MODEL
ME7840A
POWER AMPLIFIER TEST SYSTEM

OPERATION AND
MAINTENANCE MANUAL

Anritsu

490 JARVIS DRIVE - MORGAN HILL, CA 95037-2809

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DECLARATION OF CONFORMITY

Manufacturer's Name: ANRITSU COMPANY

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

declares that the product specified below:

Product Name: Power Amplifier Test System

Model Number: MS4782A, MS4782D

conforms to the requirement of:

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

Electromagnetic Interference:

Emissions:	CISPR 11:1990/EN55011:1991 Group 1 Class A
Immunity:	EN 61000-4-2:1995/EN50082-1:1997 - 4kV CD, 8kV AD EN 61000-4-3:1997/EN50082-1:1997 - 3V/m ENV 50204/EN50082-1:1997 – 3V/m EN 61000-4-4:1995/EN50082-1:1997 - 0.5kV SL, 1kV PL EN 61000-4-5:1995/EN50082-1:1997 - 1kV L-L, 2kV L-E

Electrical Safety Requirement:

Product Safety: IEC 1010-1:1990 + A1/EN61010-1: 1993

Director of Corporate Quality

Morgan Hill, CA

07-JUN-00
Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close, Stevenage Herts, SG1 2EF UK, (FAX 44-1438-740202)

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DANGER	This indicates a very dangerous procedure that could result in serious injury or death if not performed properly.
WARNING	This indicates a hazardous procedure that could result in serious injury or death if not performed properly.
CAUTION	This indicates a hazardous procedure or danger that could result in light-to-severe injury, or loss related to equipment malfunction, if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manuals

(Some or all of the following five symbols may or may not be used on all ANRITSU equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.)

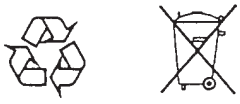
The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions BEFORE operating the equipment.

This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.

This indicates a compulsory safety precaution. The required operation is indicated symbolically in or near the circle.

This indicates warning or caution. The contents are indicated symbolically in or near the triangle.

This indicates a note. The contents are described in the box.



These indicate that the marked part should be recycled.

For Safety

WARNING

Always refer to the operation manual when working near locations at which the alert mark, shown on the left, is attached. If the operation, etc., is performed without heeding the advice in the operation manual, there is a risk of personal injury. In addition, the equipment performance may be reduced.
Moreover, this alert mark is sometimes used with other marks and descriptions indicating other dangers.

WARNING

When supplying power to this equipment, connect the accessory 3-pin power cord to a 3-pin grounded power outlet. If a grounded 3-pin outlet is not available, use a conversion adapter and ground the green wire, or connect the frame ground on the rear panel of the equipment to ground. If power is supplied without grounding the equipment, there is a risk of receiving a severe or fatal electric shock.

WARNING

Repair

This equipment can not be repaired by the operator. DO NOT attempt to remove the equipment covers or to disassemble internal components. Only qualified service technicians with a knowledge of electrical fire and shock hazards should service this equipment. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision components.

WARNING

Use two or more people to lift and move this equipment, or use an equipment cart. There is a risk of back injury, if this equipment is lifted by one person.

Table of Contents

Chapter 1 General Information

Chapter 2 Installation

Chapter 3 Operations, General

Chapter 4 Operations, Calibration

Chapter 5 Operations, Measurement

Chapter 6 Performance Verification Procedure

Chapter 7 Preamplifier Operations

Chapter 1
General Information

Table of Contents

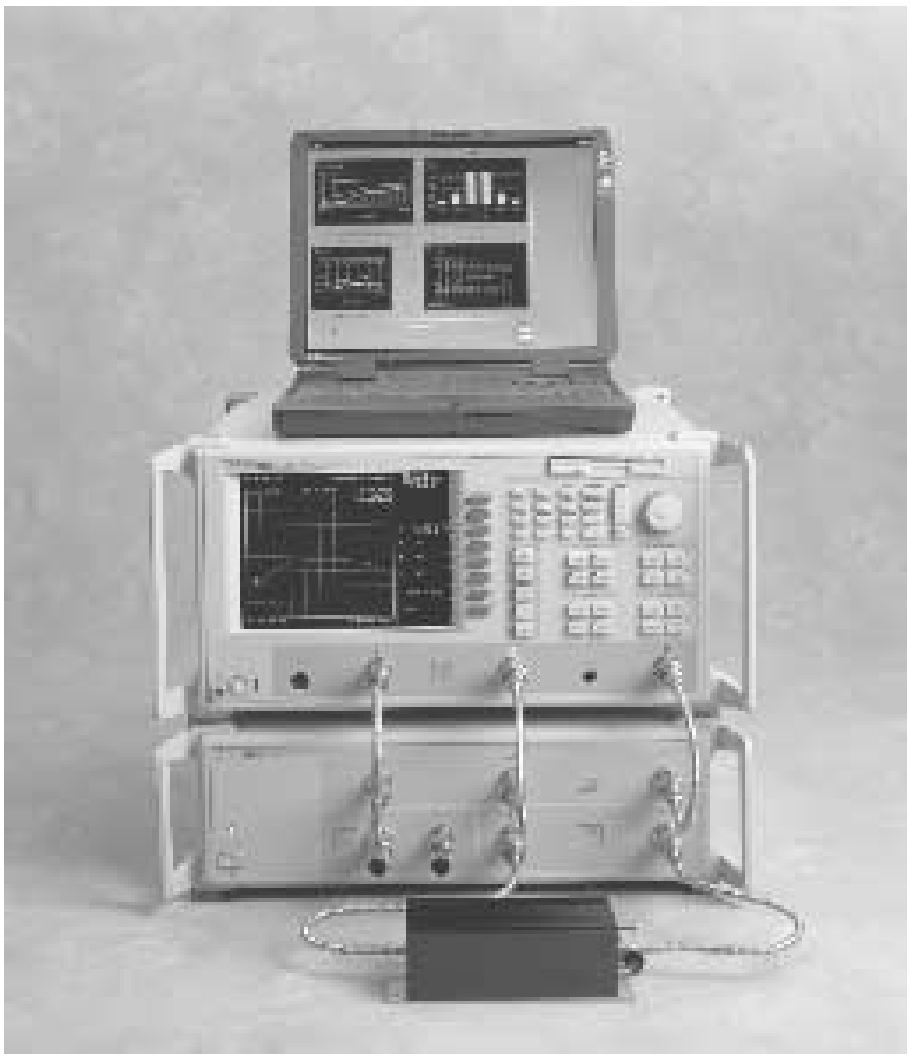


Figure 1-1. *Model ME7840A Power Amplifier Test System (PATS)*

Chapter 1
General Information

1-1 SCOPE OF THIS MANUAL

This manual provides operating and maintenance information for the ME7840A Power Amplifier Test System (PATS, Figure 1-1). The following topics are discussed:

- Equipment Description
- Equipment Installation and Connection
- Software Description
- Software Installation
- Calibration
- System Operation
- Test Procedures and Test Results Interpretation
- System Performance Verification

The procedures described in this manual presume a working knowledge of vector network analyzers and RF power amplifier testing procedures. Refer to the other manuals supplied with the ME7840A (see below) for more detailed explanations of the system equipment and procedures.

1-2 INTRODUCTION

This chapter provides information to familiarize the user with the basic ME7840A Power Amplifier Test System. Included is information about related manuals, and the available models and options.

1-3 RELATED MANUALS

The ME7840A manual set consists of the following manuals: The operating and programming manuals are supplied with the equipment; the maintenance manuals are optional items that may be purchased.

Manual Description	ANRITSU Part Number
ME7840A Operating & Maintenance Manual (OMM)	10410-00225
MS462XX Operating Manual (OM)	10410-00203
MS462XX Programming Manual (PM)	10410-00204
MS462XX Maintenance Manual (MM)	10410-00205 (Optional)
MS4782X Test Set Maintenance Manual (MM)	10410-00218 (Optional))

1-4 RELATED LITERATURE

There are a number of marketing brochures and related application notes available for the Power Amplifier Test System and the MS462XX VNMS. Refer to Table 1-1 for a listing and part numbers. Most of these items are available from our Internet site (*www.us.anritsu.com*) or can be ordered via email from AKA Direct (laura@akadirect.com).

Table 1-1. *Related Manuals, Literature, and Software for MS462XX/ME7840A*

Literature	Part Number
Brochures and Data Sheets	
Scorpion Data Sheet/Brochure	11410-00212
AutoCal Brochure	11410-00189
PATS Datasheet	11410-00239
Application Notes	
PATS Adjacent Channel Power Ratio (ACPR)	11410-00264
Scorpion Noise Figure	11410-00210
Scorpion Noise Figure Accuracy	11410-00227
Scorpion Intermodulation Distortion	11410-00213
Scorpion Harmonics	11410-00222
Scorpion Frequency Translated Group Delay	11410-00236
Scorpion Global Power Sweep	11410-00243
Scorpion Multiple Source Control	11410-00244
Reflectometer Measurements-Revisited	11410-00214
Time Domain for VNAs	11410-00206
AutoCal	11410-00258
Software	
Scorpion Command Encyclopedia	2300-364
Power Tools	2300-218
LabView Drivers	2300-358
Exact Uncertainty	2300-361
Demonstration Kits	
Scorpion Demo Kit	SC6287

1-5 CONVENTIONS

Throughout this manual, the ME7840A Power Amplifier System may be referenced as PATS or ME7840A; the MS462XC may be referenced as Scorpion or MS462XC; and the MS4782X Test Set may be referenced as Test Set or MS4782X.

1-6 SERIAL NUMBER

All ANRITSU instruments are assigned a unique six-digit serial number, such as “940101.” This number is affixed to a decal on the rear panel of each unit. In any correspondence with ANRITSU Customer Service, please use this number.

1-7 ONLINE MANUALS

This manual is available on CD ROM as an Adobe Acrobat™ (*.pdf) file and is included in a pocket on the inside front cover.. The file can be viewed using Acrobat Reader™, a free program that is also available on the CD ROM. This file is “linked” such that the viewer can choose a topic to view from the displayed “bookmark” list and “jump” to the manual page on which the topic resides. The text can also be word-searched.

1-8 PATS SYSTEM OVERVIEW

The ANRITSU ME7870A Power Amplifier Test System (PATS) is intended for the measurement and real-time graphical display of the following parameters of a power amplifier in the frequency range of 800 to 2400 MHz:

- S-Parameters including Hot S_{22}
- K Factor
- Gain Compression and Phase Distortion
- Intermodulation Distortion
- Harmonics
- Drain Current and Power Added Efficiency (PAE)
- Adjacent Channel Power Ratio (ACPR)

PATS is designed to facilitate alignment, tuning and pass/fail testing of the components, modules and subassemblies of a power amplifier as well as the completed amplifier.

1-9 HARDWARE DESCRIPTION

The ME7840A hardware (Figure 1-1) consists of a MS462XC, Direct Receiver Access (DRA) Scorpion, a MS4782X Test Set, a customer supplied Personal Computer (PC), and an optional current probe (refer to Chapter 2, Figure 2-4). The MS462XC is available in two frequency ranges: 10 MHz to 3 GHz or 10 MHz to 6 GHz.

The Test Set is available in two configurations, as described in Table 1-2 The MS4782D is standard, and the MS4782A is Option 2. A block diagram of the PATS is shown in Figure 1-2 and the Option 2 system in Figure 1-3.

Table 1-2. *Test Set Configurations*

Model	Frequency Range (MHz)	Max AUT Power Output (Watts)	Reverse Measurements (S_{22}, Hot S_{22}, S_{12} Possible)	Circulator (at AUT Output Path)
MS4782A	800 to 1000	50	Yes	Internal
MS4782D	800 to 2400 (Note 1)	100 (Note 2)	Yes	External

Notes:

1. This frequency range does not account for any restricting effects caused by use of external circulator.
2. This Max AUT power assumes a minimum isolation of 23 dB provided by external circulator(s). Two circulators may have to be used to provide the required isolation.

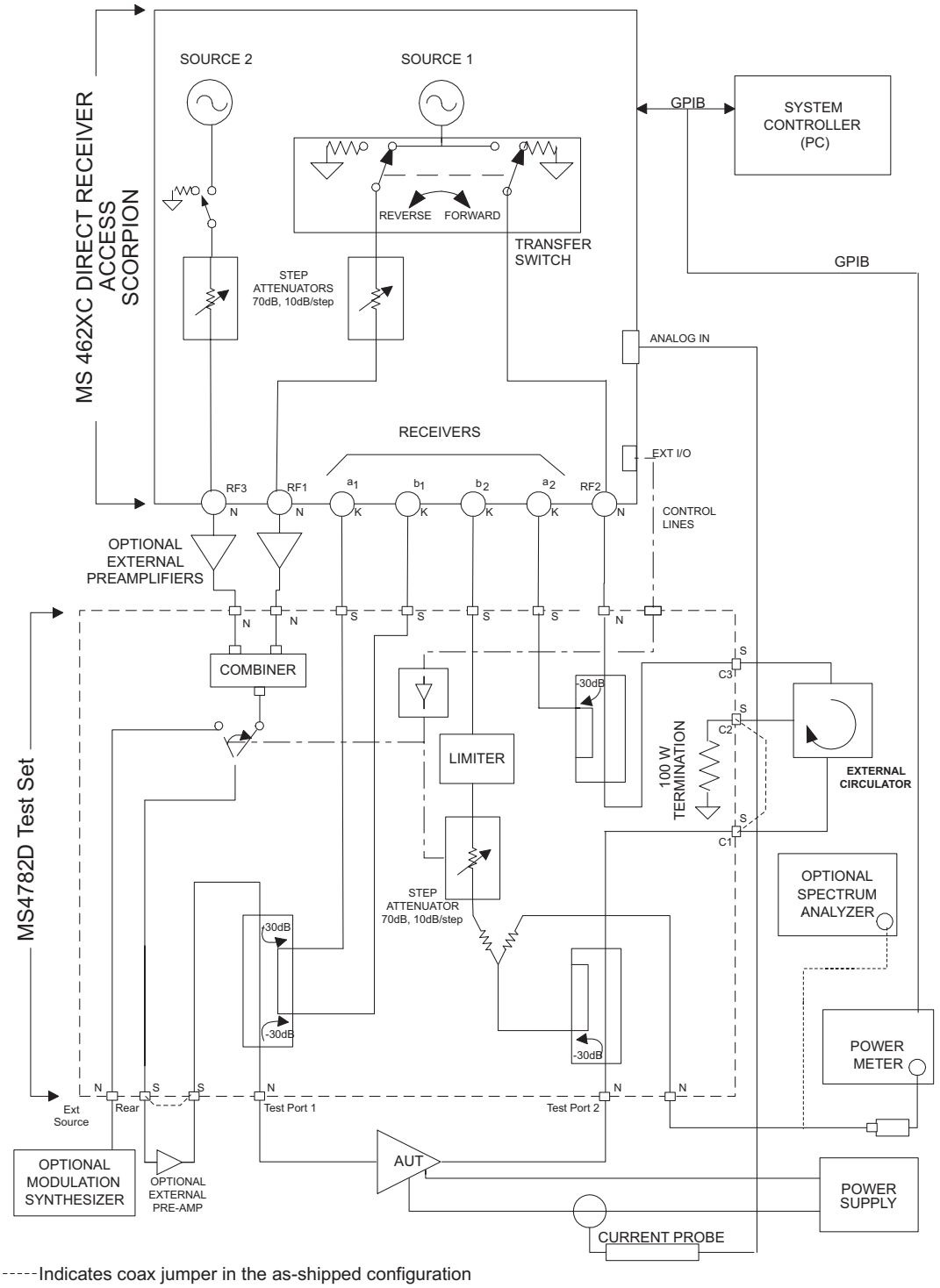


Figure 1-2. *Overall Functional Block Diagram of the Basic Power Amplifier Test System (PATS) with MS4782D Test Set*

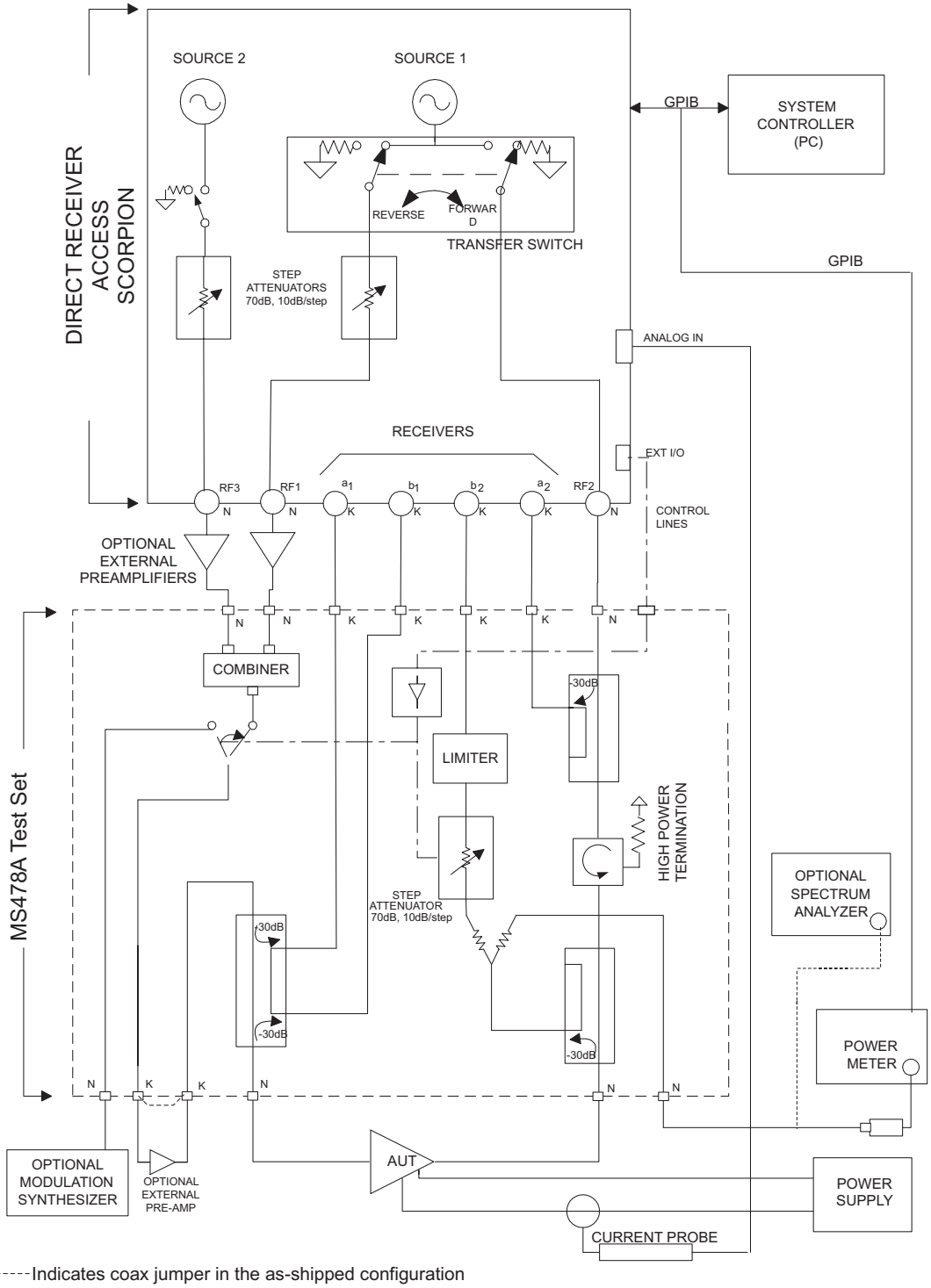


Figure 1-3. *Overall Functional Block Diagram of the Option 2 Power Amplifier Test System (PATS) with MS4782A Test Set*

1-10 SYSTEM DESCRIPTION

The Power Amplifier Test System (PATS) consists of the MS462xC Direct Receiver Access Scorpion, the MS4782x Power Amplifier Test Set and a library of external measurement software. PATS software (now also called "Scorpion PA Navigator™") orchestrates calibration and performs measurement on power amplifiers in the 800-2400 MHz range. Modules exist for S-Parameters, K-Factor, IMD, Single tone power sweep, Two tone power sweep, Harmonics, Hot S22 and ACPR. Pats software runs best on Win95/NT/2000 and needs a National Instruments GPIB controller (prefer NI-488.2 software version 1.7 or higher and NI VISA version 2.5 or higher), and Scorpion firmware version 1.11 or higher.

DRA Scorpion

The Scorpion Direct Receiver Access (DRA) version Vector Network Measurement System (VNMS) (Figure 1-2) functions under control of the software residing in the PC through GPIB commands. The software supports tuning and alignment operations by generating real time graphic displays of the measured data on the PC screen.

Under software control, 3rd, 5th and 7th order IMD products can be measured and displayed. Also, the Upper and Lower Side Band (USB & LSB) components of the IMD products are measured and displayed separately.

The DRA Scorpion includes the following capabilities:

- Two internal, independent RF sources. Each source has a range of –15 dBm to +10 dBm. A 0dB to 70dB step attenuator (10 dB / step) is provided for each source resulting in a Power Output range of –85 dBm to +10 dBm from each source.
- Complete built-in capability for IMD measurements. A combiner is provided in the Test Set.
- Internal Transfer Switch enabling S_{22} and Hot S_{22} measurements. The reflectometer set-up is provided in the Test Set.
- Direct access to each of the four receiver channels (two reference channels and two test channels) for maximum flexibility in measuring forward and reverse S-parameters over a wide range of AUT output power. The Test Set provides incident and reflected signal separation.

MS4782X Test Set

The Series MS4782X Test Set contains a Wilkinson type combiner that combines the two RF signals from Ports 1 and 3 (RF1 & RF3) of the Scorpion. External preamplifiers can optionally be provided at the combiner input to boost the input RF power to the amplifier-under- test (AUT).

CAUTION

The combiner has power input rating of 30-Watts maximum when terminated with a VSWR of 1.2:1. For an open or short at the combiner output, the combiner input power rating is 0.5 Watts maximum.

The output of the combiner is fed to a source selection switch that enables one of the following to be applied to the AUT:

- The combined signal from the Scorpion sources.
- A modulated signal from an optional external modulation synthesizer.

A provision for the insertion of an optional external pre-amplifier (after the combiner and source selection switch) is also provided. Refer to Chapter 7, “Preamplifier Operations,” for details.

The test set includes a bi-directional coupler at the input of the AUT that separates the incident signal from the reflected signal. The power rating of this bi-directional coupler is 100 watts average. The –30 dB portion of the incident and reflected signals are applied to the Scorpion reference port a1 and test port b_1, respectively, for S_{11} measurement. The S_{11} measurement determined by the DRA Scorpion is simply the ratio of the reflected signal to the incident signal.

The amplified output of the AUT is fed to a high power coupler in the test set. The power rating of this coupler is also 100-watts average. The –30 dB coupled arm of this coupler is routed to the test port b_2 of the Scorpion through a 6 dB resistive divider and a 0-dB to 70-dB step attenuator (10dB/step). A limiter is also provided in this path provide added protection for the Scorpion reference channel .

The divider enables the connections of a power meter or Spectrum Analyzer, when desired, to measure the AUT b_2 output.

The through arm of the 100-W coupler is routed to a high power (100-Watt) termination through a circulator. In the MS4782A Test Set, the circulator is internal and has a rating of 100 watts average. This circulator has an isolation specification of 20-dB minimum. This means that the AUT output power is attenuated by 20 dB (plus other losses) before reaching the Scorpion port 2. Since the maximum (no-damage) power level for this port is 27 dBm (0.5 watt), this establishes the maximum AUT output power at 50 watts.

In the MS4782D Test Set, the circulator is external as shown in Figure 1-2. In selecting an external circulator, the following criteria should be used.

- *Power rating:* Should be no less than the power output of the amplifier-under-test (AUT). It should be noted that a 100 watt termination is provided in the Test Set for the termination port of the external circulator.
- *Bandwidth:* Should be sufficiently wide to cover the frequency band of the AUT.
- *Isolation:* Should be no less than (P_o –27 dB), where P_o is the power output in dBm of the AUT. Thus for Po = 47 dBm (50 watts), a 20 dB isolation is required. For a P_o greater than 47 dBm up to 50 dBm (100 watts), two circulators in series can be used.

Where S_{22} or Hot S_{22} measurements are not required, power amplifiers with up to 100 watts average output power can be tested with the MS4782D Test Set without any circulator by connecting the through arm of the output coupler directly to the 100 watt termination (Port C1 connected to Port C2 on the rear. The unit is shipped from the factory with this loop jumper.)

For S_{22} measurements, the transfer switch located within the Scorpion routes the source 1 output signal to the output port of the AUT via Port 2 (RF2) of the Scorpion. A separate 100-watt coupler in the test set applies the –30 dB portion of this incident signal to the Scorpion reference port a_2. The –30 dB portion of the signal reflected from the AUT output port is applied to the Scorpion test port b_2 by means of the AUT output coupler.

The PATS calibration is performed with the test set in place, at the connectors where AUT will be connected directly. Therefore, the test set components and cables are included in the calibration loop and their effects are calibrated out, resulting in correct and accurate measurements of the AUT.

The software supplied by ANRITSU supports operator control of the source selection switch and step attenuator in the test set. This control is achieved through the parallel TTL control lines available at the Scorpion rear panel "External I/O" connector. The GPIB commands from the PC to the Scorpion set the TTL control lines to the desired states.

Connectors and Ports

On the front panel of the Model MS4622/3C DRA Scorpion three Type N (female) connectors are provided for Ports 1, 2 and 3.

CAUTION

Connecting the external circulator incorrectly or placing a direct connection between C1 and C3 on MS4782D rear panel will cause permanent damage to MS462XC.

Port 1 provides RF source 1 when the transfer switch is in the forward position, and is terminated in 50 ohms to ground when the transfer switch is in the reverse position.

Port 2 provides RF source 1 when the transfer switch is in the reverse position, and is terminated in 50 ohms to ground when the transfer switch is in the forward position.

Port 3 is allocated to RF source 2. Under independent control, port 3 provides RF source 2, or is terminated in 50 ohms to ground.

On the rear of the unit, four SMA connectors (Figure 1-4) are provided for Reference ports a_1 and a_2 and Test Ports b_1 and b_2. The front of the unit as well as all other mechanical specifications is the same as the model MS4623B.

On the MS4782D Test Set, three additional SMA connectors provide for connecting an external circulator. If reverse measurements (S_{22} and Hot S_{22}) are not desired, then a circulator is not required. Instead, a through line should be connected between connectors C1 and C2 (Figure 1-5). The MS4782A is shipped from the factory with this through line in place.

1-11 K FACTOR

K factor is a parameter which is sometimes used to indicate the stability of an amplifier. K factor is a function of all four S parameters and is defined by the formula

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{11}S_{21}|}$$

Where

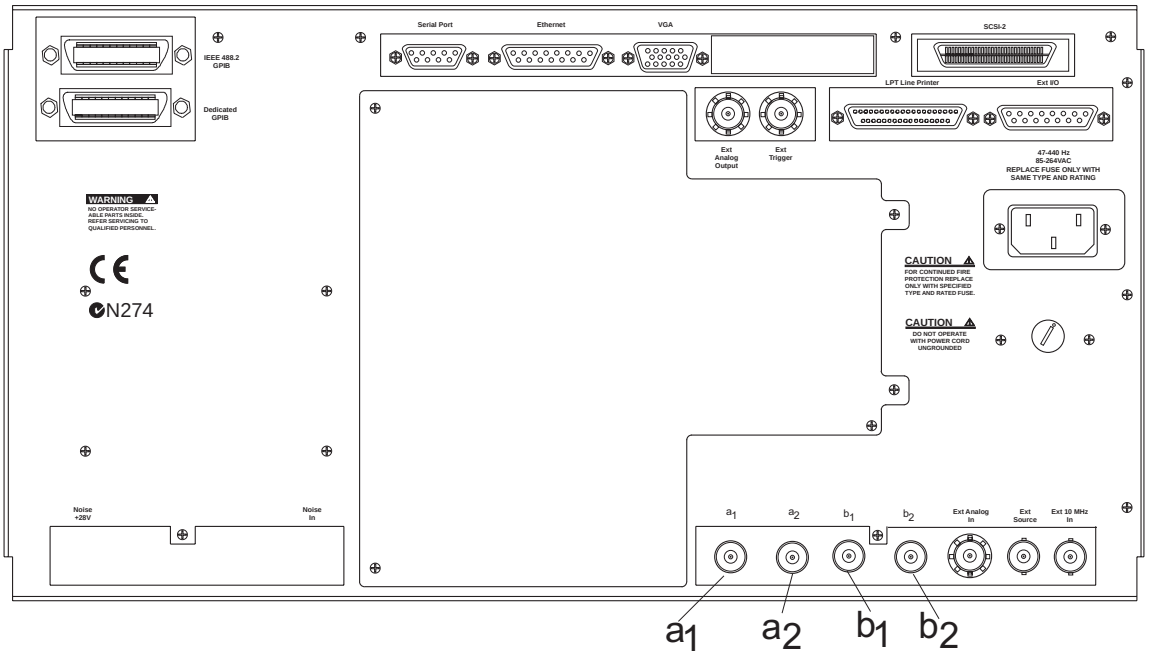


Figure 1-4. *MS462XC Rear Panel Showing Ports a_1, a_2, b_1, and b_2*

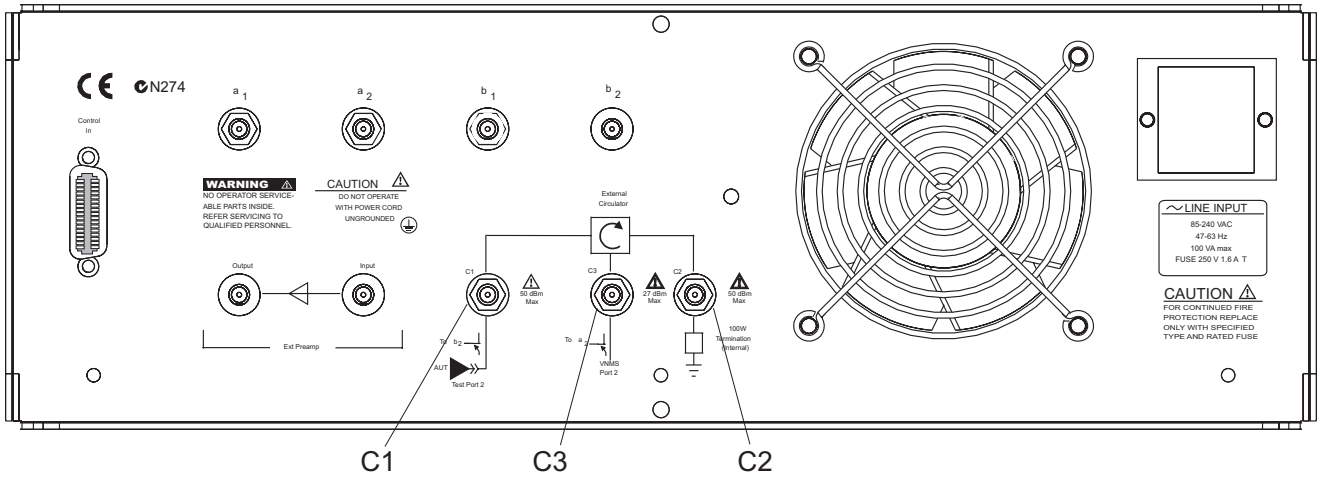


Figure 1-5. *MS4782A Rear Panel Showing Circulator Connections C1, C2, and C3*

$\Delta = S_{11}S_{22} - S_{12}S_{21}$

The necessary and sufficient condition for unconditional stability is that K>1 and $|\Delta| < 1$.

K factor is available as the sixth choice in the S parameters menu (first five choices are: S_{11}, S_{22}, S_{21}, S_{12} and ALL). The same conditions and setup as S-parameter measurements including a full 12-term calibration applies to this measurement. The result is "dynamic" meaning that the above formula is applied at each point for each sweep as the S parameters are reported to the PC over the GPIB.

1-12 ADAPTIVE P STOP

Adaptive P stop lets users enter a gain compression value at which the program will adjust the final P_{in} value during a power sweep. For example, if user sets 3 dB P-stop, the program commands the execution of one sweep, find P_{in} value where 3 dB gain compression occurs, back up 1 increment, and reset this as the upper bound of the power sweep.

1-13 MS7840A OPTIONS

The following options are available:

Table 1-3. *MS7840A Options*

Model	Option Number	Description
ME7840/1	1	Replaces MS4623C with MS4622C (3 Ghz option)
ME7840/2	2	Replaces MS4782D Test Set with MS4782A Test Set
ME7840/3	3	Delete Test Set (Note: The ND43425 Accessory and Interconnect Kit will also be deleted with this option.)

1-14 OPTIONAL ACCESSORIES

The accessories described below are available from ANRITSU.

- Model ML2430A Power Meter
- Model MG3672A Digital Modulation Signal Generator/with MG0314A W-CDMA Modulation Unit
- MG3681A Digital Modulation Signal Generator for use with ACPR measurements on W-CDMA devices
- Model MS2602A Spectrum Analyzer
- Model MS8607A Digital Mobile Radio Transmitter Tester
- AC/DC Current Probe (for AUT drain current and power-added-efficiency (PAE) measurements) (See below).

Max Current	Accuracy (at lesser current range setting)	ANRITSU Part Number
100 mV/A: 10A 10 mV/A: 100A	3% of reading ±50 mA	2000-1067
1 mV/mA: 1A 10 mV/A: 80A	2% of reading ±5 mA	2000-1085

- Circulators to be used externally with the MS4782D Test Set (see below).

Frequency Band	Isolation	Max AUT Power	ANRITSU Part Number
800 to 1000 MHz	20 dB min	50 watts	1000-50
1.8 to 2.5 GHz	20 dB min	50 watts	1000-52
1.8 to 2.5 GHz	22 dB min	79 watts	1000-53

Note: All circulators have 3 SMA female connectors.

- 15SS50-0.35B Cable Assembly. Three of these cables can be used to connect any one of the external circulators offered above to the MS4782D Test Set. The same cable is also used to connect the Test Set to the MS462XC receivers on the rear panel.

1-15 CHANGES IN VER 1.11 SOFTWARE

The PATS Version 1.11 software supports the following new measurements and features.

- ACPR measurements
  - CW and swept power ACPR
  - GPIB control of Agilent ESG for CDMA and WCDMA
  - GPIB control of Anritsu MG3681A for WCDMA
  - GPIB control of R&S FSIQ spectrum analyzer for verification
- Simplified calibration
  - Added calibration wizard
  - Eliminated use of calibration specification files
- Additional Measurements
  - Multifrequency Gain compression in One Tone power Sweep
  - Multifrequency Gain compression in Two Tone power Sweep
  - Swept offset measurements in Two Tone power Sweep
  - Power Swept measurements displayed as a function of Power Out
- Calibration File manager
  - Save and recall sets of calibration files that correspond to a particular part or test set variation

1-16 PREVENTIVE MAINTENANCE

The ME7840A Power Amplifier Test System does not require any preventive maintenance.

1-17 USER SUPPLED TEST SET

The ANRITSU MS4782X is the recommended test set for PATS; however, users supply their own test set. To ensure that such a test set will function properly with the PATS, a set of specifications and caveats is provided in Appendix B.

1-18 PERFORMANCE SPECIFICATIONS

Specifications for the M7840A Power Amplifier Test System are provided in Table 1-4.

Table 1-4. *Performance Specifications for ME7840A Power Amplifier Test System*

Characteristic	Value	Notes
Amplifier Under Test Power Output	100 W maximum	With MS4782D Test Set and with23 dB isolation between AUT power output and MS4623C, Port 2
	50 W maximum	With MS4782A Test Set
Bandwidth through Test Set	800 MHz to 2.4 GHz	With MS4782D Test Set (Note 1)
	800 MHz to 1.0 GHz	With MS4782A Test Set
Amplifier Under Test Input Power range available from PATS	–85 to +5 dBm	At AUT input
IMD 3rd Order Dynamic Range	70 dB min	With 10 Hz IF Bandwidth @300 kHz tone separation and -20 dBm tone levels
Port Power Accuracy	±0.1 dB maximum	With flat power calibration
	±1 dB maximum	Without flat power calibration
Drift over 60 hours	0.15 dB maximum, peak to peak	
Dynamic Range	80 dB minimum	Overall system, including test set
Port Match (test ports 1 and 2)	40 dB minimum	Corrected value
	13 dB minimum	Uncorrected value
Directivity	40 dB minimum	Corrected value
Environmental	Storage Temperature Range	40° C to +75° C
	Operating Temperature Range	0° C to +50° C
	Range Over Which Specifications Apply	23 ±3° C
	Relative Humidity	5% to 95% at +40° C
Physical, MS4782X Test Set	Height	152.5 mm (6 in.)
	Width	444 mm (17.4 in.)
	Depth	500 mm (19.7)
	Weight	10 kg (22 pounds) or less

Note 1: This frequency range does not take into account any restricting effects of the external circulator (if one is used for reverse measurements)

1-19 RECOMMENDED ITEMS

Table 1-5 provides a list of test equipment and other items needed for calibration and performance verification.

Table 1-5. *Recommended Test Equipment*

Item	Critical Specification/Notes	Manufacturer/Model
Power Meter	GPIB capable	ANRITSU Model ML243XA
Power Sensor	10 MHz to 6 GHz	ANRITSU Model MA247XA
N connector Calibration Kit	Type N Open, Short, Broadband Load	ANRITSU Model 3653 or 3753LF
Offset Termination	6 dB	ANRITSU Model SC5237
Offset Termination	20 dB	ANRITSU Model SC5270
Power Divider		ANRITSU Model 11N50B
Cable	50 Ohm, N-male to N-male	ANRITSU Model 3670NN50-2
Adapter	50 Ohm, N-male to N-male	ANRITSU Model 34NN50A r
GPIB Cable	None	ANRITSU 2100-2
SMA/3.5 mm Connector Calibration Kit	Required if amplifier-under-test (AUT) has SMA/3.5 mm connectors	ANRITSU 3750LF

1-20 USER SUPPLIED ITEMS

The following items required for the operation of the ME7840A Power Amplifier Test System must be supplied by the user.

Item	Critical Specification
Personal Computer (PC)	Pentium II or better, 200 MHz or faster, with Windows® 95/2000 or NT operating system and National Instruments GPIB card installed.
GPIB Cable	None

Chapter 2
Installation

Table of Contents

Chapter 2
Installation

2-1 INTRODUCTION

This chapter describes the installation, connection and set-up of the equipment that comprises the ME7840A Power Amplifier Test Station.

2-2 EQUIPMENT COMPLEMENT

The ME7840A is made up of the following pieces of equipment:

- Scorpion® Vector Network Measurement System (VNMS), Direct Receiver Access (DRA) version:
  Model MS4622C (10 MHz to 3 GHz) or
  Model MS4623C (10 MHz to 6 GHz)
- Model MS4782X Power Amplifier Test Set
- Scorpion PA Navigator™, system measurement software
- Current probe(s) (optional item)
- One or more external circulators (optional item, for use with MS4782D Test Set
- Accessory Kit: Includes interconnect cables and 50Ω terminations for Aux ports
- Optional for ACPR measurements: MG3681 Signal Generator for W-CDMA or Agilent ESG E4423B Signal Generator for CDMA.

2-3 UNPACKING and INSPECTION

The ME7840A equipment has been securely packaged. The packaging material and container should be retained in case the equipment must be re-shipped or placed into storage.

The MS4622C or MS4623C DRA Scorpion® VNMS and the MS4782X Test Set are each packed within heavy cardboard boxes.

Step 1. Carefully cut the sealing tape on the top box surface with a packing knife.

Step 2. Open the box lids, and remove the upper layer of foam material.

Step 3. Lift the equipment from the boxes. Two persons should do this, as the equipment is heavy and bulky.

A listing of the non-optional-accessories always supplied with PATS is listed below. The cables and terminators are shown in Figures 2-3 and 2-2, on page 2-5.

Item	Part No.	Quantity
Broadband Termination	28N50LF	2
Control Cable	803-49	1
RF Cables, Type N connectors (front)	15NN50-0.25B	3
RF Cables, SMA connectors (rear)	15SS50-0.35B	4

2-4 INSTALLATION - HARDWARE

System hardware is set-up is a straight-forward process. Follow the steps below in sequence to ensure a trouble free installation.

Step 1. Place the MS462XC on top of the MS4782X Test Set. Figure 2-1 shows how the green colored feet on the case of each unit stack on each other.

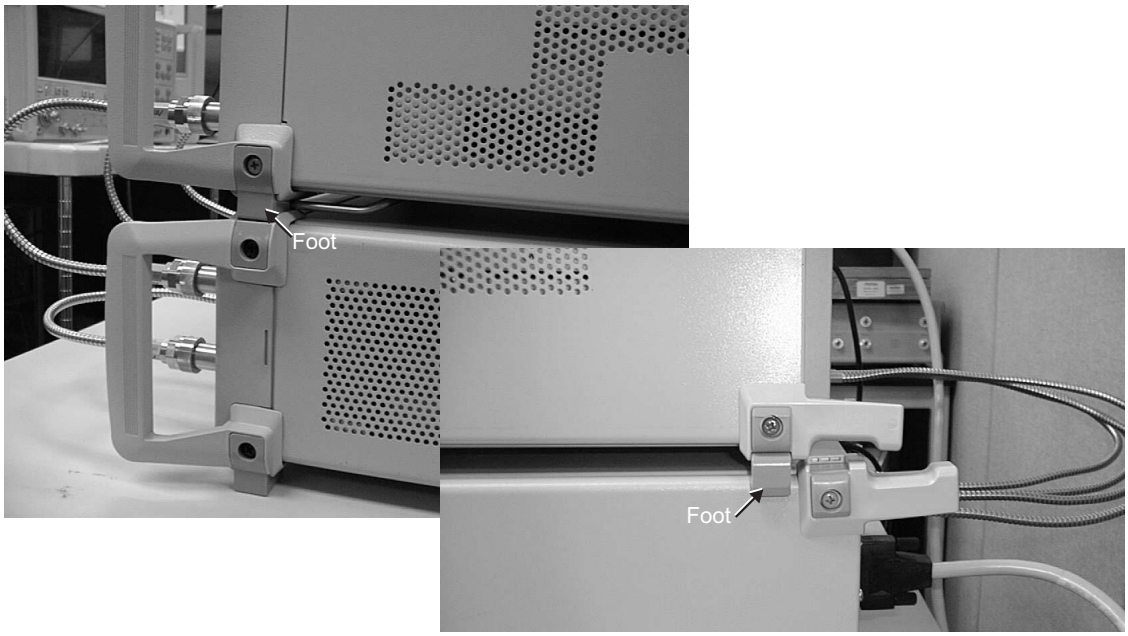


Figure 2-1. *ME7840A Component Assembly*

Step 2. Install the three front RF interconnect cables. Figure 2-3 (following page) shows the installation of the RF interconnect cables between the front panel of the MS462XC and the front panel of the Test Set. Table 2-1 lists the applicable connectors by designation or function.

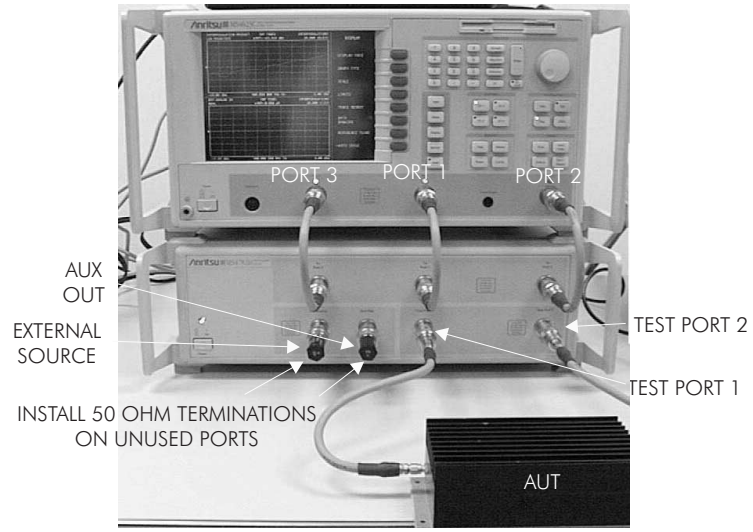


Figure 2-3. *ME7840A Front RF Cable Connections (through-line shown between test port 1 and test port 2)*

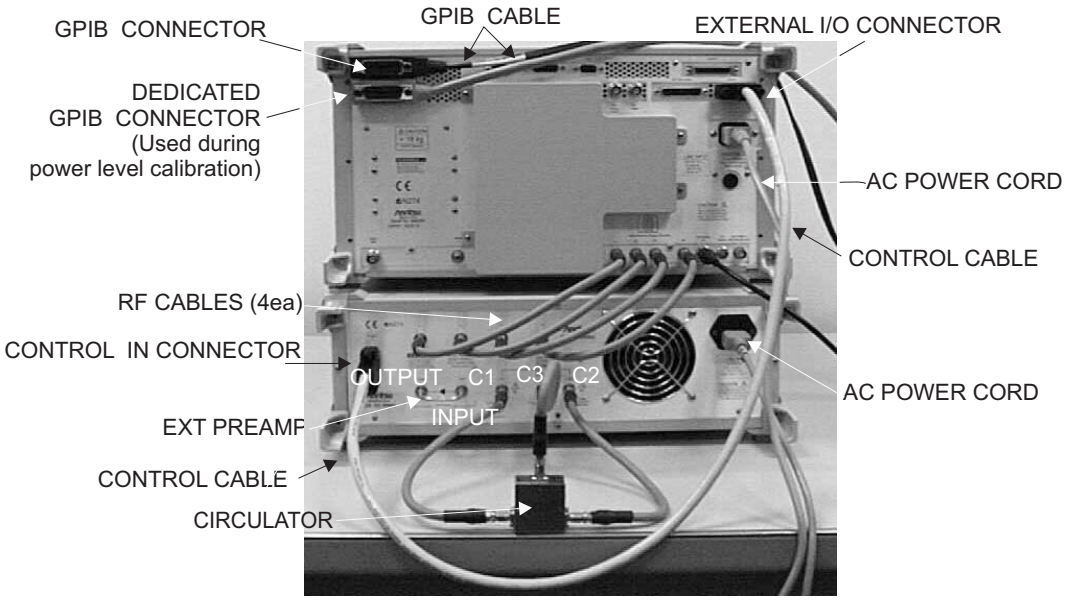


Figure 2-2. *ME7840A Rear Cable Connections*

Step 3. Install the four RF cables between the rear of the MS462XC and the Test Set. Torque the cables to 8 inch-pounds (SMA Connectors) or 12 inch-pounds (Type N connectors). Table 2-1 lists the applicable connectors by designation or function.

Table 2-1. *RF Cable Connection*

VNMS - FRONT	Connects To:	**TEST SET - FRONT**
PORT 1		"TO PORT 1"
PORT 2		"TO PORT 2"
PORT 3		"TO PORT 3"
TEST SET - FRONT	Connects To:	**DEVICE UNDER TEST**
TEST PORT 1		DUT INPUT
TEST PORT 2		DUT OUTPUT
VNMS - REAR	Connects To:	**MS4782X -REAR**
PORT a1		PORT a1
PORT a2		PORT a2
PORT b1		PORT b1
PORT b2		PORT b2
MS4782D TEST SET - REAR	Connects To (See Figure 1-2 for a block diagram)	**CIRCULATOR**
C1		Circulator 1 or C2
C2		Circulator 2 or C1
C3		Circulator 3 or Open

Step 4. Install the control cable between the External I/O connector on the rear panel of the MS462XC and the Control In connector on the rear panel of the Test Set.

Step 5. Connect the GPIB cable from IEEE-488.2 connector on the rear panel of the MS462XC to the PC/System Controller. (Note: This cable is not supplied with the ME7840A PATS.)

Step 6. Connect an AC power cord to each of the three-prong connectors on the rear panel of the Test Set and the MS462XC.

Step 7. (Optional, for drain current PAE measurements) Connect the current probe cable BNC connector to the Ext. Analog In connector on the rear of the MS462XC as shown in Figure 2-4 (page 2-7).

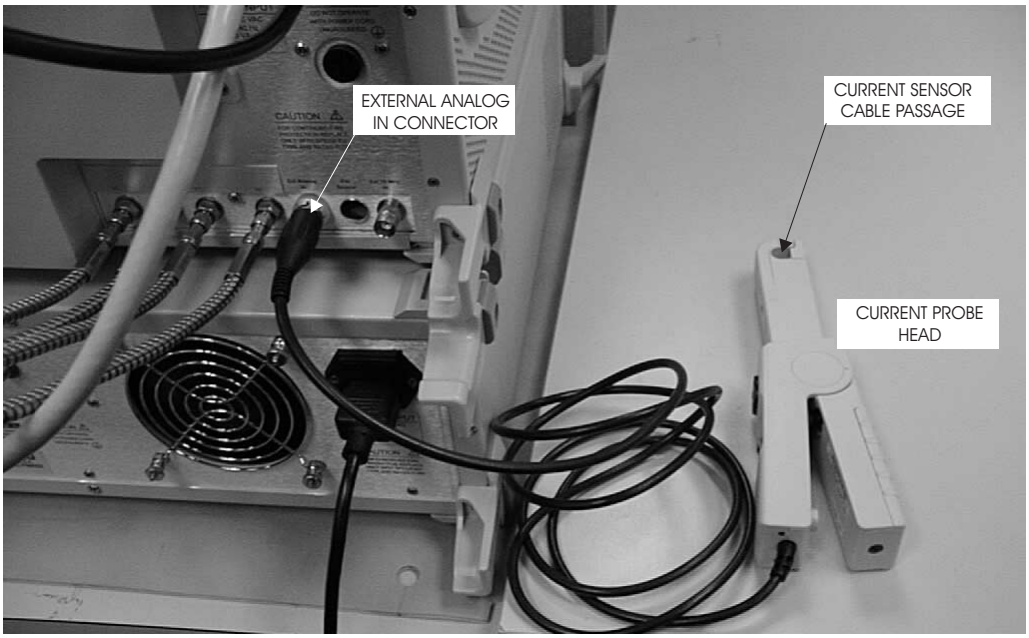


Figure 2-4. *Current Probe Connection*

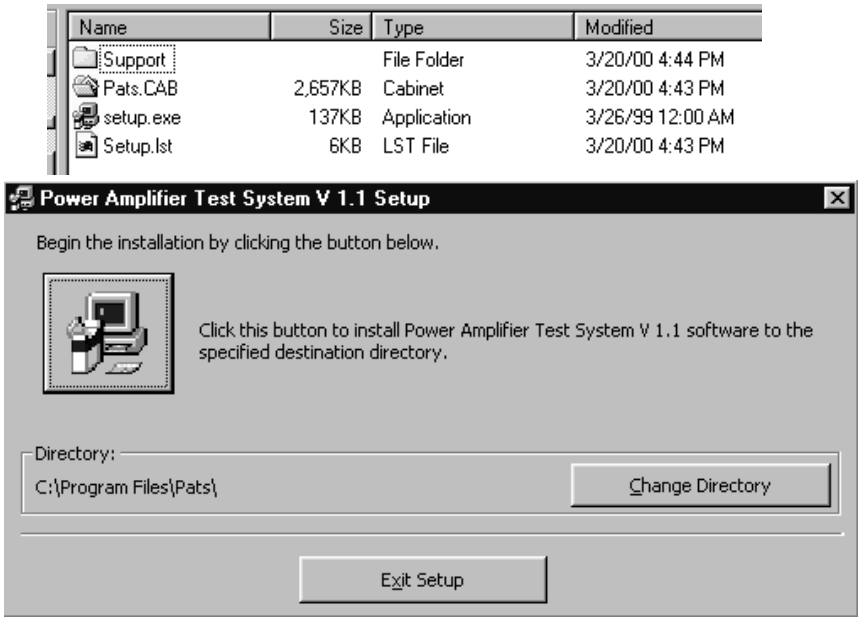


Figure 2-5. *Software Installation Window*

2-5 INSTALLATION - SOFTWARE

ME7840A software is delivered on a CD. The ANRITSU Power Tools library Version 4.0 or higher is required to be installed on the target system (the PC which is receiving the installation of ME7840A software). Power Tools Version 4.0 is also included in the ME7840A Software CD.

Installation

Run the appropriate *Setup.exe* files to install Power Tools then the ME7840A software (Figure 2-5). During installation, the system may indicate that some files being installed already exist. In general it is best to accept copying newer versions of files and reject copying older versions. If in doubt, cancel the installation, backup the files in question, and try again. The Readme.txt file lists the files and versions copied to the target system during installation of ME7840A Software.

The system may also copy some files during ME7840A installation andthen ask you to reboot. If this happens, reboot your Windows PC and run the ME7840A Setup.exe program again after rebooting.

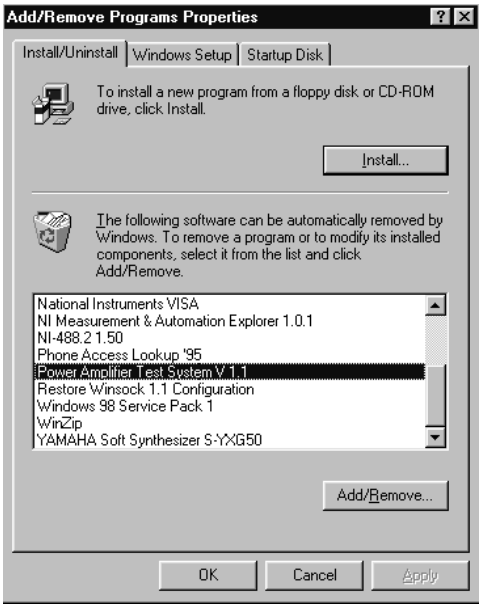
What else is on the CD?

The CD includes a Readme.txt file in the root directory and two folders. The readme file contains specific instructions for installing the software and a listing of the features in the version being installed. The folders are as follows:

- Power Tools Version 4.0 Installation files
- PATS Installation Files

Uninstalling the software

To uninstall ME7840A software or Power Tools go to the Windows Control Panel and click on “Add/Remove Programs.” Select the programs you would like to remove and follow instructions.



2-6 SERVICE CENTERS

ANRITSU Service Centers are listed in Table 2-2.

Table 2-2. *ANRITSU Service Centers*

UNITED STATES

ANRITSU COMPANY
490 Jarvis Drive
Morgan Hill, CA 95037-2809
Telephone: (408) 776-8300
1-800-ANRITSU
FAX: 408-776-1744

ANRITSU COMPANY
10 New Maple Ave., Unit 305
Pine Brook, NJ 07058
Telephone: (201) 227-8999, 1-800-ANRITSU
FAX: 201-575-0092

ANRITSU COMPANY
1155 E. Collins Blvd
Richardson, TX 75081
Telephone: 1-800-ANRITSU
FAX: 972-671-1877

AUSTRALIA

ANRITSU PTY. LTD.
Unit 3, 170 Foster Road
Mt Waverley, VIC 3149
Australia
Telephone: 03-9558-8177
FAX: 03-9558-8255

BRAZIL

ANRITSU ELECTRONICA LTDA.
Praia de Botafogo, 440, Sala 2401
CEP22250-040, Rio de Janeiro, RJ, Brasil
Telephone: 021-527-6922
FAX: 021-53-71-456

CANADA

ANRITSU INSTRUMENTS LTD.
215 Stafford Road, Unit 102
Nepean, Ontario K2H 9C1
Telephone: (613) 828-4090
FAX: (613) 828-5400

CHINA

ANRITSU ELECTRONICS (SHANGHAI) CO. LTD.
2F, Rm B 52 Section Factory Building
No. 516 Fu Te Rd (W)
Shanghi 200131 China
Telephone: 21-58680226, 58680227
FAX: 21-58680588

FRANCE

ANRITSU S.A
9 Avenue du Quebec
Zone de Courtaboeuf
91951 Les Ulis Cedex
Telephone: 016-09-21-550
FAX: 016-44-61-065

GERMANY

ANRITSU GmbH
Grafenberger Allee 54-56
D-40237 Dusseldorf, Germany
Telephone: 0211-968550
FAX: 0211-9685555

INDIA

MEERA AGENCIES (P) LTD.
23 Community Center
Kailash Colony Extension
New Delhi, India
Telephone: 91-11-6442700
FAX: 91-11-6442500

ISRAEL

TECH-CENT, LTD.
4 Raul Valenberg St
Tel-Aviv 69719
Telephone: (03) 64-78-563
FAX: (03) 64-78-334

ITALY

ANRITSU Sp.A
Roma Office
Via E. Vittorini, 129
00144 Roma EUR
Telephone: (06) 50-99-711
FAX: (06) 50-22-4252

KOREA

ANRITSU CORPORATION LTD.
8F, Seocho-Dong, Secho-Ku
Seoul, 137-070
South Korea
Telephone: 2-581-6603
FAX: 2-582-6603

JAPAN

ANRITSU CUSTOMER SERVICE LTD.
1800 Onna Atsugi-shi
Kanagawa-Prf. 243 Japan
Telephone: 0462-96-6688
FAX: 0462-25-8379

SINGAPORE

ANRITSU (SINGAPORE) PTE LTD.
6 New Industrial Road #06-01/02
Hoe Huat Industrial Bldg
Singapore 536199
Telephone: 282-2400
FAX: 282-2533

SOUTH AFRICA

ETECSA
12 Surrey Square Office Park
330 Surrey Avenue
Ferndale, Randburt, 2194
South Africa
Telephone: 011-27-11-787-7200
FAX: 011-27-11-787-0446

SWEDEN

ANRITSU AB
Botivid Center
Fittja Backe 13A
S145 84 Stockholmn
Telephone: (08) 534-707-00
FAX: (08) 534-707-30

TAIWAN

ANRITSU CO., LTD.
6F, No. 96, Section 3
Chien Kuo N. Road
Taipei, Taiwan, R.O.C.
Telephone: (02) 515-6050
FAX: (02) 509-5519

UNITED KINGDOM

ANRITSU LTD.
200 Capability Green
Luton, Bedfordshire
LU1 3LU, England
Telephone: 015-82-433200
FAX: 015-82-731303

Chapter 3
Operations, General

Table of Contents

Chapter 3
Operations, General

3-1 INTRODUCTION

The basic operation of the Model ME7840A Power Amplifier Test Station (without external preamplifiers) is described in this and the following two chapters: Calibration Operations and Measurement Operations. “Calibration Operations” describes the software measurement calibration function and “Measurement Operations” describes the software measurement function. This chapter describes the setup and general operation of the software. (See Chapter 7 for operation with external preamplifiers.)

3-2 PREPARING THE SYSTEM

Refer to Figure 3-1 to identify the equipment named in the recommended power-up sequence for the ME7840A.

Step 1. Connect the output of the AUT to Test Port 2 of the MS4782X.

Step 2. Connect the input of the AUT to Test Port 1 of the MS4782X.

Step 3. Ensure that the power rating of the cables is suitable for the test, and that the connections are tightened.

Step 4. Turn on the MS462XC then the MS4782X Test Set.

Step 5. Set the output of the MS462XC so that the AUT output power does not exceed the maximum Test Port 2 input level. See below.

CAUTION

The AUT RF power output maximum level should be no more than the level shown in the tabulation at right. Otherwise, damage to equipment will occur.

Test Set Model	External Circulator Used	Test Port 2 Max Power
MS4782A	Not Applicable	50 watts
MS4782D	None (port C1 directly connected to port C2)	100 watts
MS4782D	1000-50 or 1000-52 (20 dB isolation)	50 watts
MS4782D	1000-53 (22 dB isolation)	79 watts
MS4782D	Two circulators providing greater than 23 dB isolation	100 watts

Step 6. When ready for measurements, cautiously apply DC power to the AUT.

Step 7. Check that the normally factory-installed RF coaxial "jumper" cable is installed on the rear panel of the Test Set:

- MS4782X: Between Ext Preamp Input and Output connectors.
- MS4782D: Between connectors C1 and C2, unless a circulator is installed.

Step 8. If drain current and/or PAE measurements are desired, the optional current probe (ANRITSU part number 2000-1067 or -1085) can be used. Ensure the probe (Figure 3-1) has a fresh battery, and set the zero offset using the MS4623C as follows:

a. Using Domain softkey, set to **Transmission & Reflection**; using the Display soft key, set for **Single Channel**; using the Graph Type softkey, set for **Real**; using the Scale softkey and Data Entry keys, set for 1 mU/Division. Use the Avg key and associated softkeys to set **Averaging** for 10 and **IF Bandwidth** for 300 Hz. Use the Config key, **DATA POINTS** and associated softkeys to set for 101 **Max Data Points**.

b. Use the Measure softkey and select **Ext. Analog In**.

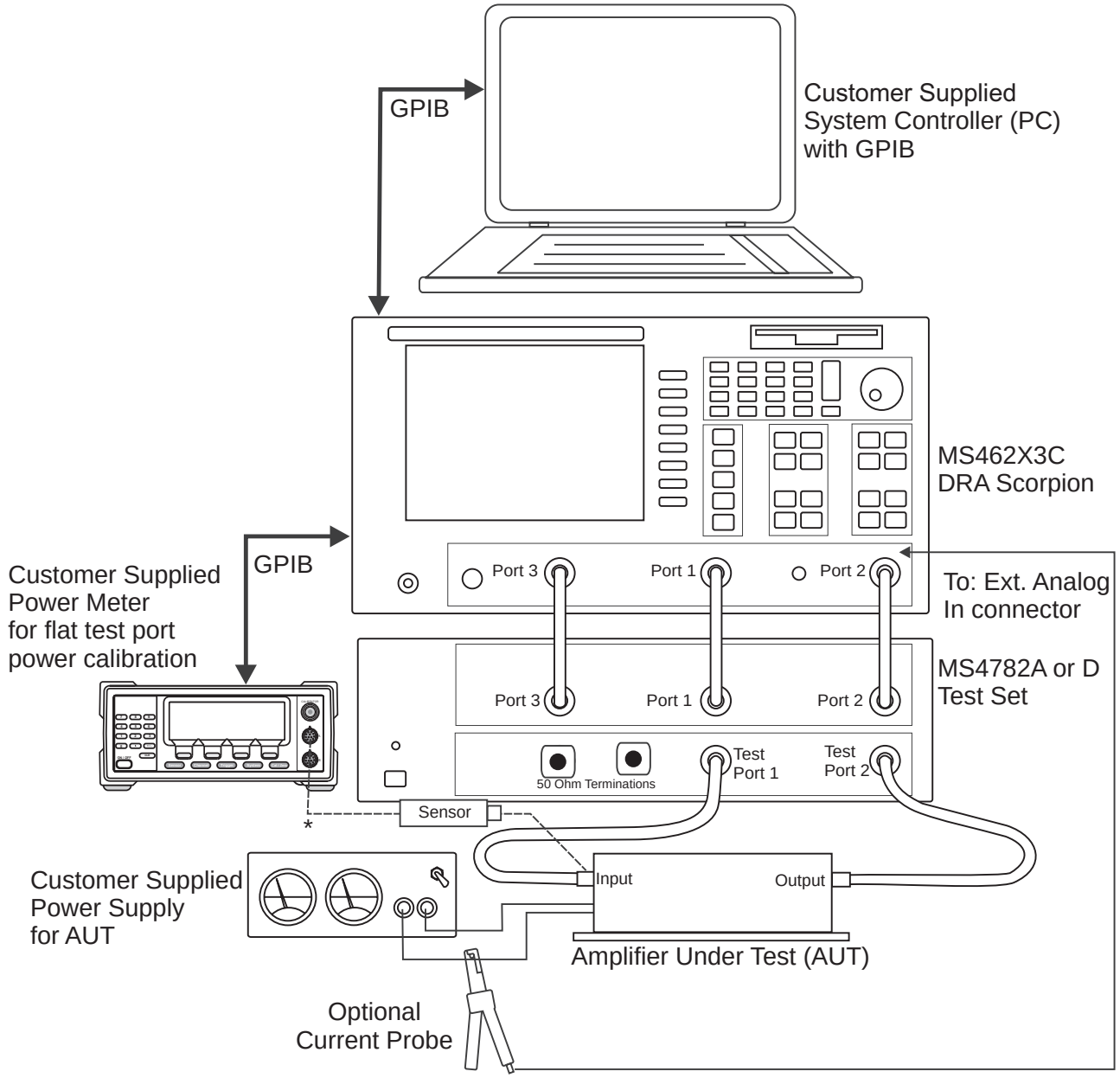
c. Turn on the current probe and set it for the desired range.

d. Adjust the "Zero Adjustment" thumbwheel until the reading is minimum (typically 0 ±100μU).

e. On the current probe:
Orient the probe such that the "Current Direction" arrow points away from the power supply.

Place the jaws only over the DC wire (not both wires)..

Unused Connections The EXT. SOURCE and AUX. OUT connectors must be terminated with 50Ω terminations when not in use.



* Connect when directed by procedure for power calibrations

Figure 3-1. *PATS Power On Sequence*

3-3 USING PA NAVIGATOR SOFTWARE

PA Navigator software requires a computer with GPIB capability running Windows 95 or better (NT/2000). The software is started by selecting the "Start" button, then "Programs," "Pats," then "Pats" (Figure 3-2).

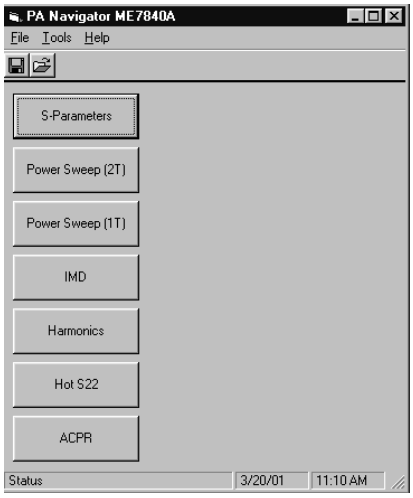
Figure 3-2. *Starting the PA Navigator software*

Software Organization

The PA Navigator software has two main and three collateral functions. The two main functions, calibration and measurement, are described in Chapters 3 and 4, respectively. The collateral functions, accessed from the PATS program's top menu, are described in paragraph 3-6.

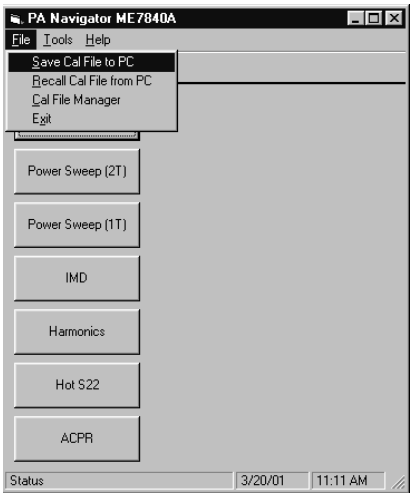
3-4 COLLATERAL FUNCTIONS

The PA Navigator software collateral functions are found on the top menu bar under “Files,” “Tools,” and “Help.” (below)



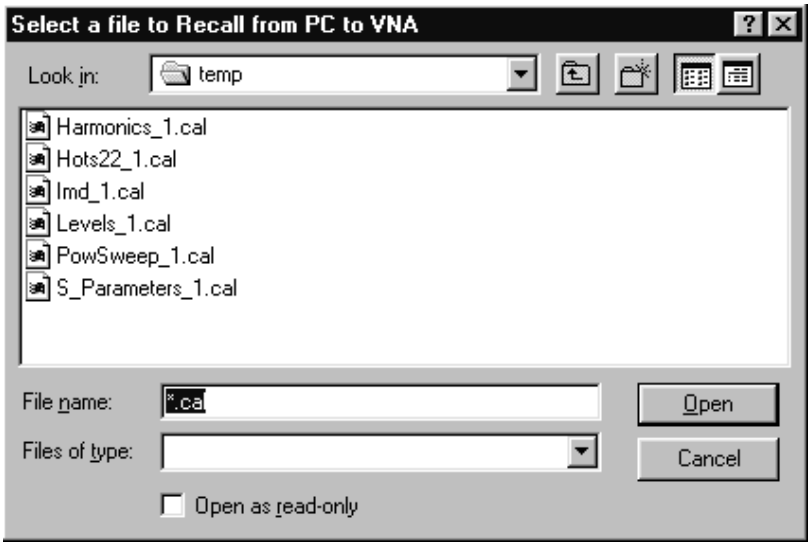
File

The file menu (below) provides for saving files from the PC to the MS462XC, recalling files from the MS462XC to the PC, and for exiting the system.

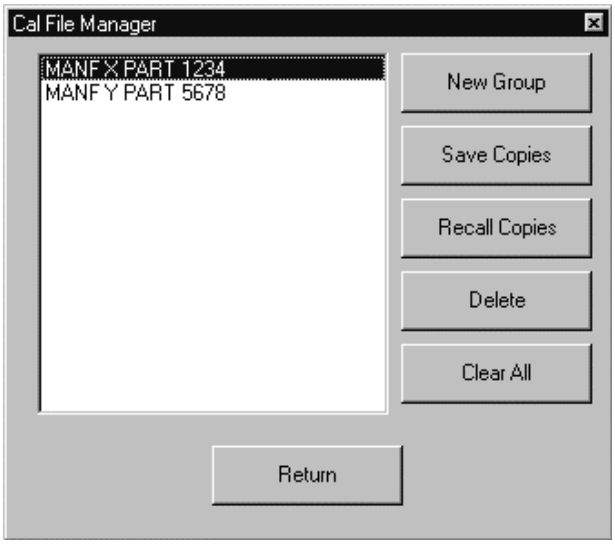


Click on File to display a drop-down list (above) that provides the four options described below. PATS Save and Recall functions have the exact same behaviors as the Save/Recall button on the Scorpion. However, instead of saving to the Scorpion hard disk or recalling from the hard disk, the PA Navigator software allows users to Save to the PC’s hard disk and Recall from the PC’s hard disk.

- *Save Cal Files to PC.* Displays a dialog box (similar to that shown for *Recall Cal Files from PC*, below) showing the cal files stored in the default folder (Temp). This function is useful for saving the front panel setup and calibration data to a file on the PC. The user has the option of overwriting an existing file by selecting an existing file from the file listing or creating a new file by typing in a file name. The user must type in a ".cal" extension or the program will report an error. The calibration procedure automatically saves cal files to the PC. The file names of these files is specified in the calibration specification file (*.txt file).
- *Recall Cal Files from PC:* Displays a dialog box similar to that shown below with the listing of file name. This function transfers a .cal file from the PC to the Scorpion over the GPIB bus (and names the file a.cal on the Scorpion's hard disk) and then recalls the front panel setup and cal data from a.cal.



- *Cal File Manager:* Lets users save and recall sets of calibration files under a logical name (see below). For example, a manufacturer may have two different parts which require two different calibrations. With this utility the user can acquire a complete calibration for part “1234” and then save the complete calibration to “MANF X PART 1234”. A complete calibration is actually a set of 8 “.CAL” files and they are copied to a directory under C:\temp on the user’s PC. Then, the user can acquire a complete calibration for part “5678” and then save the complete calibration to “MANF Y PART 5678”. The “Active” calibration is the most recently acquired calibration. The user can replace the “Active” calibration by “Recalling” a calibration set that was previously “Saved”.



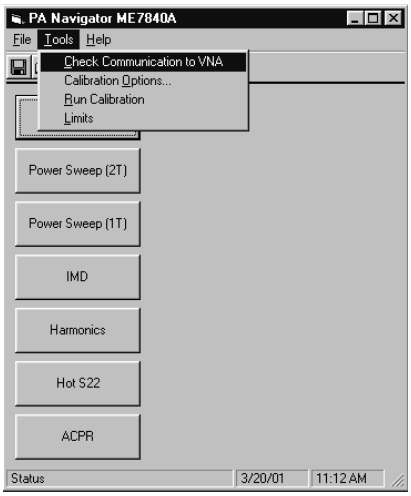
- Exit: Exits the PA Navigator software.

Help

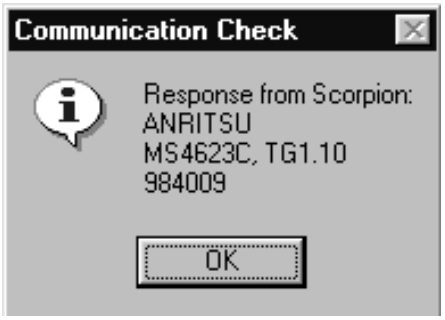
The “Help” function is not available in the current software. It will be available in future software versions.

Tools

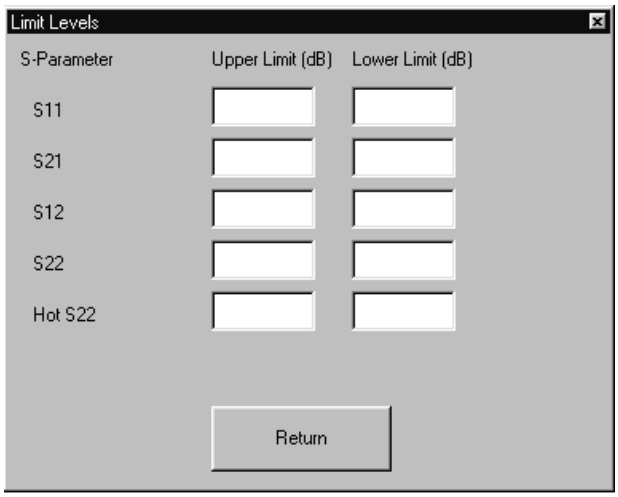
The “Tools” menu (below) displays a drop-down list that provides two collateral options described below. The “Calibration Options” and “Run Calibration Files” options are described in Chapter 4.



a. *Check Communications to VNA:* Runs a test to check that the VNA communicates with the PC. Run this option first to ensure that the PATS setup is correct and functioning properly. If so, a dialog box appears like that shown below.



b. *Limits:* Provides for setting limts for S-Parameter measurements.



Chapter 4
Operations, Calibration

Table of Contents

Chapter 4
Operations, Calibration

4-1 INTRODUCTION

Measurements always include a degree of uncertainty due to imperfections in the measurement system. The measured value is always a combination of the actual value plus the systematic measurement errors. Calibration, as it applies to network analysis, characterizes the systematic measurement errors and subtracts them from the measured value to obtain the actual value. Each of the ME7840A measurements requires a calibration to account for measurement uncertainties. This chapter describes the measurement calibration operations of the Model ME7840A Power Amplifier Test System software.

4-2 OPERATION, GENERAL

Refer to Chapter 3 for general operation and setup of the ME7840A.

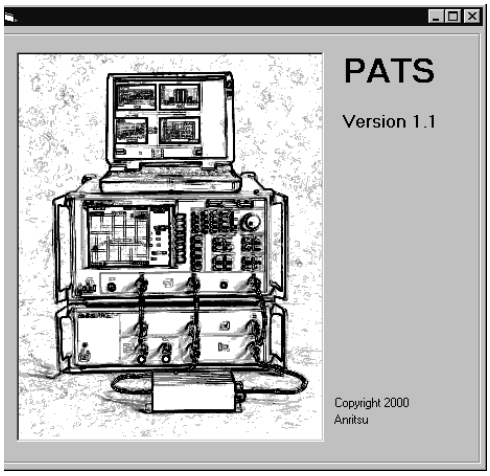
4-3 TEST EQUIPMENT

A power meter, power sensor, and Type N calibration component kit is required for power level and S-parameters calibrations. See Table 1-3, page 1-12. Additionally, the MG3681 Digital Modulation Signal Generator is supported for ACPR measurements on W-CDMA devices.

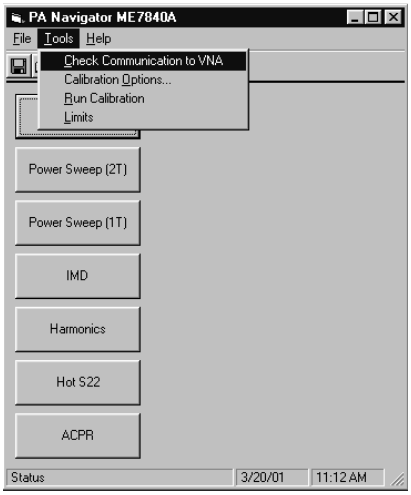
4-4 GENERAL

Calibration operations are described in this and the following paragraphs

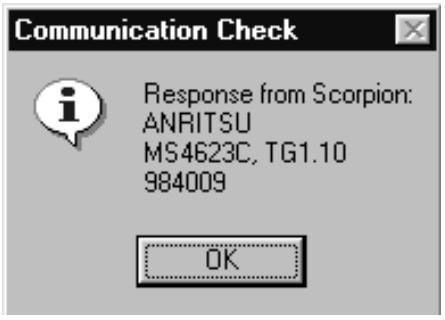
Step 1. Click on “Start,” “Programs,” “Pats,” then “PA Navigator” (Figure 3-2, page 3-6) to start the software.The PATS flash screen (below) briefly appears, then the main screen.



The main screen (below) provides access to all software options.



Step 2. Click on "Tools" then "Check Communications to VNA" to ensure that the equipment is properly connected to the bus. If so, the following screen will be displayed:

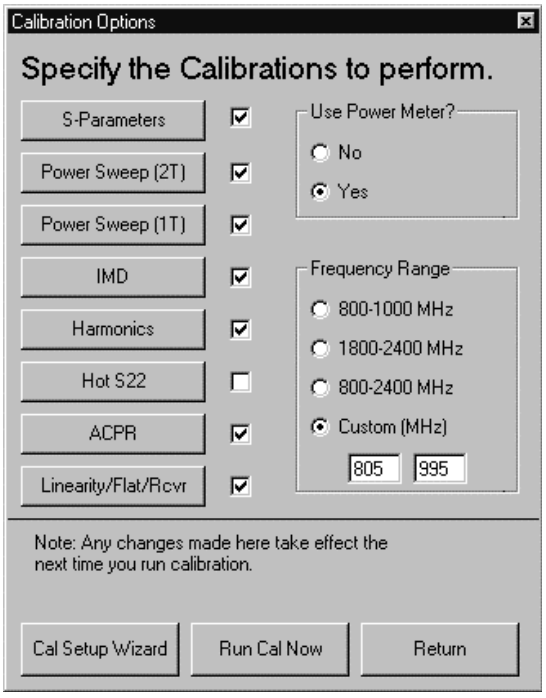


Step 3. *Run Calibration:* Starts the calibration. After the calibration is started, screens will display depending on the check boxes selected in the Calibration Options screen (next page). All checked items will get calibrated. PA Navigator determines order, as follows: Linearity, Flat, Receiver, Hot S22, S-Parameter, Power Sweep, IMD, Harmonics, ACPR.The calibration screens are straight forward. In general, follow the instructions before pushing the "Next" button. The PC's "Enter" key should execute "Next". The "Return" button should return PA Navigator to the main window abort the calibration procedure. However,the Scorpion will retain whichever calibration steps had been run.

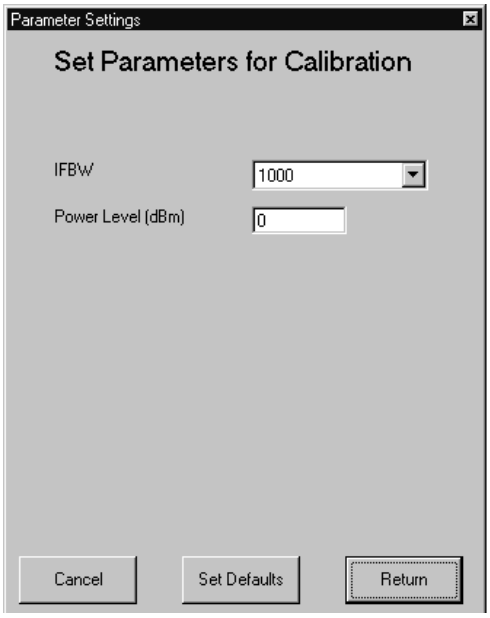
Step 4. *Calibration Options:* Provides options (below) configuring measurement calibrations when either "Run Calibration" is selected or the "Run Cal Now" button is pressed. Although there are seven measurement buttons on the main form, there are eight calibration buttons. The bottom button is for Linearity, Flat Power and Receiver Calibrations. Each of these buttons leads to a Calibration parameter setup form. The check boxes indicate which calibrations should be run if the user pushes the "Run Cal Now" button on this form or the "Run Calibration" menu item on the main form.

User Power Meter?: Select "No" if a power meter will not be needed for the calibration. Linearity and Flat power calibrations will be skipped. Some of the measurement results may be different than expected.

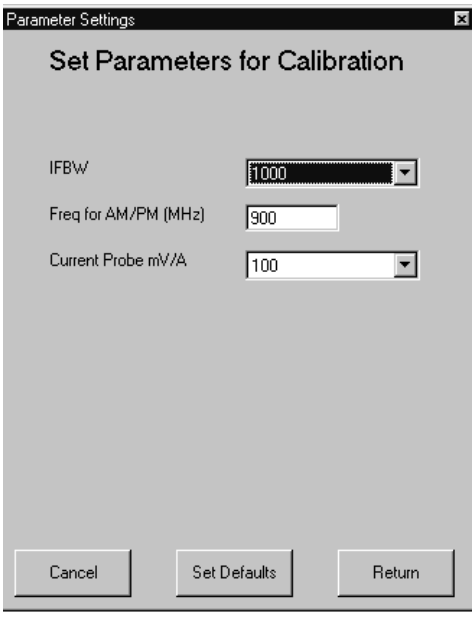
Frequency Range: Used to select the appropriate frequency range. The frequency range must be compatible with the hardware in the test set.



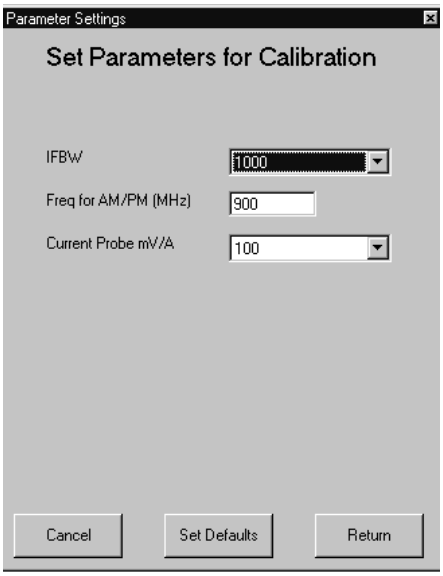
S Parameters: Pressing this button brings up the S Parameters screen shown below. Use the drop-down list arrow keys to display parameter selections.



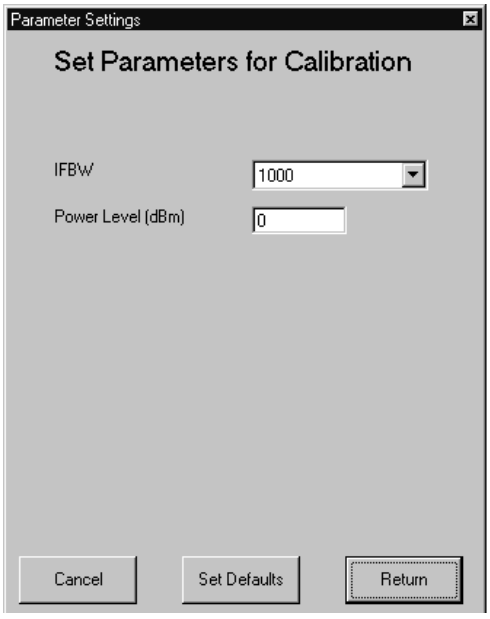
Power Sweep (2T): Pressing this button brings up the two-tone power sweep screen shown below. Use the drop-down list arrow keys to display parameter selections.



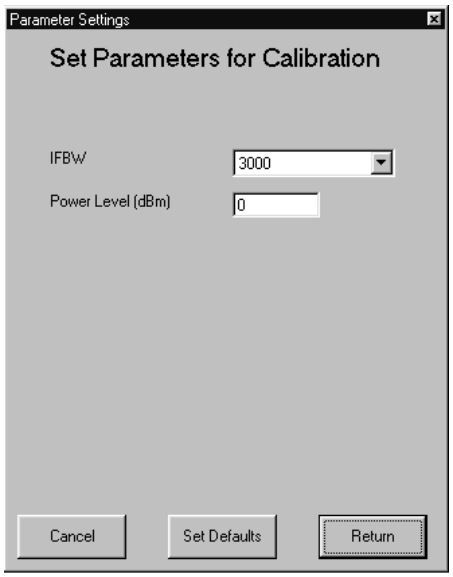
Power Sweep (1T): Pressing this button brings up the one-tone power sweep screen shown below. Use the drop-down list arrow keys to display parameter selections.



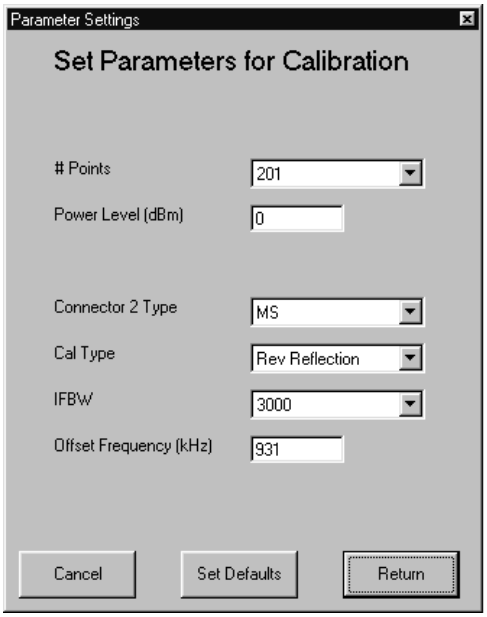
IMD: Pressing this button brings up the intermodulationdistortion screen shown below. Use the drop-down list arrow keys to display parameter selections.



Harmonics: Pressing this button brings up the harmonics screen shown below. Use the drop-down list arrow keys to display parameter selections.

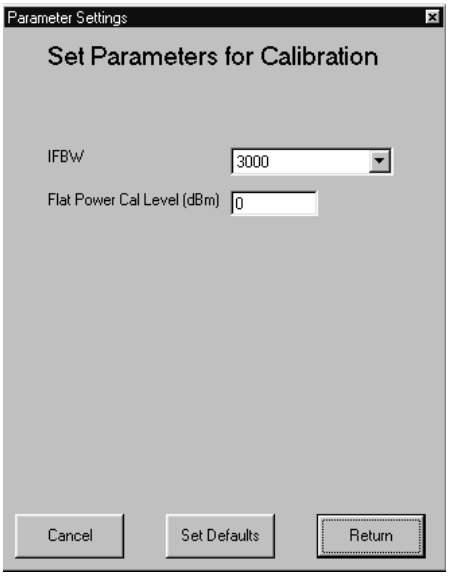


Hot S22: Pressing this button brings up the hot S22 screen shown below. Use the drop-down list arrow keys to display parameter selections.



ACPR: No parameter options for this button.

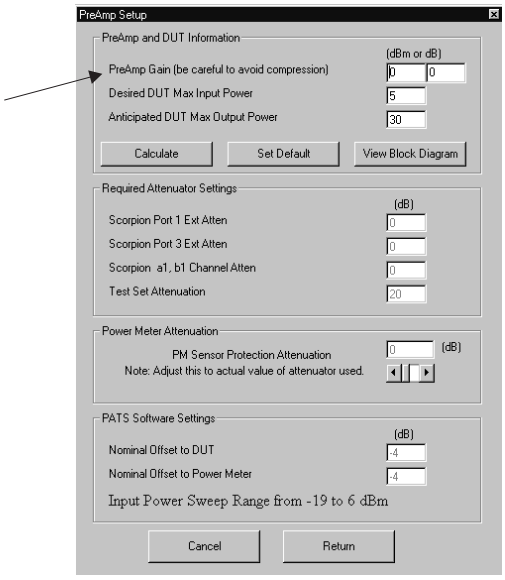
Linearity/Flat/Rcvr: Pressing this button brings up the linearity/flat power/receiver screen shown below. Use the drop-down list arrow keys to display parameter selections.



Cal Setup Wizard: Provides forms (shown on next page) that will automatically set some parameters, like nominal offset, and suggest attenuators to add to the calibration and measurement setup.Run the Cal Setup Wizard before running the calibration.

Pre Amp Setup: Many power amplifier measurements require higher power input to the DUT than the Scorpion sources are able to generate. PATS users will insert preamps (or driver amps) into the measurement setup to boost the RF power from the Scorpion sources to a level desirable for measurement.

Pre Amp Gain: To properly set up the calibration, PA Navigator needs to know the gain of this preamplifier in the frequency range being measured. If the gain varies in the frequency range then enter the maximum gain.

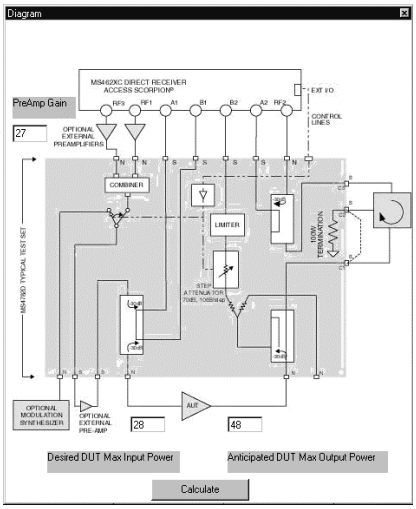


This form helps users set up the ME7840 for calibration. “Set Default” assumes that the user is using the standard MS4782x test set and has a DUT that needs a maximum calibrated input power of +5 dBm and produces a maximum output power of +30 dBm. Think of this form as a spreadsheet. When the user moves to a new field the parameters are “calculated”. The user can enter a number and then press the “Calculate” button to make sure the parameters are being calculated.

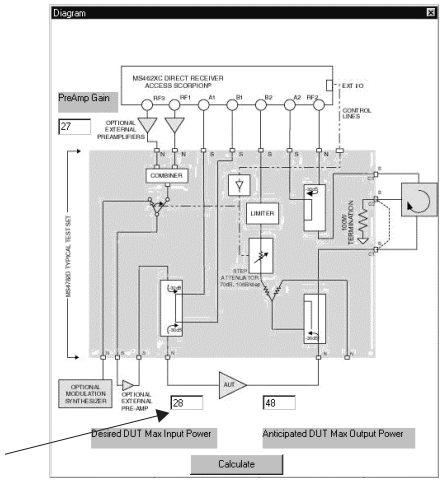
NOTE

It is important that the values listed on these forms be true representations of the user’s setup, otherwise calibration errors will occur.

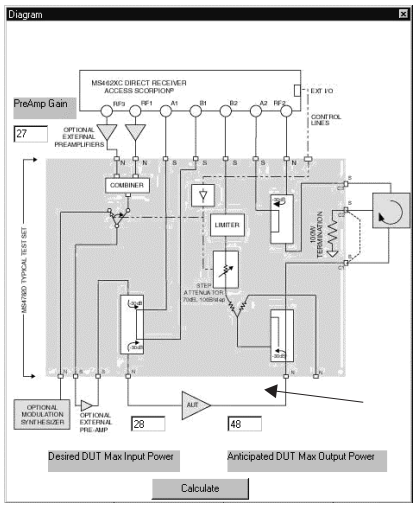
View Block Diagram: Pressing this button causes a block diagram (below) to appear. This diagram provides a graphic indication of input and output locations.



Desired DUT Max Input Power: Used to set the desired maximum input power. Many amplifier measurements involve sweeping the input power to the DUT (device-under-test). PA Navigator needs to know the maximum desired RF power at the input to the DUT. In this example the linearity calibration will attempt to calibrate from +8 dBm to +28 dBm (20 dB sweep range). When no preamp is present and a standard test set isused, the default linearity calibration is from –19 dBm to +6 dBm (or 25 dB sweep range).



Anticipated DUT Max Output Power: Used to set the maximum output power. Assuming the Max input power is applied to the DUT, what is the expected maximum DUT output power? PA Navigator needs to know this to help set the test set attenuator during calibration and measurement.



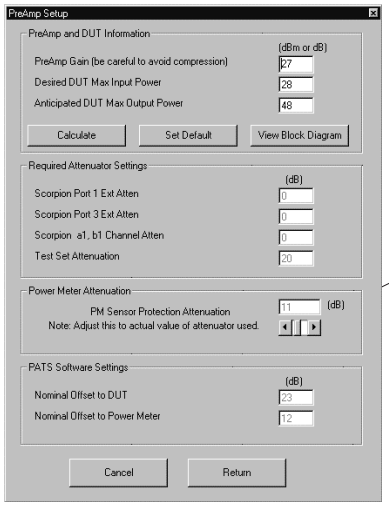
Required Attenuator Settings:

Scorpion Port 1 Ext Atten:

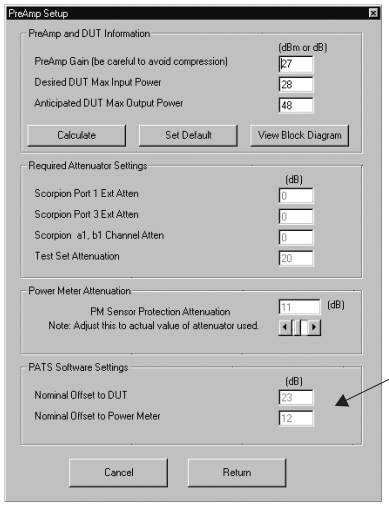
Scorpion Port 3 Ext Atten:

Scorpion a1, b1 Channel Atten:

Power Meter Attenuation: When preamps are used in the system, the calibration strategy is to add an known attenuator before the power meter while acquiring the linearity calibration and the flat power calibration. In this PA Navigator first suggests an attenuator value to use, but this value should be adjusted to exactly match the value of the attenuator.

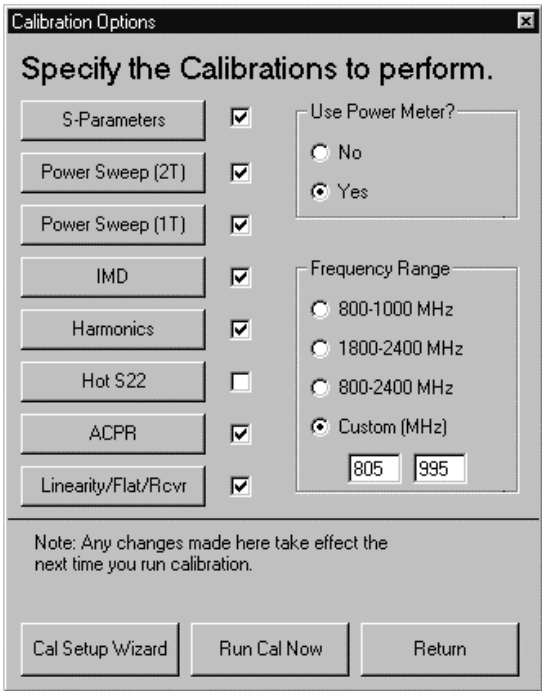


Nominal Offset Power: Note that the value in this box will change as the Power meter attenuation value is changed. Make sure that the value in this box doesn't exceed the specification of the power meter sensor.



Cancel: Aborts the Setup Wizard and returns to the Calibration Options form.

Returns: Returns to the Calibration Options form.

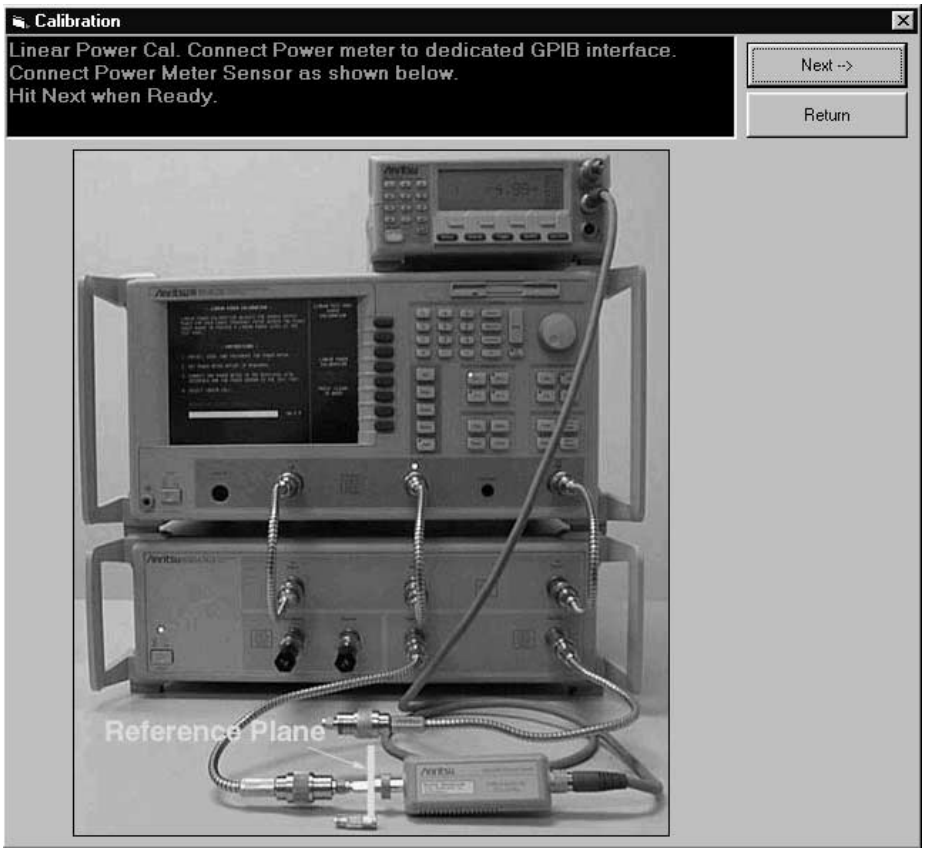


Return: Returns to the Tools menu.

Run Cal Now: This button starts the calibration; it performs the same function as “Run Calibration,” in the Tools menu. Pressing this button brings up calibration screens based on measurement boxes checked in an order determined by PA Navigator. If the Linearity/Flat/Rcvr box is checked, it is the first calibration screen (next page).

Step 5. Linearity/Flat/Receiver calibration starts by displaying the following screen.

This calibration begins by displaying the following parameter screen:



Step 6. Before hitting the “Next” button, connect the power meter to at the point where power enters the device-under-test (AUT), which becomes the power reference plane as shown in the prompt.

The use of cables and/or adapters does not effect the final measurement result, if they are in place for the calibration process. The vector error corrections established during the calibration process eliminates cable and/or adapter effects as long as the ports used are stable and exhibit good repeatability, which is the case if good quality components are used.

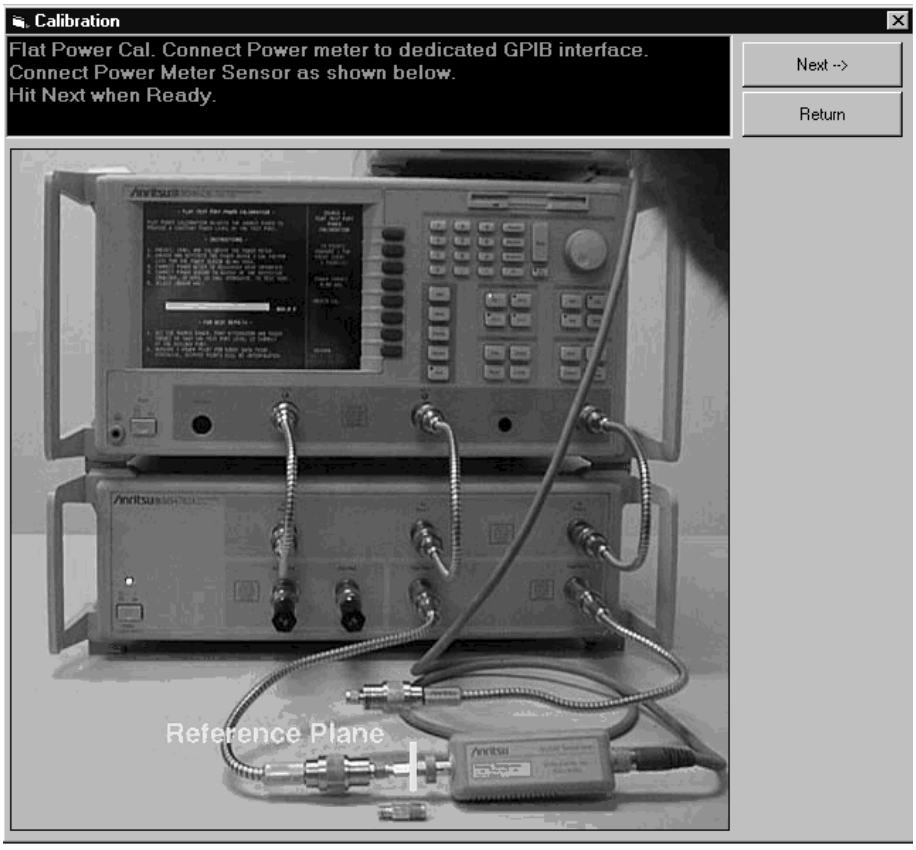
Many calibration kits include adapters that are designed to have equal phase length. These parts are called phase equal adapters (PEA). ANRITSU designs in-series adapters (e.g.,

SMA Connector M-M, M-F, F-F) to be phase insertable when technically possible.

NOTE

The linear power calibration takes up-to-5 minutes to complete. It calibrates the output power at the reference plane for both internal sources (power out of Port 1 then Port 3) according to the target power across the frequency range set in the calibration specification file. When the test completes, the "Next" button will become available.

Step 7. Press "Next" to calibrate flat power response (below).

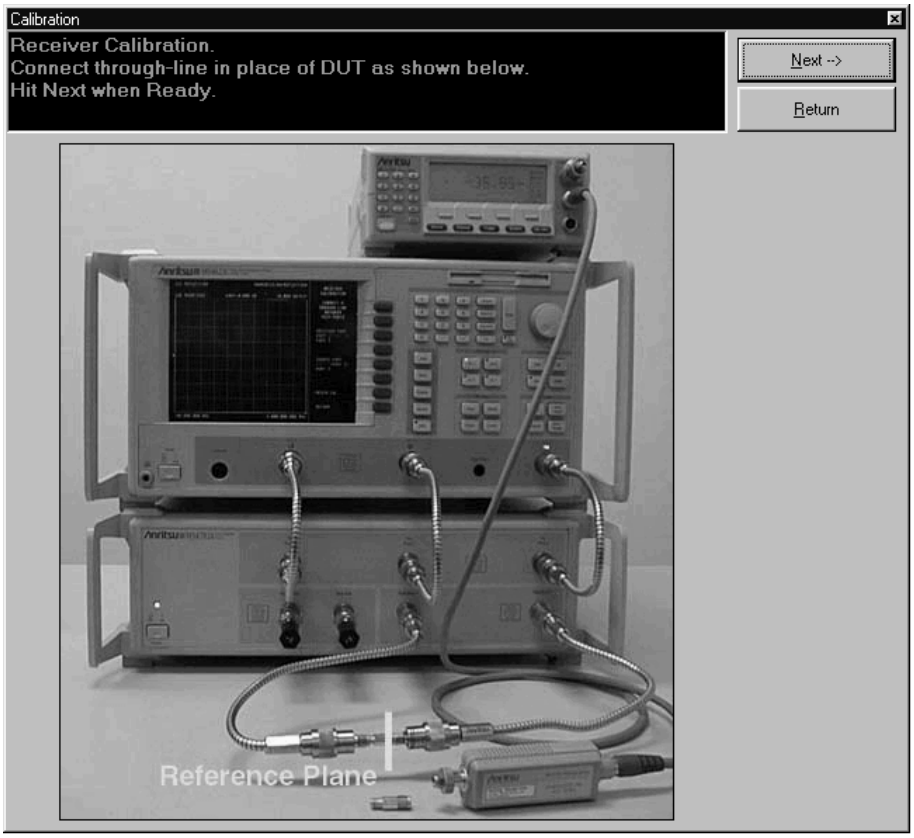


NOTE

The flat power calibration also takes less than 1 minute to complete. It calibrates the output power at the reference plane for both internal sources (power out of Port 1 then Port 3) according to the target power across the frequency range set in the calibration

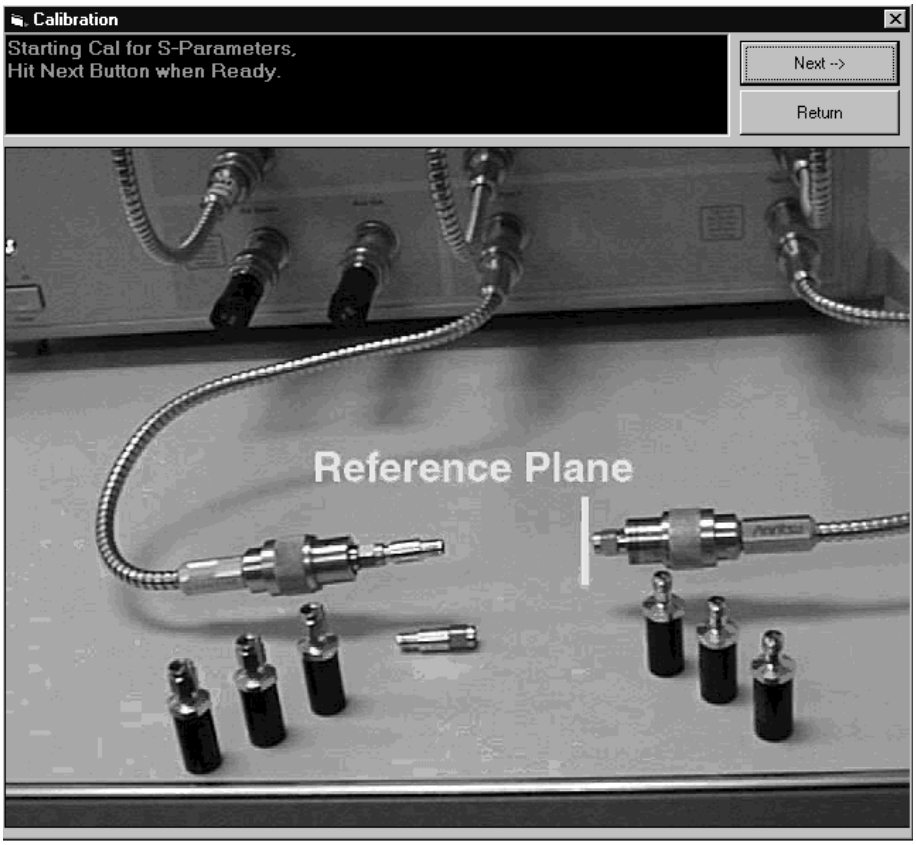
specification file. When the test completes, the “Next” button will become available.

Step 8. Before pressing “Next” disconnect the power sensor and connect a throughline between Test Ports 1 and 2 on the MS4782X Test Set, as shown below.

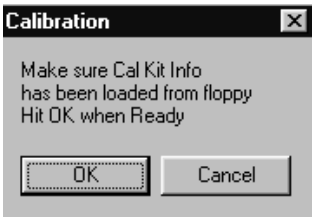


Step 9. Press “Next” to perform a receiver calibration. When this calibration finishes, the program returns to the main screen.

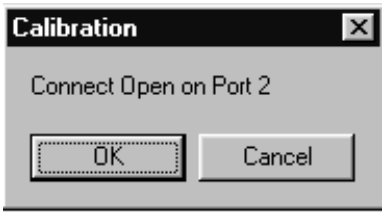
Step 10. *Hot S22:* If the Hot S22 box is checked, it is the next calibration to appear. Hot S_{22} is a return loss measurement of an amplifier's output port (Port 2) while stimulus is applied to its input port. The prompts cause the Scorpion to be placed into a state where it is ready to make calibrated measurements on the user's AUT. At the completion of the program, the state information is saved to a *.cal file. To run this program, proceed as follows.



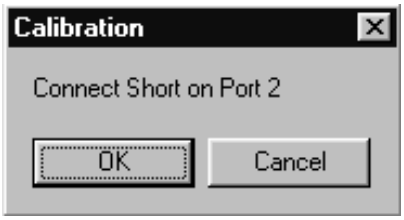
Step 11. Press “Next” for the next prompt (below). The 3653 or 3753LF Calibration Kits contain a disk with calibration data. The data has to be installed from the MS462C front panel. To do so, place the floppy disk from the kit into the MS462XC disk drive. Press the Cal key then COMPONENTS UTILITIES/INSTALL KIT INFO FROM FLOPPY DISK. softkeys.



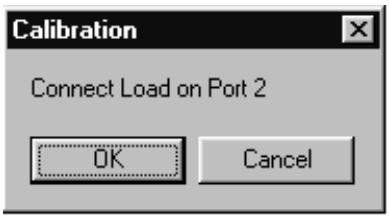
Step 12. Press “OK” for the next step (below). Connect the Open to Port 2.



Step 13. Press “OK” for the next step (below). Connect the Short to Port 2.

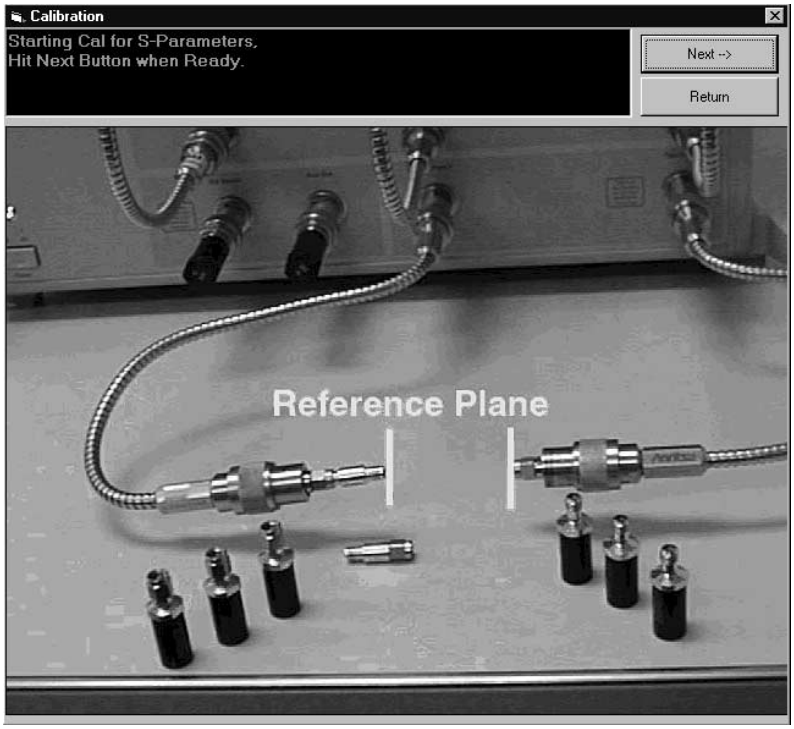


Step 14. Press “OK” for the next step (below). Connect the Load to Port 2.



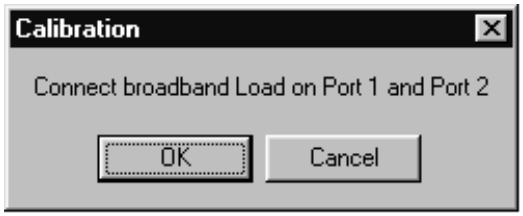
Step 15. Press “OK” to complete the Hot S_{22} calibration.

Step 16. *S-Parameters Cal:* If the S-Parameters box is checked, it is the next calibration. The prompts cause the Scorpion to be placed into a state where it is ready to make calibrated measurements on the user’s AUT.



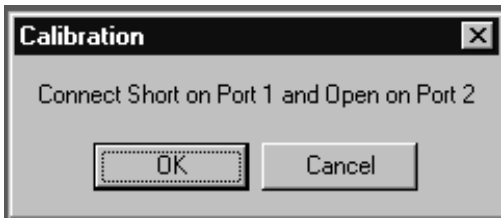
Step 17. Press “Next” for the next step (below). The 3653 or 3753LF Calibration Kits contain a disk with calibration data. The data has to be installed from the MS462C front panel. To do so, place the floppy disk from the kit into the MS462XC disk drive. Press the Cal key then COMPONENTS UTILITIES/INSTALL KIT INFO FROM FLOPPY DISK softkeys.

Step 18. Press “OK” for the next step (below). Connect the Broadband Load on Test Ports 1 and 2 on the ME7840A Test Set.

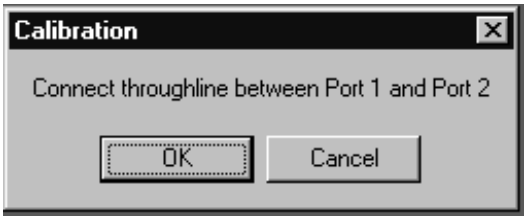


Step 19. Press “OK” for the next step (below). Connect the Open to Test Port1 and the Short to Test Port 2.

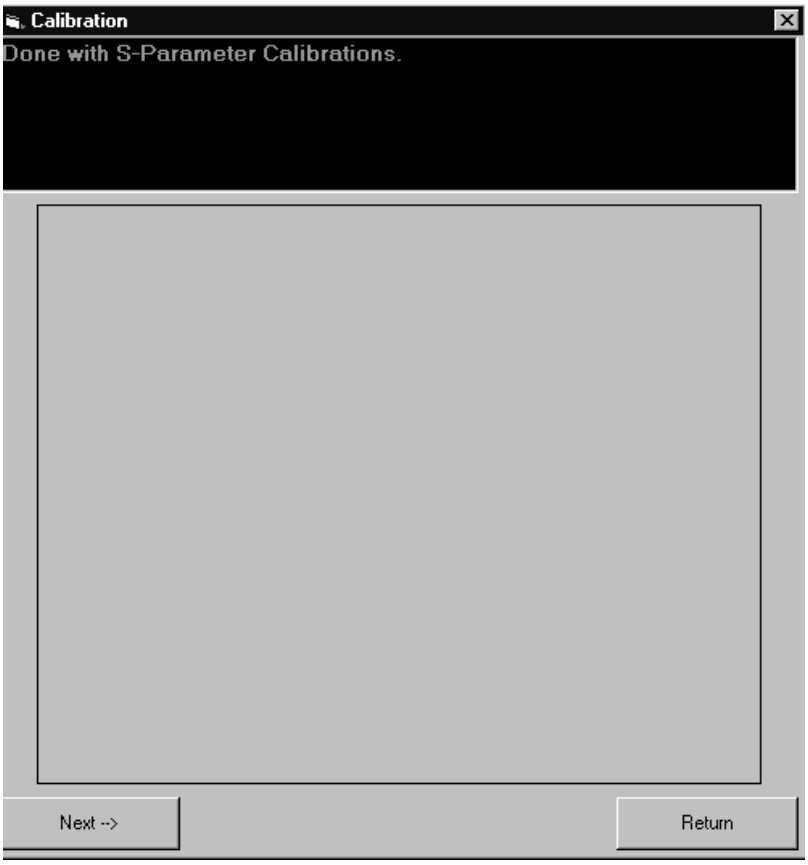
Step 20. Press “OK” for the next step (below). Connect the Short to Test Port 1 and the Open to Test Port 2.



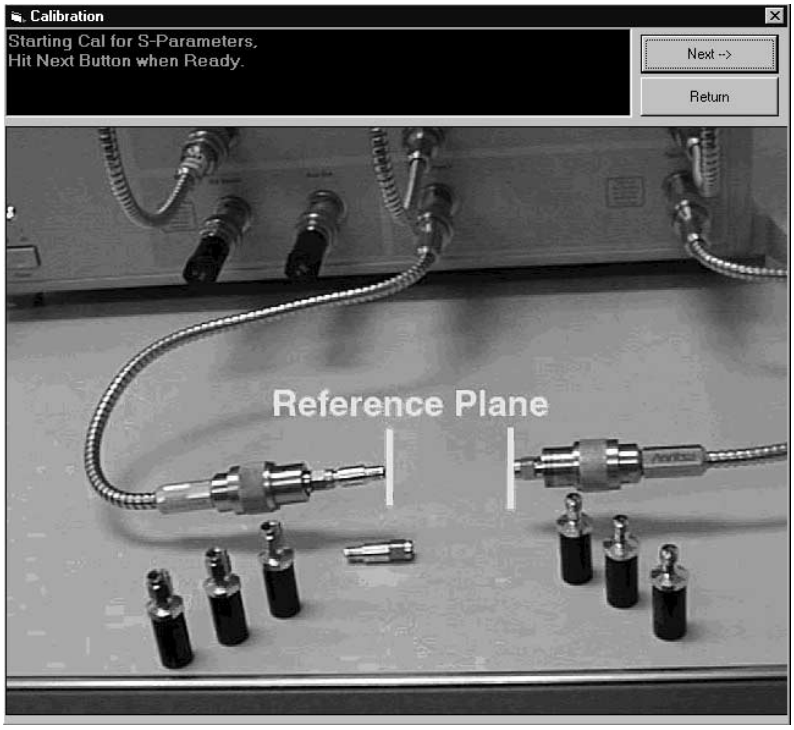
Step 21. Press “OK” for the next step (below). Connect the Throughline between Test Ports 1 and 2.



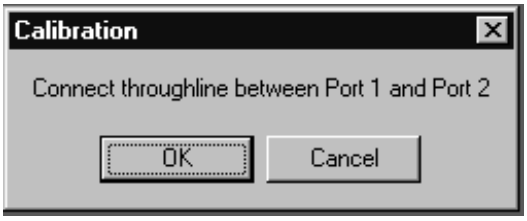
Step 22. Press “OK” to complete the S Parameters calibration (below).



Step 23. *Power Sweep (1T)/Power Sweep (2):* If the Power Sweep (1T) or (2T) box is checked, it is the next calibration to appear.The prompts cause the Scorpion to be placed into a state where it is ready to make calibrated measurements on the user's AUT.

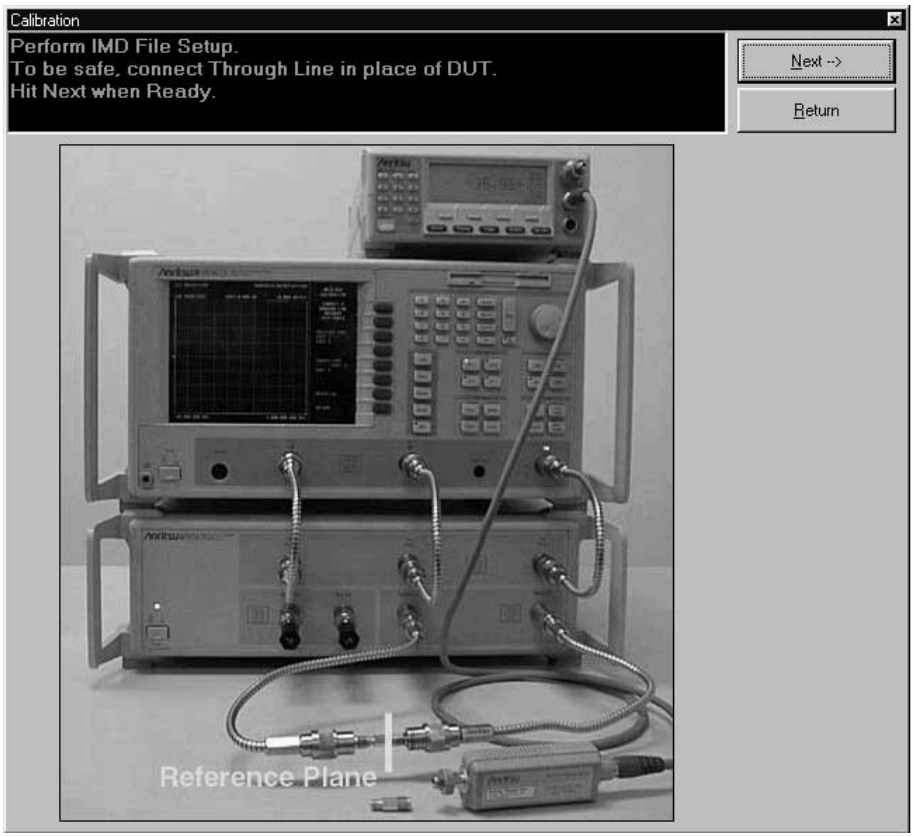


Step 24. Connect the Throughline between Test Ports 1 and 2 on the MS4782X Test Set.

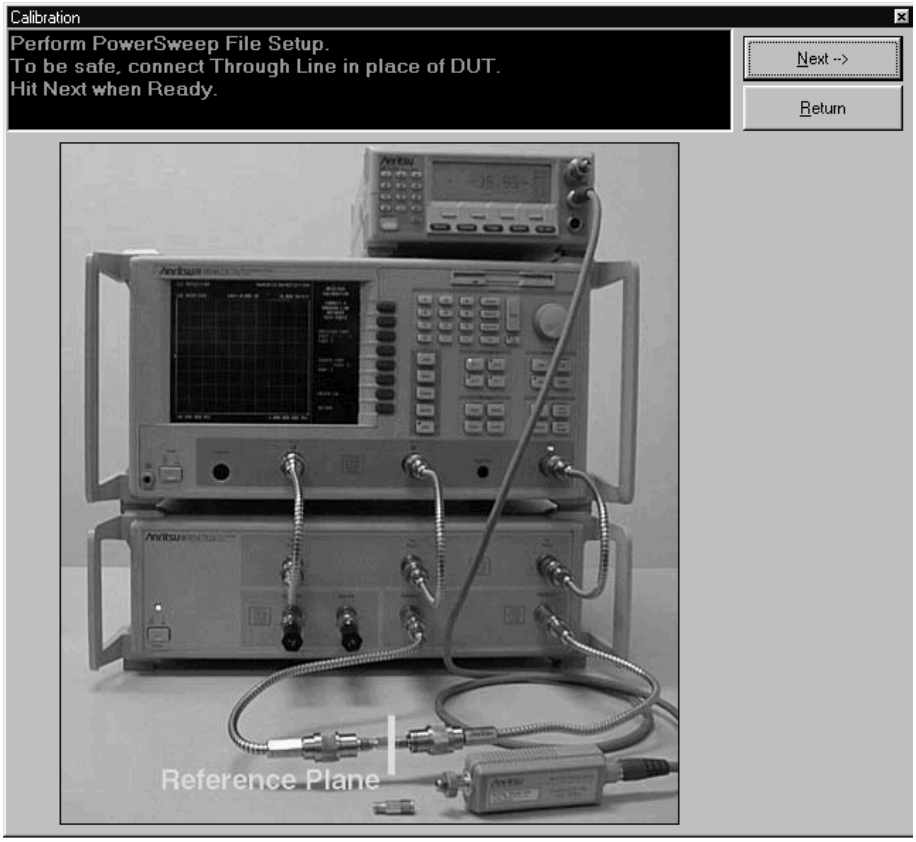


Step 25. IMD: If the IMD box is checked, it is the next calibration to appear.The prompts cause the Scorpion to be placed into a state where it is ready to make calibrated measurements on

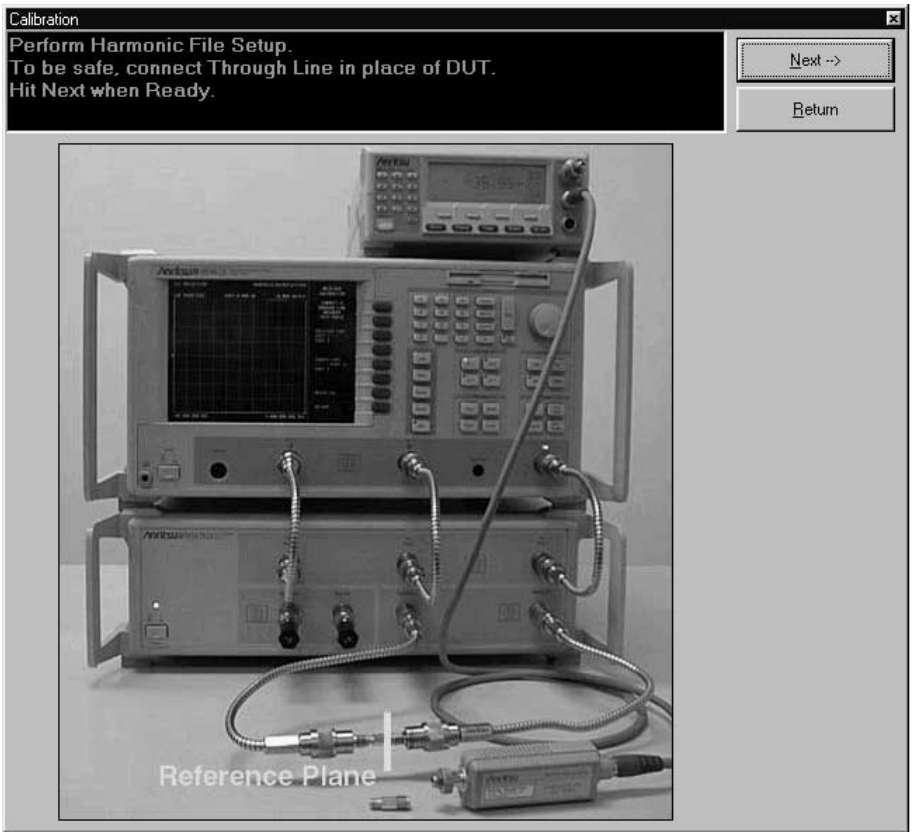
the user's AUT. Follow the prompt and connect a throughline between Test Ports 1 and 2 on the MS4782X Test Set.



Step 26. Press “Next” to begin the Power Sweep cal file setup (below).



Step 27. Harmonics: If the Harmonics box is checked, it is the next calibration to appear.The prompts cause the Scorpion to be placed into a state where it is ready to make calibrated measurements on the user's AUT.



Step 28. Press "Next" to end the calibration and return to the main screen.

Chapter 5
Operations, Measurement

Table of Contents

Chapter 5
Operations, Measurement

5-1 INTRODUCTION

This chapter describes the seven measurements available with the ME7840A software: S-Parameters, Power Sweep, IMD (intermodulation distortion), Harmonics, and Hot S_{22}.

5-2 OPERATION, GENERAL

Refer to Chapter 3 for general operation and setup of the ME7840A.

5-3 MEASUREMENT CALIBRATION

Measurements always include a degree of uncertainty due to imperfections in the measurement system. The measured value is always a combination of the actual value plus the systematic measurement errors. Calibration, as it applies to network analysis, characterizes the systematic measurement errors and subtracts them from the measured value to obtain the actual value. Each of the ME7840A measurements requires a calibration to account for measurement uncertainties. Refer to Chapter 4 for measurement calibration procedures.

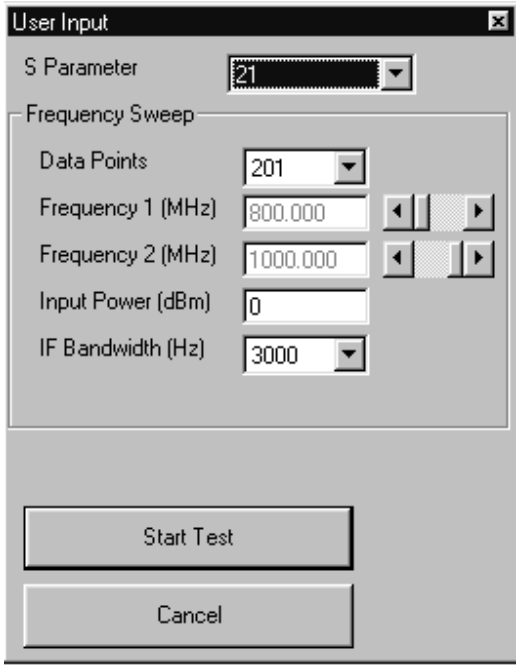
5-4 S-PARAMETER TESTS

This test measures the scattering parameters (S-parameters). The test module comprises six tests: S_{11}, S_{12}, S_{21}, S_{22}, and ALL. (The K Factors test is described in paragraph 5-5.) In each case, the measurement screens are the similar. This procedure will present a test screen for the "S_{21}" measurement and will describe certain differences at the end of the procedure.

Procedure.

Prepare the ME7840A as shown in Chapter 3.

Enter the appropriate test values in the displayed User Input screen. The input fields are described below: The inputs required for this test are described below.



- **S-Parameter:** Drop down options. Set to S_{21} for this procedure. Other selections include S_{11}, S_{12}, S_{22}, ALL, and K Factor (paragraph 5-5).
- **Data Points:** Drop down options – number of data points in frequency sweep.
- **Frequency 1 (MHz):** Lower frequency or start frequency.
- **Frequency 2 (MHz):** Upper frequency or stop frequency.
- **Input Power (dBm):**Input power level, in dBm.
- **IF Bandwidth (Hz):**Intermediate frequency bandwidth for test, in Hertz.Select **Start Test**:

Observe that the test screen (Figure 5-1) appears.

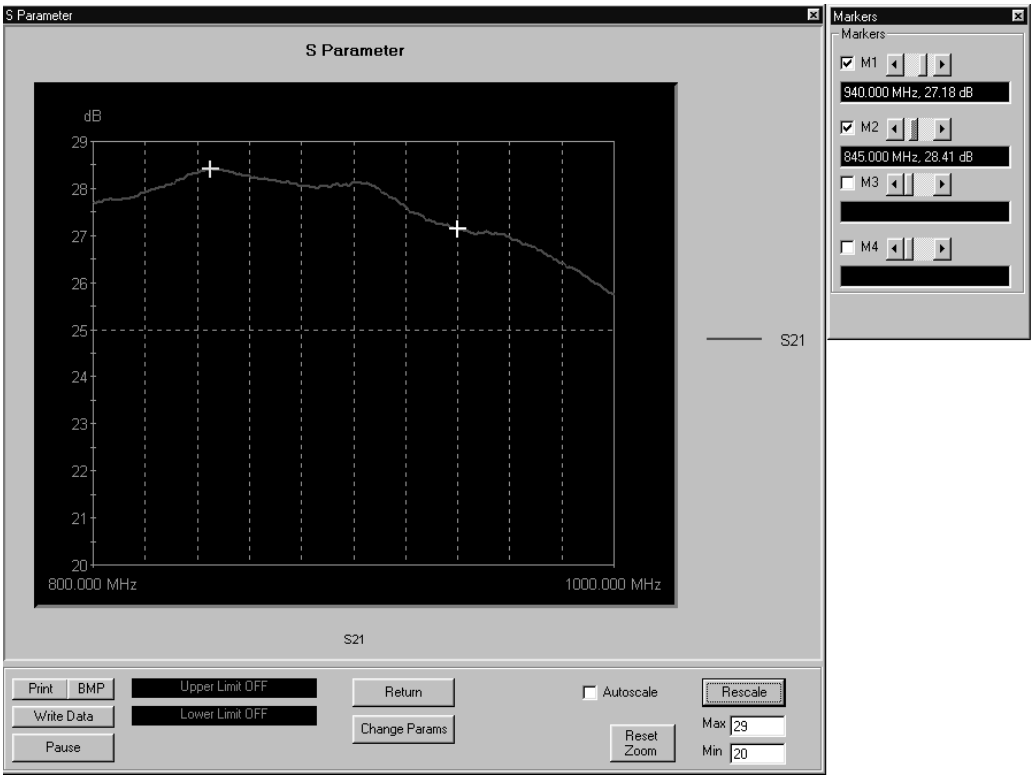


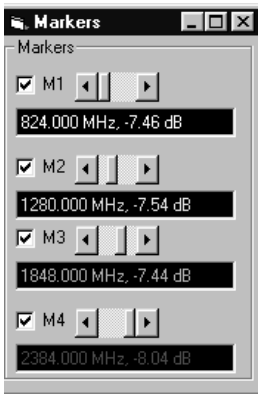
Figure 5-1. *S-Parameters Test Screen for S_{21}*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **Write Data:** Two data files are written to the C:\Program Files\Pats\Datafiles folder; the file name will have a time stamp. One datafile has a ".csv" file extension and the other has a ".s2p" file extension. *For example:* "S17-16-19-29.csv (and s2p)" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV and S2P files are comma separated text and can be opened in the Windows Microsoft Excel spreadsheet.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.
- **Upper Limit/Lower Limit:** Limit values as set using Tools menus (Chapter 3).
- **Return:** Returns to the main PATS screen.

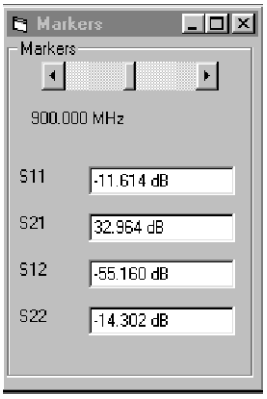
- **Change Params:** Returns to User Input screen.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.
- **Reset/Zoom:** Disabled for this test.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Rescale:** Rescales the measurement results.

Markers Screen Options for S_{11}, S_{21}, S_{12}, S_{22} (left):



- **M1:** Turns marker on or off (checked or unchecked). If on: Slider moves marker between data points, and window below displays marker frequency and amplitude values amplitude value at the marker.
- **M2:** Same as above.
- **M3:** Same as above.
- **M4:** Same as above.

Markers Screen Options for ALL (left):



- **Marker Slider:** Moves marker between data points.
- **Frequency Display**: Displays marker frequency.
- **S_{11}:** S_{11} input return loss.
- **S_{21}:** S_{21} gain.
- **S_{12}:** S_{12} output isolation.
- **S_{22}:** S_{22} output return loss.

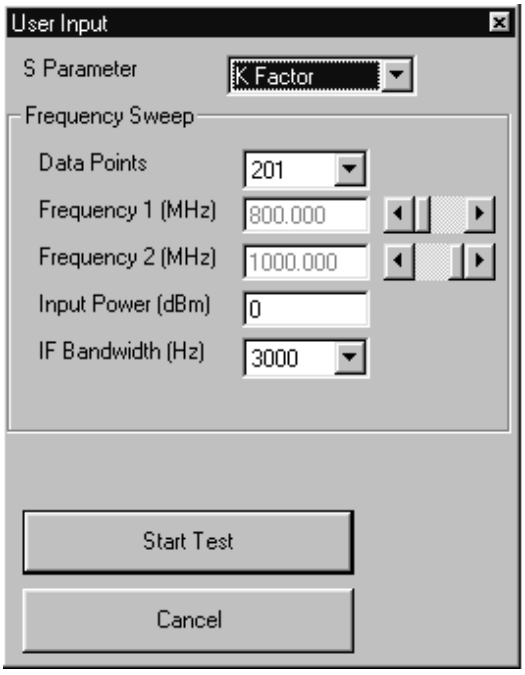
5-5 S-PARAMETER TEST: K FACTOR

This test describes the K Factors measurement. This measurement is described in Chapter 1, paragraph 1-11.

Procedure.

Prepare the ME7840A as shown in Chapter 3.

Enter the appropriate test values in the displayed User Input screen. The input fields are described below: The inputs required for this test are described below.



- **S-Parameter:** Drop down options. K Factor for this measurement.
- **Data Points:** Drop down options – number of data points in frequency sweep.
- **Frequency 1 (MHz):** Lower frequency or start frequency.
- **Frequency 2 (MHz):** Upper frequency or stop frequency.
- **Input Power (dBm):**Input power level, in dBm.
- **IF Bandwidth (Hz):**Intermediate frequency bandwidth for test, in Hertz.

- **Select Start Test:** Observe that the test screen (Figure 5-1) appears.

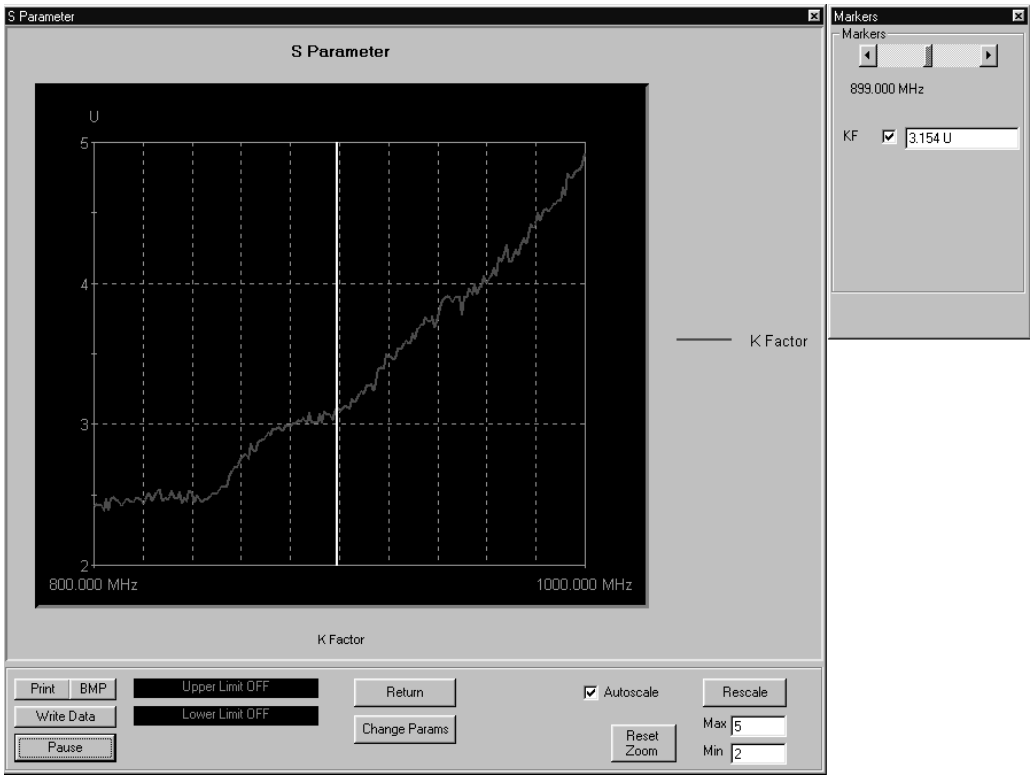


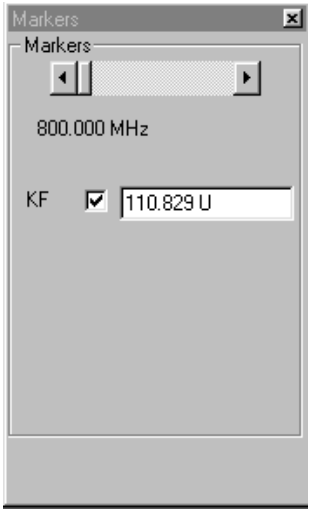
Figure 5-2. *S-Parameters Test Screen for S_{21}*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **Write Data:** Two data files are written to the C:\Program Files\Pats\Datafiles folder; the file name will have a time stamp. One datafile has a ".csv" file extension and the other has a ".s2p" file extension. *For example:* "S17-16-19-29.csv (and s2p)" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV and S2P files are comma separated text and can be opened in the Windows Microsoft Excel spreadsheet.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.
- **Upper Limit/Lower Limit:** Limit values as set using Tools menus (Chapter 3).

- **Return:** Returns to the main PATS screen.
- **Change Params:** Returns to User Input screen.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.
- **Reset/Zoom:** Disabled for this test.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Rescale:** Rescales the measurement results.

Markers Screen Options for K Factor (left):



- **Marker Slider:** Moves marker between data points.
- **Frequency Display**: Displays marker frequency.
- **KF:** Displays the K factor value. K factor is a stability factor of interest for amplifier designers.

5-6 POWER SWEEP, TWO TONE

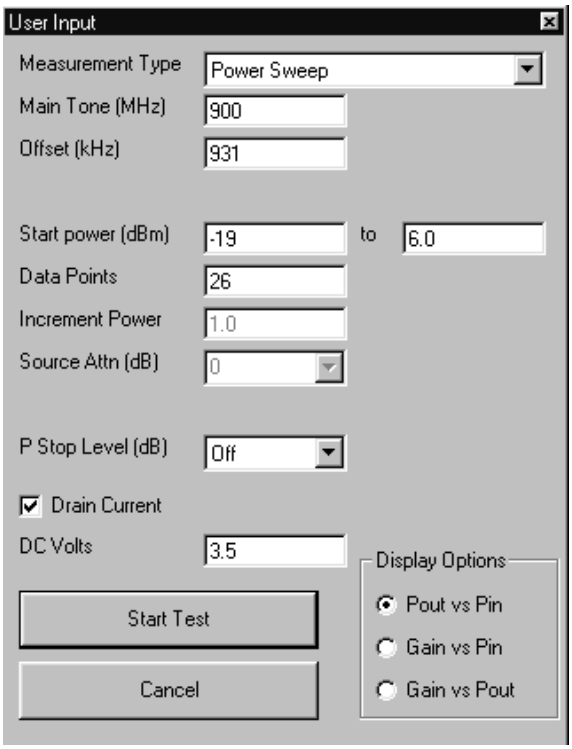
This measurement module has three variations of possible Measurement Types: Power Sweep (single frequency), Multi Frequency Power Sweep, Gain and IMD.

Single Frequency Power Sweep

Procedure.

Prepare the ME7840A as shown in Chapter 3.

Enter the appropriate test values in the displayed User Input screen. The input fields are described below:



- **Measurement Type:** Drop down options showing Power Sweep (single frequency), Multi Freq Power Sweep (uses 3 frequencies), Gain & IMD. Set to "Power Sweep " for this test.
- **Main Tone (MHz):** CW Frequency setting for source 1.
- **Offset (kHz):** Offset frequency for Source 2 (Source 2 will be set to Main Tone + Offset).
- **Start Power (dBm):** Power will be swept starting at the start power (input RF power to AUT). Both sources are simultaneously set to each power setting. The stop power is also entered in the "to" window.
- **Data Points:** Number of data points in power sweep.
- **Increment Power (dBm):** Value to increment power for each data point (calculated and displayed only).
- **Source Attn (dB):**Value of Source attenuation, between 0 and –70 (calculated and displayed only).
- **Drain Current Checkbox:** When checked the drain current is measured and power added efficiency is calculated and displayed.
- **PStop Level (dB):**Provides the ability to set the PStop value based on the level of gain compression. Drop down options include compression levels of 1 dB through 10 dB in 1 dB increments, and OFF. If OFF is selected, then the P Stop equals the value entered in the "to" window above. If the selected compression occurs, PStop for all subsequent power sweeps is reset to one increment before the P_{in} value where this compression level is reached.

- **Display Options:**
  - Power Sweep
    - Pout vs Pin
    - Gain vs Pin
    - Gain vs Pout
  - Overlay Power Sweep
    - Pout vs Pin
    - Gain vs Pin
    - Gain vs Pout
  - MultiFrequency Power Sweep
    - Gain
    - Pout
  - IMD Offset Sweep
    - Gain
    - Pout

Select **Start Test** and observe that the test screen (Figure 5-3) appears.

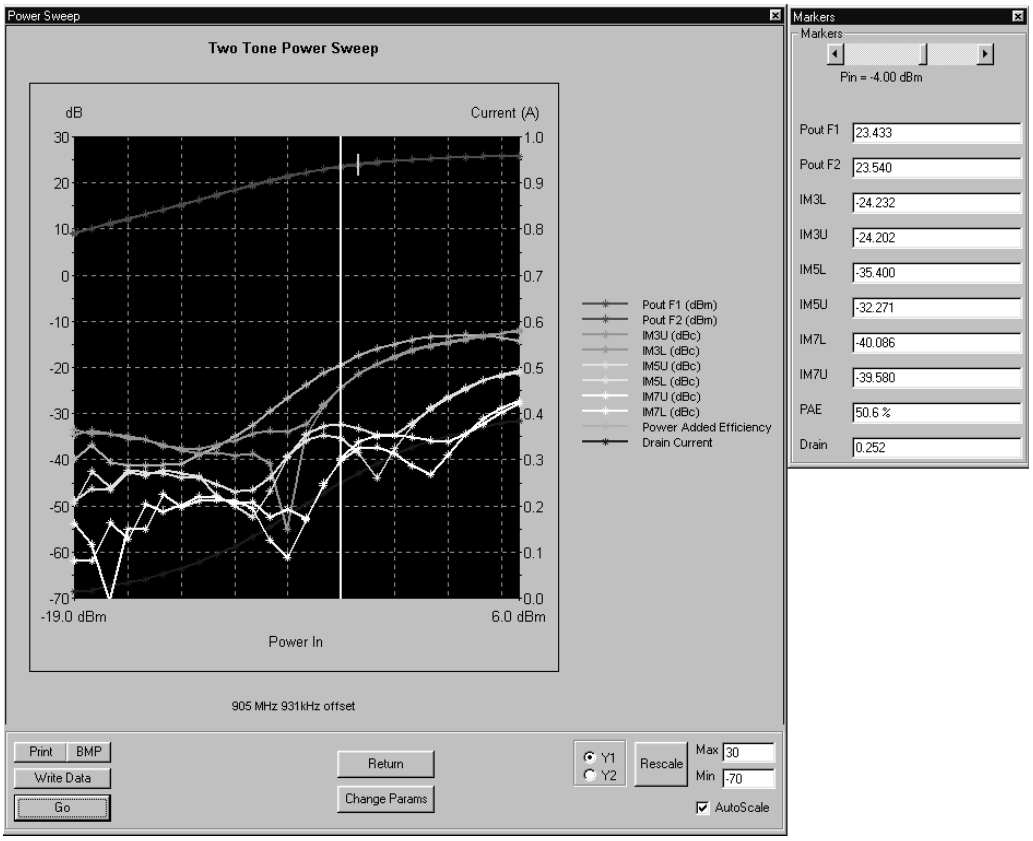


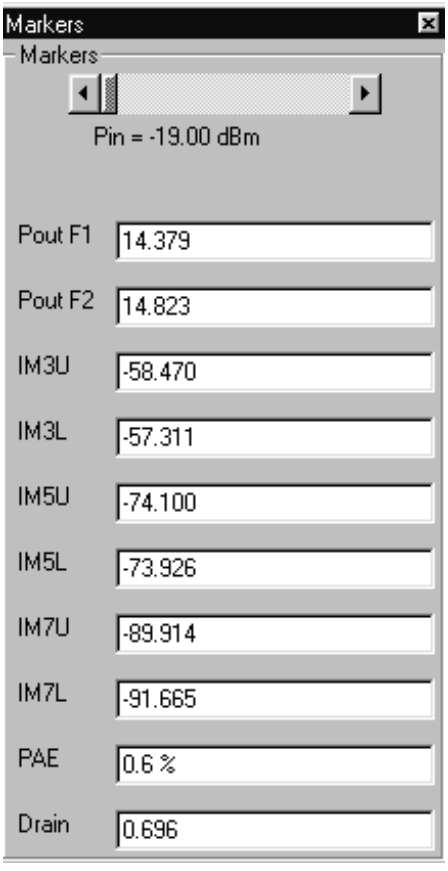
Figure 5-3. *Single Frequency Power Sweep Test*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **Write Data:** Excel data is written to C:\Program Files\Pats\Datafiles - the file name will have a time stamp. *For example:* "S17-16-19-29.csv" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV files are comma separated text and can be opened iin Windows Excel.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.
- **Pause/Go:** Stops data transfer from VNA to PC and places MS4623C in "Local" mode.
- **Return:** Returns to the main PATS screen.

- **Change Params:** Returns to User Input screen.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.
- **Reset/Zoom:** Disabled for this test.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Rescale:** Rescales the measurement results.
- **Pause/Go: Pause** stops data transfer from VNA to PC and places MS462XC in "Local" mode. **Go** starts data transfer to MS462XC in "Remote" mode.

Markers Screen Options (left):

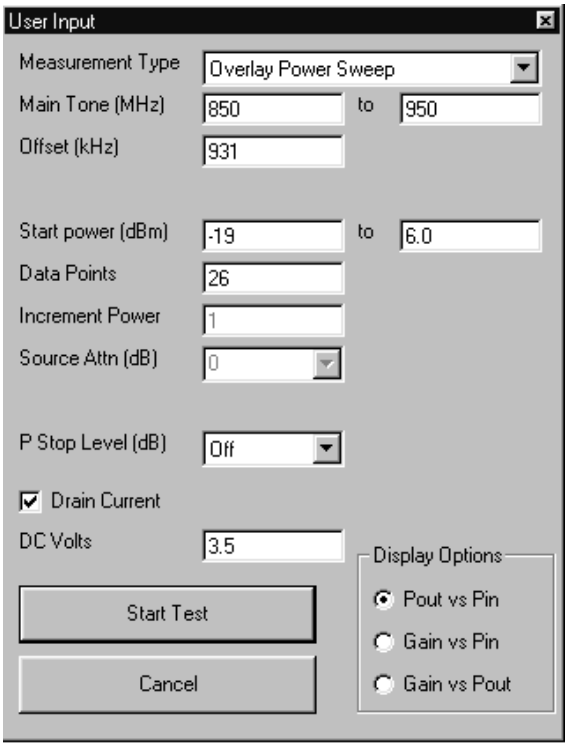


- **Markers slider:** Moves marker between data points.
- **Power In Reading:** Indicates the input power value.
- **Pout F1:** Power output at frequency 1.
- **Pout F2:** Power output at frequency 2.
- **IM3U:** Intermodulation product 3 upper sideband
- **IM3L:**Intermodulation product 3 lower sideband
- **IM5U:**Intermodulation product 5 upper sideband
- **IM5L:**Intermodulation product 5 lower sideband
- **IM7U:**Intermodulation product 7 upper sideband
- **IM7L:**Intermodulation product 7 lower sideband
- **PAE:** Power-added efficiency percentage.
- **Drain:** Drain current value.

NOTE

PAE and **Drain** may be on or off according to check box in parameter screen.

Overlay Power Sweep **Procedure.**



- **Measurement Type:** Drop down options. Set to "Multi Freq Power Sweep " for this test.
- **Main Tone (MHz):** CW Frequency setting for source 1. The user may set a lower tone and upper tone. The software will sweep three frequencies (the two input plus one between) and the RF input power to produce the display data.
- **Offset (kHz):** Offset frequency for Source 2 (Source 2 will be set to Main Tone + Offset).
- **Start Power (dBm):** Power will be swept starting at the start power (input RF power to AUT). Both sources are simultaneously set to each power setting. The stop power is also entered in the "to" window.
- **Data Points:** Number of data points in power sweep.
- **Increment Power (dBm):** Value to increment power for each data point (calculated and displayed only).
- **Source Attn (dB):**Value of Source attenuation, between 0 and –70 (calculated and displayed only).
- **Drain Current Checkbox:** When checked the drain current is measured and power added efficiency is calculated and displayed.
- **PStop Level (dB):**Provides the ability to set the PStop value based on the level of gain compression. Drop down options include compression levels of 1 dB through 10 dB in 1 dB increments, and OFF. If OFF is selected, then the P Stop equals the value entered in the "to" window above. If the selected compression occurs, PStop for all subsequent power sweeps is reset to one increment before the P_{in} value where this compression level is reached.

Select **Start Test**. Observe that the test screen (Figure 5-4) appears.

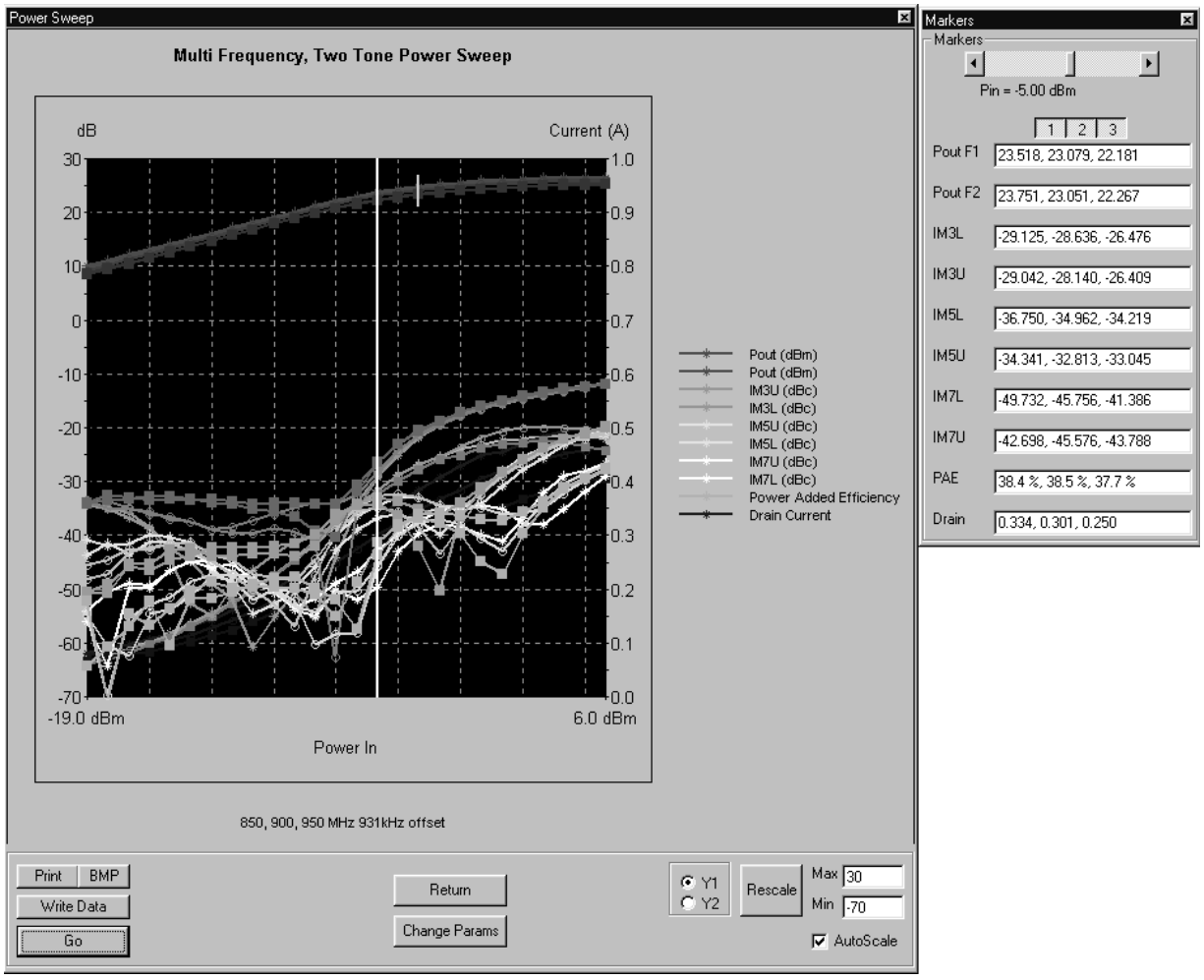


Figure 5-4. *Multiple Frequency Power Sweep Test*

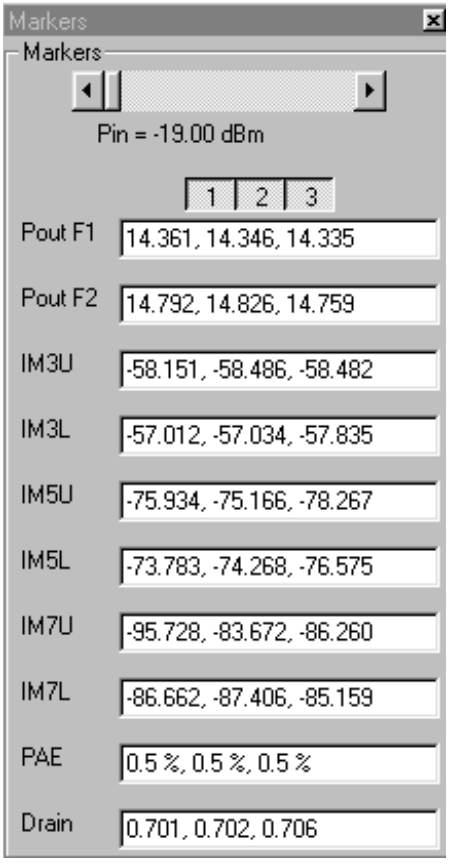
Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.
- **Write Data:** Excel data is written to C:\Program Files\Pats\Datafiles - the file name will have a time stamp. *For example:* "S17-16-19-29.csv" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV

files are comma separated text and can be opened iin Windows Excel.

- **Pause/Go:** Stops data transfer from VNA to PC and places MS4623C in “Local” mode.
- **Return:** Returns to the main PATS screen.
- **Change Params:** Returns to User Input screen.
- **Y1, Y2:** Provides for rescaling the left or right axis.
- **Rescale:** Rescales the measurement results.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.

Markers Screen Options (left):



- **Markers slider:** Moves marker between data points.
- **Pout F1:** Power output at frequency 1.
- **Pout F2:** Power output at frequency 2.
- **IM3U:** Intermodulation product 3 upper sideband
- **IM3L:**Intermodulation product 3 lower sideband
- **IM5U:**Intermodulation product 5 upper sideband
- **IM5L:**Intermodulation product 5 lower sideband
- **IM7U:**Intermodulation product 7 upper sideband
- **IM7L:**Intermodulation product 7 lower sideband
- **PAE:** Power-added efficiency percentage.
- **Drain:** Drain current value.

5-7 POWER SWEEP, ONE TONE

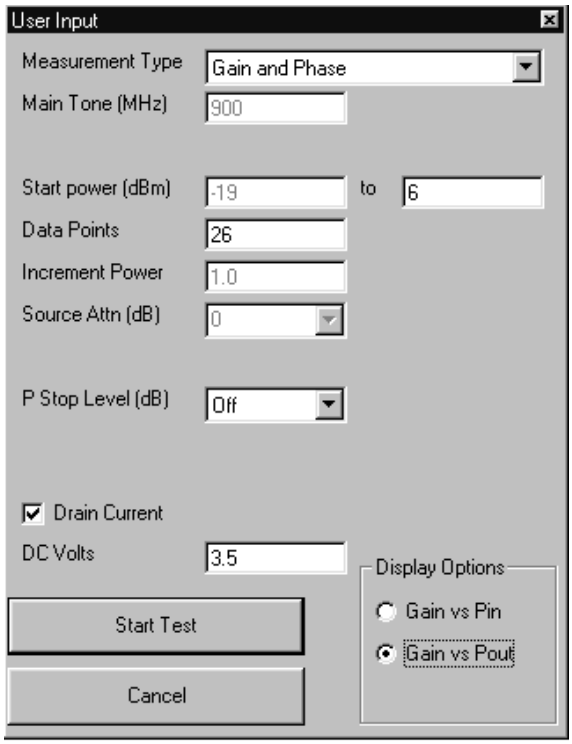
This measurement module has three variations of possible Measurement Types: Power Sweep (single frequency), Multi Frequency Power Sweep, Gain and IMD.

Single Frequency Power Sweep

Procedure.

Prepare the ME7840A as shown in Chapter 3.

Enter the appropriate test values in the displayed User Input screen. The input fields are described below:



- **Measurement Type:** Drop down options set to "Gain and Phase " for this test.
- **Main Tone (MHz):** CW Frequency setting for source 1.
- **Start Power (dBm):** Power will be swept starting at the start power (input RF power to AUT). Both sources are simultaneously set to each power setting. The stop power is also entered in the "to" window.
- **Data Points:** Number of data points in power sweep.
- **Increment Power (dBm):** Value to increment power for each data point (calculated and displayed only).
- **Source Attn (dB):**Value of Source attenuation, between 0 and –70 (calculated and displayed only).
- **Drain Current Checkbox:** When checked the drain current is measured and power added efficiency is calculated and displayed.
- **PStop Level (dB):**Provides the ability to set the PStop value based on the level of gain compression. Drop down options include compression levels of 1 dB through 10 dB in 1 dB increments, and OFF. If OFF is selected, then the P Stop equals the value entered in the "to" window above. If the selected compression occurs, PStop for all subsequent power sweeps is reset to one increment before the P_{in} value where this compression level is reached.

- **Display Options**
  - Power Sweep
    - Pout vs Pin
    - Gain vs Pin
    - Gain vs Pout
  - Gain/Phase
    - Gain/Phase vs Pin
    - Gain/Phase vs Pout
  - MultiFrequency Power Sweep
    - Gain
    - Pout

Select **Start Test** and observe that the test screen (Figure 5-3) appears.

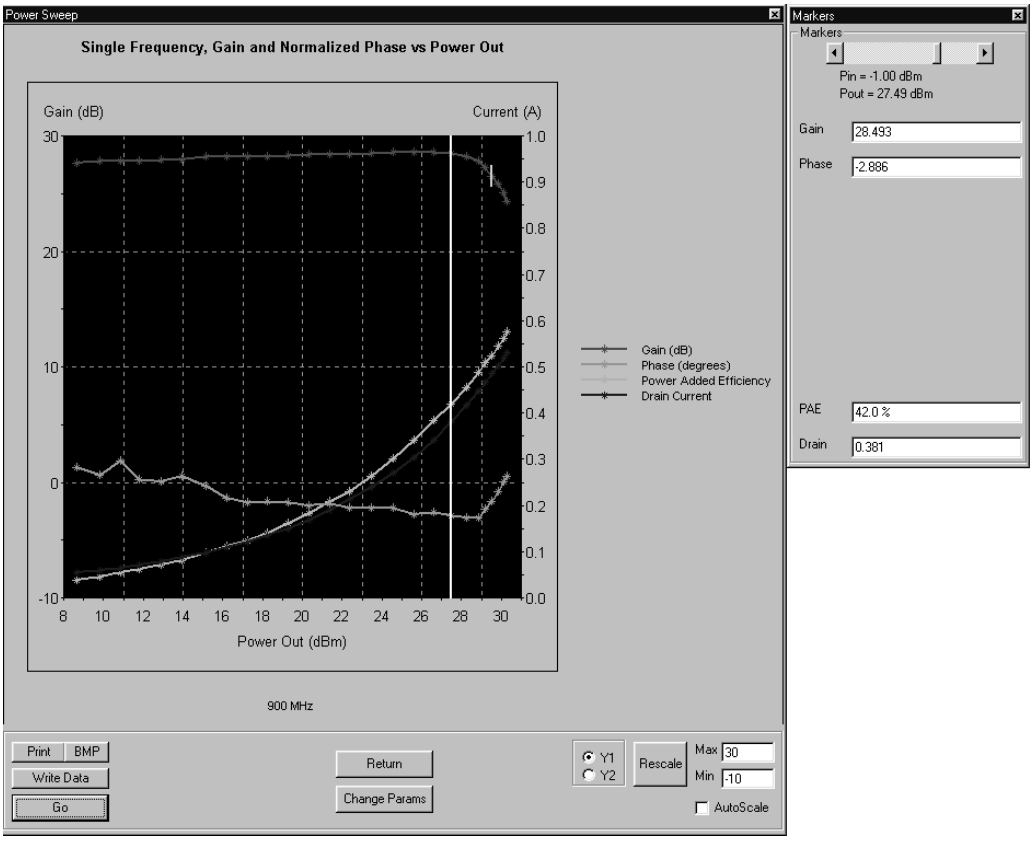
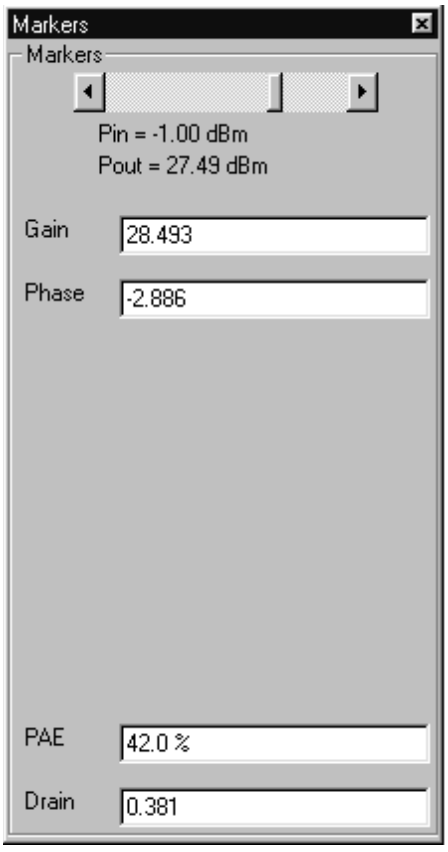


Figure 5-5. *Single Frequency Power Sweep Test*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.
- **Write Data:** Excel data is written to C:\Program Files\Pats\Datafiles - the file name will have a time stamp. *For example:* "S17-16-19-29.csv" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV files are comma separated text and can be opened iin Windows Excel.
- **Pause/Go:** Stops data transfer from VNA to PC and places MS4623C in "Local" mode.
- **Return:** Returns to the main PATS screen.



- **Change Params:** Returns to User Input screen.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Rescale:** Rescales the measurement results.

Markers Screen Options (left):

- **Markers slider:** Moves marker between data points.
- **Gain:** Gain is in dB and is the Gain, measured at the CW frequency for each power level in the power sweep. (Could also be called Gaini compression measurement.) The displayed power in the power of 1 input tone.
- **Phase:** Phase is an AM/PM measurement/display – the phase at the initial power level of the power sweep is used as a normalized level (zero). As the power is swept, the Phase displayed is the difference from the normalized value.

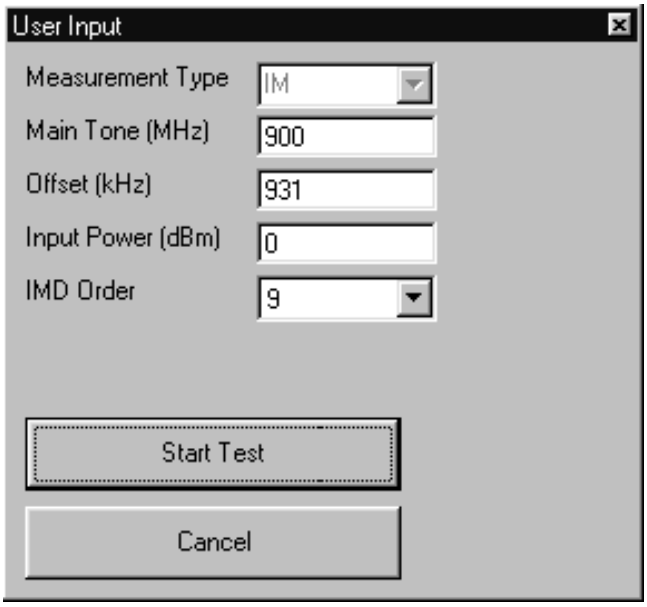
5-8 IMD

This test measures inter-modulation distortion.

Procedure

Prepare the ME7840A as shown in Chapter 3.

Enter the appropriate test values in the displayed User Input screen. The input fields are described below:



- **Measurement Type:** Already set to "IM" for IMD – input disabled.
- **Main Tone (MHz):** CW Frequency setting for source 1.
- **Offset (kHz):** Offset frequency for Source 2 (Source 2 will be set to Main Tone + Offset).
- **Input Power (dBm):** Input RF power to AUT.
- **IMD Order:**

Select **Start Test**. Observe that the test screen (Figure 5-6) appears.

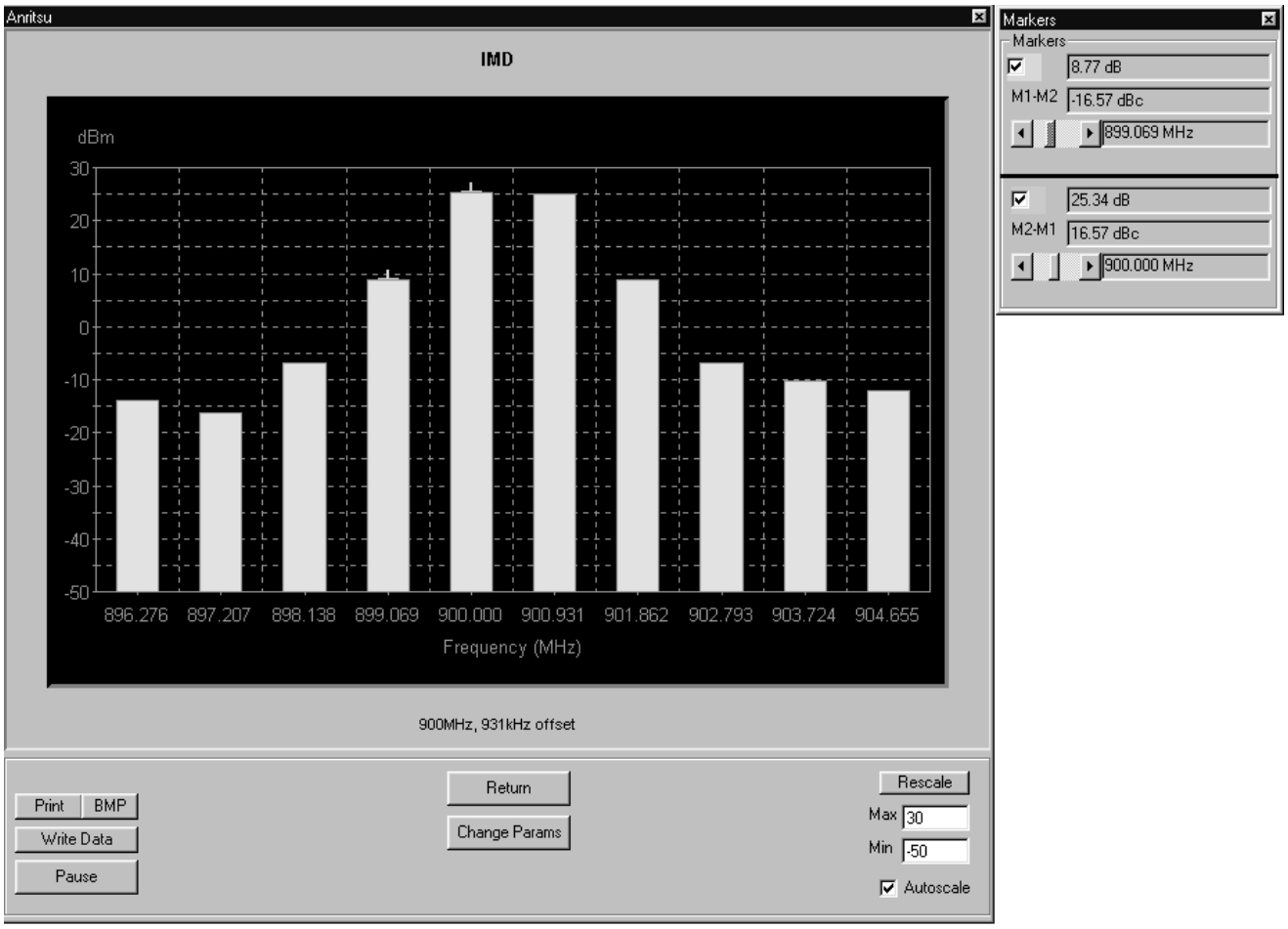


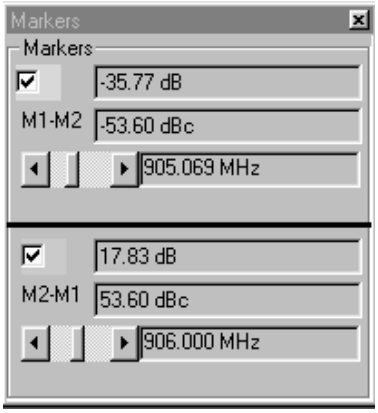
Figure 5-6. *Intermodulation Distortion Test Screen*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **Write Data:** Excel data is written to C:\Program Files\Pats\Datafiles - the file name will have a time stamp. *For example:* "S17-16-19-29.csv" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV files are comma separated text and can be opened iin Windows Excel.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.

- **Pause/Go:** Stops data transfer from VNA to PC and places MS4623C in “Local” mode.
- **Return:** Returns to the main PATS screen.
- **Change Params: Returns to the User Input screen.**
- **Rescale:** Rescales the measurement results.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.

Markers Screen Options (left):



- **M1-M2 Checkbox:** Turns M1-M2 feature on or off.
- **M1-M2 Readout:** Displays the value of M1 minus M2.
- **M1 Slider:** Moves M1 between displayed harmonics. A blue + symbol appears on the top of the selected harmonic.
- **M2-M1Checkbox:** Turns M2-M1 feature on or off.
- **M2-M1 Readout:** Displays the value of M2 minus M1.
- **M2-M1 Slider:** Moves M2 between displayed harmonics. A blue + symbol appears on the top of the selected harmonic.

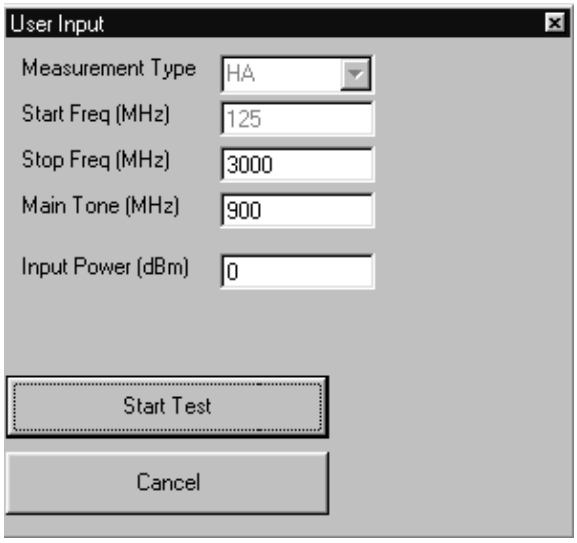
5-9 HARMONICS

The harmonics test measures and displays the harmonics in the device under test.

Procedure

Prepare the ME7840A as shown in Chapter 3.

Enter the appropriate test values in the displayed User Input screen. The input fields are described below:



- **Measurement Type:** Already set to "HA" for Harmonics – input disabled.
- **Start Frequency (MHz):** Lower frequency to be displayed. Typically set to a value less than or equal to the main tone.
- **Stop Frequency (MHz):** Upper Frequency to be displayed. Set to a value less than the system's maximum frequency (for example, for MS4623C set to a max of 5000 MHz).
- **Main Tone (MHz):** CW Frequency setting for source 1.
- **Input Power:** Input RF power to AUT.

Select **Start Test** and observe that the test screen (Figure 5-7) appears.

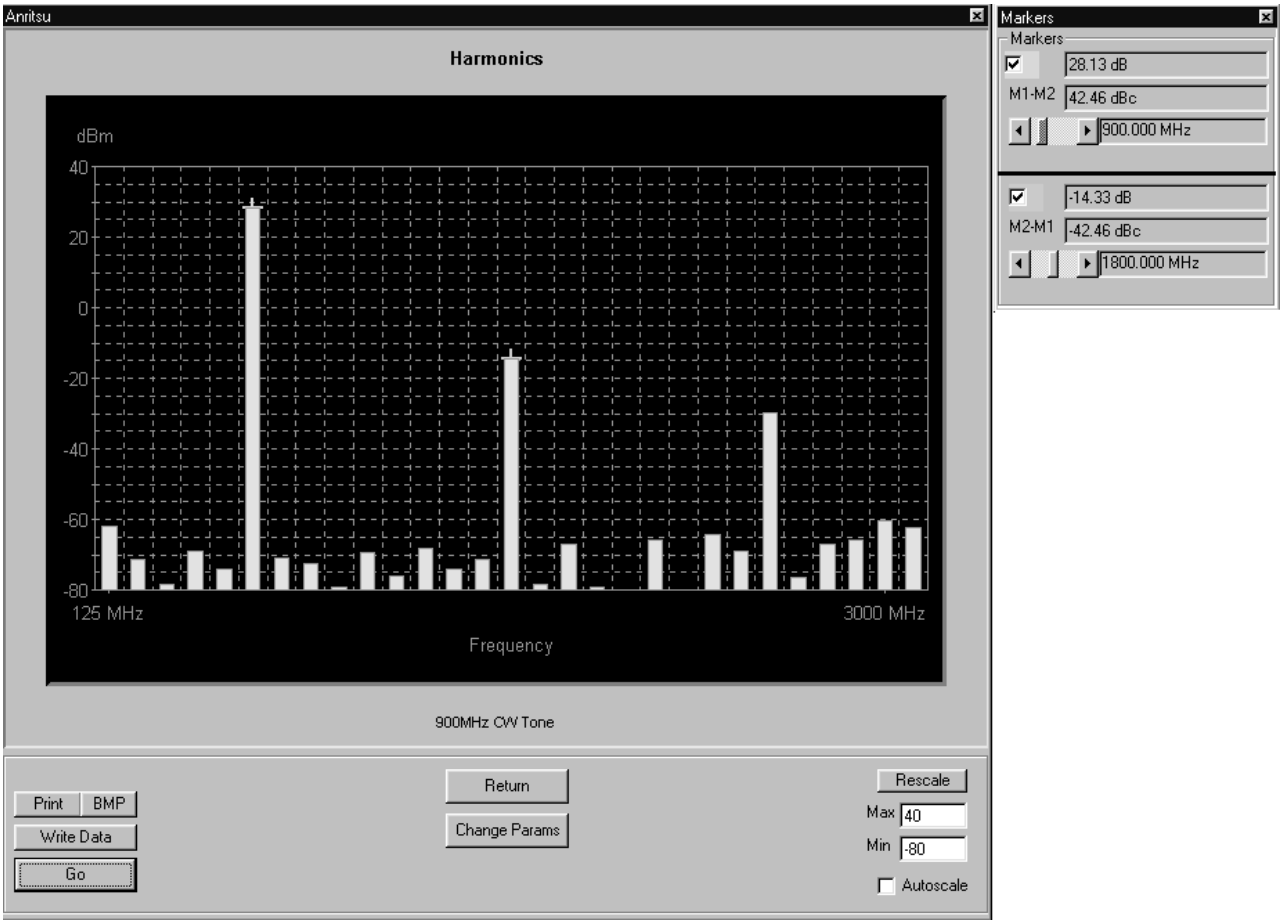


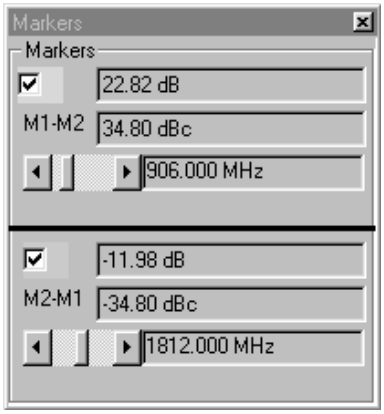
Figure 5-7. *Initial Harmonics Test Screen*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **Write Data:** Excel data is written to C:\Program Files\Pats\Datafiles - the file name will have a time stamp. *For example:* "S17-16-19-29.csv" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV files are comma separated text and can be opened iin Windows Excel.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.

- **Pause/Go:** Stops data transfer from VNA to PC and places MS4623C in “Local” mode.
- **Return:** Returns to the main PATS screen.
- **Change Params:** Returns to User Input screen.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Rescale:** Rescales the measurement results.

Markers Screen Options (left):



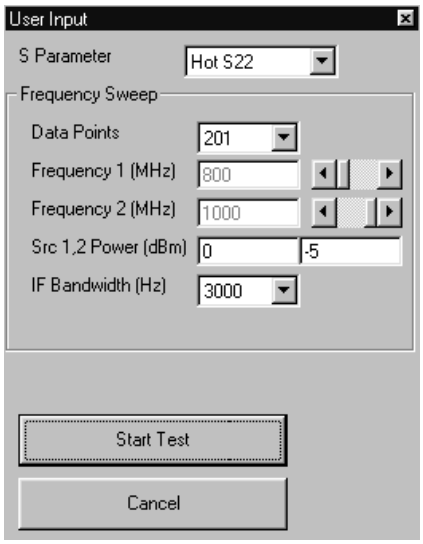
- **M1-M2 Checkbox:** Turns M1-M2 feature on or off.
- **M1-M2 Readout:** Displays the value of M1 minus M2.
- **M1 Slider:** Moves M1 between displayed harmonics. A blue + symbol appears on the top of the selected harmonic.
- **M2-M1Checkbox:** Turns M2-M1 feature on or off.
- **M2-M1 Readout:** Displays the value of M2 minus M1.
- **M2-M1 Slider:** Moves M2 between displayed harmonics. A blue + symbol appears on the top of the selected harmonic.

5-10 HOT S22

The output match of a power amplifier under excited conditions is critical information that has a strong bearing on efficiency, output power, stability, and often the economic viability of the design. One way of dealing with this information—primarily in power devices operating well away from compression or in somewhat matched amplifiers— is a quasi-linear measurement of S_{22} while the amplifier is operating under normal drive. Such a measurement is termed hot S_{22}, and it can provide (1) some information on the degree of mismatch in the system, (2) potential operational stability, and (3) the effects of the amplifier's performance on subsequent stages or an antenna. In the PATS, the Hot S_{22} measurement uses one source (Source 2) to provide stimulus to the amplifier-under-test (AUT) input port while the other source (Source 1) provides a pilot tone injected to the output of the AUT for measuring S_{22} at the AUT output port.

Procedure

Prepare the ME7840A as shown in Chapter 3.



Enter the appropriate test values in the displayed User Input screen. The input fields are described below:

- **S Parameter:** Already set to "Hot S_{22}" for test – input disabled.
- **Data Points:** Drop down options – number of data points in frequency sweep.
- **Frequency 1 (MHz):** Lower frequency to be displayed. Typically set to a value less than or equal to the main tone. Can be reset using slider control.
- **Frequency 2 (MHz):** Upper Frequency to be displayed. Set to a value less than the system's maximum frequency (for example, for MS4623C set to a max of 5000 MHz). Can be reset using slider control.
- **Src 1 Power (dBm):**Source 1 power level, in dBm.
- **IF Bandwidth (Hz):**Intermediate frequency value, in Hertz.

The PATS Hot S_{22} measurement provides the following additional features:

- Ability to vary the AUT input excitation power level (Source 2 of Scorpion, at Port 1) while observing the Hot S_{22} response. Pressing "U" on the PC keyboard increases the input excitation power level (U for up). Pressing "D" decreases it. The actual input excitation power in dBm is displayed on the PC screen.
- Ability to turn the amplifier input excitation source (Source 2 of Scorpion, at Port 1) ON and OFF while observing the Hot S_{22}. Shift S turns Source 2 OFF. S turns it ON. This basically provides a comparison of "Cold" S_{22} with Hot S_{22}.
- Ability to capture the Hot S_{22} plot at a given excitation level (history plot on the PC screen) for comparison with other levels. Press "C" captures (creates history plot). Press "Shift + C" removes it.
- Ability to show Hot S_{22} Smith Chart on the Scorpion Screen while Log Magnitude is displayed on the PC screen. The Scorpion display can be selected by Scorpion front panel controls during the measurement.

The level of the tone injected to the output of the AUT (Source 1 of Scorpion, at Port 2) can be set by the user prior to the measurement.

Select **Start Test** and observe that the test screen (Figure 5-8) appears.

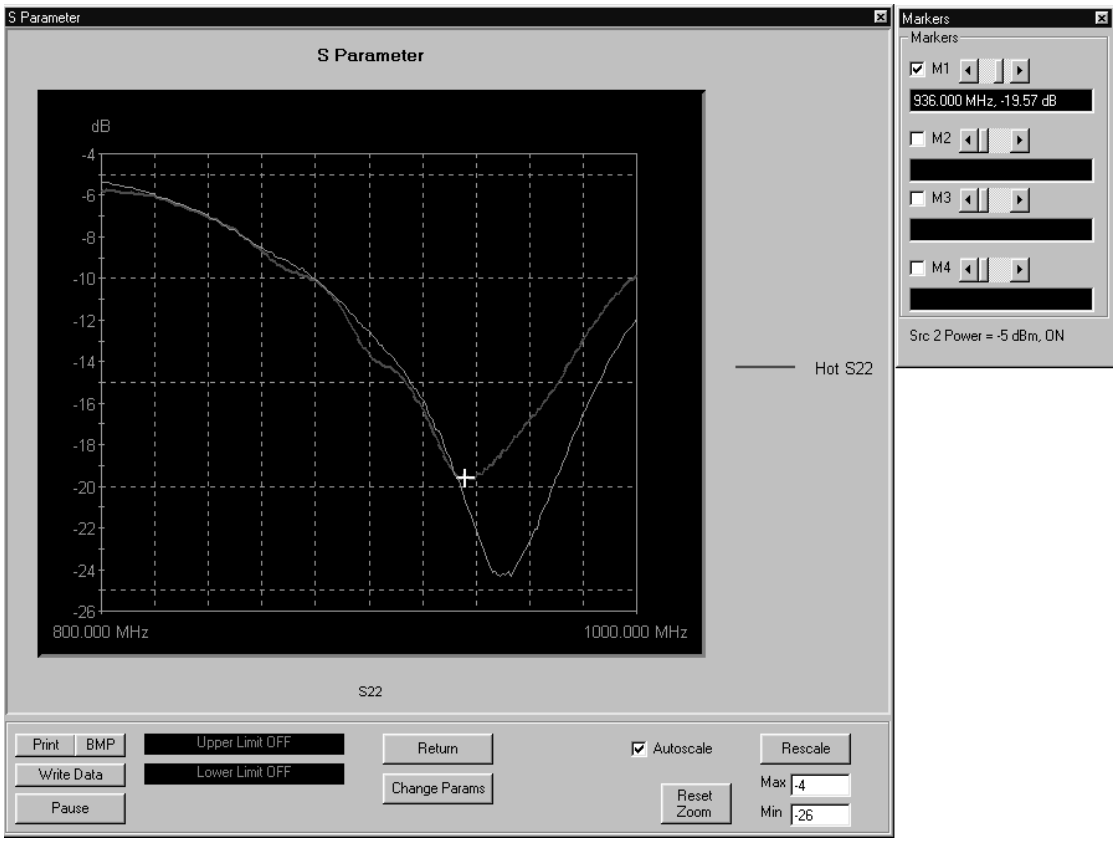
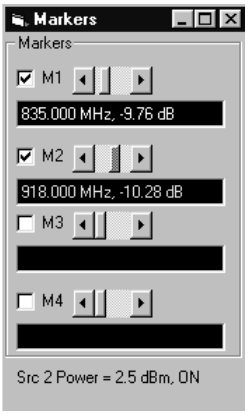


Figure 5-8. *Hot S_{22} Test Screen*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **Write Data:** Excel data is written to C:\Program Files\Pats\Datafiles - the file name will have a time stamp. *For example:* "S17-16-19-29.csv" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV files are comma separated text and can be opened iin Windows Excel.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.
- **Pause/Go:** Stops data transfer from VNA to PC and places MS4623C in "Local" mode.
- **Upper Limit/Lower Limit:** Limit values as set using Tools menus (Chapter 3).



- **Return:** Returns to the main PATS screen.
- **Change Params:** Returns to User Input screen.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.
- **Reset/Zoom:** Disabled for this test.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Rescale:** Rescales the measurement results.

Markers Screen Options (left):

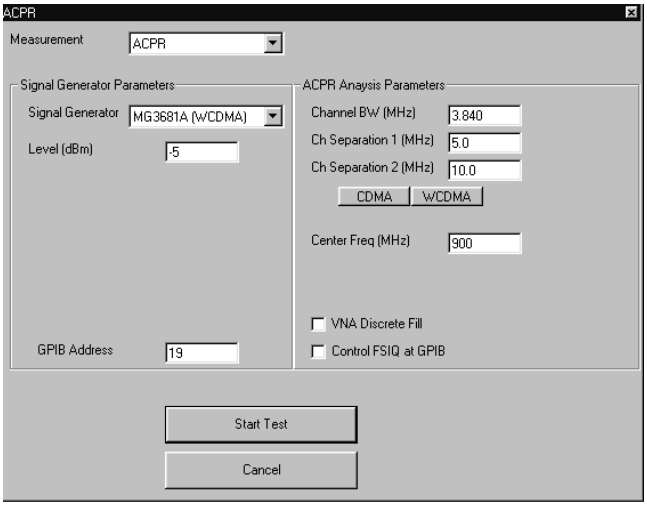
- **M1:** Turns marker on or off (checked or unchecked). If on: Slider moves marker between data points, and window below displays marker frequency and amplitude values amplitude value at the marker.
- **M2:** Same as above.
- **M3:** Same as above.
- **M4:** Same as above.

5-11 ACPR

This section describes the screens that guide the user through the adjacent channel power ratio (ACPR) measurement. ACPR is fully described in Anritsu Application Note 11410-00264, which is available from your local representative or from our Internet site, *www.us.anritsu.com*.

CW Measurements Procedure

Prepare the ME7840A as shown in Chapter 3.



Enter the appropriate test values in the displayed User Input screen. The input fields are described below:

- **Signal Generator Parameters:** Provides controls for the Signal Generator: Anritsu MG3681 for WCDMA, Agilent ESG for CDMA and WCDMA. In addition, PA Navigator will support manual setup of the modulated signal.
  - Signal Generator: Displays the signal generator model number. Choose from drop-down list.
  - Level (dBm): Displays the signal generator signal level.
  - GPIB Address: Displays the signal generator GPIB address.
- **ACPR Analysis Parameters:** Provides controls for signal analysis. PA Navigator will support the R&S FSIQ series of analyzers for comparison purposes only. The Scorpion handles the brunt of ACPR analysis.
  - Channel BW (MHz):
  - Ch Separation 1 (MHz):
  - Ch Separation 2 (MHz):
  - CDMA
  - WCDMA
  - Center Freq (MHz):
  - VNA Discrete Fill:
  - Control FSIQ at GPIB:

Select **Start Test** and observe that the test screen (Figure 5-8) appears.

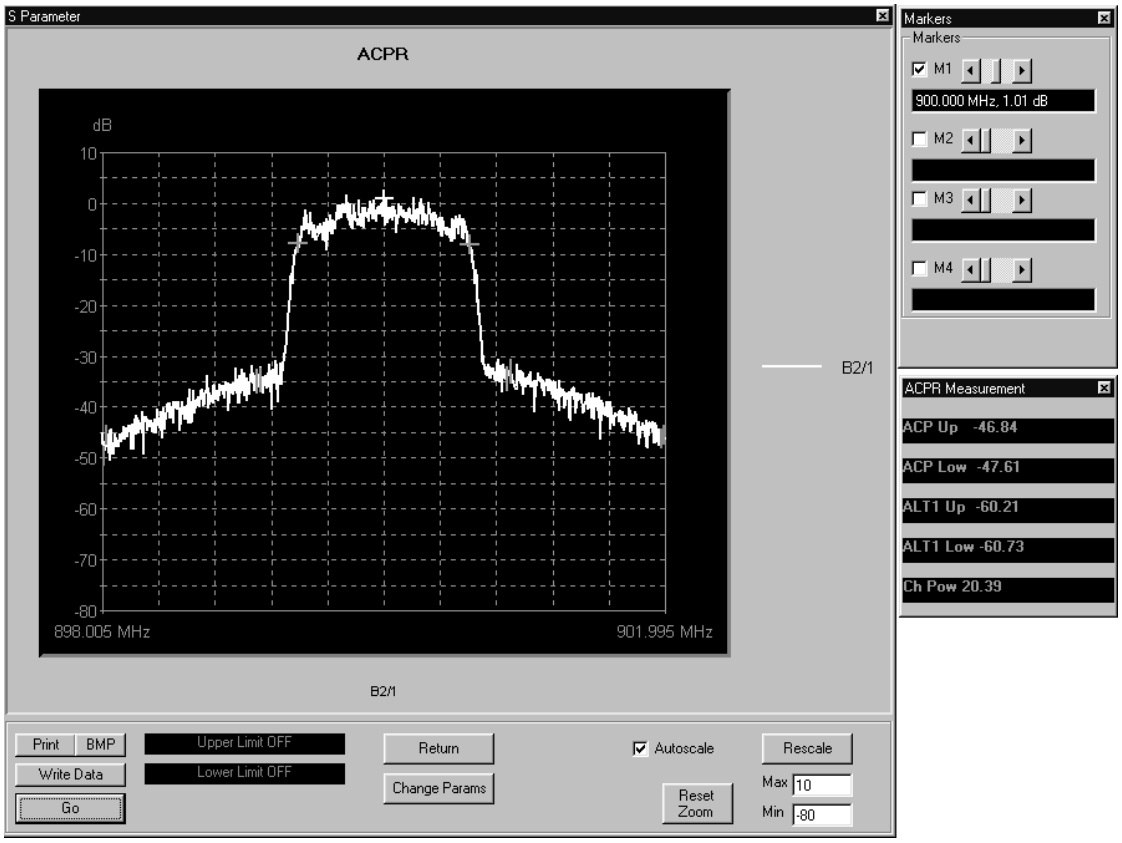


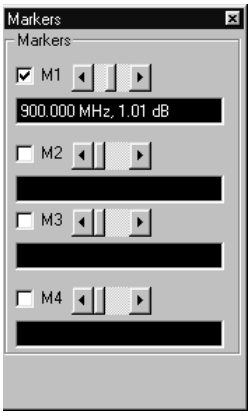
Figure 5-9. *ACPR Test Screen*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **Write Data:** Excel data is written to C:\Program Files\Pats\Datafiles - the file name will have a time stamp. *For example:* "S17-16-19-29.csv" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV files are comma separated text and can be opened iin Windows Excel.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.
- **Pause/Go:** Stops data transfer from VNA to PC and places MS4623C in "Local" mode.
- **Upper Limit/Lower Limit:** Limits are off for ACPR.

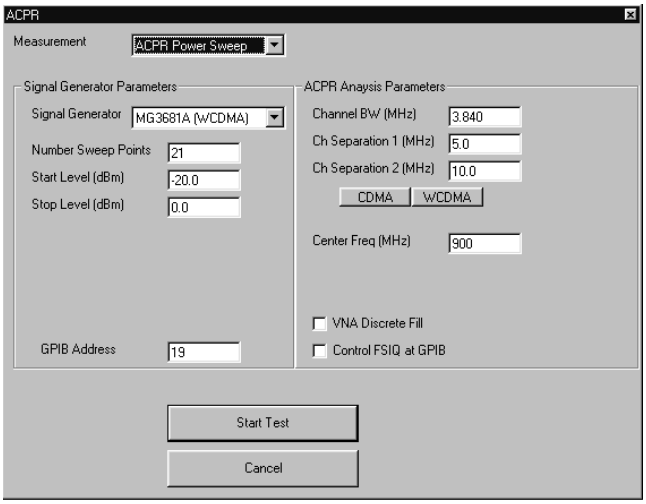
- **Return:** Returns to the main PATS screen.
- **Change Params:** Returns to User Input screen.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.
- **Reset/Zoom:** Disabled for this test.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Rescale:** Rescales the measurement results.

Markers Screen Options (left):



- **M1:** Turns marker on or off (checked or unchecked). If on: Slider moves marker between data points, and window below displays marker frequency and amplitude values amplitude value at the marker.
- **M2:** Same as above.
- **M3:** Same as above.
- **M4:** Same as above.

Power Sweep Measurements **Procedure**



Prepare the ME7840A as shown in Chapter 3.

Enter the appropriate test values in the displayed User Input screen. The input fields are described below:

- **Signal Generator Parameters:**Provides controls for the Signal Generator: Anritsu MG3681 for WCDMA, Agilent ESG for CDMA and WCDMA. In addition, PA Navigator will support manual setup of the modulated signal.
  - Signal Generator: Displays the signal generator model number. Choose from drop-down list.
  - Level (dBm): Displays the signal generator signal level.
  - GPIB Address: Displays the signal generator GPIB address.
- **ACPR Analysis Parameters:** Provides controls for signal analysis. PA Navigator will support the R&S FSIQ series of analyzers for comparison purposes only. The Scorpion handles the brunt of ACPR analysis.
  - Channel BW (MHz):
  - Ch Separation 1 (MHz):
  - Ch Separation 2 (MHz):
  - CDMA
  - WCDMA
  - Center Freq (MHz):
  - VNA Discrete Fill:
  - Control FSIQ at GPIB:

Select **Start Test** and observe that the test screen (Figure 5-8) appears.

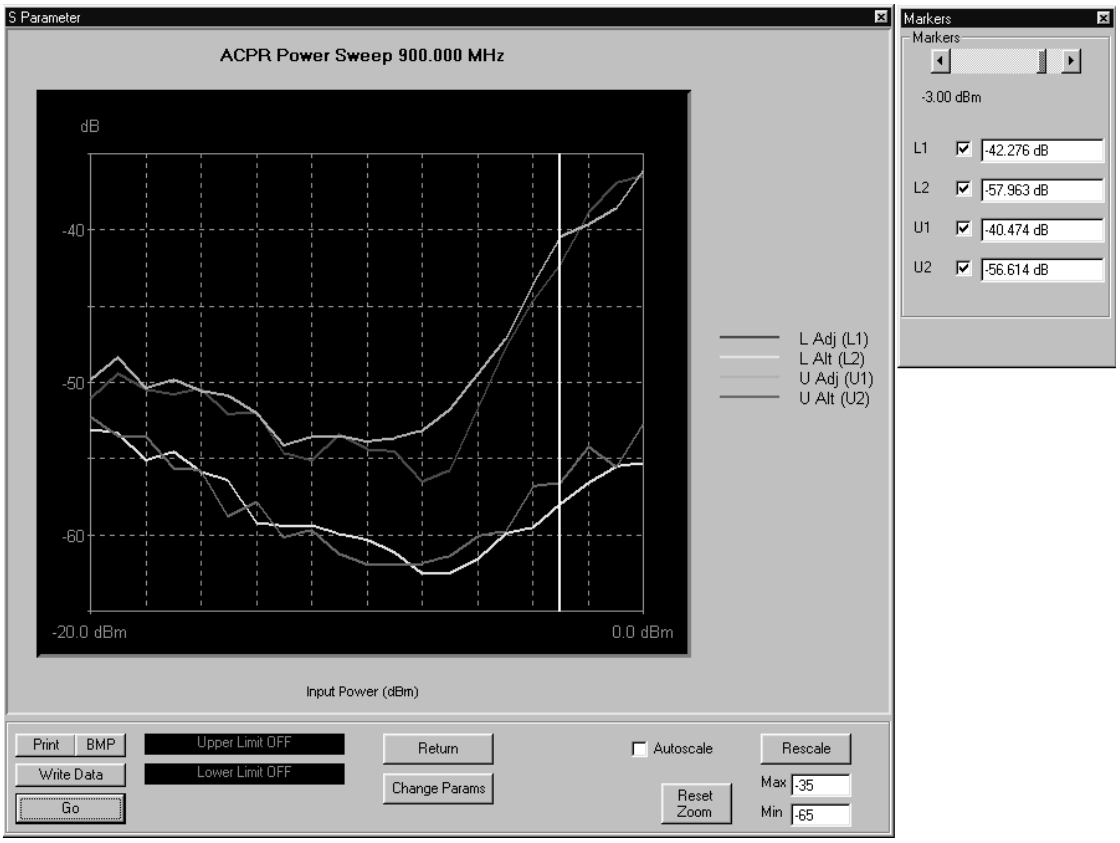


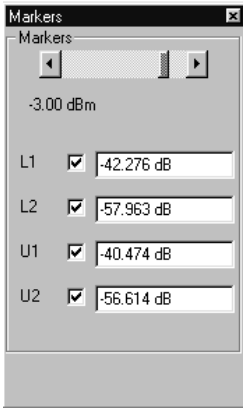
Figure 5-10. *ACPR Test Screen*

Button Panel Options:

- **Print:** Prints a copy of the screen graphic to a printer.
- **Write Data:** Excel data is written to C:\Program Files\Pats\Datafiles - the file name will have a time stamp. *For example:* "S17-16-19-29.csv" was created on the 17th day of the month at 4:19 PM and 29 seconds. CSV files are comma separated text and can be opened iin Windows Excel.
- **BMP:** Same data that is sent to printer may be saved to a bmp (bitmap) file.
- **Pause/Go:** Stops data transfer from VNA to PC and places MS4623C in "Local" mode.
- **Upper Limit/Lower Limit:** Limits are off for ACPR.

- .
- **Return:** Returns to the main PATS screen.
- **Change Params:** Returns to User Input screen.
- **Autoscale Checkbox:** Turns autoscale on or off. Autoscale automatically scales the measurement results.
- **Reset/Zoom:** Disabled for this test.
- **Max/Min:** Type in maximum and minimum display value. Use Rescale after changing values.
- **Rescale:** Rescales the measurement results.

Markers Screen Options (left):



- **L1:** Lower Adjacent Channel Power
- **L2:** Lower Alternate Channel Power
- **U1:** Upper Adjacent Channel Power
- **U2:** Upper Alternate Channel Power

Chapter 6
Performance Verification Procedure

Table of Contents

Chapter 6
Performance Verification Procedure

6-1 INTRODUCTION

The following are the specific tests that should be used to verify the performance of the Power Amplifier Test System (PATS)

- Source Output Level Accuracy Test
- Return Loss Measurement Confidence Test
- System Dynamic Range Test
- Receiver Magnitude Display Linearity Test

6-2 CONVENTIONS

In the tests in this chapter, instructions will direct use front panel hard keys and softkeys. The hard keys and softkeys will appear in a different typeface. For example:

Step 1. Press the Utility key and select:

DIAGNOSTICS
TROUBLESHOOTING
MORE
VERIFY ALC CALIBRATON

The Utility key is a front panel hard key and DIAGNOSTICS, TROUBLESHOOTING, MORE, and VERIFY ALS CALIBRATION are all softkeys.

6-3 TEST EQUIPMENT

The following equipment is required to performthe verification procedures.

- ANRITSU Model ML243XA Power Meter
- ANRITSU Model MA247XA Power Sensor
- ANRITSU Model 3653 or 3753LF N connector Calibration Kit
- ANRITSU Model SC5237 6 dB Offset Termination
- ANRITSU Model SC5270 20 dB Offset Termination
- ANRITSU Model 11N50B Power Divider
- ANRITSU Model 3670NN50-2 Cable
- ANRITSU Model 34NN50A Adapter
- ANRITSU 2100-2 GPIB cable

6-4 SOURCE OUTPUT ACCURACY

This test verifies the source output accuracy of the MS462XC. The test procedure uses the Power ALC Verification built-in function of the MS462XC Basic Measurement software.

Setup:

Step 1. Connect a GPIB cable between the power meter GPIB connector and the MS462XC dedicated GPIB connector, as shown in Figure 6-1.

Step 2. Turn on the MS462XC VNMS and allow it to warm-up at least one hour.

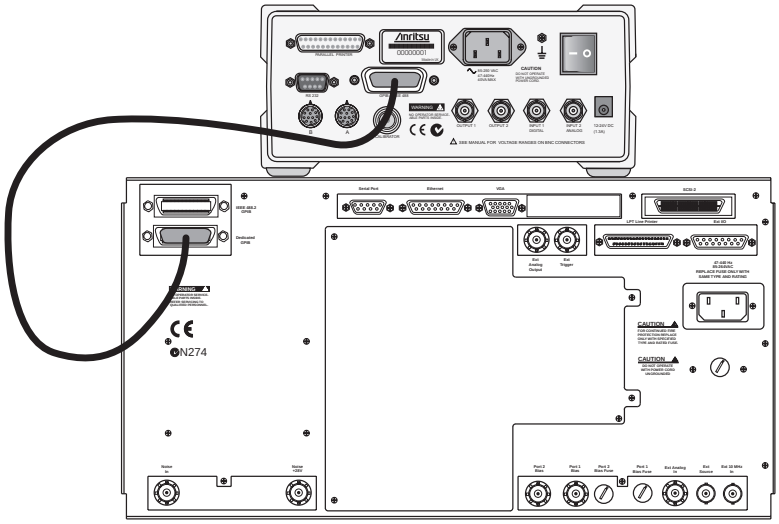


Figure 6-1. *ML2430A Series Power Meter GPIB connection to the MS462XX Vector Network Measurement System*

Test Procedure

Step 1. Disconnect cables between MS462XC Port 1 and Port 1 of MS4782 Test Set and between Port 3 of MS462XC and Port 3 of MS4782 Test Set.

Step 2. Press Utility key and select:

DIAGNOSTICS
TROUBLESHOOTING
MORE
VERIFY ALC CALIBRATON

Step 3. Calibrate and zero the power sensor.

NOTE
The worst case test result will be displayed on the screen when the instrument fails this test only. The failed test result is also recorded in theService Log.

Step 4. Connect power sensor to MS462XC Port 1 and select START VERIFICATION softkey.

Step 5. Verify that Source 1 passes this test.

Step 6. Press the SELECT SOURCE soft key to select 2

Step 7. Connect power sensor to MS462XC Port 3 and select START VERIFICATION soft key.

CAUTION
The TROUBLESHOOTING function must be properly exited to restore normal

Step 8. Verify that Source 2 passes this test.

Step 9. Select the menu soft key as follows to exit the TROUBLE-SHOOTING mode:

RETURN
RETURN
FINISHED, RECOVER FROM TROUBLESHOOTINGT

Step 10. Reconnect cables between MS462XC Port 1 and Port 1 of MS4782 Test Set and between Port 3 of MS462XC and Port 3 of MS4782 Test Set.

6-5 *RETURN LOSS CONFIDENCE TEST*

This test verifies the accuracy of return loss measurements.

Setup

Turn on the MS462XC VNMS and MS4782X Test Set and allow them to warm up for 30 minutes.

Step 1. Press Default key then 0 key.

Step 2. Press Seq key and .select:

TTL I/O.
PARALLEL OUT SETUP
SET PARALLEL OUT PORT (0-255)

Step 3. Change the value from 0 to 8.

Step 4. Select:

RETURN

RETURN

Step 5. Press Display key and select:

DISPLAY MODE

SINGLE CHANNEL

RETURN

Step 6. Press Ch 4 key and then Display key.

Step 7. Select:

GRAPH TYPE

LOG MAGNITUDE

Step 8. Press Ch 1 key and select LOG MAGNITUDE.

Test Procedure: Insert the Calibration Component Coefficients disk into the MS462XC floppy disk drive.

Step 1. Press Cal key and select:

COMPONENT UTILTIES

INSTALL KIT INFO FROM FLOPPY DISK

RETURN

Step 2. Follow the prompts and select:

PERFORM CAL: 2 PORT

CAL METHOD: STANDARD

LINE TYPE: COAXIAL

SELECT CALIBRATION TYPE: REFLECTION ONLY – PORT 1 ONLY

FREQUENCY RANGE OF CALIBRATION: 800 MHz TO 2400 MHz

SELECT CALIBRATION DATA POINTS: NORMAL

DATA POINTS: 401 POINTS

PORT 1 CONNECTOR TYPE: N (F)

LOAD TYPE: BROADBAND LOAD

Step 3. Select START CAL soft key to begin calibration.

Step 4. Install calibration device per instruction on the display. Select the appropriate soft key to measure the calibration device.

Step 5. When the "CALIBRATION SEQUENCE COMPLETED" message is displayed, press the Enter key to continue.

Step 6. Connect SC5237 6 dB Offset Termination to Test Port 1 of MS4782 Test Set. Record the measured value in Table 6-1 and verify the measured S_{11} value is 6 ±0.4 dB. Remove SC5237 Termination.

Step 7. Connect SC5270 20 dB Offset Termination to Test Port 1 of MS4782 Test Set. Record the measured value in Table 6-1 and verify the measured S_{11} value is 20 ± 1.0 dB. Remove SC5270 Termination.

Step 8. If system does not have Hot S_{22} capability, skip steps 8 to 15.

Step 9. Press Cal key.

Step 10. Follow the prompts and select:

PERFORM CAL: 2 PORT

CAL METHOD: STANDARD

LINE TYPE: COAXIAL

SELECT CALIBRATION TYPE: REFLECTION ONLY – PORT 2 ONLY

FREQUENCY RANGE OF CALIBRATION: 800 MHz TO 1000 MHz

SELECT CALIBRATION DATA POINTS: NORMAL

DATA POINTS: 401 POINTS

PORT 2 CONNECTOR TYPE: N (F)

LOAD TYPE: BROADBAND LOAD

Step 11. Select START CAL soft key to begin calibration.

Step 12. Install calibration device per instruction on the display. Select the appropriate soft key to measure the calibration device.

Step 13. When the "CALIBRATION SEQUENCE COMPLETED" message is displayed, press the Enter key to continue.

Step 14. Connect SC5237 6 dB Offset Termination toTest Port 2 of MS4782 Test Set. Record the measured value in Table 6-1 and verify the measured S_{22} value is 6 ± 0.4 dB. Remove SC5237 Termination.

Step 15. Connect SC5270 20 dB Offset Termination to Test Port 2 of MS4782 Test Set. Record the measured value in Table 6-1 and verify the measured S_{22} value is 20 ± 1.0 dB. Remove SC5270 Termination.

Table 6-1. *Return Loss Specifications*

Offset Termination	Measured S_{11} Value	Measured S_{22} Value*	Specification
SC5237			6 ±0.4 dB
SC5270			20 ±1.0 dB

* Apply to Test Set with Hot S_{22} Capability only.

6-6 SYSTEM DYNAMIC RANGE

This test verifies the PATS system dynamic range.

Test Procedure:

Step 1. Press Default key then 0 key of MS462XC to reset the system.

Step 2. Press Seq key.

Step 3. Select:

TTL I/O.
PARALLEL OUT SETUP
SET PARALLEL OUT PORT (0-255)

Step 4. Change the value from 0 to 8.

Step 5. Select:

RETURN
RETURN

Step 6. Press Ch 3 key.

Step 7. Press Display key and select:

DISPLAY MODE
SINGLE CHANNEL
RETURN
GRAPH TYPE
LOG MAGNITUDE
RETURN

Step 8. Press Cal key.

Step 9. Follow the prompts and select::

PERFORM CAL: 2 PORT

CAL METHOD: STANDARD

LINE TYPE: COAXIAL

SELECT CALIBRATION TYPE: TRANSMISSION FREQUENCY RESPONSE

PATH: FORWARD PATH (S_{21})

USE OF ISOLATION IN CALIBRATION: INCLUDE

FREQUENCY RANGE: 800 MHz TO 2400 MHz

SELECT CALIBRATION DATA POINTS: NORMAL

DATA POINTS: 401 POINTS

TEST SIGNAL/PORT 1 POWER: 10 dBm

Step 10. After the selections are complete, press the START CAL soft key to begin calibration.

Step 11. Install calibration device per instruction on the display. Select the appropriate soft key to measure. Connect a cable between Test Port 1 and Test Port 2 of MS4782X Test Set when the software prompts for a throughline on the display.

Step 12. When the "CALIBRATION SEQUENCE COMPLETED" message is displayed, press the Enter key to continue.

Step 13. Press Avg key and select:

SELECT I.F. BANDWIDTH

I.F. BW 10 Hz

Step 14. Remove the through cable between Test Port 1 and Test Port 2 of MS4782X Test Set and connect terminations to both ports.

Step 15. Press Display key and then select SCALE.

Step 16. Set REFERENCE VALUE to -80.

Step 17. Verify that the trace is less than -80 dB.

6-7 RECEIVER DISPLAY LINEARITY

This test verifies the magnitude display linearity of the receiver.

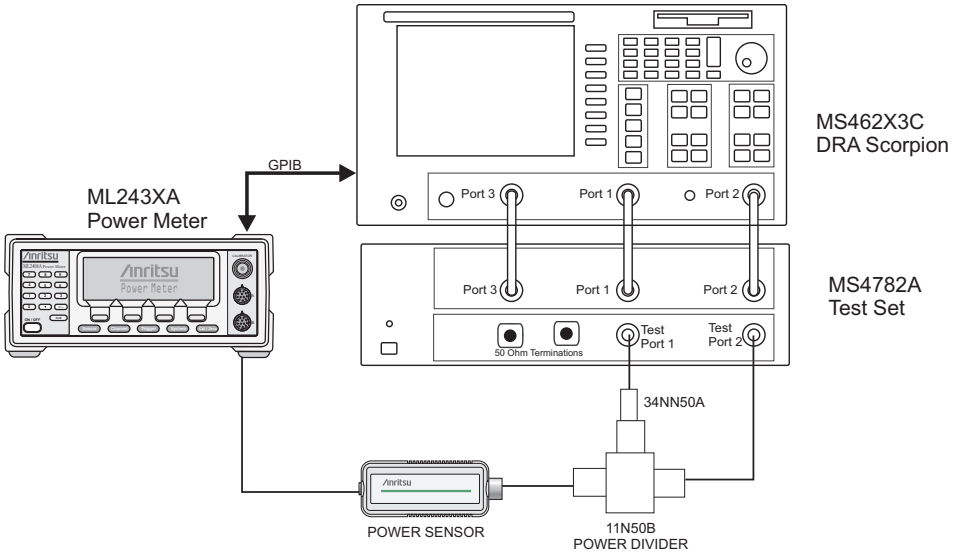


Figure 6-2. *Receiver Magnitude Display Linearity Test Setup*

Setup:

NOTE
Zero and calibrate Power Sensor prior to connecting to the power divider.

Step 1. Setup the equipment as shown above.

Step 2. Allow the system to warm up for at least one hour.

Step 3. Press Default key then 0 key.

Step 4. Press Seq key and select:

TTL I/O.
PARALLEL OUT SETUP
SET PARALLEL OUT PORT (0-255)

Step 5. Change the value from 0 to 8.

Step 6. Select:

RETURN
RETURN

Step 7. Press Freq key.

Step 8. Change START FREQUENCY to 800 MHz and STOP FREQUENCY to 1 GHz.

Step 9. Toggle C.W. MODE OFF soft key to C.W. MODE ON.

Step 10. Change C.W. Frequency to 1 GHz.

Step 11. Press Config key and select:

DATA POINTS

POINTS DRAW IN C.W. – 51 POINT(S)

Step 12. Press Avg key and select:

SELECT I.F. BANDWIDTH

I. F. BW 10 Hz

NOTE
Ensure that the Power Sensor Cal Factor is set for 1 GHz. Refer to the ML24XXA Operational

Step 13. Press Power key and select SOURCE 1 SETUP.

Step 14. Adjust SOURCE 1 POWER so that the power meter readout is 0 dBm ± 0.1 dB.

Step 15. Press Ch 3 key.

Step 16. Press Meas key and select USER DEFINED.

Step 17. Change RATIO to $b_2/1$.

Step 18. Select S21/USER 1 soft key to use user defined parameter.

Step 19. Press Display key and select:

GRAPH TYPE

LOG MAGNITUDE

RETURN

TRACE MEMORY

Step 20. Allow the trace to sweep twice. Select:

STORE DATA TO MEMORY

VIEW DATE (/) MEMORY

Step 21. Press Marker key and select MARKER READOUT.

Step 22. Use the soft key to turn on Marker 1. Then use the numeric data entry key to change POINT to 25.

Step 23. Press Marker key again.

Step 24. Use the soft key to SCREEN DISPLAY ON.

Step 25. Press Power key and select SOURCE 1 SETUP.

Step 26. Set PORT 1 ATTN to 10 dB. Record the Power Meter Readout and the Marker 1 Readout to the table on next page. Repeat this step for other PORT 1 ATTN setting listed in the table.

Step 27. Verify if the difference of the two measured values are within specifications (Table 6-2).

Table 6-2. *Receiver Magnitude Display Linearity Specifications*

PORT 1 ATTN Setting (dB)	Power Meter Reading	MS462XC Marker 1 Reading	Difference Between Two Readings	Specification
10				≤0.1 dB
20				≤0.1 dB
30				≤0.1 dB
40				≤0.2 dB
50				≤0.2 dB
60				≤0.2 dB

Chapter 7
Preamplifier Operations

Table of Contents

Chapter 7
Preamplifier Operations

7-1 INTRODUCTION

This chapter describes the use of external preamplifiers to boost signal power at the input of an test amplifier.

7-2 USE OF EXTERNAL PREAMPLIFIERS

External preamplifiers can be used to boost signal level at the input of the Amplifier Under Test (AUT). The maximum power per tone at the AUT input without any external preamplifier is +5 dBm.Block diagrams showing this feature are contained in Figures 7-1 and 7-2.

As shown in Chapter 1, Figures 1-2 and 1-3, a single preamplifier can be used after the combiner and before the bi-directional input coupler. However the nonlinearity of this preamplifier may adversely affect the linearity measurements of the AUT, unless it is far below the AUT.

If an individual preamplifier for each tone is used at the input to the combiner, then this problem is avoided, but two other issues must be addressed:

- Driving the DRA Scorpion channels a_1 and b_1 into compression
- Possibility of damage to the combiner

The first issue is avoided by using an attenuator at the input of channels a_1 and b_1. The value of this attenuator should be selected noting that the maximum operating signal level at a_1 and b_1 is –5 dBm, and that the coupling factor between AUT input and channel a_1/ b_1 input is –30 dB. Thus, if measurements with an AUT input power of 1 watt (30 dBm) is required, a 5 dB attenuator in each path is needed. In general, attenuators are needed if P_{in} (max power at AUT input) is greater than 25 dBm and the value of attenuator is given by A (dB) = P_{in} (dBm) – 25.

Depending on the power output level of the preamplifier, two alternatives exist for dealing withthe second issue.

Alternative 1

For moderate power levels (say up to 34 dBm at each preamplifier output), the internal combiner can be used with a user-supplied circulator as shown in the Figure 7-1. This will protect the combiner against a disconnected or mismatched AUT (e.g. power off) , but care must be exercised to ensure that the source switch in the test set is correctly positioned before power is applied to the preamplifier(s).

Alternative 2

For greater preamplifier power levels, an external combiner should be used. Figure 7-2 is a suggested block diagram for this configuration.

PATS is designed to enable power calibrations in the presence of external preamplifiers. For the flat power calibration, the user can specify his target power (at the AUT input which is the calibration reference plane) and

an approximate source power (at the Scorpion Port 1, Port 3, or both). For tests involving power sweep, the MS7840A enables a linear power calibration over the desired power range (and the frequency range). For this calibration, the user can specify his target power start and stop values and a nominal power offset between this reference plane and the Scorpion source (the net of preamplifier gain minus test setup losses).

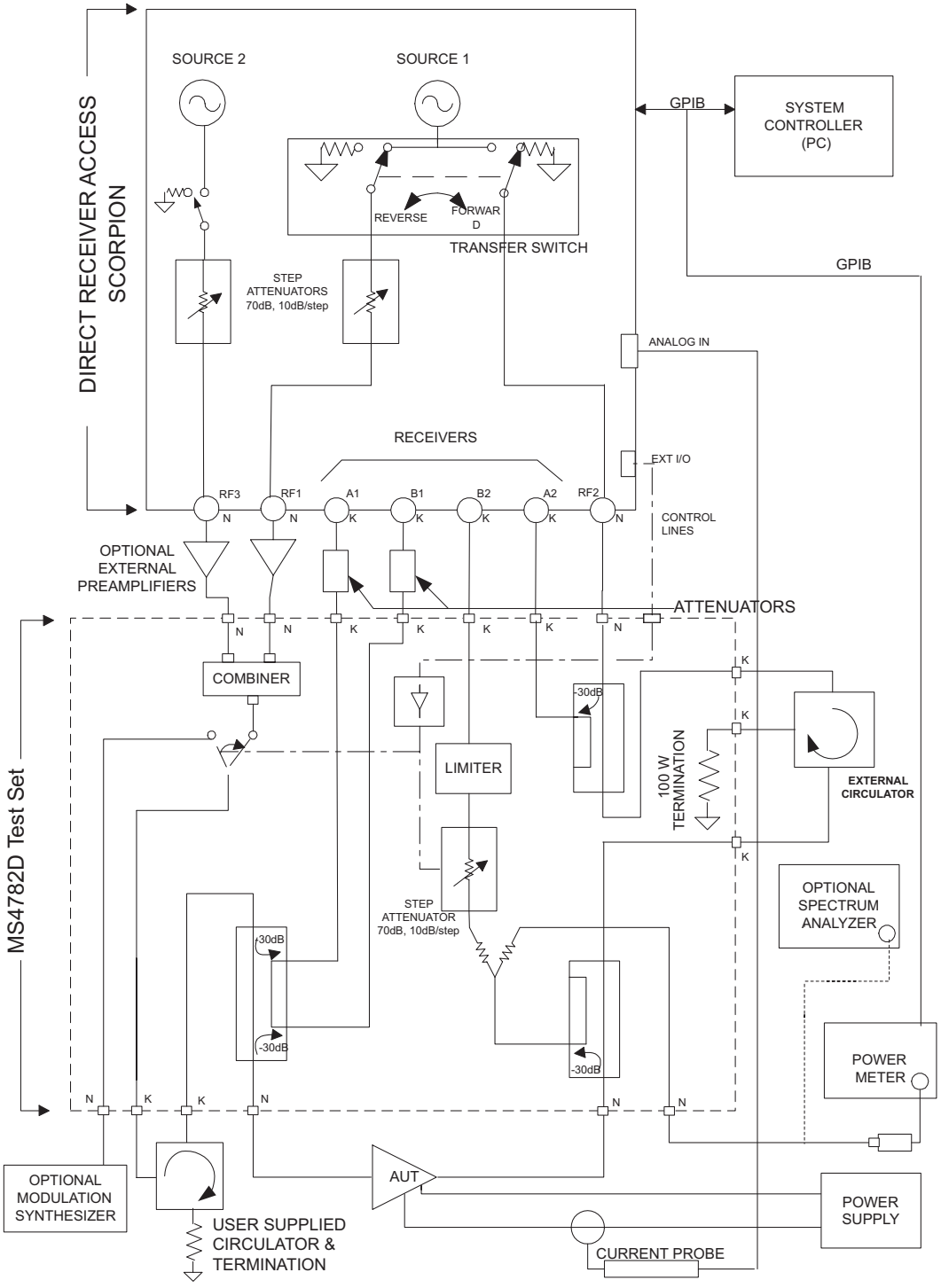


Figure 7-1. *MS4782A with External Preamplifiers (Moderate Power)*

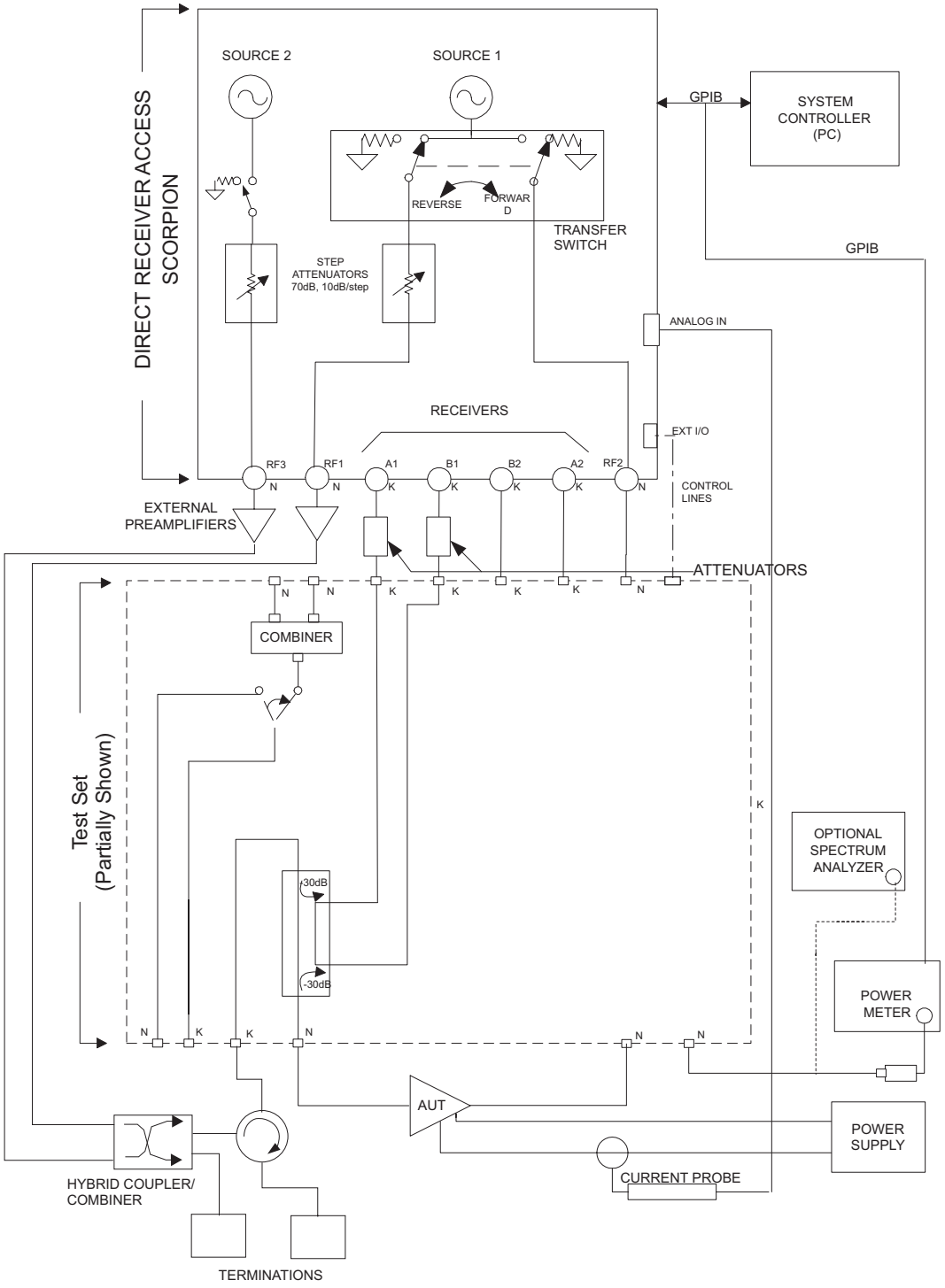


Figure 7-2. *MS4782A with External Combiner*

Index