switch controled by the **AT-2000R/RQ**. This option shows the information regarding the switch position live on screen.

Company Identification:
Enter your company name in alphanumeric characters via the keypad. Maximum 30 characters.

User Identification:
Enter your name in alphanumeric characters via the keypad. Maximum 30 characters.

Date Format:
Toggle between International or US date and time format. Depending on the selection of US or International settings, the Temperature in the MAIN MENU screen will display in degrees Celsius (INTERNATIONAL) or Fahrenheit (US).

Date:
Set current date on internal clock/calendar (MMDDYY). Unit is year 2000 (**Y2K)** compliant.

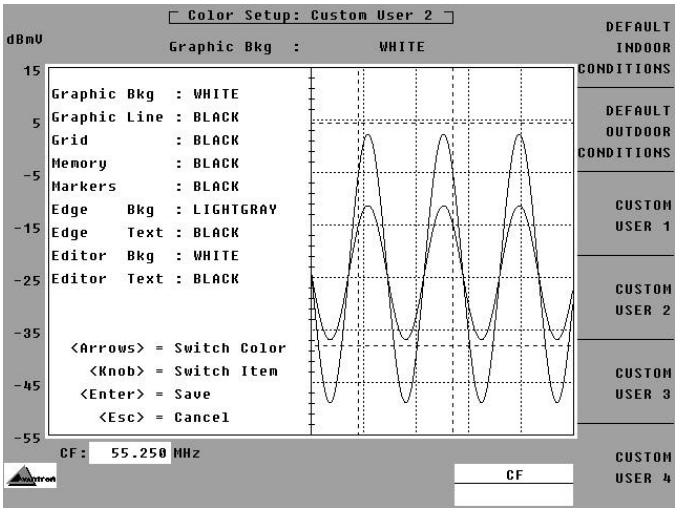
Time:
Set current time on internal clock/calendar (HHMMSS).

Invalid Key Beep (On/Off):
A warning beep sounds when an invalid key is pressed, if activated (ON).

Power Off Beep (On/Off):
A warning beep sounds when the timer initiates the shutdown process, if active. This allows the user to ignore the warning and let the unit auto shut down or to intervene by pressing a key to restart the timer and continue operation.

Printer Type (Epson/Hp):
Toggle between an Epson compatible printer driver and a HP LaserJet™ print driver.

Custom Screen Colours



The Model **AT-2000R/RQ** has an excellent colour TFT active matrix LCD screen display. Unlike CRT displays, this type of LCD panel has distinct advantages. It remains in perfect focus while displaying exceptional detail on a 640 x 480-pixel display. The recessed polarised screen is bright and clear and is viewable even in direct sunlight.

The added value of colour makes using your Model **AT-2000R/RQ** much easier to use since individual components of the screen colours can be customised.

The COLOR SETUP screen shows the 9 components of the screen in which the colour can be edited. Graphic Background, Graphic Line, Grid, Memory, Markers, Edge Background, Edge Text, Editor Background and Editor Text.

The soft-key menu on the right of the screen includes [F1] **DEFAULT 1** and [F2] **DEFAULT 2**. You can create 4 customised USER colour settings by pressing [F3] **USER 1** to [F6] **USER 4.** Use the spin-knob to select the desired item that you want to edit and use the arrow keys to select the desired colour for that item. When all item colours have been chosen, press **[ENTER↵]** to save and exit the **COLOR SETUP** mode.

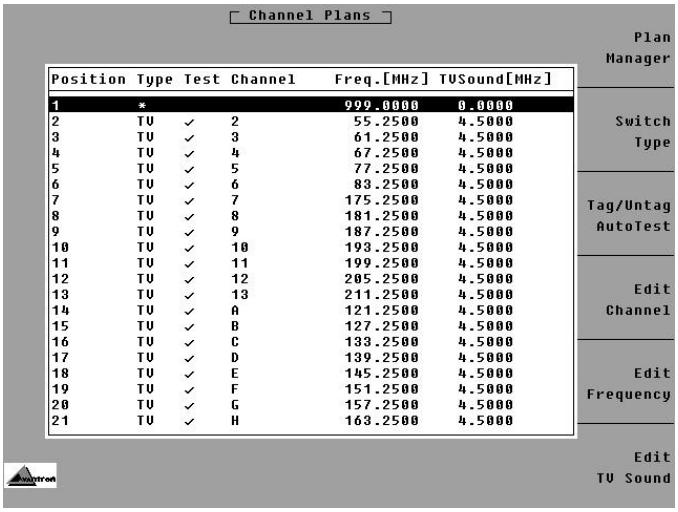
If you wish to exit without saving, press **[ESC]** and a prompt will question (Exit without save?) **[ENTER↵]** will exit the screen, **[ESC]** will allow you to remain in COLOR SETUP mode until you are ready to save set-up and exit.

Channel Plan Set-up

The Channel Plan feature is only available with the optional **CATV MEASUREMENT PAK**. A directory shows 4 separate channel plans that you can edit and customise. Channel Plans are helpful when dealing with multiple CATV headends that have different channel line-ups. From the Channel Plan directory screen, you can also edit the CHANNEL FREQUENCY allocation and NTSC / PAL transmission standards.

Edit Plan

The **CHANNEL PLAN** is used to select the channels to be measured during **AUTOTEST** mode and to permit setting frequency offsets for individual channels.



Position	Type	Test	Channel	Freq.[MHz]	TVSound[MHz]
1	*			999.0000	0.0000
2	TV	✓	2	55.2500	4.5000
3	TV	✓	3	61.2500	4.5000
4	TV	✓	4	67.2500	4.5000
5	TV	✓	5	77.2500	4.5000
6	TV	✓	6	83.2500	4.5000
7	TV	✓	7	175.2500	4.5000
8	TV	✓	8	181.2500	4.5000
9	TV	✓	9	187.2500	4.5000
10	TV	✓	10	193.2500	4.5000
11	TV	✓	11	199.2500	4.5000
12	TV	✓	12	205.2500	4.5000
13	TV	✓	13	211.2500	4.5000
14	TV	✓	A	121.2500	4.5000
15	TV	✓	B	127.2500	4.5000
16	TV	✓	C	133.2500	4.5000
17	TV	✓	D	139.2500	4.5000
18	TV	✓	E	145.2500	4.5000
19	TV	✓	F	151.2500	4.5000
20	TV	✓	G	157.2500	4.5000
21	TV	✓	H	163.2500	4.5000

To access the **Channel Plans** screen go to **MAIN MENU** select **SETUP** and from the on screen menu choose **Channel Plans** (F3). The **TEST** column is used to indicate whether that position will be included in the Auto Test or not. A tag is used to select the channels for the AUTOTEST levels, and frequency measurements. TV and FM channels selected with the Tag will be measured automatically when AUTOTEST is initiated.

Channel tables have the added feature of allowing a user to enter non-standard frequencies such as leakage detector pilot or data carrier etc. There are a number of extra slots for custom user-defined frequencies.

To make changes in the channel line-up or edit frequencies, simply do the following. Access the CHANNEL PLANS screen by selecting from the on screen menu **Channel Plans** (F3) in the SET-UP screen. From the choice of plans select the one that is to be edited, by using the spin knob to scroll through. At this point if the **[ENTER ↵]** key is pressed, you will not be able to edit anything, but instead what you have done is simply select that Channel Plan. To edit, select from the on screen menu **Edit Plan** (F1), this will bring you to the Channel Plans Menu. Scroll through the displayed channels by using either the spin knob to highlight your choice on this page, or use the arrow keys (Pg Dn ↓ - Pg Up ↑) to access the other pages. You are able to tag or untag the channels that are to be included in AUTO TEST, by selecting **Tag/Untag AutoTest** (F3).Once your changes are made press the **[ENTER ↵]** key to save. To edit a

frequency select from the on screen menu **Edit Frequency** (F5) make your changes and save. The same procedures are followed to edit TV Sound and Edit Channel.

[F1] = PLAN MANAGER
Returns you to the Channel Plan directory.

[F2] = Switch Type
Switch channel type between TV, FM or * User Defined (CW).

[F3] = Tag/Untag AutoTest
This switch (TAG) selects if the channel or frequency is included in the AUTOTEST mode.

[F4] = Edit Channel
Allows entering an alpha-numeric Channel identification.

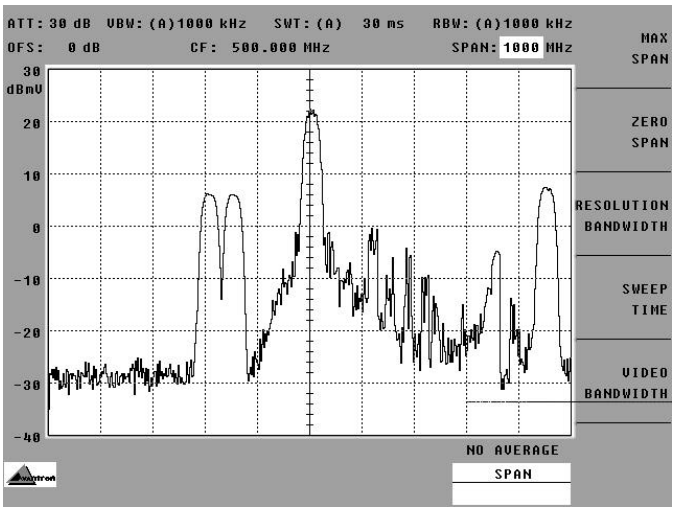
[F5] = Edit Frequency
Allows editing the frequency in MHz.

[F6] = Edit TV Sound
Allows you to edit the intercarrier spacing of a TV channel in MHz.

Using Avantron's AT-2000R/RQ Spectrum Analyzer

Your new Model **AT-2000R/RQ** Spectrum Analyzer is an invaluable tool for use in today's modern broadband network. The field portable Spectrum Analyzer, with it's broad spectrum input (5MHz – 1GHz), excellent resolution, sensitivity, wide dynamic range and simple straight forward controls, allows for ease of operation and repeatability.

This analyzer enables you to view your entire RF spectrum at a glance, or select a single frequency for close scrutiny. A spectrum analyzer allows for troubleshooting of extraneous signal interference with easy to understand graphical spectral displays. It can be used for many applications to locate the source of an interference problem or to optimise RF based equipment alignment. Testing and maintenance are easier because the effects of most adjustments can be observed instantly and precisely across the whole 1 GHz spectrum. The Model **AT-2000R/RQ** also enables you to demodulate and listen to signals at the centre frequency in zero span mode. The AM/FM demodulator is a valuable aid in identifying interfering signals.



Main Control Keys & Menus

There are 5 major control keys which access soft-key control menus.

[FREQ] [F1] = **[CENTER FREQUENCY]**
[F2] = **[VIDEO CARRIER]** (available with optional CATV Measurement Pak)
[F3] = **[AUDIO CARRIER**] (available with optional CATV Measurement Pak)

[SPAN] [F1] = **[MAX SPAN]**
[F2] = **[ZERO SPAN]**
[F3] = **[RESOLUTION BANDWIDTH]**
[F4] = **[SWEEP TIME]**
[F5] = **[VIDEO BANDWIDTH]**
[F6] = **[TRIGGER]**

[AMPL] [F1] = **[ATTEN.]**
[F2] = **[REFERENCE LEVEL]**
[F3] = **[VERTICAL SCALE]**
[F4] = **[REFERENCE OFFSET]**

[MARK]
[F1] = **[V1 MARKER]** vertical marker 1
[F2] = **[V2 MARKER]** vertical marker 2 and dB/Hz
[F3] = **[H1 MARKER]** horizontal marker 1
[F4] = **[H2 MARKER]** horizontal marker 2
[F5] = **[V1 > CF]** tunes vertical marker 1 at the center frequency
[F6] = **[V2 > CF]** tunes vertical marker 2 at the center frequency

[TRACE]
[F1] = **[NO AVERAGE]** averaging off
[F2] = **[AVERAGE 1]** fast update
[F3] = **[AVERAGE 2]** slow update
[F4] = **[PEAK HOLD]**

Pressing the **[ESC]** key brings up a secondary soft-key menu of other modes which can be directly accessed using the same soft-keys.

Frequency

[F1] = [CENTER FREQUENCY]

The FREQ (abr. for Frequency) control key accesses the frequency tuning functions of the Model **AT-2000R/RQ** spectrum analyzer. The basic mode of tuning is by simply entering a center frequency value in MHz and pressing **[ENTER ↵]** or by using the spin-knob and arrow keys.

The frequency tuning function is activated by default whenever accessing a mode which may require tuning, spectrum analyzer, single carrier, etc…

[F2] = [VIDEO CARRIER]
[F3] = [AUDIO CARRIER]

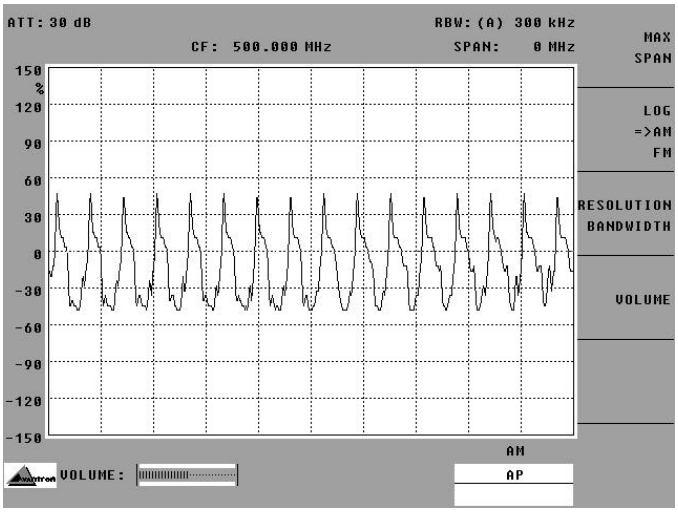
Included with the optional CATV MEASUREMENT PAK, are 2 additional tuning modes which appear in the [FREQ] menu. Select Video Carrier [F2] or Audio Carrier [F3] puts the **AT-2000R/RQ** in TV channel tuning mode. Simply entering a channel reference (as per CHANNEL PLAN SETUP) will automatically tune to the frequency that coincides with the channel allocation. The spin-knob and arrow keys can be used to scroll up or down the in the channel tuning mode, incrementing the frequency as per the channel allocations in the CHANNEL PLAN.

Span

The SPAN control key accesses the soft-key menu which includes span related functions such as **[F1] MAX SPAN** and **[F2] ZERO SPAN**. These keys speed up the process of going from any span to maximum 1000 MHz span or to minimum 0 MHz span.

When the SPAN is selected, the default function allows you to enter a value in MHz and press **[ENTER ↵]** key. The spin knob and the arrow key also increment the span settings. Spans are variable from a Max Span of 1000 MHz to as little as 100 kHz and then Zero Span.

Zero Span

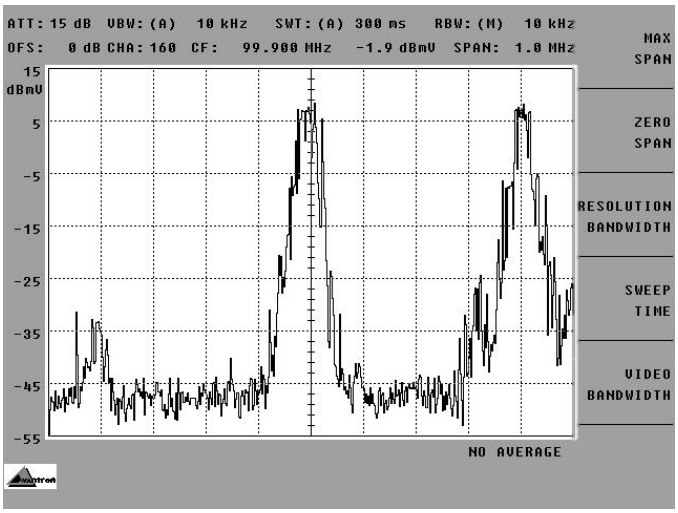


The Zero Span menu gives you access to the built-in AM/FM demodulator. You can detect aural signals by tuning a specific frequency and activating the audio demodulator with [F2] = [LOG AM FM].

Toggle between log scale, AM detector with % of modulation scale and FM detector with deviation scale in kHz.

Resolution Bandwidth (RBW)

[F3] RBW



When analysing signals, a spectrum analyzer traces out the shape of the analyzers intermediate (IF) filters. As we change the filter bandwidth, we change the width of the displayed response. Signal resolution is determined by the IF filters inside the spectrum analyzer. The wider a filter is, the wider the signal appears on the screen. One way to determine if the RBW filter is wide enough to respond fully to the input signal is to increase the filter and watch until the amplitude no longer increases. The RBW and VBW settings should be set to 300kHz and 100kHz respectfully, or wider if spans wider than 10MHz are to be used. It is preferable to couple sweep time and bandwidths to change automatically.

The Resolution bandwidth (RBW) function selects the IF filter setting for a measurement.

The Model **AT-2000R/RQ** has 4 different Resolution Bandwidth (RBW) settings to choose from; 1MHz, 300 kHz, 30 kHz and 10 kHz.

Sweep Time (SWT)

[F4] SWEEP TIME

In order to keep the spectrum analyzer calibrated, sweep time is automatically set to a value that is inversely proportional to the square of the resolution bandwidth. In order to use the fastest sweep times, use the widest Resolution bandwidth that still allows you to distinguish between the various signals to be measured. The Model **AT-2000R/RQ** has 8 different Sweep Time settings to choose from; 3 mS, 6mS, 15mS, 30 mS, 100 mS, 300 mS, 1000 mS and 3000 mS.

Video Bandwidth (VBW)

[F5] VBW
The Model **AT-2000R/RQ** has 3 different video bandwidth settings to choose from: 1 MHz, 100 kHz and 10 kHz.

Amplitude

[F1] Attenenuator
Variable 65 dB attenuator. Select input attenuation by increasing or decreasing in steps of 5 dB.

[F2] Reference Level
Sets top of the screen reference level in steps of 1dB.

[F3] Vertical Scale
Select vertical scale by toggling between 10 dB to 5 dB to 2 dB/div.

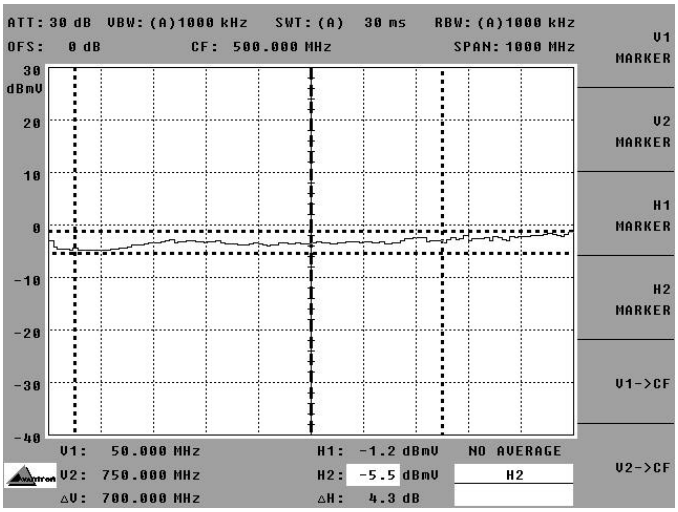
[F4] Reference Offset
Set reference level offset value from -40 to +40 dB. All level readings will automatically be compensated. This function is useful when working with amplifiers or other equipment that have test points. All that has to be done for TestPoint (TP) compensation is to enter the value of that TP.

Sensitivity Measuring Low-Level Signals

Spectrum analyzer sensitivity is the ability to measure low-level signals and is limited by the noise inside the spectrum analyzer. The spectrum analyzer input attenuator and resolution bandwidth settings affect the sensitivity by changing the signal-to-noise ratio. Attenuator settings affect the level of signal passing through the input of the instrument, whereas the resolution bandwidth affects the level of internal noise without affecting the signal.

Visibility of a signal that is still near the noise can be improved by using digital averaging functions found in the TRACE control menu.

Markers



Two vertical markers and two horizontal markers can be used to set level and frequency references. The vertical V1 and V2 markers indicate the frequency and in certain appropriate spans, the level is also displayed. When both markers V1 and V2 are selected and displayed on the screen while in the 5, 1, .1 MHz span/div, the delta level is automatically calculated.

The horizontal H1 and H2 markers indicate reference levels only.

When both reference markers are displayed on screen, the delta levels are automatically calculated. This is especially useful for peak-to-valley measurements.

Marker values will remain current until new data is entered. Press **[ESC]** to end Marker functions and go back to the previous menu.

[F5] = [V1 > CF] and [F6] = [V2 > CF]

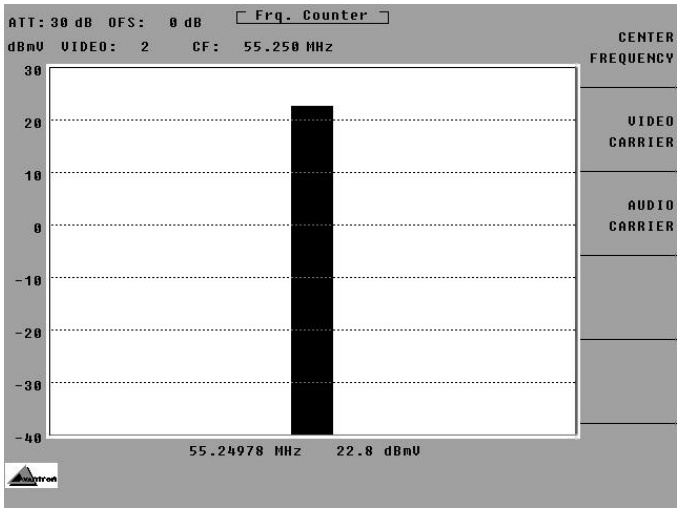
Tunes Analyzer center frequency instantly to V1 or V2 marker frequency.
Especially useful for rapidly tuning between two reference carrier frequencies.

Precision Frequency Counter

To access the Frequency Counter, just return to the MAIN MENU and select the **FREQ. COUNTER** icon.

The Model **AT-2000R/RQ** features a extremely precise frequency counter measurement function.

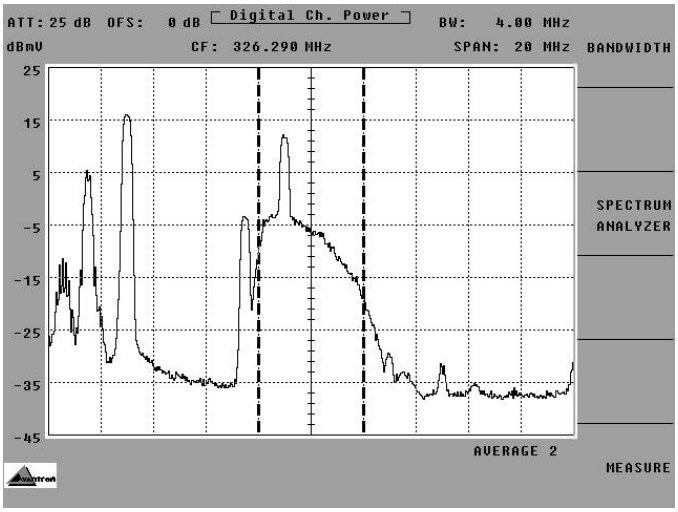
The FREQUENCY COUNTER allows you to measure both carrier frequencies and levels very accurately. The built-in frequency counter is as accurate on CW carriers as it is on modulated AM, FM or TV channels. The counter displays frequency with a 10 Hz resolution while the accuracy is delivered through the stable 1 PPM reference time base.
As an example, for a frequency of 100MHz the accuracy would be 100 X 1, which is equivalent to ±100Hz.



CATVPAK - Automated CATV Measurements (Optional)

The Avantron Model **AT-2000R/RQ** is a versatile instrument that can be configured with various options to allow you to create your own unique test system. This combination of field portable spectrum analyzer and modular options provides expanded measurement capabilities for future technologies or individual specialised requirements.

Digital Channel Power



Maintaining the correct carrier power levels throughout your system is crucial in both analog and digital cable systems. Unlike the measurement of analog visual carrier level, average channel power in a digital system is a wide bandwidth measurement. The **AT-2000R/RQ** spectrum analyzer carries out the measurement by sweeping the channel and taking an average of the power levels at each measurement point across the trace.

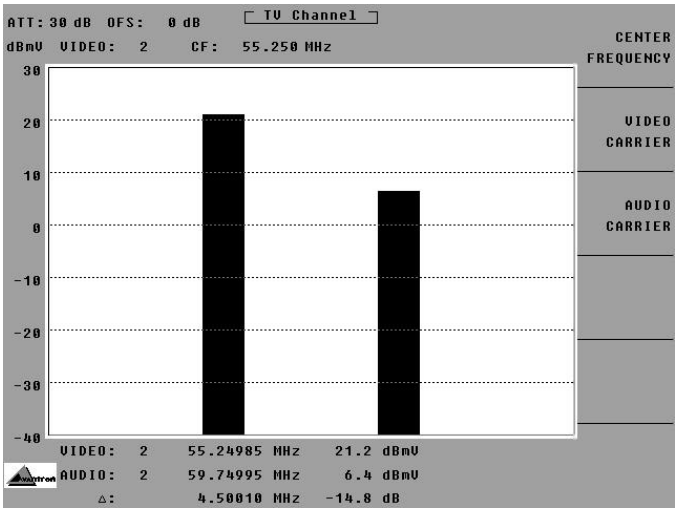
Set the centre frequency and the bandwidth of the channel to be measured (default bandwidth is 6 MHz). Pressing the [F6] MEASURE initiates an automatic sampling of the power at many points within the selected bandwidth and sums them all (integrates). Averaging and corrections are applied to the measurement and displayed in both dBmV and equivalent dBm.

Typical amplitude of digital carriers on a mixed broadband system (analog/digital channels) should about -10 dBc relative to analog visual carrier peaks.

Frequencies and Levels

TV Channel Mode

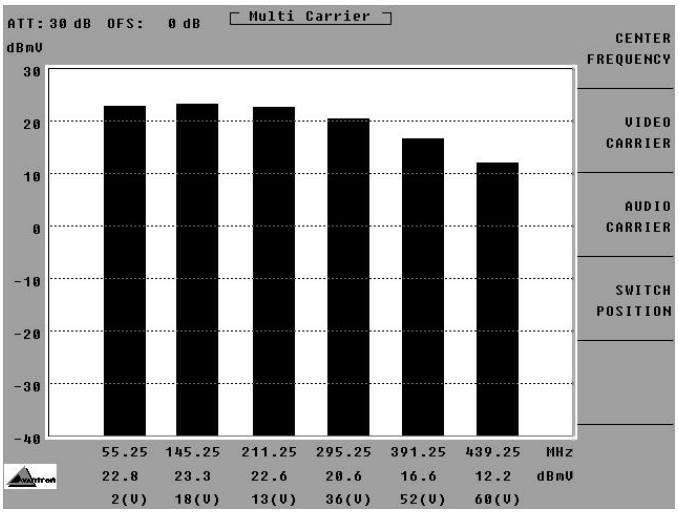
Select **TV CHANNEL** from the Main Menu screen.



The TV CHANNEL mode provides the capability to make accurate level and frequency measurements. The built-in frequency counter measures modulated video and audio carriers as well as 4.5 MHz intercarrier spacing with a. 10 Hz display resolution. RF carrier level and frequency is as simple has tuning in the frequency or TV channel and both visual and aural levels and frequencies are continuously measured. Results are displayed at the bottom of the screen showing the delta values as well.

Multi Carrier Mode

Select **MULTI CARRIER** from the Main Menu screen

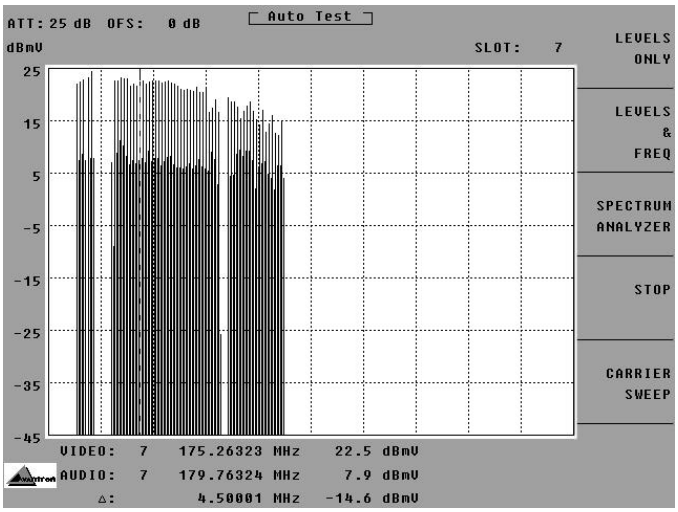


The Multi Carrier mode features simultaneous level measurements of 6 carrier or TV channel frequencies. The function is especially useful for the accurate setting of the amplifier high and low AGC pilot channels. The programming of the display bars is a simple procedure.

Once in the MULTI CARRIER mode press the **[FREQ]** key on the front panel and then either enter a frequency in megahertz (F1), channel number (F2), or audio carrier (F3). You will notice that the bar on the left has a marker through it, this is to indicate that it is active and ready to be programmed. To switch between the display bars, select from the on screen menu **SWITCH POSITION** (F4), and continue programming the rest of the display bars to your needs. Press the **[ESC]** key and the **AT-2000R/RQ** will read the levels of the six carriers.

AUTOTEST

The Model **AT-2000R/RQ** uses one of two modes to perform an AUTOTEST. One mode is levels only, and the other is levels and frequencies. All tagged channels and frequencies in the active Channel Plan will be tested. An entire headend can be accurately scanned and measured within a minute.



An additional mode, CARRIER SWEEP, allows a continuous scan of channel levels. Although the display can be used to evaluate frequency response, this is not an accurate representation and should be used as a reference only. To get an accurate frequency response of the system a true sweep test should be performed by using the low level non intrusive Sweep option for the **AT-2000R/RQ**. Both system sweeping and measurement tests can be performed simultaneously.

Select the channels and set the frequency offsets (if required) in the **CHANNEL PLAN** which can be accessed from the **SETUP** menu. See section 4.4.1 Edit Plan for details of how to add channels or frequencies. After the AUTOTEST measurements, the display can be scanned with the knob or arrow keys to view the measurements. **AUTOTEST** measurements can be stored for later scanning, or printing.

Distortion Measurements

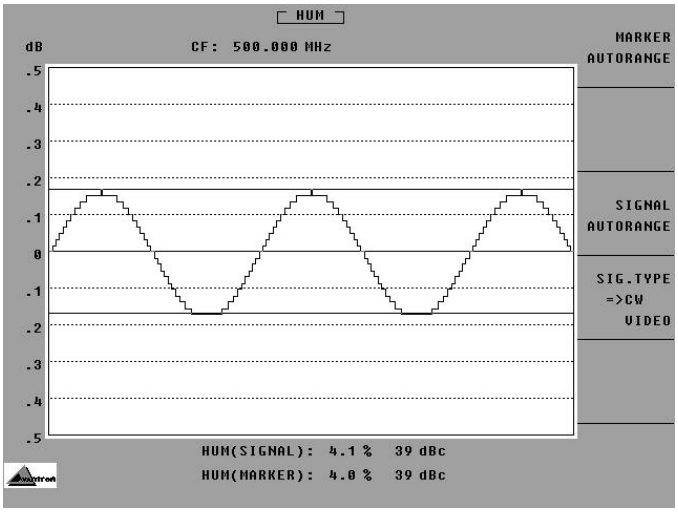
Because of the nature of a broadband network, and the "cascading" of RF amplifiers, certain parameters of operation must be maintained to achieve optimum operation. This *optimum operation* includes maximising the Carrier-to-Noise ratio (the actual ratio of carrier level on the system to the system noise floor at any point in the system), and maximising the Carrier-to-Intermodulation ratios. The intermodulation ratios include both random intermodulation, which could be noted on almost any active RF system, and CATV-specific intermodulation, which includes unique types of intermodulation created during the transmission of CATV-type carriers.

All software routines for measuring CATV distortions are designed for optimal performance and follow the NCTA Recommended Practices for Measurements on Cable Television Systems. To further enhance distortion measurement capabilities, the Model **AT-2000R/RQ** has a built-in pre-amp, thus achieving a 70 dB on screen dynamic measurement range, with a sensitivity of -65 dBmV to + 65 dBmV. True level measurement accuracy is +/- 0.75 dB including all internal system components such as attenuator flatness, log amplifier etc.

There are several ways of entering the **DISTORTION MEASURE** mode. From the **MAIN MENU** by pressing the **[MENU]** key on the front panel and select the **HUM MOD** or **C/N, CSO, CTB** icon. If already in spectrum analyzer mode press the **[ESC]** key and then select **DISTORTION MEASURE** (F4). Now from this screen select **C/N CSO CTB** (F2), this will bring you into the desired screen, now go ahead and perform your tests.

Hum Modulation Measurement

To enter the HUM mode you can go to the **MAIN MENU** and select **HUM**, or if you are already in the Spectrum Analyzer mode, simply press the **[ESC]** key and from the on screen menu select **DISTORTION MEASURE** (F4) and then select **HUM** (F1).



Hum modulation is generally caused by line power related AM modulation. As defined for Cable Television, it is the total peak to peak power line hum and low frequency AM modulation at all frequencies from DC to 1 KHz expressed as a percentage relative to the peak level of the reference carrier.

Hum that is power line related causes rolling bars to appear on the television screen. Generally these bars will start to appear at a distortion level of about 2%. If one is visible this indicates a 60Hz hum, and if 2 bars scroll through the picture this indicates a 120Hz hum. Some television receivers are more sensitive than others and will show up the distortion at a lower level. When the hum level starts to reach the 3.5% and higher, the picture may start to tear along the edges.

It is a good practice to document the hum levels at your test points and watch for any major changes during routine maintenance. Observing a significant change indicate that there is a potential problem in the offing. The cause could be a power supply, connection, passive, or an amplifier. As an example here are some possible causes of hum.

- Low line voltage, causing the DC power supply not to function properly. (120Hz)
- Bad filter capacitor. (120Hz)
- Defective diode in the DC power supply. (60Hz)
- Loose or corroded connector forming a diode junction. (60Hz)

Hum Modulation - Test Procedure:

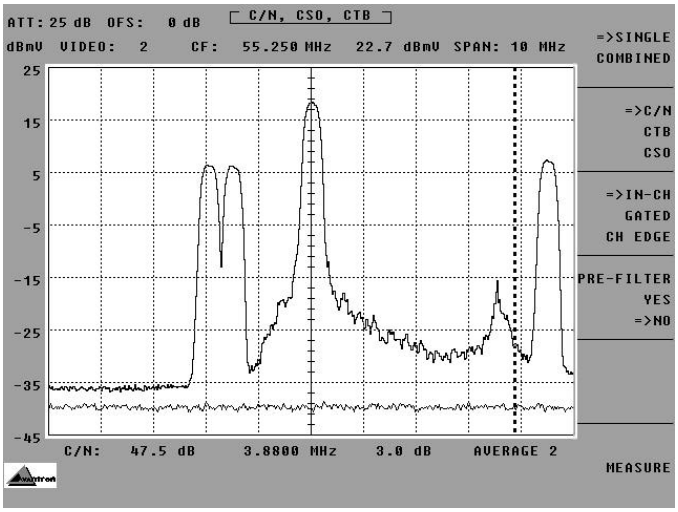
Step 1: Tune to the carrier frequency or TV channel that you want to perform the test on, if not already tuned. The input attenuator can be set to view the carrier on-screen however, the **AT-2000R/RQ** will auto-range the attenuator while performing the test. Press [**ESC**] if necessary to return to the top level of function key menus which display the HUM choices. To tune while in the HUM mode, press the blue **[FREQ]** key on the front panel. At this point you can key-in a channel number and press the **[ENTER]** key. This is the default mode when choosing **[FREQ]**. If you wish to key-in a specific frequency then from the on screen menu select **CENTER FREQUENCY** (F1). Once you have entered the proper channel or frequency press the **[ESC]** key to bring you back to the **HUM** screen.

Step 2: Now the selection of doing the test on a CW, or Video Carrier must be made. If the test is to be made on a CW, make sure that there is no modulation present, otherwise the readings will not be accurate. Select your choice from the on screen menu **SIG. TYPE CW, VIDEO** (F4) by toggling the key (=> indicates choice).

Step 3: The **AT-2000R/RQ** will automatically set the instrument settings and sequence the test. The real-time hum is displayed in dBc (decibels below reference carrier) and in percentage.

Combined C/N, CTB and CTB

This mode combines all the measurement requirements for C/N, CSO and CTB. With the exception of CTB, all measurements can be done in-service with the powerful GATED Measurement feature.



This mode also allows for an individual measurement, or as a Combined Test for saving time and memory space when storing.

WARNING - Verify that the analyzer is not being overloaded. A quick indication is if the spurious beats increase by 10 dB while only reducing the attenuator by 5 dB. This 2 - 1 ratio is an indication that the input of the analyzer is overloading and causing excessive distortions. Measuring with an overload condition will cause errors in the measurement results and can damage the input of the AT-2000R/RQ. The use of a pre-selector filter is suggested in order to prevent the overloading of the analyzer, and ensure precise repeatable tests.

With the Combined Distortion Tests function, Carrier-to-Noise (C/N), Composite-Triple-Beat (CTB) and Composite-Second-Order (CSO) are measured simultaneously, reducing the number of times that the channel carrier is disabled. Measure and store the whole routine as 1 record. Measurements are semi-automated IN-CHANNEL type, and require momentary disabling of channels carriers as well as user confirmation of specific steps during testing. The procedure for performing this combined test is similar to any of the individual measurement modes.

Carrier-To-Noise (C/N)

Television visual carrier-to-noise ratio is the power in a sinusoidal signal, whose peak is equal to the peak of a visual carrier, divided by the associated system noise power in a 4 MHz bandwidth. This ratio is expressed in dB. A critical parameter that is affected by the actual level of the carriers on the system is the carrier-to-noise ratio of the system. Just as the overall quality of the viewed TV picture is affected by video noise (prior to modulation and transmission) the noise floor of the RF transmission system can adversely affect the transmitted RF channel.

This is logical, as the ideal carrier (and consequently the TV picture created) would have an infinite range above the noise floor of the system, creating a noise-free picture. As this is not technically possible, a balance must be struck between a level that is too high, thus creating an excellent Carrier-to-Noise, but a poor Carrier-to Composite Triple Beat. Subsequently, a carrier that is too low in level, would create an excellent Composite Triple Beat, but a poor Carrier-to-Noise ratio. This is especially true, as the nature of RF amplifiers creates a 3 dB degradation in the Carrier-to-Noise ratio every time the number of amplifiers in cascade is doubled.

This means that for a 16-amplifier cascade, there will be a degradation of 12 dB in the Carrier-to-noise ratio (i.e. it doubles four times: 1 to 2, 2 to 4, 4 to 8, and finally 8 to 16 amplifiers. 4 (doubling) x 3 (dB per doubling) = a total degradation of 12 dB). The only good news is that the cascade must be doubled in length (from 16 amplifiers to 32 amplifiers) before the next full 3 dB degradation occurs. This does emphasise the critical nature of the set-up of these line amplifiers.

C/N Test Procedure:

The **AT-2000R/RQ** can perform C/N tests in 3 different ways.

Method 1: In-Channel.
Requires the removal of either the carrier or its modulating signal at the system head end. The unit will prompt you through the measurement steps. Once the test is terminated save the results for future reference.

Method 2: Gated.
This totally non-intrusive method, measures the channel noise of a selected line during the vertical blanking period of the video signal.

Method 3: Channel Edge.
Uses the channel edge where the noise floor in the guardband is scanned to find the lowest level. The automated tests for carrier to noise are pre-programmed by Avantron to calculate the C/N for an NTSC-TV modulated channel and compensate for an effective video bandwidth of 4 MHz. It is

recommended that the noise to be measured be greater than 10 dB over the internal noise of the **AT-2000R/RQ** Spectrum Analyzer. The use of a pre-selector bandpass filter maybe required, if the RF energy content is high due to the number of carriers.

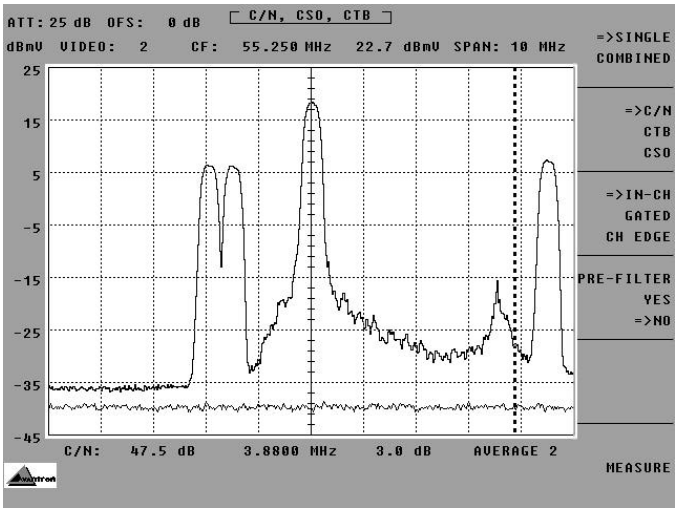
During the test sequences the **AT-2000R/RQ** will apply a correction factor for **Noise-Near-Noise Correction.** The noise correction factor is obtained when the internal noise of the spectrum analyzer is compared to the measured system noise (in dB). This reading will be displayed separately at the bottom of the screen, and the value is already included in the C/N measurement.

C/N In-Channel Method:

Step 1: Tune to the carrier frequency or TV channel by any of the methods already described in this manual. The input attenuator can be set to view on-screen the carrier being tested, however, the **AT-2000R/RQ** will auto-range the attenuator when measuring the carrier level. Press **[ESC]** if necessary to return to the top level of the function key menu, which displays the C/N choices.

Step 2: With the softkey menu, select the following combination.
[F1] => **SINGLE**
[F2] => **C/N**
[F3] => **IN-CH**
[F4] **PRE-FILTER**
=>**YES** (Recommended to prevent overloading the analyzer, user supplied equipment, and installed at the input of **AT-2000R/RQ**, also allows for the reduction of attenuation for the measurement of noise.)
NO (If no filter used.)

Step 3: Press the **MEASURE** [F6] key to start the measurement. The **AT-2000R/RQ** will measure the peak amplitude of the test carrier and the internal noise of the Analyzer and temporarily saves them. The **AT-2000R/RQ** will then prompt the user to REMOVE THE TEST



CARRIER AT HEAD END, or at this time remove the modulation, and reduce the attenuation to obtain a noise measurement at least 10 dB above the internal noise of the analyzer.

Step 4: Press **[ENTER↵]** to confirm that all of the steps have been performed and the measurement will proceed. The results will be displayed at the bottom of the screen and will show the frequency, the measured C/N ratio in dB, and the Noise-near-Noise Correction factor used in the calculation. It is recommended that measurements be made with as little noise-near-noise correction as possible.

C/N - Gated (in-service) and Channel Edge Method:

These methods do not require the removal of the RF carrier or modulation of the channel under test, but sometimes under some circumstances is a slightly less accurate method, and should be used only as a reference. One cause for this is that the line selected for the Gated test may not be free of noise. A quiet line inserter could be used at the Head End to do just that, insert a quiet line. Follow instructions supplied with inserter.

Step 1: Tune to the carrier frequency or TV channel by any of the methods already described in this manual.

Step 2: The input attenuator **should** be set to so that the system noise is at least 10 dB above the internal noise of the analyzer. The **AT-2000R/RQ** will auto-range the attenuator when measuring the carrier level.

Step 3: With the softkey menu, select the following combination;
[F1] => **SINGLE**
[F2] => **C/N**
[F3] => **GATED**
CH EDGE
[F4] **PRE-FILTER**
=>**YES** (Recommended to prevent overloading the analyzer, user supplied equipment, and installed at the input of **AT-2000R/RQ**, allows for the reduction of attenuation for the measurement of the Analyzer noise floor.)
NO (If no filter used.)

Step 4: Press the **MEASURE** [F6] key to start the measurement. During the test the **AT-2000R/RQ** will measure the peak amplitude of the test carrier, the internal noise of the Analyzer, and measures the system noise during the vertical blanking pulses of the video signal.

The results will be displayed at the bottom of the screen and will show the frequency, the measured C/N ratio in dB, and the Noise-near-Noise Correction factor used in the calculation. It is recommended that measurements be made with as little noise-near-noise correction as possible.

Composite Triple-Beat (CTB)

The CTB interference is formed by the mixing of carriers. Composite third order distortion is the ratio, expressed in dB, of the peak level of the RF signal to the peak of the average level of the cluster of distortion components centred around the carrier frequency. Composite Triple-Beat is created as another type of third order intermodulation. It is unique to CATV, as the majority of the CATV channels in the Standard Channel line up set-up have exact spacing of 6MHz from each other, (i.e. channel 2 visual is 55.25 MHz, channel 3 visual is 61.25 MHz). With the exception of channel 5 which is spaced 10MHz from channel 4. The remainder of the CATV channels, starting with A5 (91.25MHz), are all evenly spaced at 6.0 MHz intervals. HRC and IRC are other Channel Plans available with different offsets.

This creates some unique intermodulation problems in amplifiers. The potential for the creation of intermod (or just 'beats' for short) is there. This is obviously due to the simple quantity of RF signals present in the passband, and with these carriers having the same spacing, is what generates the beats that actually add with each other at 6 MHz intervals. CTB, is the power-addition of the beats created in the system, very typically is at its worst in the centre of the occupied band. As an example, the number of signals at the centre frequency of a 60 channel system is greater than 1,350. This area has the best potential for this type of intermodulation.

During the test sequences the **AT-2000R/RQ** will apply a correction factor for **Beat-Near-Noise Correction.** The beat correction factor obtained when the internal noise of the spectrum analyzer is compared to the measured system noise (in dB), will be displayed separately at the bottom of the screen, although the value is already added to the CTB measurement displayed.

CTB - In-Channel Method ONLY:

Step 1: Tune to the carrier frequency or TV channel, by one of the methods previously described. The input attenuator can be set to view on-screen the carrier being measured, however, the **AT-2000R/RQ** will auto-range the attenuator when measuring the carrier level. Press **[ESC]** if necessary to return to the top level of function key menu, which displays the choices.

Step 2: With the softkey menu, select the following combination:
[F1] => **SINGLE**
[F2] => **CTB**
[F3] => **IN-CH**
[F4] **PRE-FILTER**
=>**YES** (Recommended to prevent overloading the analyzer, user supplied equipment, and installed at the input of **AT-2000R/RQ**, allows for the reduction of attenuation for the measurement of the Analyzer noise floor.)
NO (If no filter used.)

Step 3: Press the **MEASURE** [F6] softkey to start the measurement. During the test the **AT-2000R/RQ** measures the peak amplitude of the test carrier and the internal noise of the Analyzer and temporarily saves them. The **AT-2000R/RQ** will then prompt the user to shut off the test carrier or the modulation and reduce the attenuation to obtain a beat measurement at least 10 dB above the internal noise of the analyzer.

Step 4: Press **[ENTER↵]** to confirm that all of the steps have been performed and the measurement will proceed.

The test results will be displayed at the bottom of the screen and will show the frequency where the measurement was taken, the measured CTB ratio in dB and the Beat-near-Noise Correction factor used in the calculation. It is recommended that measurements are made with as little noise-near-noise correction as possible.

Composite Second Order (CSO)

Composite Second Order: Products generated by the direct addition or subtraction of fundamental visual carrier frequencies. CSO products normally fall at +/- 750 kHz or +/- 1.25 MHz from the visual carriers and require the removal of modulation for measurement. In practice, only the components above visual carrier are measured as they fall in the channel of interest.

During the test sequences the **AT-2000R/RQ** will apply a correction factor for **Beat-Near-Noise Correction**. The beat correction factor obtained when the internal noise of the spectrum analyzer is compared to the measured system noise (in dB), will be displayed separately at the bottom of the screen, although the value is already added to the CTB measurement displayed.

CSO - In-Channel Method:

Step 1: Tune to the carrier frequency or TV channel, by one of the methods previously described. The input attenuator can be set to view on-screen the carrier being measured, however, the **AT-2000R/RQ** will auto-range the attenuator when measuring the carrier level. Press **[ESC]** if necessary to return to the top level of function key menus which displays the choices.

Step 2: With the softkey menu, select the following combination.
[F1] => **SINGLE**
[F2] => **CSO**
[F3 => **IN-CH**
[F4] **PRE-FILTER**
=>**YES** (Recommended to prevent overloading the analyzer, user supplied equipment, and installed at the input of **AT-2000R/RQ**, allows for the reduction of attenuation for the measurement of the Analyzer noise floor.)
NO (If no filter used.)

Step 3: Press the **MEASURE** [F6] softkey to start the measurement. During the test the **AT-2000R/RQ** measures the peak amplitude of the carrier under test, and the internal noise of the Analyzer and temporarily saves them. The **AT-2000R/RQ** will then prompt the user to turn off the test carrier, or remove the modulation, and then reduce the attenuation to obtain a beat measurement of at least 10 dB above the internal noise of the analyzer.

Step 4: Press **[ENTER↵]** to confirm that all of the steps have been performed and the measurement will proceed.

The test results will be displayed at the bottom of the screen and will show the frequency where the measurement was taken, the measured CSO ratio in dB and the Beat-near-Noise Correction factor used in the calculation. It is recommended that measurements are made with as little noise-near-noise correction as possible.

CSO - Gated (in-service) Method :

This method does not require the removal of the RF carrier or modulation of the channel under test but sometimes under some circumstances is a slightly less accurate method.

Step 1: Tune to the carrier frequency or TV channel.

Step 2: The input attenuator **should** be set so that the system noise is at least 10 dB above the internal noise of the analyzer. The **AT-2000R/RQ** will auto-range the attenuator when measuring the carrier level.

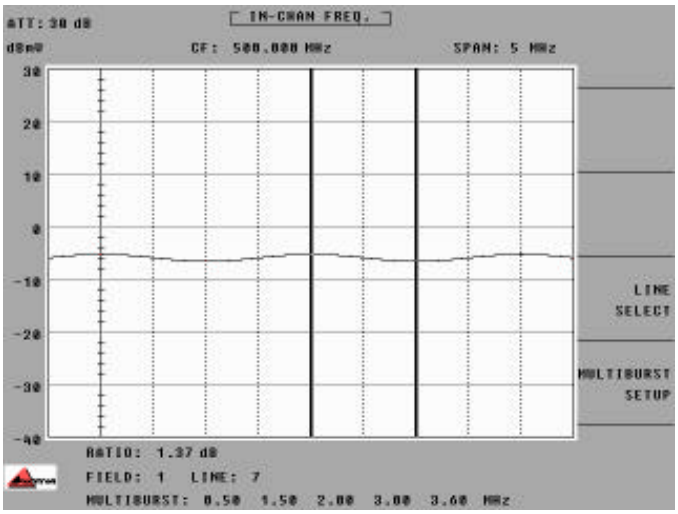
Step 3: With the softkey menu, select the following combination:
[F1] => **SINGLE**
[F2] => **CSO**
[F3] => **GATED**
[F4] **PRE-FILTER**
=>**YES** (Recommended to prevent overloading the analyzer, user supplied equipment, and installed at the input of **AT-2000R/RQ**, allows for the reduction of attenuation for the measurement of the Analyzer noise floor.)
NO (If no filter used.)

Step 4: Press the **MEASURE** [F6] softkey to start the measurement. During the test the **AT-2000R/RQ** measures the peak amplitude of the test carrier and the internal noise of the Analyzer and measures the system noise during the vertical blanking pulses of the video signal.

In-Channel Frequency Response

In-channel frequency response is a window of amplitude between the vestigial sideband and the aural carrier.

Uniform response over the channel bandwidth assures proper relative signal levels throughout the system and balanced response at the subscriber's terminal.



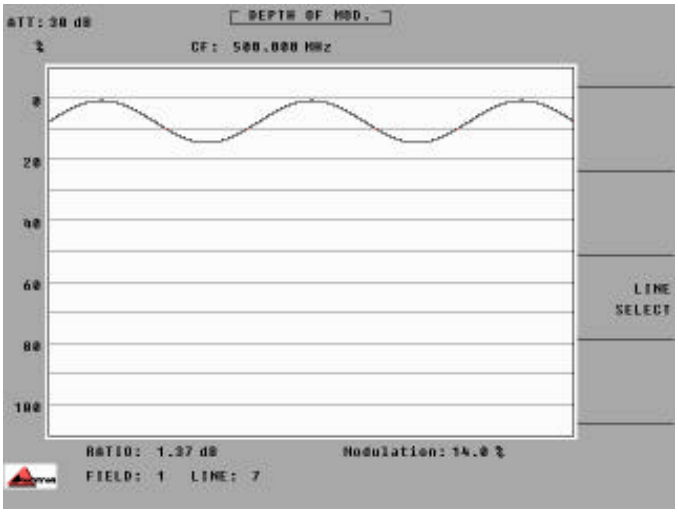
To avoid interrupting program video the in-channel frequency response can be made with a vertical interval test signal or VITS. The test signal transmitted on the VITS of program video provides the multi-burst standard to video frequency response. The channel selected should be one that has a VITS signal.

Press [F4] LINE SELECT and select a VITS video line with the multiburst present. To set the multiburst frequencies, press [F5] MULTI-BURST SETUP and set each frequency of the burst. These are the reference points for calculating the peak-to-peak frequency response in dB.

Depth-of-Modulation

The video depth of modulation screen provides percent modulation in both graphical and precise numeric format.

The depth of modulation is measured as the percentage of the total amplitude change of the carrier, as the signal progresses from synch tip to peak white. Standard video modulation requires 87% of the total range of the carrier envelope, from full carrier to no carrier.



Depth Of Modulation With VITS

Accurate and repeatable measurement of depth of modulation requires a video test signal. However, good measurements may also be made on program material with a vertical interval test signal or VITS. A test signal transmitted on the VITS of program video provides a standard to calibrate the video depth of modulation.

Press [F4] LINE SELECT and select a VITS video line with white reference

QAM 64/256 - Digital Measurement Analyzer (Optional on AT-2000R)

Introduction to Digital Measurements

As digital signals become more widespread, performing accurate digital cable measurements is essential to efficiently install and maintain the cable network. Unlike with analog pictures, digital video can appear to operate normally and yet it may be very close to failing. Digital measurements will be the only way to ensure that the system is operating well within limits.

Until now, cable operators had to choose between very expensive lab digital test equipment or hand held QAM instruments which means technicians have to carry a second instrument just to test the digital channels. These instruments are often limited in performance allowing only forward path measurements.

Integrating the QAM digital measurements with an affordable field spectrum analyzer such as the **AT-2000RQ** is truly a breakthrough from both a cost and performance point of view. The **AT-2000RQ QAM Analyzer** features a high performance field spectrum analyzer with a 1 MHz to 1 GHz frequency range, high sensitivity and 3 ms scan speed that is the fastest of any CATV spectrum analyzer.

The Avantron Model **AT-2000RQ QAM Analyzer** demodulates and accurately measures the QAM signals carried through the cable system. It provides the measurement power the field technicians need for the latest 64/256 QAM digital technologies and is very simple to use, making the transition from analog to digital testing a breeze.

The built-in digital demodulator makes it possible to measure:

- Bit Error Rate (BER), Pre and Post Error Correction
- Modulation Error Ratio (MER) and Error Vector Modulation (EVM)
- Estimated Noise Margin (ENM)

Information is displayed clearly and graphically on the **AT-2000R QAM Analyzer's** full color high-resolution active matrix LCD screen. Display modes include:

- Constellation Display with zoom capabilities.
- Error Statistics Graph Display
- Adaptive Equalizer Display.

Quadrature Amplitude Modulation

Quadrature Amplitude Modulation is a modulation scheme that generates a set of modulation values that comprises the superposition of two separate modulations on two carriers that share the same frequency but are 90° apart or in quadrature. For instance QAM 16 has a set of 16 values, 4 in each of the **I or IN-PHASE** and **Q or QUADRATURE**. Each of the two carriers is modulated with a set of 4 values (+3, +1, -1, -3); as the two modulation data are independent we can generate a set of 16 = 4 x 4.

The generation of QAM with quadrature carriers and modulators is a very convenient physical circuit. It can also be used at reception to separate the complex incoming signal into 2 simpler signals. It is also very useful to visualize the symbol set of values in a plane where Abscissa X is the In-phase and Ordinate Y is the Quadrature.

We then have a **constellation** where each value of the set is clearly positioned. Back to our QAM 16, I and Q set of 4 values are represented by 2 bits, for a total of 4 bits by symbol. Similarly QAM 64 has a set of 8 x 8 = 64 values represented by 3 + 3 = 6 bits per symbols, QAM 256 is represented by 4 + 4 = 8 bits. In practice QAM modulation uses the same size set in both I and Q, such as 16, 64 and 256 plus 32 and 128. In the latter two cases the full constellation is not used in the far corners. The allocation of the symbol bits to each of the location of the constellation is the **Mapping**.

Finally, each constellation point in the rectangular plane can be defined by I and Q values, but it can also defined in a polar plane as a **Vector with an amplitude and an angle**. QAM is two amplitude in quadrature or one **complex modulation** with amplitude and phase.

DOCSIS and J.83 ANNEX B

DOCSIS or Data Over Cable Service Interface Specification is a standard developed to provide a common set of rules enabling interoperability between transmitting equipment and receiving equipment through a transmission channel. In order to achieve this interoperability with various makes and designs, the standard defines in details normal operation and recovery mechanism. This detailed specification minimizes different interpretations by various designers that leads to non-interoperability. DOCSIS covers at length the data transmission protocol and interface to the cable network.

For the downstream transmission modulation it refers to another standard defined by the ITU (International Telecommunication Union) in its Digital Television J series of Recommendations. J83 covers cable delivery and its Annex B covers a specific case of QAM 64 and QAM256. The data stream in

this process is referred to as MPEG2, which is another standard; this one covers a transport stream of digital television that has been compressed according to algorithms of the **M**otion **P**ictures **E**xpert **G**roup.

The picture encoding is followed by channel coding before transmission, while at the reception the reverse processes are applied in reverse order. The picture encoding according to MPEG2 process is a compression of the digitized picture to reduce the required bit rate for transmission. It uses the human vision physiological response to reduce redundancy both in time and space in motion picture. Reference picture frames are transmitted regularly, but in between these, motion detection and differences are transmitted.

The MPEG also defines transport stream packets of compressed that can be multiplexed: multiple pictures, sounds or ancillary data. The basic packet has 188 bytes including one Sync byte and 24 bits of Packet Identification Data. In some instances 16 bytes of error correction codes are added (204 bytes packets) but are unused in the Annex B. Although data (e.g. cable modem or telephony) can replace compressed video, it still uses the MPEG Transport Stream format.

The J83 Annex B channel coding goes through the following process:

- The sync byte of the 188 packet is replaced by a parity checksum such that at the reception after calculation on the received packet a valid sync byte is regenerated;
- The next step is Reed-Solomon Forward Error Correction codes insertion, the block size is 122 data symbols + 6 FEC symbols, (at 7 bits per symbols there is **no** relationship between MPEG transport stream packets and FEC blocks);
- Interleave is applied to the FEC blocks, that means that blocks are not transmitted as generated but stored and then transmitted starting by the1st bits of a series of blocks and then the 2nd bits and the 3rd.... (in practice 128 blocks of 128 bits are interleaved in the QAM 64 level 1, while level 2 allows reduced and enhanced interleave for both QAM64 and QAM256 , I and J parameters commonly default I - 128 and J - 1); the purpose of interleave is to disperse adjacent bits in a FEC block such that a burst error will affect a few bits in a large number of blocks rather than many bits in a small number of blocks;
- The interleaved data is then framed with a synchronization sequence, in QAM 64 there is a trailer of 42 bits for 60 FEC blocks and in QAM 256 it is a 40 bit trailer for 88 FEC blocks;
- The data is then randomized to prevent long strings of 1 or 0;
- Trellis coded modulation is then applied to the modulator symbols (6 bits for QAM64 and 8 bits for QAM256), the purpose of trellis coding is to enhanced the distance in the constellation plane for adjacent transmitted symbols, hence reducing the effect of noise and distortion at the reception;
- Finally the symbols are mapped to the I and Q modulators.

J83 ANNEX B

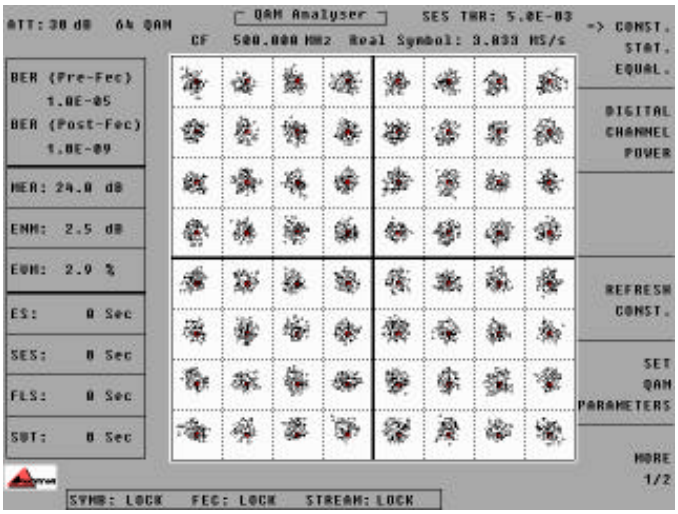
Parameter	QAM 64	QAM 256
SYMBOLS	6 bits, 3 in I + 3 in Q	8 bits, 4 in I + 4 in Q
SYMBOL RATE	5.056941 Ms/s	5.360537 Ms/s
Information bit rate	26.97035 Mb/s	38.81070 Mb/s
Raw bit rate and channel throughput	30.341646 Mb/s, 88.88%	42.884296 Mb/s, 90.5%
Baseband filtering	Square root raised cosine, α = 18%	Square root raised cosine, α = 12%
FEC framing	42 bit trailer for 60 FEC blocks, each block 128 symbols of 7 bits	40 bit trailer for 88 FEC blocks, each block 128 symbols of 7 bits
Interleave	Level 1, I = 128, J = 1 Level 2, I = 128,64,32,16,8 J = 1, 2, 3, 4, 5, 6, 7, 8, 16	Level 2, I = 128,64,32,16,8 J = 1, 2, 3, 4, 5, 6, 7, 8, 16
Channel coding	Reed-Solomon (122, 128) + Trellis coding binary convolutional (4/5 punctured)	

INTERLEAVE PROTECTION

I (# OF TAPS)	J (INCREMENT)	BURST PROTECTION QAM 64 - QAM 256	LATENCY QAM 64 - QAM 256
128 (default setting)	1 (default setting)	95µs / 66µs	4.0ms / 2.8ms
64	2	47 / 33	2.0 / 1.4
32	4	24 / 16	0.98 / 0.68
16	8	12 / 8.2	0.48 / 0.33
8	16	5.9 / 4.1	0.22 / 0.15
128	2	190 / 132	8.0 / 5.6
128	3	285 / 198	12 / 8.4
128	4	379 / 264	16 / 11
128	5	474 / 330	20 / 14
128	6	569 / 396	24 / 17
128	7	664 / 462	28 / 19
128	8	759 / 528	32 / 22

Testing QAM Signals

To access the QAM mode, select the QAM ANALYZER icon on the Main Menu or from Digital Channel Mode, select [F2] QAM ANALYZER. The default conditions for QAM mode is Constellation Display set for 64 QAM operation.



Step 1: Tune to the center frequency of the digital signal that you want to perform the test on, if not already tuned. The **AT-2000R/RQ** will auto-range the attenuator while performing the test. Press [**ESC**] if necessary to return to the top level of function key menus to display the QAM choices. To tune while in the QAM mode, press the blue **[FREQ]** key on the front panel. At this point you can key-in a specific frequency then from the on screen menu select [F1] CENTER FREQ. Once you have entered the proper frequency press the **[ESC]** key to bring you back to the QAM menu.

Step 2: Set the QAM parameters for the type signal being tested. Select [F5] SET QAM PARAMETERS.

Modulation Type :
Set for 64 or 256 QAM.

Symbol Rate :
Can be user set from 1.000 to 7.000 MS/sec. Default values are; 64QAM = 5.057 and 256 QAM = 5.360.

Polarity Type :
Default setting is Automatic. User selectable for Normal or Reverse. Reverse is used with IF signals from modulators (before up-conversion)

Compensation (On/Off) :
Default setting is ON.

For 256 QAM setting only.

Interleave -> I <- (1 to 255):
Most transmission equipment has a default setting is 128.

Interleave -> J <- (1 to 255):
Most transmission equipment has a default setting is 001.

Once all settings have be properly entered, select the [F5] INIT. QAM function to initialize the QAM measurement with the current settings.

Use [F6] RESET DEFAULTS to return all setting to factory default values.

Step 3: The **AT-2000R/RQ** will automatically set the instrument settings and start testing the digital signal in real-time. The initial test performed is attempting to lock in to the Forward Error Correction. At the bottom of the screen, there are 3 separate lock indicators. If there is a problem, the display will indicate **UNLOCK** in red box.

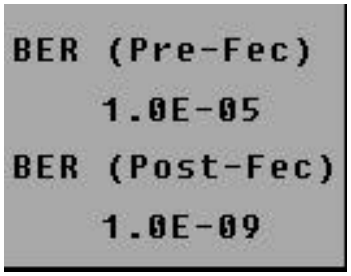
Symbol Lock:

FEC Lock:

Stream Lock:

Pre and Post Bit Error Rate (BER)

Bit Error Rate (BER) is a very important indicator of the health of a digital transmission system. As data is transmitted, some of the bits may not arrive properly at the receiver and the more bits that are incorrect, the more the signal will be affected.



BER measurements are done after digital decoding, that is after Trellis decoding, De-randomization, De-interleave but before and after Reed-Solomon error correction.

The Error Correction mechanism detects all errors hence the **Bit Error Rate Pre-FEC** indicates all errors found in the previous second, it is displayed as a ratio to the total transmitted bits in the second. But all errors cannot be corrected, even if they are flagged, so the **Bit Error Rate Post-FEC** is the ratio over a second of errors that cannot be corrected and are feed to the end-user. The BER Pre-FEC is obviously always higher than BER Post-FEC, typically Pre-FEC will increase with noise input while Post-FEC remains 0 until very close to loosing lock where it increases very rapidly.

Other disturbances than pure noise, such as burst interference have different effect. Burst interference may affect BER Post-FEC even for a low BER Pre-FEC if its duration exceeds the burst protection period as seen in the interleave section.

BER is displayed in scientific notation. The more negative the exponent, the better the BER. The **AT-2000RQ** has a range of 1.0×10^{-9} to 1.0×10^{-4}. Better than 1.0E -8 is required after FEC for system to operate properly. By looking at the Pre-FEC and Post-FEC BER, you can determine how hard the FEC is working to correct errors. The harder it's working, the closer the system is to failure.

Modulation Error Ratio (MER)

MER is the best overall "figure of merit" measurement to determine 64/256 QAM signal quality. MER provides an indication of transmission impairments. MER indicates the ratio of average total signal power in the ideal constellation to average error power in the constellation as received by the **AT-2000RQ** QAM analyzer**.** The measurement includes error power due to any impairment. MER is expressed in dB where higher is better. MER is analogous to a composite ratio of signal-to-noise and distortions in analog cable TV measurements

Modulation Error Ratio = 10 X log (average symbol power/average error power)dB

Estimated Noise Margin (ENM)

The **ENM or ESTIMATED NOISE MARGIN** is an indication of the headroom of the system. It is calculated from the MER taking into account modulation type (64/256), symbol rate and bandwidth. It assumes noise disturbance only, other disturbances will give a false ENM. The headroom is related to the critical operating level or 1e-8 uncorrected error rate, at which point impairments are visible in a picture.

Visual **Constellation examination** is a way of diagnostic for signal disturbances. **Pure Thermal Noise appears as cloud** around the ideal point, getting lighter as it expands.

Other typical transmission disturbances have characteristics visual effect:

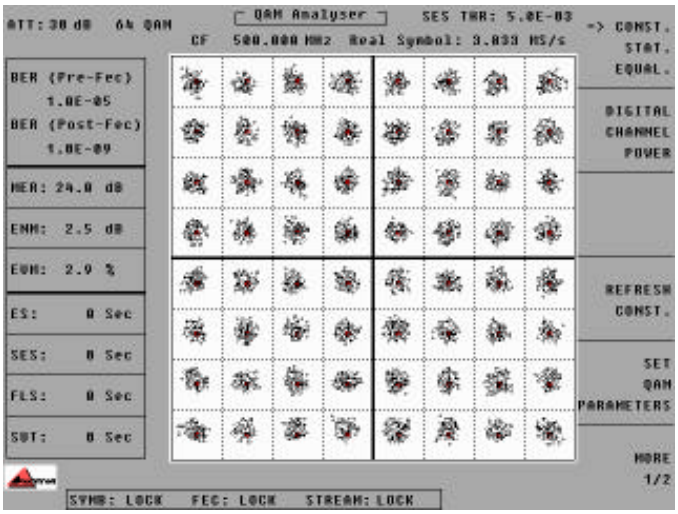
- **phase noise appears as crescent shaped constellation points** ,more apparent on the outer edge, because of angular shift of the signal
- **coherent distortion or CW interference appears as doughnut shaped constellation points** all over, because of the sum of different frequency vectors (Signal and Interference)
- **amplifier compression appears as shift toward center for the outer edge points** because it more severe on large amplitude, it may be associated with phase shift (AM to PM conversion)

Error Vector Magnitude (EVM)

EVM is the measurement of modulation quality of the transmitted signal before the forward error correction stage. EVM will indicate how much interference or distortion is present on the signal. If there is significant degradation on the signal, the constellation points will become unclear and the decoder may not be able to reconstruct the received signal correctly. The **AT-2000RQ** QAM analyzer demodulates the QAM signal, equalizes and then calculates the average size of the error vector in relation to the maximum symbol magnitude.

Error Vector Magnitude = (maximum symbol magnitude / rms error magnitude) X 100%

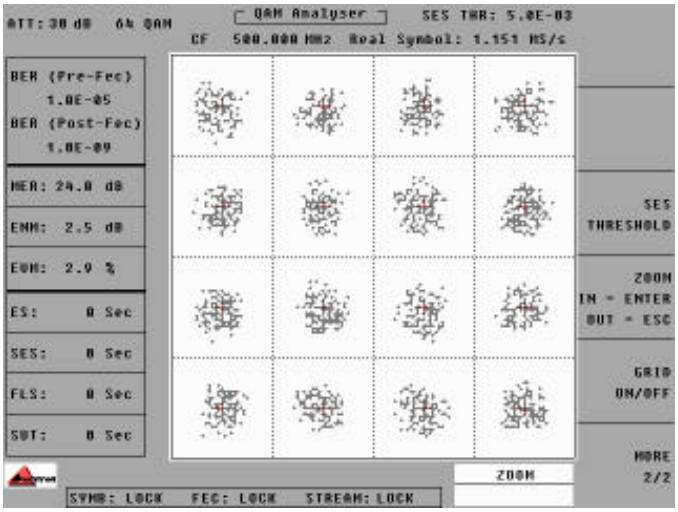
Constellation Display



When measuring the quality of digital signals, it is very useful to see the graphical representation of the constellation. The Constellation Display shows both the I (in-phase component) and Q (quadrature component) values. Each location on the constellation is framed by decision boundaries. If the signal falls within these boundaries, the correct data will be received. The data is in error if it falls outside of its boundaries into adjacent location such as when the signal is affected by noise or other interference. Significant degradations in the signal scan be identified including noise, coherent interference and transmission distortions as well as modulator impairments such as I/Q imbalance or quadrature error.

Understanding the constellation display can help in quickly troubleshooting problems by allowing the operator to identify the type of impairment and isolate the source. Following installation and adjustment of modulators, amplifiers and splitters, modulation impairments can appear due to various I and Q vectors being distorted in amplitude or phase.

Zoom Mode



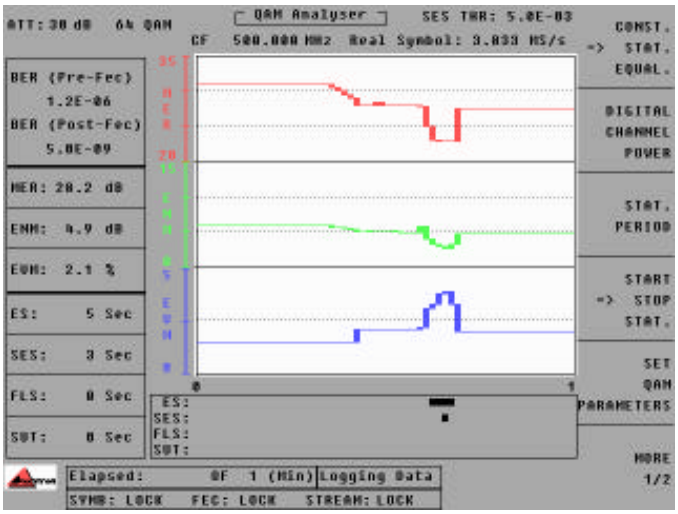
The **AT-2000RQ** also includes a ZOOM mode feature. Select [F6] MORE 1/2 to get to the second menu level. Press [F4] ZOOM and a frame appears around 1/4 of the constellation. Use the spin knob or arrow keys to move the frame to any one of the corners of the constellation and press

the ENTER key to select it for *zooming*. QAM 64 has 1 level of zoom (from 64 to 16) and QAM 256 mode has 2 levels of zoom (256 to 64 to 16).

Pressing [F5] GRID ON/OFF allows turning the grid off and viewing the constellation with out the grid boundaries showing.

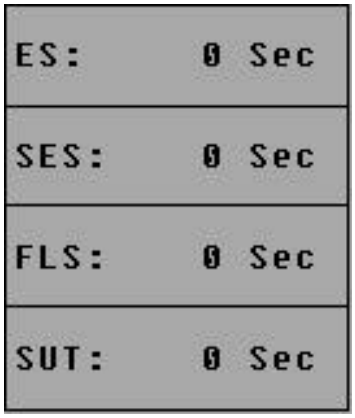
Statistics Graph Display

The constellation analysis and the MER-EVM-ENM measurements are a convenient way to diagnose a system, but quite often it is convenient to characterize a connection for a longer period of time. The **AT-2000RQ** has the capability to gather and store statistics for a period of 1 to 60 minutes or 1 to 72 hours.



Error Statistics

Recorded measurements are MER-EVM-ENM on graph form plus 4 events time markers for the following:



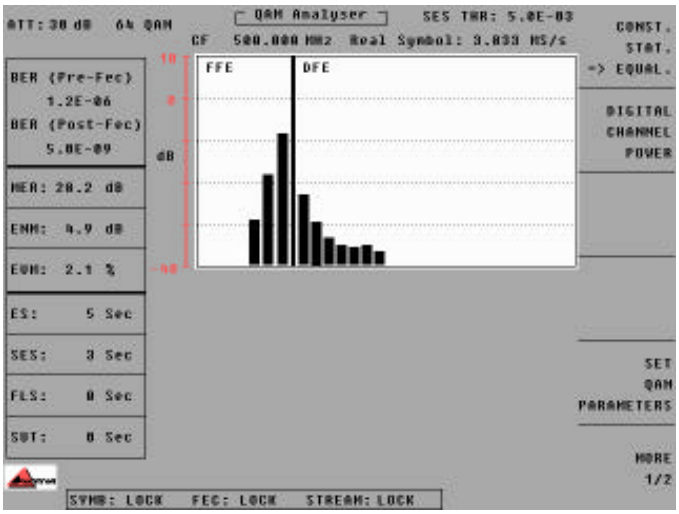
- **ES or ERRORRED SECOND**; that is within each measurement second if one packet has an uncorrected error (Post-FEC)
- **SES or SEVERELY ERRORRED SECOND**; within each measurement second, the ratio of errored packets to transmitted packets is higher than a user settable threshold, between 1e-4 to 1e-2.
- **FLS or FRAME LOSS SECONDS**; within each measurement second, there has been at least one Frame Lock Loss.
- **UNAV or UNAVAILABILITY TIME**; there has been at least 10 consecutive SES.

During statistics gathering period MER-EVM-ENM, a graph is dynamically updated as well as ES, SES, FLS and SUT time markers. At the end of the set period all measurements are recorded and can be visualized globally, or one can zoom into details.

The recorded measurements for BER (Pre and Post) are that of the total period but during the measurement period the dynamic values, second per second, are displayed.

Adaptive Equalizer Display

Digital signals are very susceptible to reflections in the cable. These can be caused by a number of different problems such as bad splitters, loose or bad connectors as well as damaged cables. These reflections can cause errors in the data transmission. To resolve potential problems due to reflections, the digital receivers such as set top converters have an adaptive equalizer that senses the amount of reflections and compensates for them. The receiver manufacturer will recommend a maximum correction specification.



This display shows linear impairments such as poor frequency response reflection. Tap values show how hard the equalizer is working to compensate for impairments. The display includes a bar graph.

The **AT-2000RQ** shows the coefficients of the equalization filter, updated every second. This is a tool used to diagnose bandpass distortion (gain tilt, reflections...). The graph presents the 32 coefficients (8 Feed-Forward Equalizers and 24 Decision Feedback Equalizers). The 8th coefficient is the main signal path, so it is normally very close to 0 dB (gain of 1). The higher the other coefficients the higher the filter needs to compensate distortion, hence less headroom. As the instrument is not ideal there is always some compensation (3/4 coefficients in the -20/-40 dB around the main response and at the 8th DFE a response close to -20 dB {this is the SAW filter triple transit response}).

BAS-1 Bi-Directional Alignment (Optional)

The system consists of the **BAS-1** Headend unit and the Avantron **AT-2000R/RQ** with optional FSK receiver built-in and a **AT402P** Dual Carrier Signal Generator. At the headend, the 19" rack mount **BAS-1** dual channel receiver stands by awaiting the 2 incoming CW carriers (e.g. 6 & 29 MHz).

The technician injects the CW carriers on the return signal path at the field amplifier test point using a **AT402P** Dual Carrier Signal Generator field unit, (e.g. 6 & 29 MHz). The **BAS-1** at the headend monitors the return signal path and will then measure the actual levels of the incoming test signals. The **BAS-1** then transmits the measurement results (dBmV readings) in real-time mode on the forward path using an FSK modulated data carrier at 52 MHz (or whatever custom frequency you may desire).

The field technician using the **AT-2000R/RQ** equipped with the optional FSK data carrier decoder will read the data on the forward path at 52 MHz and will simultaneously display both CW carrier level readings as measured at the headend by the **BAS-1** headend unit.

Model BAS-1 Headend Unit

The Model **BAS-1** is connected at the headend where typical return in-bound signals are to be monitored. The **BAS-1** output **telemetry** carrier must be connected to the forward path headend combiner, where the data transmitted at 52 MHz (other freqs. Available) can be fed out on the forward path of the broadband coaxial system.

Figure 2 - Model BAS-1 Headend Unit

Model AT402P 2 Carrier Generator

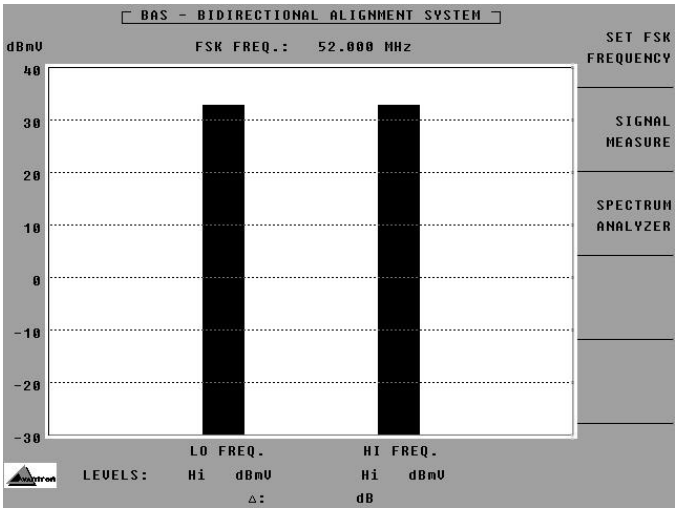
In the field, the Avantron **AT402P** serves to inject a LOW and HIGH (eg. 6 and 29 MHz) CW test carriers on the return path of the 2-way broadband network. The output test point of most line amplifiers will serve as a typical return path input.

Figure 3 - AT402P 2 carrier generator.

Operating BAS-1 Option on AT-2000R/RQ

When the Model **BAS-1** receives these carriers, the LOW and HIGH status LED's will illuminate to indicate that the presence of in-bound test signals was detected. The **BAS-1** measures the actual amplitude levels in dBmV and converts the results to numerical data, which is transmitted using an FSK modulated telemetry carrier. The transmission of the data on a carrier frequency within the forward path bandwidth (standard 52 MHz) will complete the loop from field-to-headend as well as headend-to-field.

The **BAS** is a special function tunes a single, programmable frequency, and looks for the modulated data carrier transmitted at 52 MHz (or other customs frequencies) from the BAS-1 headend unit. While in this position, screen will show a dual bar level display.



If a **BAS-1** FSK data carrier is not present, the display will show **"NO SIGNAL"** or if carrier is present, but no data is modulated upon it, the upper display will shoe **"NO DATA**". If a **BAS-1** data carrier with modulated data is present, the display will show the carrier levels measured by the **BAS-1** at the headend.

The left display bar indicates the low frequency carrier amplitude and the right display bar indicates the high frequency carrier amplitude. A delta differential in dB is also displayed which is convenient for determining tilt.

Setting FSK Receive Frequency

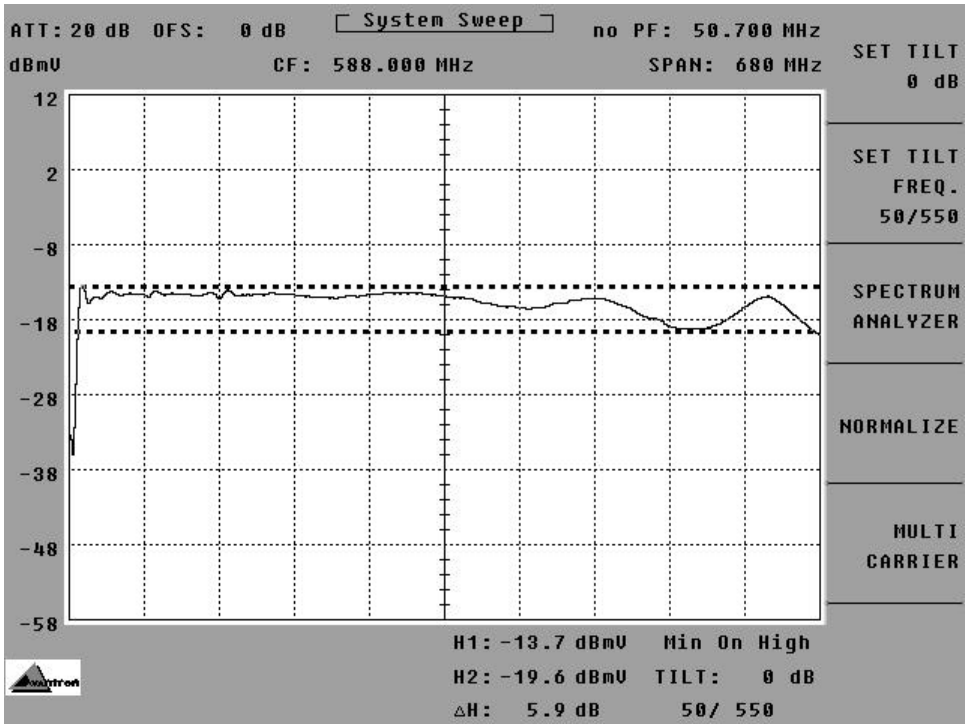
The BAS-FSK receive frequency is displayed at the top of the BAS mode screen.

1. To set the BAS-FSK receive frequency, press the [F1] softkey.
2. If the value is incorrect, use the backspace key to erase the figure.
3. Enter the new frequency with the numeric keys. (the alpha function is automatically disabled)
4. Once the new value has been entered, press the [ENTER] key to save the new value.

Non-Interfering RF Sweep System (Optional)

Low-Level RF Sweep testing remains the one of the best tools for adjusting RF frequency response and analyzing a whole frequency band. The Avantron Model **AT-2000R/RQ** optional low-level synchronous RF Sweep System does not disturb the reception of distributed signals. This is accomplished by a reliable tracking spectrum analyzer approach to frequency response testing which doesn't require an elaborate setup. The RF sweep signal is simply integrated with the other signals using a standard RF coupler.

A level of 35 to 40 dB below the carriers makes it entirely invisible to the signals carried by the network (including scrambled TV channels, data, FM carriers and specialized pilot carriers). Real-time update of thousands of data points per second means exceptional resolution, while eliminating "rubber screwdriver" effects. Yet, in the field, the operator has full control to zoom-in to any portion of the band for precise alignment.



Installing Sweep System

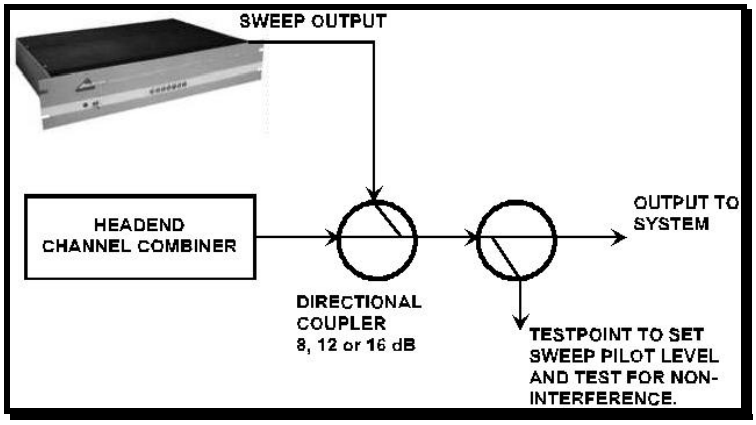
The system functions with the optional **Model AT-2000G RF SWEEP TRANSMITTER**. In order to avoid any interference on the network, it is essential to inject the reference sweep test signal at correct levels before making the hook-up shown in Figure 26. Two signals are transmitted by the **AT-2000G**:, a fixed frequency reference pilot at 50.7 MHz (custom frequencies available) and a 5 to 1 GHz sweeping test signal.

Model AT-2000G Sweep Generator.

The reference sweeping test signal of the **AT-2000G** is maintained at a level of approximately 20 dB below the pilot carrier level, thus the **AT-2000G** output pilot signal is normally set at a level of approximately 20 dB below the lowest video carrier level when combined with the system channels.

On initial set-up, the Avantron model **AT-2000G** RF SWEEP TRANSMITTER and the **AT-2000R/RQ** must normalised by connecting both units directly, using the same cable length which will be used in the final hook-up. From the SWEEP menu on the **AT-2000R/RQ**, a ***Sweep Normalise*** function is initiated (See NORMALIZE PROCEDURE) in order to fully correct the frequency response signatures of the Sweep Reference Generator and the Sweep/Analyzer.

The Model **AT-2000G** is connected at the headend as referred to in *diagram.* Avantron recommends installing a directional coupler between the channel combiner network and the outgoing trunk. The coupler value should be chosen so that the coupled tap loss of the coupler and the internal attenuator of the **AT-2000G** allow adjusting for proper operational reference sweep test signal levels.



Connecting Sweep Generator at Headend.

The directional coupler should be connected so that the "Output" port is connected to the channel combiner and the **AT-2000G** is connected to the coupled port or tap, which will allow the test signal to be combined with the system output and directed toward the distribution system.

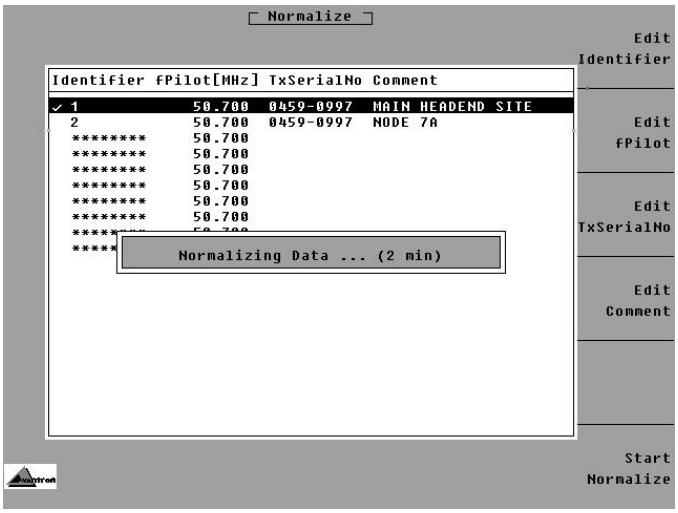
Use a length of coaxial cable, no longer than necessary to reach from the **AT-2000G** output to the directional coupler.

NOTE: Avantron recommends connecting a standard TV set on the outgoing trunk test point and checking for any noticeable interference. The proper output level of the AT-2000G is established at the point where no interference is observed on the TV monitor.

Normalising Sweep Response

The NORMALIZE function will correct the frequency response signatures of both the **AT-2000G** Reference Sweep Generator and the **AT-2000R/RQ** Sweep/Analyzer.

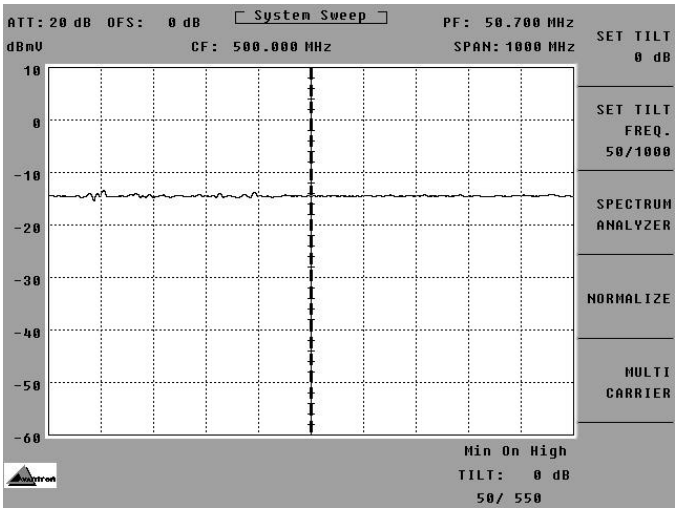
The initial setup, the **AT-2000R/RQ** and the **AT-2000G** Test Generator to be connected directly to each other, using the same cable which will be used in the final hook up so that the sweep response signatures can be normalised..



1- Set **AT-2000G** attenuator for proper system operation. Typical level of the pilot carrier is between 16 to 20dB below the visual carrier levels. Using a television monitor, set the pilot level with the front attenuator just below the threshold of interference.

2- Enter SWEEP mode on the **AT-2000R/RQ** and select [F4] to begin the normalise procedure.

3- A table will pop up to indicate in which of the 10 slots the curve will be stored. Hi-lighting one of the choices and pressing [F6] key will select the slot and start the normalise function.



WARNING - Do not disconnect RF input of the AT-2000R/RQ until the procedure has completed, otherwise the sequence will have to be repeated.

Operating System Sweep

The **AT-2000R/RQ** SWEEP mode operates in conjunction with the **AT-2000G** Test Generator. When this mode is accessed, the **AT-2000R/RQ** must lock on and synchronise to the 50.7 MHz reference pilot carrier that is generated by the **AT-2000G**. If the reference pilot is not present when this mode is selected, the **AT-2000R/RQ** will return to the Spectrum Analyzer mode.

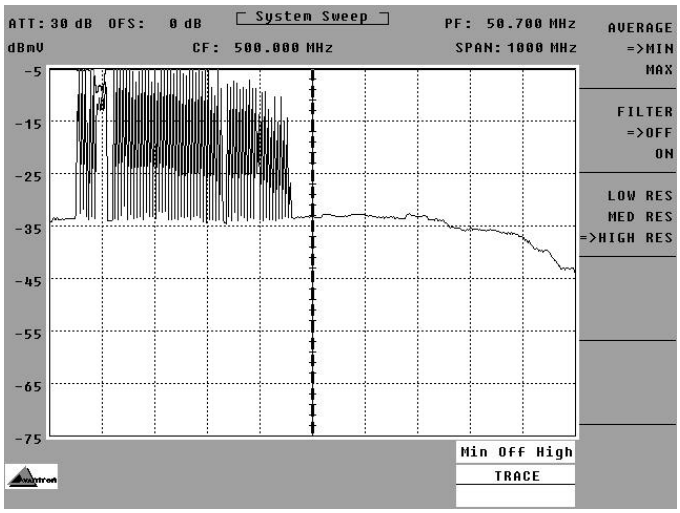
In SWEEP mode, the SPAN is continuously variable from Max Span of 1000 MHz to as little as 10 MHz. Vertical scale can be toggled between 10, 5, 2 dB/div.

A system tilt value as well as start (F1) and stop (F2) frequencies can be entered to compensate the displayed trace. This will bring trace back to a flat display, so that proper peak-to-valley measurements can be made using H1 and H2. (The tilt value effects the portion of the displayed sweep between the F1 and F2 frequency points. Markers if desired, can be set by pressing the [MARK] key and accessing the MARKER MENU. (See the Marker section for more information on how to set markers)

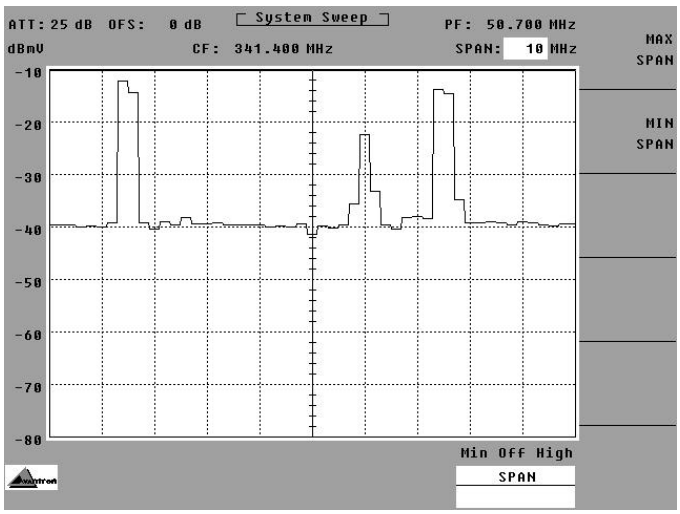
NOTE - To normalise the AT-2000R/RQ Sweep/Analyzer with an AT-2000G Test Generator, select [F4] = NORMALIZE. Connect AT-2000R/RQ directly to AT-2000G generator output and follow instructions on the screen.

Sweep Display Selections

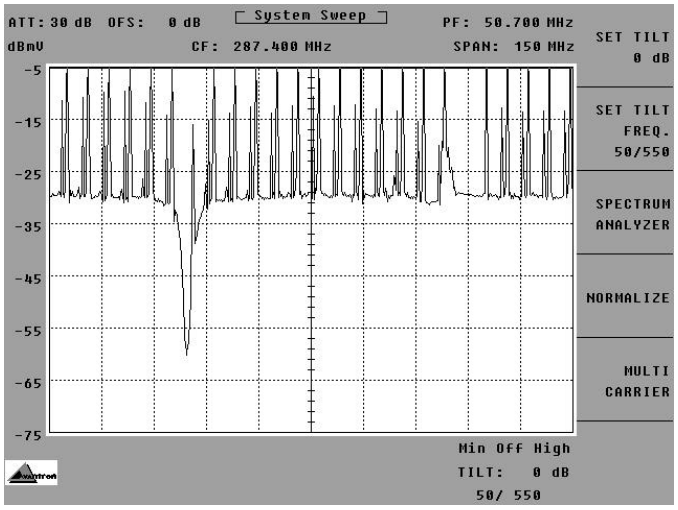
Several Digital Averaging options are available from the DISPLAY softkey menu. A raw Sweep display trace shows the actual carriers that are at least 35 - 40 dB above the reference sweep signal. The FILTER display function as shown in Figure 29 uses special software technique to extrapolate the sweep trace from the channel signals on the system.



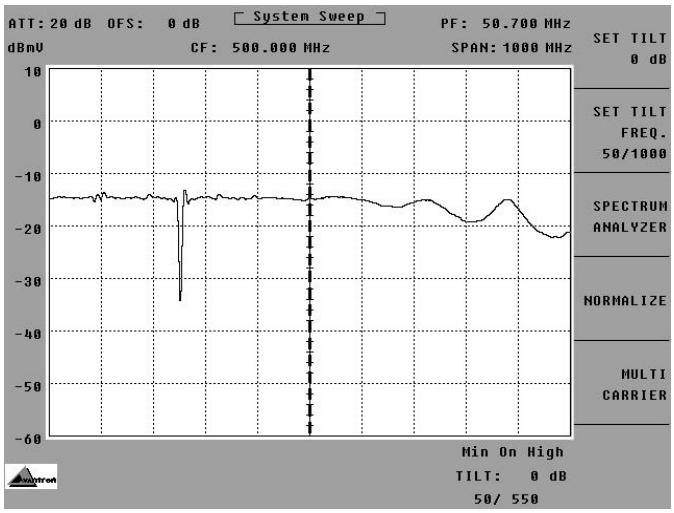
The Avantron sweep system processes 5000 data points across 1 GHz of bandwidth. This fine resolution allows Avantron to offer the unique feature of ***ZOOMING*** in to small portions of the sweep response. The *ZOOM* can be set to as little as 10 MHz Span, 1 MHz per division is sufficient for viewing in-channel frequency response.



Two levels of digital averaging are available, AVERAGE MIN or MAX



The Avantron System Sweep display will show very subtle problems such as bad VSWR mismatch problems. The display clearly shows the video and audio carriers on the system, as well as any response problem or suckout that may appear between the carriers.



Avantron Service and Support

Avantron is committed to excellent service worldwide. Our goal is to provide you with professional assistance in the use of our software and services, wherever you are located.

Technical Support and Customer Service solutions vary by country. If you have questions about the services described below, please refer to the section “Technical Support” at the end of this chapter.

At Avantron we get everyone involved and trained to handle Customer service and support requirements. This assures our customer that there is always someone that can be reached at a moment's notice. Avantron also provides sufficient product training to regional Avantron representatives allowing them to actually provide some of the product support locally and in a prompt and personalised manner.

AT-2000R/RQ Maintenance

RF Connector Replacement

Since the RF input and output connectors may receive many insertions per day of coaxial cable, the life of the connectors can be fairly short. The connectors are a 1 GHz rated, common type "F" double female that can be easily replaced with the aid of a 7/16 inch wrench. No case disassembly is required. Exact replacement F-connectors are available from AVANTRON.

Battery Pack Replacement

Sealed Lead Acid batteries will last for hundreds of charge-discharge cycles, if properly cared for. However after the normal lifetime of service the battery pack will need to be replaced. This requires some disassembly of the unit. To replace the battery pack, perform the following steps:

1. Remove the unit from its optional canvas carry bag.
2. Remove the six (6) Phillips screws on the upper /rear of the **AT-2000R/RQ** unit.
3. Slide the upper cover towards the rear and lift up and out.
4. Carefully unplug the two wire terminal connectors and do not short the positive and negative battery connections.

5. Remove the strap that holds down the Sealed Lead-acid battery by removing the securing screws, one is located on the rear panel and the other is located on the chassis.
6. Insert the new battery pack into the battery holder portion of the chassis.
7. Re-install the hold down strap and chassis screws and reconnect the 2 wire terminal connectors to the replacement battery.
8. To reinstall the chassis into the case, slide the chassis assembly into the case and replace the six (6) Phillips screws on the upper / rear of the **AT-2000R/RQ** unit.

When re-assembly is completed, turn the unit on and press the [MENU] key to show the charge level of the battery. If the battery is nearly discharged (10.5 to 11 VOLTS), connect the Battery Charger/power supply into the mains power and the **AT-2000R/RQ**, turn the analyzer off and allow the battery to charge at least 6 hours.

Technical support

Avantron is located on the Eastern Time zone with regular office hours from 8:00AM to 5:00PM. A toll free number service covering all of North America is provided at no charge. Key Avantron personnel can always be reached any time of the day through a toll free number or electronic mail service over the Internet.

International Customers should contact the nearest Avantron Representative or the factory at (514) 725-6652 or by Fax at (514) 725-5637

North America Toll Free: (800) 297-9726
E-mail address for Technical Support: info@avantron.com
WEB SITE: www.avantron.com

AUTHORIZED AVANTRON SERVICE CENTERS

Canada

Avantron Technologies Inc.
8596 Pie IX Blvd.
Montreal, Quebec
H1Z 4G2
Tel: (514) 725-6652
Fax: (514) 725-5637

USA

Avantron Technologies Inc.
710 East Ogden, Suite 160
Naperville, Illinois
60563

Returning Equipment To Avantron

Avantron manufactures equipment to very high standards. Products are warranted against defects in materials and workmanship, as specified in our published product warranty. When properly used and operated, your equipment will provide many years of service. Should it become necessary to return the, equipment to Avantron for in or out of warranty repairs or calibration, the following steps should be followed.

(Note: If products are repaired or altered by persons not authorised by Avantron, or not in accordance with instructions furnished by Avantron or if the products have become defective due to a result of misuse, improper repair, abnormal operating conditions; the labour and materials required to effect the changes will be billed at our standard repair rates.)

Customer's Responsibility

- Contact Avantron and request a **R**eturned **M**aterial **A**uthorisation number. Be sure to have your model and serial number ready.
- After receiving the authorisation number (RMA#), return the equipment with an accurate description of the symptoms and be sure to state the authorisation number on your paperwork. Transportation charges to Avantron is the responsibility of the client.
- Original packaging is preferred. If unavailable, carefully package the equipment in alternate packing material to ensure adequate protection during shipping.

Avantron's Responsibility

- Avantron will acknowledge the receipt or the returned equipment and at that time bring any discrepancies to your attention.
- Avantron will replace or repair, at it's discretion, any component or sub-assembly it deems necessary to return the unit to a proper condition.
- After the necessary repairs, Avantron will undergo complete test and re-calibration.
- Every precaution is taken by Avantron to ensure that every unit meets all electrical and mechanical specifications prior to returning the equipment to the client.

Note: Avantron is not responsible for failures caused by transportation to/from the customer's location; nor by rough handling by the customer after receipt

causing further damage to the product. Avantron is solely responsible for the defects stated above and in our standard product warranty policy.

If you require information or assistance, contact Avantron at (800) 297-9726 toll free from anywhere in North America or by fax (514) 725-5637 or by E-mail to: info@avantron.com.

Glossary of Terms

ASCII
Stands for American Standard Code for Information Interchange. The ASCII character set is the most universal character-coding set.

baud rate
See speed.

click
To press and release a mouse button quickly.

command button
A button that carries out an action. A command button usually has a Label that describes the action it carries out.

communication port
See serial port.

communications settings
Settings that specify how the information is transferred from your computer to a device.

control-menu box
The icon that opens the control menu for the window. It is always at the left of the title bar.

database
A set of related data tables organized as a group.

database record
Defines a single element of a single element of a relational database file that contains each of the fields defined for the file. A record is the logical equivalent of a row of a table.

double-click
To rapidly press a release a mouse button twice without moving the mouse.

download
To transfer information from an external data source (other computer or equipment) to your computer.

extension
The period and up to three characters at the end of a filename. An extension usually identifies the kind of information the file contains.

file
A block of information saved in a computer.

file format
The way information is structured in a file.

icon
Graphical representation of an element.

menu
A list of available commands in an application window. Menu names appear in the menu bar near the top of the window. You open a menu by selecting the menu name.

Modem
An abbreviation for "modulator-demodulator", the device that converts digital data to analog signals before sending across phone lines, and converts analog signals back to digital data when receiving them.

parallel port
A connection on a computer, usually LPTI, where you plug in the cable for a parallel printer.

port
A connection or socket on the computer. Ports are used for connecting devices, such as printers, monitors, and modems, to your computer, and for sending information from your computer to the devices. Serial ports (COM) and parallel ports (LPT) are the most commonly used ports.

selection
To mark an item so that a subsequent action can be carried out on that item. You usually select an item by clicking it with the mouse or pressing a key. After selecting an item, you choose the action that you want to affect the item.

serial port
A connection on a computer, usually COM1, where you plug in the cable for a serial device. Modems and Avantron System Analyzers are serial devices.

speed
Refers to the rate at which the data is sent through the serial port, measured in bits per seconds (BPS). The Avantron System Analyzer is set for 115 Kbs.

test point
Name of a file saved in a STAR 2010 device. Often called file name.

text file
A file containing only letters, digits, and symbols. A text usually consists of characters coded from the ASCII character set. Also known as data file.

toolbar
A group of command button icons arranged horizontally across the top of a window that performs functions that would ordinarily require one or more menu choices.

upload
to transfer your computer to an external device.

window
A rectangular area on your screen in which you view an application. Sometimes windows are displayed within other windows.

Index

AM detector, 49
AM/FM demodulator, 47
AMPL menu key, 22, 48
Amplitude, 51
AT1000G RF SWEEP TRANSMITTER., 85
AT2000R Maintenance, 90
AT2000R Spectrum Analyzer Specifications, 8, 15, 17
AT402P Dual Carrier Signal Generator, 81
Attenenuator, 51
AutoCalibration, 20
AUTOTEST, 29, 45, 56
Averaging, 88
BACKSPACE key, 23
BAS-1 Bi-Directional Alignment, 69, 81
Battery Pack Replacement, 90
Battery type, 9
Beat-Near-Noise Correction, 64
C/N Test Procedure, 60
CARRIER SWEEP, 56
Carrier-To-Noise (C/N), 60
CATV distortions, 57
CATV MEASUREMENT PAK, 45
CHANNEL PLAN, 56
Channel Plan Setup, 45
COLOR SETUP, 44
COMM key, 23, 33
COMMENT field, 27
Company Identification, 43
Comparing, 30
Composite Second Order (CSO), 64
CONNECTOR REPLACEMENT, 90
Context related help screens, 20
CURSOR keys, 23
Custom Screen Colors, 44
Date, 43
Date Format, 43
Default Instrument Settings, 27, 41
default settings, 19
Deviation kHz scale, 49
Digital Averaging, 88
Documenting, 31
Edit Plan, 45
ENTER key, 23
Erasing Records And Settings, 31
ESC key, 23
External power jack, 15
FCC Testing and Compliance, 32
F-connectors, 90
FILTER display, 88
FM detector, 49
Free up memory, 31
FREQ menu key, 22, 48
Frequency Counter, 53
Frequency references, 22
frequency tuning, 48
Front-Panel Keys, 21
FSK modulated data carrier, 81
FUNCTION keys, 22
Gated Measurements, 60
HELP? key, 23
horizontal markers, 52
Hum Modulation - Test Procedure, 58
Hum Modulation Measurement, 57
Initial Checkout, 19
in-service, 65
Installing Sweep System, 85
Interference, 86
Invalid Key Beep (On/Off), 43
Key Description, 22
KNOB, 23
LCD Backlight Off Timer, 42
Levels & Frequencies, 56
Log off, 25
Log on, 25
Log scale, 49
Low-Level RF Sweep testing, 84
Main Control Keys & Menus, 48
MARK menu key, 22, 48
Markers, 22, 52, 88
Max Span, 49
MEM C key, 23
MEM+ key, 23
MENU key, 22
Menu Keys, 21
Model BAS-1 Headend Unit, 81
Modulation scale, 49
Multi Carrier Mode, 55
Noise-near-Noise Correction, 62, 63
Non-Interfering Rf Sweep System, 84
Non-volatile memory, 22
Normalize, 88
Operating BAS-1 Option on AT2000R, 82
Operating System Sweep, 88
Operating Time, 9
pilot, 85
PLAN MANAGER, 46
POWER key, 22
Power Off Beep (On/Off, 43
Power Off Timer, 42, 73, 74
Precision Frequency Counter, 53
Preprogrammed settings, 28

PRESET key, 22
PREV MODE key, 22
PRINT key, 23
printer driver, 43
printer drivers, 31
Printer Type (Epson/Hp):, 43
Printing reports, 56
proof of performance testing, 31
RBW, 50
RECALL key, 22
RECALL RECORDS directory, 29
Recall Stored Records, 29
Recall Stored Settings, 29
Reference Level, 51
Reference Offset, 51
report headers, 32
Resolution Bandwidth, 50
Return in-bound signals, 81
Returning Equipment, 92
RF Input Connector, 90
RS-232 Serial Interface, 33
RS-232C, 23
Screen Colors, 44
Sensitivity, 51
Service Centers, 91
Setting FSK Receive Frequency, 83
Setup Screen, 41
SITE ID, 27
Soft Keys, 21
SPAN menu key, 22, 48
span related functions, 49
Storage capabilities, 27
STORE key, 22
Store Records, 27
Store Settings, 28
Stored records, 31
Superimpose on live trace, 22
Superimpose On Live Trace, 30
Sweep Display Selections, 88
Sweep Normalize, 85
Sweep Test Generator, 88
Sweep Time, 50
SWT, 50
Tag records, 31
Test signal, 85
Time, 43
TRACE memu key, 22
TRACE menu key, 48
Transferring to PC, 27
TV Channel Mode, 55
Typical return path input, 82
User Identification, 43
User Parameters, 41
VBW, 51
vertical markers, 52
Vertical scale, 88
Vertical Scale, 51
Video Bandwidth, 51
Zero Span, 49
ZOOMING, 89