Caution

Do not exceed the operating input power level, voltage level, current level, and signal type that is appropriate for the instrument being used. Refer to your instrument's operation manual for safe operating practices and device limitations.

Electrostatic Discharge (ESD) can damage the highly sensitive circuits in the instrument. ESD is most likely to occur as test devices are being connected to, or disconnected from, the instrument's front and rear panel ports and connectors. You can protect the instrument and test devices by wearing a static-discharge wristband. Alternatively, you can ground yourself to discharge any static charge by touching the outer chassis of the grounded instrument before touching the instrument's front and rear panel ports and connectors. Avoid touching the test port center conductors unless you are properly grounded and have eliminated the possibility of static discharge.

Repair of damage that is found to be caused by electrostatic discharge is not covered under warranty.

MS462XX
VECTOR NETWORK MEASUREMENT SYSTEM

MAINTENANCE MANUAL

Anritsu

490 JARVIS DRIVE • MORGAN HILL, CA 95037-2809

P/N: 10410-00205
REVISION: H
PRINTED: JULY 2004

WARRANTY

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

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

LIMITATION OF WARRANTY

The foregoing warranty does not apply to Anritsu connectors that have failed due to normal wear. Also, the warranty does not apply to defects resulting from improper or inadequate maintenance by the Buyer, unauthorized modification or misuse, or operation outside of the environmental specifications of the product. No other warranty is expressed or implied, and the remedies provided herein are the Buyer's sole and exclusive remedies.

TRADEMARK ACKNOWLEDGMENTS

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HP 437B, HP 438A, DeskJet, and LaserJet are registered trademarks of Hewlett-Packard Company.
GPC-7 is a registered trademark of Amphenol Corporation.
Microsoft Excel, Notepad, and Windows are trademarks of Microsoft Corporation.

NOTICE

Anritsu Company has prepared this manual for use by Anritsu Company personnel and customers as a guide for the proper installation, operation and maintenance of Anritsu Company equipment and computer programs. The drawings, specifications, and information contained herein are the property of Anritsu Company, and any unauthorized use or disclosure of these drawings, specifications, and information is prohibited; they shall not be reproduced, copied, or used in whole or in part as the basis for manufacture or sale of the equipment or software programs without the prior written consent of Anritsu Company.

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: Vector Network Measurement System

Model Number: MS4622A; MS4622B; MS4622C; MS4623A; MS4623B; MS4623C; MS4622D; MS4623D, MS4624D

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
EN 61000-3-2:1995 Class A
EN 61000-3-3:1995 Class A

Immunity:
EN 61000-4-2:1995/EN50082-1: 1997 - 4kV CD, 8kV AD
EN 61000-4-3:1997/EN50082-1: 1997 - 3V/m
ENV 50204/EN50082-1: 1997 – 3V/m
EN 61000-4-4:1995/EN50082-1: 1997 - 0.5kV SL, 1kV PL
EN 61000-4-5:1995/EN50082-1: 1997 - 1kV L-L, 2kV L-E
EN 61000-4-6:1994/EN61326: 1998 – 3V
EN 61000-4-8:1994/EN61326: 1998 – 3A/m
EN 61000-4-11:1994/EN61326: 1998 – 100% @ 20msec

Electrical Safety Requirement:

Product Safety: EN 61010-1:2001

Director of Corporate Quality

Morgan Hill, CA

22 DEC 2003
Date

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

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Company uses the following symbols to indicate safety-related information. For your own safety, please read this information carefully BEFORE operating the equipment.

Symbols Used in Manuals

DANGER	Indicates a very dangerous procedure that could result in serious injury or death if not performed properly.
WARNING	Indicates a hazardous procedure that could result in serious injury or death if not performed properly.
CAUTION	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

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.

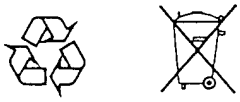
Some or all of the following five symbols may or may not be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

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

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

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

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



These symbols 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

or

When supplying AC 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 cannot 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

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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Chapter 3 Operational Performance Tests

Chapter 4 System Performance Verification

Chapter 5 Adjustments

Chapter 6 Troubleshooting

Chapter 7 Removal and Replacement Procedures

Appendix A Connector Care and Handling

Appendix B Performance Specifications

Subject Index

Chapter 1
General Information

Table of Contents

Figure 1-1. *MS462XX Vector Network Measurement System*

Chapter 1
General Information

1-1 SCOPE OF THIS MANUAL

This manual provides general information, performance verification, calibration, theory, and service information for the Anritsu MS462XX Vector Network Measurement System. The MS462XX Vector Network Measurement System is shown in Figure 1-1 (facing page).

1-2 INTRODUCTION

This chapter provides information to familiarize the user with the basic MS462XX Vector Network Measurement System. Included is information about related manuals, and the available models and options.

1-3 RELATED MANUALS

This manual is one of a five manual set consisting of this Maintenance Manual, the *MS462XX Operation Manual* (Anritsu part number 10410-00203), the *MS462XX Programming Manual* (10410-00204), the *MS462XX Scorpion Measurement Guide* (10410-00213), and the *MS462XX GPIB Quick Reference Guide* (10410-00206).

1-4 MODELS

With twelve basic models and a number of powerful options to choose from, the MS462XX can be configured to address many measurement requirements. The following models are available as platforms:

Model Number	Frequency Range	Configuration
MS4622A	10 MHz to 3 GHz	Transmission/Reflection
MS4622B	10 MHz to 3 GHz	Full Reversing
MS4622C	10 MHz to 3 GHz	Direct Receiver Access
MS4622D	10 MHz to 3 GHz	Balanced/Differential
MS4623A	10 MHz to 6 GHz	Transmission/Reflection
MS4623B	10 MHz to 6 GHz	Full Reversing
MS4623C	10 MHz to 6 GHz	Direct Receiver Access
MS4623D	10 MHz to 6 GHz	Balanced/Differential
MS4624A	10 MHz to 9 GHz	Transmission/Reflection
MS4624B	10 MHz to 9 GHz	Full Reversing
MS4624C	10 MHz to 9 GHz	Direct Receiver Access
MS4624D	10 MHz to 9 GHz	Balanced/Differential

The Transmission/Reflection models offer an economical solution for the manufacturing line that requires only S_{11} and S_{21} measurements without sacrificing the excellent performance of the Full Reversing models.

1-5 OPTIONS

The following options are easily added to the MS462XX platform for increased measurement capabilities:

Option Number	Description	Availability
2	Time Domain	All Models
3A	Second Internal Source[4]	3 GHz Source – B Models
3B	Second Internal Source[4]	6 GHz Source – B Models
3C	Second Internal Source[5]	3 GHz Source – C Models
3D	Second Internal Source[5]	6 GHz Source – C Models
3E	Second Internal Source[7]	9 Ghz Source – D Models
3F	Second Internal Source[7]	9 Ghz Source – C Models
4, 4D, 4F	Noise Figure[1]	B, C and D Models Only
4B, 4E, 4G	Noise Figure[6]	B, C and D Models Only
5	Frequency Translating Group Delay	B and C Models Only
6	Third Test Port[3]	B and C Models Only
7	T/R Step Attenuator	A Models Only
8	Harmonic Measurement	All Models
10	AutoCal Control	All Models
11	Test Port Connector	All Models [2]
13	Intermodulation Distortion	All Models
24	Processing Upgrade	B and C Models Only

1. 50 MHz to 3 GHz
2. Standard Connector is N-female, No cost option for 3.5 mm (male), 3.5 mm (female), N-Male, or GPC-7.
3. Requires external source, 68XXX Synthesizer
4. Third test port included
5. Third output port included
6. 50 MHz to 6 Ghz
7. Third and Fourth output port included

1-6 IDENTIFICATION NUMBER

The MS462XX Vector Network Measurement System's ID number is affixed to the rear panel. Please use the complete ID number when ordering parts or corresponding with the Anritsu Customer Service department.

1-7 SERVICE POLICY

The MS462XX Vector Network Measurement System's modular design, extensive built-in diagnostics, and automated service tools are designed to support fast exchange of functional assembly level repairs.

Failed assemblies are not field repairable. Once an assembly is found to be faulty, it should be returned to an authorized Anritsu Service Center (Table 1-4) for exchange.

1-8 SPARE PARTS LISTING

The assemblies and spare parts listed in Table 1-1 through Table 1-3 are available for the MS462XX Vector Network Measurement System. Refer to Chapter 7 for removal and replacement procedures. Contact your nearest Anritsu Customer Service or Sales Center for price and availability information (Table 1-4).

Table 1-1. *Assemblies Common to All MS462XX Instruments*

Description	Part Number
Main Source Module	52392
Optional Source Module	52393
CPU Board	See Table 1-3
CPU Heatsink with Fan	650-34
CPU Boot PROM	58-1638
Lithium Battery (for CPU)	633-25
Receiver PCB	See Table 1-3
Power Supply (PDU) Entire	ND55521
Power Supply Fan Assembly	ND49520
Power Supply Fuse	631-90
Option Module Assembly	ND56500
Floppy Drive	ND50711
LCD Display	15-100
LCD Backlight Driver PCB	2000-770
LCD Window (Plastic shield)	48177
Lamp for Sharp LQ9D340 LCD	632-55
Chassis (Instrument frame)	D43325
Front Panel PCB, Keypad, Knob for 2 or 3 Ports	ND48996
Front Panel PCB, Keypad, Knob for 4 Ports	ND58272
Backplane PCB	48522-4
Test Port Connector (N Female)	B45259
Test Port Connector (N Male)	B45261
Test Port Connector (GPC-7)	B47086
Test Port Connector (3.5mm Male)	B47088
Test Port Connector (3.5mm F)	B47087
Operating Software	2300-244
Boot Utility Software	2300-246
Handle, Standard (Right)	D37169-4
Handle, Standard (Left)	D37168-4

Table 1-2. *Replaceable Internal Microwave Components*

Description	Part Number
AutoReverse Module (9 GHz units)	54530
AutoReverse Module (3 and 6 GHz units)	44666
Source Doubler Module (3 and 6 GHz units)	28875
Down Converter Module (3 and 6 GHz units)	29830
Down Converter Module (9 GHz units)	54610
Port 3 Module (all units)	44668
Port 1, 2 Module (all units)	46720
Tripler Module (9 GHz units)	56630
Hi Iso Switch (3 and 6 GHz units)	53077
Hi Iso Switch (9 GHz units)	60261
Non-Reversing Module (all units)	49983
Low Noise Amp for Opt. 4 (3 and 6 GHz units)	53300
Switch Module for Opt. 4 (3 and 6 GHz units)	46718

Table 1-3. *Model-Specific Exchange Kits*

Model	Receiver PCB Exchange Kit	CPU Exchange Kit
MS4622A	ND49524	ND55522
MS4622B	ND49524	ND55522 *
MS4622C	ND53277	ND55522 *
MS4622D (without Opt.4)	ND57968	ND57970
MS4622D (with Opt.4)	ND60706	ND57970
MS4623A	ND49524	ND55522
MS4623B	ND49524	ND55522 *
MS4623C	ND53277	ND55522 *
MS4623D (without Opt.4)	ND57968	ND57970
MS4623D (with Opt.4)	ND60706	ND57970
MS4624A	ND55524	ND55522 *
MS4624B	ND55524	ND55522 *
MS4624C	ND60331	ND55522 *
MS4624D (without Opt.4)	ND57968	ND57970
MS4624D (with Opt.4)	ND60706	ND57970

* Use ND55522 if Option 24 is not installed. Use ND57970 if Option 24 is installed.

1-9 ASSEMBLY EXCHANGE PROGRAM

Anritsu maintains an exchange assembly program for selected MS462XX subassemblies and RF components. If a malfunction occurs in one of these subassemblies, the defective unit can be exchanged. All exchange subassemblies or RF components are warrantied for 90 days from the date of shipment, or the balance of the original equipment warranty, whichever is longer. A hard copy or saved to disk copy of the instrument Service Log must accompany all exchange modules. To access the Service Log, press the Utility front panel key, followed by the SERVICE LOG menu soft key. Select either PRINT LOG or SAVE LOG TO DISK.

> ***NOTE***
> When sending an assembly to the factory for exchange, a copy of the Service Log *must* accompany the assembly. Exchange prices can only be offered if the Service Log data is included with the assembly to be exchanged.

Please have the exact model number and serial number of your unit available when requesting this service, as the information about your system is filed according to the instrument model and serial number. For more information about the assembly exchange program, contact your local sales representative or call your local Anritsu Service Center. Refer to Table 1-4 for a list of current Anritsu Service Centers.

1-10 PREVENTIVE MAINTENANCE

The MS462XX CPU module contains a battery-backed memory/real time clock chip (BBRAM) and a static memory (SRAM) backup battery. The BBRAM chip has a rated life span of 10 years, and the SRAM backup battery has a worst-case life span of two years at 25°C when the instrument is stored (always off). Exposure to temperatures above 60°C will dramtically reduce this worst-case life span. The SRAM backup battery should be replaced every three years.

For instruments with serial number 995299 and below, the LCD (Anritsu part number 15-92) contains a backlight flourescent lamp that has a rated 10,000 hour life span. For instruments with serial number 000101 and above, the LCD (Anritsu part number 15-100) contains a backlight flourescent lamp that has a rated 50,000 hour life span. Both the SRAM backup battery and backlight lamp should be replaced periodically per the procedures in Chapter 7.

1-11 RECOMMENDED TEST EQUIPMENT

The following test equipment is recommended for servicing the MS462XX Vector Network Measurement System. The list is a suggestion and by no means comprises a comprehensive list of all equipment necessary to service this system. Functionally equivalent equipment may be substituted for the recommended manufacturer or model as long as the critical specifications are met. Inclusion on this list does not constitute an endorsement or suitability of purpose of any particular equipment or manufacturer. The Application Code column of the following table represents when or where the specified equipment would be used:

Instrument	Critical Specifications	Recommended Manufacturer or Model	Application Code
Computer or Controller	Personal Computer: Pentium class processor, Win 95 (16 MB RAM min.) GPIB Interface	Any Desktop PC: National Instruments PCI-GPIB or AT-GPIB/TNT (plug-and-play) Notebook PC: National Instruments PCMCIA-GPIB	O, P
Performance Verification Software		Anritsu 2300-482	P
GPIB Cable		Anritsu 2100-X	O, P, A
RF/Microwave Cable	DC to 6 GHz, K or 3.5 mm connectors (male or female)	Any	O
Printer Port Test		Anritsu ND51900	O
Throughline	(3 each)	Anritsu 3670A50-2, 3670K50-2, 3670N50-2, 3670NN50-2	O, P
Calibration Kit	N test port connector	Anritsu 3753LF/3753R with Option 1 and 3	O, P
	3.5 mm test port connector	Anritsu 3750LF/3750R with Option 1 and 3	O, P
	GPC-7 test port connector	Anritsu 3751LF/3751R with Option 3	O, P
Short	Two each of: N male test port N female test port 3.5mm male test port 3.5mm female test port GPC-7 test port	 Anritsu 23NF50 Anritsu 23N50 Anritsu 23LF50 Anritsu 23L50 Anritsu 23A50	O
Verification Kit	N test port connector 3.5mm test port connector GPC-7 test port connector	Anritsu 3663LF/3663R Anritsu 3666LF/3666R Anritsu 3667LF/3667R	P
Frequency Counter	Frequency: 1 to 20 GHz Input Impedance: 50 Ω Frequency Stability: Temperature = $1x10^{-7}$	Anritsu MF2412B or EIP Microwave, Inc., Model 548B	A

Instrument	Critical Specifications	Recommended Manufacturer or Model	Application Code
Power Meter and Sensor	Power Meter: Power Range –70 to +20 dBm GPIB controllable Power Sensor: Frequency Range 10 MHz to 18 GHz Power Range –70 to +20 dBm	Anritsu ML2430A Series Anritsu MA2472A	O, A, P
Digital Multimeter	Resolution: 4 ½ digits DC Accuracy: 0.1 % AC Accuracy: 0.1 %	Any	T
Oscilloscope	Bandwidth : DC to 100 MHz Sensitivity: 2 mV Horiz. Sensitivity: 50 ns/division	Tektronix Inc., Model 2445	T
Power Supply	Voltage: +12V Current: 100 mA min.	Any	O
Power Amplifier	Gain: 10 dB min. Noise Figure: 5.5 dB typical	Mini-Circuit ZJL-4G (4 GHz) APN:60-242 ZJL-6G (6 GHz) APN:60-234	O
Noise Source	15 dB ENR	Anritsu NC346B	O
Step Attenuator	With calibration data at 50 MHz	Anritsu MN510C	P
Attenuator	10 dB	Anritsu 43KC-10	P

Application Codes:
A = Adjustment / Internal Hardware Calibration
O = Operational Testing
P = Performance Verification
T = Troubleshooting

1-12 CONVENTIONS

Throughout this manual, path names may be used to represent the key-strokes for a desired action or procedure. The path name begins with a front panel key selection, followed by additional front panel or soft key selections, each separated by a forward slash (/). Front panel key names and soft keys are presented in the manual as they are on the system, that is, in initial caps or all uppercase letters as appropriate. For example, the following path name representation displays the system model number, serial number, current software version, and installed options:

Utility/INSTRUMENT STATE PARAMETERS/SYSTEM

Following the path above, the user would press the Utility front panel key, followed by the INSTRUMENT STATE PARAMETERS soft key, then the SYSTEM soft key to display the system information.

Individual steps within a procedure may also be presented as sequentially numbered steps for clarity. Again, front panel key names and soft keys are presented in the manual as they are on the system. For example, the following procedure displays the system model number, serial number, current software version, and installed options:

1. Press the Utility front panel key.
2. Select the menu soft keys as follows:

   INSTRUMENT STATE PARAMETERS

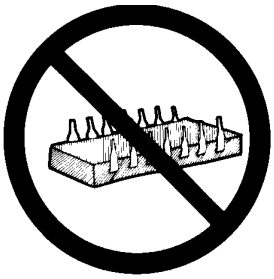
   SYSTEM

1-13 COMPONENT HANDLING

The MS462XX series contains components that can be damaged by static electricity. The following figures illustrate the precautions that should be followed when handling static-sensitive subassemblies and components. If followed, these precautions will minimize the possibilities of static-shock damage to these items.

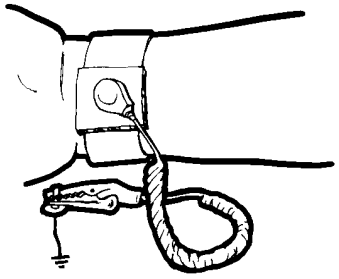
> ***NOTE***
> Use of a grounded wrist strap when removing and/or replacing subassemblies or parts is strongly recommended.

1. Do not touch exposed contacts on any static sensitive component.



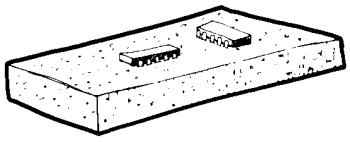
2. Do not slide static sensitive component across any surface.

3. Do not handle static sensitive components in areas where the floor or work surface covering is capable of generating a static charge.

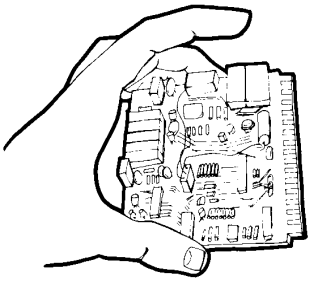


4. Wear a static-discharge wristband when working with static sensitive components.

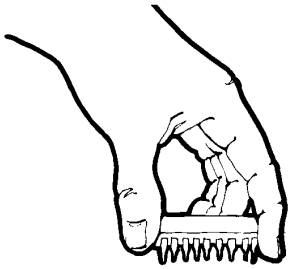
5. Label all static sensitive devices.



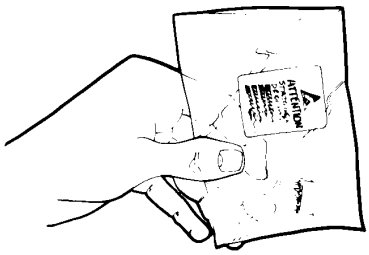
6. Keep component leads shorted together whenever possible.



7. Handle PCBs only by their edges. Do not handle by the edge connectors.



8. Lift & handle solid state devices by their bodies—never by their leads.



9. Transport and store PCBs and other static sensitive devices in static-shielded containers.

ADDITIONAL PRECAUTIONS

Keep work spaces clean and free of any objects capable of holding or storing a static charge.
Connect soldering tools to an earth ground.
Use only special anti-static suction or wick-type desoldering tools.

CAUTION

Electrostatic Discharge (ESD) can damage the highly sensitive circuits in the MS462XX VNMS. ESD is most likely to occur as test devices are being connected to, or disconnected from, the instrument's front and rear panel ports and connectors. You can protect the instrument and test devices by wearing a static-discharge wristband. Alternatively, you can ground yourself to discharge any static charge by touching the outer chassis of the grounded instrument before touching the intrument's front and rear panel ports and connectors. Avoid touching the test port center conductors unless you are properly grounded and have eliminated the possibility of static discharge.

Repair of damage that is found to be caused by ESD is not covered under warranty.

1-14 SERVICE CENTERS

Table 1-4. *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: (973) 227-8999
1-800-ANRITSU
FAX: 973-575-0092

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.
700 Silver Seven Road, Suite 120
Kanata, Ontario K2V 1C3
Telephone: (613) 591-2003
FAX: (613) 591-1006

CHINA

ANRITSU ELECTRONICS (SHANGHAI) CO. LTD.
2F, Rm B, 52 Section Factory Building
No. 516 Fu Te Rd (N)
Shanghai 200131 P.R. China
Telephone:21-58680226, 58680227, 58680228
FAX: 21-58680588

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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 PVT. LTD.
23 Community Centre
Zamroodpur, Kailash Colony Extension,
New Delhi, India 110 048
Phone: 011-2-6442700/6442800
FAX : 011-2-644250023

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
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Telephone: (06) 50-99-711
FAX: (06) 50-22-425

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Yeoksam Dong, Kangnam-Ku
Seoul, South Korea 135-080
Telephone: 02-553-6603
FAX: 02-553-6605

JAPAN

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

SINGAPORE

ANRITSU (SINGAPORE) PTE LTD.
10, Hoe Chiang Road
#07-01/02 Keppel Towers
Singapore 089315
Telephone: 6-282-2400
FAX: 6-282-2533

SOUTH AFRICA

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12 Surrey Square Office Park
330 Surrey Avenue
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Chapter 2
Theory of Operation

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Chapter 2
Theory of Operation

2-1 INTRODUCTION

This chapter provides a brief overview of the functional assemblies and major parts that comprise a typical MS462XX Vector Network Measurement System. It also briefly describes the operation of each major assembly.

2-2 SYSTEM OVERVIEW

MS462XA/B Series Vector Network Measurement Systems are ratio measurement systems used to measure complex vector signal characteristics of devices and systems in the 10 MHz to 9 GHz range. They also incorporate special measurement capabilities such as Noise Figure measurement, Intermodulated Distortion measurement, and more.

The MS462XC Series Vector Network Measurement Systems are configured as Direct Access Receivers for antenna, frequency conversion, and multiple output device measurements in the 10 MHz to 9 GHz range. They also maintain the ability to measure all four S-parameters with the addition of a reflectometer setup at the front end of the receiver.

The MS462XD Series Vector Network Measurement Systems are used to measure complex vector signal characteristics of multiport balanced/differential devices and systems in the 10 MHz to 9 GHz range.

The MS462XX performs complex vector signal measurements by sourcing a stimulus signal to the Device Under Test (DUT) connected to the front panel Port 1, Port 2, Port 3 (optional for MS462XB), or Port 4 (for MS462XD) connectors. It simultaneously measures the DUT response, which consists of reflected or transmitted (attenuated or amplified) signals at the connectors of the DUT. The reflected or transmitted signal(s) and a sample of the stimulus signal are down converted to 125 kHz intermediate frequency (IF) signals.

These IF signals are then converted into digital information and sent to the Central Processor Module where the digital information is processed by a Digital Signal Processor (DSP) using Single Frequency Digital Fourier Transfer to determine the magnitude and phase of the signal being measured. The information is then normalized for the desired S-parameter and presented to the user via the front panel color LCD display. The display information is also available on the rear panel VGA Out connector for use with an external VGA monitor.

The normalized measurement information is also available on the rear panel Printer Out connector and Dedicated GPIB connector for use with an external printer and plotter respectively.

A front panel keypad, rotary knob, and IBM compatible keyboard interface provide user interaction with the MS462XX Central Processor Module. The system is also equipped with a floppy disk drive and non-volatile internal memory for storage and retrieval of data and front panel setup information.

The MS462XX implements an IEEE 488.2 GPIB interface that allows an externally connected instrument controller to control the MS462XX system in the "Remote-Only" mode. All MS462XX measurement and input/output operations may be controlled remotely in this mode.

An internal service log stores a record of system failures, data about the failures, and other key system service information. The service log is implemented using an internal battery-backed SRAM memory.

2-3 SOURCE MODULE

There are two source modules for the MS462XX Series Vector Network Measurement System. The Source/Local Oscillator Module is standard on all models and an Optional Source Module is installed when using 3- and 4-port configurations with an active internal source.

The Source/Local Oscillator module generates the primary source RF and local oscillator output. This module contains the phase lock circuitry for the oscillator's circuitry to generate different output frequency bands covering 10 MHz to 3000 MHz, and banks of switched filter sections. The source output level is controllable through an ALC loop, whereas the Local Oscillator output level is fixed. In addition to the Source and Local Oscillator RF outputs, this module also provides Common Offset and Heterodyne VCO signals used by the optional second source.

The optional Source module generates the optional source RF output. This module contains the phase lock circuitry for the oscillator's circuitry to generate different output frequency bands spanning 10 MHz to 3000 MHz, and banks of switched filter sections. The source output level is controllable through an ALC loop. The module receives the Common Offset and Heterodyne VCO signals from the Primary Source/Local Oscillator Number modules.

While both modules are similar, the Source/ Local Oscillator module is a fully laden assembly, while the optional Source module contains only the circuitry for the optional source output. Each module has a separate PCB assembly, but both use a common housing.

Typical RF output specifications for the modules are:

RF Output Frequency Range:	10 MHz to 3 GHz
Unleveled Source Port Power Level:	27 dBm Max., 16 dBm Min.
LO Port Power Level:	12 dBm Max., 1 dBm Min.
RF Output Frequency Range:	800 MHz to 1600 MHz
Heterodyne Output Power Level:	4 dBm Max., –3 dBm Min.
Common Offset Power Level:	7 dBm Max., 1 dBm Min.

The internal ALC level loop allows for a leveled range of –11 dBm to +20 dBm out of the Source RF port.

The Local Oscillator is not used on the optional Source module. All frequency loops are phase locked to the internal 10 MHz reference oscillator in the MS462XX.

> ***NOTE***
> Six gigahertz instruments use a Switched Doubler module immediately following the source(s). Nine gigahertz instruments use a Switched Tripler module immediately following the source(s). The doublers or triplers are installed on the Receiver PCB assembly.

Digital Interface

All modules in the instrument share the same bus connections to the microprocessor via the motherboard. The common data and address bus consists of 16 data bits, 5 address lines, and 5 board select lines. Within the Source/LO module, the incoming address and board select lines are decoded to direct data between the common bus and internal module latches. Transceivers are used to buffer the common data bus from an internal data bus. When a latch located on the module is addressed, the transceivers will enable the transfer of data to or from the internal data bus.

Main Oscillator Loops

The Source and LO RF outputs are both generated by voltage controlled oscillators (VCOs) that nominally cover 800 to 1600 MHz. The outputs of the VCOs are processed to ultimately produce the final outputs of the module. Additionally, the outputs of the main oscillators are sampled and fed back, in order to be phase-locked to the system reference 10 MHz. The phase locking circuitry for the Source and LO VCOs are essentially identical in their implementation.

When phase locking the main oscillator, the VCO is mixed with an offset oscillator to produce a lower frequency signal. This mixed down signal is input to a phase detector and is compared to a signal produced by a Direct Digital Synthesis (DDS) IC. The DDS has better than 1 Hz resolution, which is transferred to the main VCO. The phase detector output is fed into a loop filter, which supplies the tuning voltage (0.5 to 20 volts) to the VCO.

Offset Oscillator Loops

The offset oscillator used by the source and the LO are also 800 to 1600 MHz VCOs. The VCOs are also phase-locked to the system's 10 MHz reference (f_{ref}) using a PLL IC. The PLL IC integrates two programmable dividers, a prescaler and a phase/frequency detector. The PLL IC operates in frequency ranges up to 2.5 GHz. The circuitry used to lock up the source offset oscillator is reproduced for the LO offset VCO.

The outputs of the two dividers are programmed to 625 kHz. The phase detector issues a correction current pulse using the internal charge pump. The loop amplifier integrates current pulses from the PLL IC. The tuning sensitivity at the VCO input is approximately 50 MHz/V.

The loop amplifier has a gain of 4; therefore, the sensitivity at the PLL IC output is very high. Thus, any noise injected at this point has noticeable affects on the output noise characteristics.

DDS Reference Clock

In order to generate accurate DDS frequencies, an accurate reference clock must be provided to the two DDS ICs. The 32 bits of the DDS frequency register allow the minimum output resolution of F_{clk} divided by 232. By phase locking the DDS reference clock VCXO to 26.8435456 MHz, the resulting minimum resolution is 0.00625 Hz.

To get such a precision frequency from the VCXO, it is phase-locked to the system's 10 MHz reference. A third DDS IC, using the VCXO as its clock, is programmed to output 100 kHz. The system reference is divided down to 100 kHz and is compared against the DDS output. Only when the clock is exactly 26.8435456 MHz will the programmed DDS produce a phase locked 100 kHz.

The phase detector feeds back to the VCXO tuning line to precisely tune the clock frequency.

Bounding Circuitry

Bounding is a term for the circuitry that is used to ensure that the VCOs are kept within their range and that the correct frequency is generated.

The mixing of the main and offset signals produces an additive as well as the desired subtractive product. Therefore, there is the potential that the main oscillator loops will try to lock on to the wrong signal. To prevent locking on the wrong side, additional PLL ICs are wrapped around the main loop phase detector as bounding circuits. The proper polarity in the loop requires that the main oscillator always be lower in frequency than the offset oscillator.

The upper bound PLL is programmed for the offset VCO frequency. When the main VCO goes higher in frequency than the offset VCO, a correction pulse is generated that is fed into the main oscillator loop. This magnitude of the correction pulse is large enough to push the main VCO to the correct side.

In addition to being prevented from swinging too high, the main VCO must also be bounded on the low end. For lower main VCO frequencies, the difference frequency increases. However, the mixer has a limited bandwidth. When the bandwidth is exceeded, the output response drops off and it will seem as if the main VCO is too high in frequency, instead of too low. Once again, positive feedback would result. A lower bound PLL will issue a correction pulse to push the main VCO higher in frequency when the bound is exceeded.

Both the source and the LO sides incorporate bounding circuits. When the main VCO is within an acceptable range, there is no contribution from the bounding circuits. The PLL ICs used for the bounding circuits are the same components used in the offset VCO loops.

Speed-Up Circuitry

In addition to the phase-lock and bounding circuitry, there is also circuitry to help speed the locking of the loop. The settling time of the main loop and its phase detector is very slow. Frequency lock detect circuitry emits pulses to help get the source main VCO locked on frequency quicker. Once on frequency, the speed-up circuit's contribution drops out and the normal phase lock circuitry locks up the loop the rest of the way. In this way, the loop locking occurs more rapidly, but the stability of the loop is not compromised.

However, for this speedup to work, the polarity of the loop must be correct. If on the wrong side, then the speedup circuitry only acts to push the VCO even farther off, even faster. Thus a hierarchy of control must be established. The bounding correction circuits must be strong enough to counter the contribution of the speedup circuits, but should not be so strong that the loop ends up banging back and forth between its two extremes.

Frequency Bands and Switched Filters

Although the main oscillator produces an output of 800 to 1600 MHz only, the module output frequency covers 10 MHz to 3 GHz. There are four distinct bands of operation to achieve the desired frequency range. If the desired output frequency is between 10 to 400 MHz, the circuit is in the heterodyne mode. The VCO output is mixed with a heterodyne oscillator (typically 1200 MHz). Passing the VCO output through a divide-by-two circuit produces frequencies between 400 to 800 MHz. For 800 to 1600 MHz, the VCO signal passes directly. To achieve 1600 to 3000 MHz, a doubler is used.

To improve harmonics and spurious performance, output signals are passed through switched filter sections. A given frequency mode (Heterodyne, divide-by-two, through, or multiply-by-two) may have one or more switched filter band sections. The switching for the frequency generation modes is combined with the control for the switched filter section.

Heterodyne Oscillator

In the heterodyne mode, a heterodyne oscillator is used to mix with the main VCO outputs of the source and LO to generate frequencies less than 400 MHz. This VCO is the same type as that used for the main and offset loops. The VCO has an 800 to 1600 MHz range, but will typically be tuned to 1200 MHz. The main VCO is tuned higher than the fixed heterodyne oscillator, so that positive steps in system frequency will correspond to positive steps in the main VCO. To avoid mixing spurs, the heterodyne VCO is allowed to step down as far as 900 MHz. The circuitry for the phase-locking of this heterodyne oscillator is similar to the offset VCO locking. The heterodyne VCO signal is also passed along out of the module to be supplied to the optional source for use in its heterodyne mode.

ALC Circuitry

The source side differs from the LO side primarily in its ability to have controllable output power. The feedback from a level detector controls the level of the source output. The level of the signal can be controlled over a 20 dB range. In the ALC circuitry, a DAC is set to a calibrated value for a desired power level. The ALC loop then adjusts the level of the source output until the detector output matches the reference voltage. A shaper circuit compensates for the non-linear characteristics of the modulator and doubler.

Once placed into a system, the Source/LO Module may be calibrated for leveled power out of the port. In general, the Power Level DAC is stepped while the Source is tuned to a fixed frequency. The port output level is measured with a power meter. The power level at the port is dependent not only on the source output power itself, but also upon the losses through various components in the RF deck. The results are then used to curve-fit an equation that relates DAC values to port power. For a 3 GHz system, the measurements are performed at 1 GHz. If the system is a 6 GHz unit, the measurements are performed at both 1 GHz and 4 GHz.

The power curve did not change much with frequency, only the offsets. Therefore, the same curve-fit equations could be used with a correction for the different offsets at various frequencies. The curve-fit equation calculated using 1 GHz data is applied for system frequencies less than 3 GHz. The 4 GHz curve-fit equation is used in the doubler band (i.e. frequencies greater than 3 GHz). The power DAC is set to a 0 dBm port power using the appropriate curve-fit equation, then the resulting error offset is measured. The offsets for different frequency steps are stored in a table and intermediary frequencies are interpolated.

Additionally, a shaper DAC calibration is performed when the system is a 6 GHz unit. The shaper DAC is in place to help compensate for changes in the doubler characteristics.

At band switch points, the source takes longer to settle. During the settling period, there is a lack of RF signal to the ALC detector diode, thus the ALC circuitry will set the output power higher. Therefore, the ALC is level-dipped at band switch points to prevent large power spikes from hitting the DUT during these transition periods. The level-dip is performed by switching a fixed voltage into the loop.

Operation Modes

There are two operation modes:

Common Offset Mode

Traditionally, the source and LO output signals are generated independently. An alternative mode of operation is possible where the LO offset VCO also locks up the source loop. The source offset VCO is disabled in this mode. The DDS outputs on the two sections then make up the frequency difference between the two outputs. Sharing a common offset VCO allows the two signal sources to better track each other. The resulting IF has better phase noise because much of the offset VCO noise is ratioed out.

To make accurate measurements, the IF must be settled before the Digital Signal Processing (DSP) is triggered. When operating in common offset mode, the IF settles faster. In fact, even though the offset VCO (and therefore the main VCOs) may still be slewing in phase, the IF itself may already be settled because the Source and LO are tracking. The two main VCOs are able to track the offset VCO settling because of their higher bandwidths. Therefore, measurements can be made sooner in the common offset mode and overall system speed is thus faster.

However, the common offset mode can only be used when the source and LO frequencies are relatively close, because the range of the DDS limits the allowable difference. Additionally, the source and LO must be operating in the same frequency band. High-IF frequency measurements, such as Wide-Band Noise Figure, must operate in the independent offset mode. However, common offset mode is beneficial for typical S-parameter measurements where speed is an important parameter.

Harmonic Generator Mode

In most measurements, the presence of harmonics on the RF is undesirable. However, for measurements of phase in the harmonic measurements application, a reference is needed. The second and third harmonics of the source are used, and therefore must be of a significant enough level to be measured accurately. A harmonic generator diode can be switched into the circuit to pump the harmonics to levels above –45 dBc. Without the harmonic generator, the harmonics may be lower than –45 dBc.

2-4 RECEIVER MODULE

The Receiver module is made up of the RF components that are used to configure the system for the various options. This encompases the frequency translation module, which produces the 125 kHz Intermediate Frequency, the Test and Reference channel Intermediate Frequency paths, the system 10 MHz time base, and the circuitry for the control of the RF components. At the end of the Intermediate Frequency paths, the signal to be measured is sampled and sent to the Central Processor Module. This module has Digital Signal Processing (DSP) prior to processing the numerical values into the CPU. Determination of magnitude and phase for S-Parameter measurements is done by calculating a single frequency Digital Fourier Transfer (DFT) of a coherently sampled Intermediate Frequency Signal. A Programmable Logic Device (PLD) accomplishes control of the receiver board and Analogue to Digital (ADC) clock generation.

An intermediate frequency signal of 125 kHz was chosen because of the division ratio to the 10 MHz reference combined with the optimized sample rates used in the analogue to digital conversions.

Down Conversion Module

The Down Conversion Module (DCM) translates the Test Port and the Reference Port signals down to the 125 kHz intermediate frequency signal.

The input at J5 takes the local oscillator signal from the Source Module. The signal is split into two paths, one for the Test Port Mixer and the other for the Reference Port Mixer. Two identical paths are used to provide the mixer local oscillator drive. The reason for the two paths is to maintain good isolation between the two signal paths. After the power divider, the local oscillator signal passes through a limiter that is used to flatten the power level variations of the incoming local oscillator signal. In so doing, it minimizes the AM to PM conversion in the local oscillator path. The local oscillator signal is filtered to provide a clean signal for the mixer. Built into the Down Conversion Module is a local oscillator doubler (used in 6 GHz models) or a tripler (used in 9 GHz models).

The Test Port signal and the Reference Port signal go to J4 and J1, respectively. The outputs from the mixers are fed through buffer amplifiers before going to the intermediate frequency amplifiers.

Digital Interface

The Programmable Logic Device provides the main digital interface with the microprocessor. The load pulse, board select 5, data bits D0-D11, and address bits A0-A4 are inputs to this device that provide the address decoding and data latching. Latches are written to by setting the desired address and data bits, then the strobing board selects 5 low. An additional strobe, the load pulse, is used on certain latches as a final strobe when pre-loading is performed. Note that every latch is a write latch and every latch uses board select 5 for strobing.

Test Channel Intermediate Frequency Path

The purpose of the Test Channel I.F. circuitry is to amplify, filter, and sample the test channel signal after it has been down converted to a fixed intermediate frequency. Sampling is performed by an18-bit ADC at the fixed sampling rate of 156.25 samples/second. Amplification is necessary to optimally position the test signal within the input signal range of the ADC. Filtering is performed to prevent aliasing of noise onto the desired signal that occurs through the sampling process.

There are three different types of signals that are sent as inputs to the I.F. chain:

- 125 kHz sinusoid
- 453.125 kHz sinusoid
- DC signal

The origin and subsequent processing of these signals is discussed below.

In S-Parameter operation, a 10 MHz to 6 GHz sinusoid is sent out one of the front panel ports, appropriately channeled to the down converter, and converted to a fixed 125 kHz sinusoid. This signal is cabled to the front end of the Test Channel I.F. chain (J21) through an MCX connector. An RC lowpass filter with a cutoff of 160 kHz follows the input switch to prevent RF feed through signals from reaching the input amplifier.

If the instrument is reversing, the signal is routed directly to the input amplifier and the gain of the following amplifier is 20 dB. If the instrument is non-reversing, the signal is routed through a 10 dB attenuator before the input amplifier and the gain of the following amplifier is 15 dB, controlled by the TEST_GAIN bit. This gain is appropriately set upon instrument power-up, after which it remains constant while the instrument is in use.

After the input amplifier, the signal is filtered by a fifth order elliptical lowpass filter with a cutoff of approximately 125 kHz. This amplifier provides 30 dB of switched gain, controlled by the T_GR1 bit, so that low level signals can be amplified to a more optimal ADC range. This process of gain ranging is done by detecting the signal level, determining if it is low enough for 30 dB of extra gain, applying the gain if necessary, then remeasuring the signal.

When the extra 30 dB of gain is used, software division by this gain factor is subsequently performed so that a linear transfer function is obtained. A switched attenuator follows the second amplifier for the purpose of removing gain if the input signal level is too high. After the switched attenuator, a second order Chebyshev active highpass filter filters the signal before it is sampled by the ADC. The overall cascade of the elliptical lowpass filter and the Chebyshev highpass forms the bandpass filter required for under sampling.

In the frequency translation group delay mode, a 453.125 kHz sinusoid is switched in on J20 from the options board. The switching is controlled by the direct in bit, and is done at the high impedance node of the ADC buffer amplifier. Sampling of this signal is done at the same 156.25 kHz rate, and this under sampling results in 10 samples of a 15.625 kHz

aliased signal. Amplification and bandpass anti-alias filtering on the 453.125 kHz signal occurs on the options board.

The other signal that comes from the options board is a DC signal, also switched in on J20, that results from noise figure measurements. This DC signal is sampled and subsequently averaged in the DSP.

Reference Channel Intermediate Frequency Path

Similar to the Test Channel, the Reference Channel I.F. Chain amplifies, samples, and filters the reference signal after it has been down converted to a fixed intermediate frequency. Both the test and reference signals originate at the Source module. The Source generates a 10 MHz to 3 GHz sinusoid and this signal is routed to either the Auto-Reversing Module, or the Non-Reversing Module, depending on the system configuration. In the A.R.M. (or the N.R.M.), a coupler separates this single signal into two signals, one of which becomes the reference input to the Down Conversion Module and the other becomes an output to one of the front panel ports. The signal sent out the front panel becomes the test signal, as it goes through the DUT, and the signal internally routed to the Down Converter module is the reference signal.

The I.F. chain used to process the reference signal is similar to that for the test signal. Since the reference signal is approximately the same level for both reversing and non-reversing system configurations, the value of the input amplified gain is fixed at 5.2 dB. The reference signal passes through a 5th order elliptical lowpass filter, and into a gain range amplifier, U13.

Gains of 10 dB or 30 dB can be chosen with the R_GR1 bit. The process of gain ranging on the reference channel is similar to that in the test channel, however reference channel gain ranging is only performed in the harmonic measurement mode. In this mode, the source harmonic is used as the reference signal and must be amplified to achieve better resolution after ADC conversion. In all other measurement modes, the reference channel signal level is high enough so that gain ranging is not necessary.

In addition to switching of the options board output into the reference channel ADC (J17), since the reference signal level is always relatively high, switching of the analog monitor and rear panel ADC is done at the end of the reference channel chain. If this switching were done into the test channel, leakage of noise and high level signals through the switches onto a low level test channel signal would be a concern.

The analog monitor multiplexes +28V, the two bias voltages, +5V, -13.4V, +6.5V, -10V and the noise source +28V onto the ANA_MUX line after appropriate division. This line is switched into the reference channel A/D by the EXT_SW1, SW_MON, and direct in bits. The rear panel external A/D input allows the user to inject a signal directly into the reference channel A/D through J25, controlled by the EXT_SW2, EXT_SW1, SW_MON and direct in bits in a serial switch arrangement.

Sampling of the Intermediate Frequency

At the end of the test and reference Intermediate Frequency chains is an 18 bit ADC converter. Although this converter produces 18 bits on its output, its effective number of bits is approximately 15, meaning that it has resolution up to 15 ideal bits. The ADC is a sampling converter, so it samples then holds the input signal while the conversion takes place, thus eliminating the need for an external sample and hold chip.

As mentioned earlier, the ADC samples 3 types of signals:

- 125 kHz sinusoid
- 453.125 kHz sinusoid
- DC signal

The input signal range of the ADC is ± 2.75V, and the preceding Intermediate Frequency chains ensure that signals at the ADC input are as close to the full scale range as possible, thereby utilizing as much of the ADC's dynamic range as possible. The A/D sampling rate is fixed at 156.25 kHz, which is clearly less than twice the 125 kHz and 453.125 kHz signals that are input to the ADC. This under sampling technique allows the L.O. and R.F. signals at the mixer to have more separation than the resulting aliased signal produced by the sampling process.

Nyquist sampling theory states that a signal must be sampled at a frequency greater than twice the highest frequency present in the signal, or twice the bandwidth of the signal, in order to prevent aliasing. Aliasing occurs when a high frequency signal takes on the alias of a lower frequency signal after sampling. Aliasing results from the fact that, given a fixed sampling frequency, samples of a cosine with frequency f are indistinguishable (except for a phase change) from samples of a cosine with frequencies (k*Fs + f), where Fs is the sampling frequency and k is a fixed integer.

For example, cos(2*pi*f*t), becomes after sampling with period Ts, cos(2*pi*f*n*Ts), where n is an integer. Since Ts = 1/Fs, the sampled sinusoid can be expressed as cos(2*pi*f*n/Fs). Now, if the sinusoid's frequency is (k*Fs + f) before sampling, after sampling it becomes cos(2*pi*(k*Fs + f)*n/Fs), which reduces to cos([2*pi*f*n/Fs] + 2*pi*k*n). Since the cosine function is periodic with period 2*pi, adding integer multiples of 2*pi to the argument doesn't change the value of the function, so the result is equivalent to cos(2*pi*f*n/Fs).

In our case, the sampling frequency Fs = 156.25 kHz, and f is either 125 kHz or 453.125 kHz. Since under sampling is being used, the frequency of the sampled sinusoid will be different from f. To calculate the frequency of the resulting sampled sinusoid, the relationship between Fs and f must be calculated. For f = 125 kHz, (Fs - f) = (156.25 - 125) = 31.25 kHz, so after sampling, a 31.25 kHz sinusoid results. Since Fs/31.25 = 5, five samples per cycle of the 31.25 kHz result. For f = 453.125 kHz, (3*Fs - f) = (468.75 - 453.125) = 15.625 kHz. In this case, Fs/15.625 = 10, so ten samples per cycle of the 15.625 kHz result. In both cases, coherent sampling is done since an integer number of samples per cycle is obtained.

ADC Clock Generation/ DSP Communication Port Interface

The ADC requires specific clock pulses to convert the signal, and it's very sensitive to these pulses. To generate the clock signals required for correct operation, a state machine was designed in the PLD. The PLD state machine takes the system 10 MHz clock as an input, and generates the ADC clocks as outputs. The ADC requires a start conversion pulse, the CCMD signal at the sampling frequency (156.25 kHz), along with subsequent bit conversion clock pulses at the bit output frequency. The bit output frequency is approximately 3.33 MHz. The EXT_CLK is the bit conversion clock. The A/D bits are sent out through the backplane to the DSP COMM PLD on the microprocessor board. To clock the bits into the DSP COMM PLD, the BIT_CLK signal is used. The DSP requires four separate bytes to be clocked into its communication port to form a 32-bit word. Since the ADC on the receiver board only generates 18 serial bits, the DSP COMM PLD shifts these bits into byte words and clocks the bytes into the DSP communication port. A dummy byte is clocked into the DSP to complete the 32-bit word.

10 MHz Clock Distribution

The 10 MHz system time base resides on the receiver board. An external 10 MHz clock can be switched in via J16 using the EXT_10MHZ bit. The 10 MHz time base is used on the receiver board to generate the ADC clocks, and it is also routed to the Source Module via J13, the Optional Source Module via J14, and the Options Board via J15.

RF Component Control

Mounted on the receiver board are the RF signal separation components. Depending on the system configuration, these include:

- Port modules
- Auto-Reversing Module (MS462XB/C/D only)
- Non-Reversing Module (MS462XA only)
- Primary and Secondary Source Switched Doubler Module
- Primary and Secondary Source Switched Tripler Module
- Port 1 and Port 3 Step Attenuators
- Port 3 Module (MS462XB and MS462XC only)
- Port 1 and Port 2 Switch Modules
- High Isolation Switch Module (MS462XD only)

The receiver board PLD controls these components via 14-pin ribbon connectors (10 pin for the Step Attenuators). Dual peripheral drivers control the Step Attenuators. DC bias can be supplied through the rear panel BNC connectors (J26, J27) to the Port Modules via 3-pin Berg connectors on the PCB Assy. Bias current is fused at 0.5 amp and bias switching is provided by a relay controlled by a driver IC.

2-5 FRONT END RF COMPONENTS

The receiver demodulates the signals for processing by the CPU. Various RF components are used to configure the different options.

Test Port Connectors

Five configurations of the RF connectors are offered:

- Test Port Connector N-Male (B45261)
- Test Port Connector N-Female (B45259)
- Test Port Connector GPC-7 (B47086)
- Test Port Connector 3.5 mm Female (B47087)
- Test Port Connector 3.5 mm Male (B47088)

Switched Frequency Doubler Module

The Switched Doubler Module is used to multiply the RF source frequency by two to provide the 3000 to 6000 MHz output. The RF input level is a nominal 20 to 30 dBm, providing an output of +20 dBm. Harmonics of the doubled output are better than –30 dBc.

The frequency doubler requires +12 volts at 0.5 amperes maximum, +5 volts at 0.2 amperes maximum, and –13.5 volts (floating) at 0.2 amperes maximum.

Three switched filters are used to reduce the output harmonics and are controlled by two logic lines DB0 and DB1.

Switched Frequency Tripler Module

The Switched Tripler Module is used to multiply the RF source frequency by three to provide the 3000 to 9000 MHz. The RF input level is a nominal 20 to 30 dBm, providing an output of +20 dBm. Harmonics of the tripled output are better than –25 dBc.

The frequency tripler requires +12 volts at 0.5 amperes maximum, +5 volts at 0.2 amperes maximum, and –13.5 volts (floating) at 0.2 amperes maximum.

Five switched filters are used to reduce the output harmonics and are controlled by three logic lines TR0, TR1, and TR2.

Auto-Reversing Module

The Auto-Reversing Module provides three output signal paths:

- ALC leveling coupler output (FT1)
- Transfer switch outputs (J1 and J2)
- Reference signal sampling coupler output (J3)

The input signal port is J4. The input signal is sampled by the ALC leveling coupler and converted to a DC signal that is used by the ALC circuits located in the Source Module. In the forward sweep direction, the input signal from J4 is routed to the Port 1 Module via J1 by the internal transfer switch. This provides the forward stimulus signal for the DUT. In the reverse sweep direction, the output signal is routed via J2 to the Port 2 Module by the internal transfer switch. This provides the reversing stimulus signal for the DUT.

The forward or reverse stimulus signals are sampled by the reference signal sampling couplers and are then sent to a SP3T switch. In the MS462XB, the Port 3 reference signal that is input via J5 is also sent to this switch. In the MS462XD, the Port 3 or Port 4 reference signal from the second ARM is also sent to this switch.

This SP3T switch selects the proper Port reference signal to be output via J3, depending on sweep direction and test port used. The signal from J3 is used by the Down Conversion Module as a reference signal. In the MS462XD, a second Auto-Reversing Module is used to distribute the stimulus signal from the second source module to the Port 3 and Port 4 modules. The ALC Leveling Coupler's DC output signal is used by the ALC circuits located in the second source module.

Non-Reversing Module The Non-Reversing Module contains the ALC leveling coupler and coupler providing two signal paths. The signal input port is J4. The output signal from J1 goes to the Port 1 Module providing the stimulus signal for the DUT. The signal from the coupled port, J3, is used by the Down Conversion Module as the Reference signal.

Step Attenuator The Step Attenuator is a 0 to 70 dB attenuator that provides attenuation in 10 dB increments.

Port Module The Port 1/2 Module contains a directional coupler and an integrated bias tee.

Port 3 Module The Port 3 Module contains a directional coupler, an ALC leveling coupler, the Port 2/Port 3 test signal switch and a coupled port for the source signal.

The signal input port is J2. The output signal from J3 goes to J1 via the Step Attenuator (if equipped). The Port 2 test signal is input to J6. The internal switch selects the test signal to be output via J5, depending on the Port used. The signal from J5 is used by the Down Conversion Module as the Test signal. The signal from J4 is the sampled Port 3 Reference signal and is routed to the Down Conversion Module via J5 of the Auto-Reversing Module.

Low Noise Pre-Amplifier This Pre-Amplifier provides a minimum gain of 16 dB (up to 6 GHz) with a Noise Figure of less than 3 dB.

Switched Module The Switched Module contains a bi-directional SPDT switch.

High Isolation Switch Module This SPDT switch multiplexes the test signals from Port 3 and Port 4 to the Down Conversion Module.

Receiver Module Configurations There are 20 possible front end configurations of the Receiver Module, depending on the model and installed options. Refer to the block diagrams at the end of this chapter.

Receiver Module Configurations, MS462XA

The front end consists of the following items:

- Non-Reversing Module
- Port 1 Module
- 20 dB Fixed Attenuator
- Port 1 Step Attenuator (Option 7)
- Switched Doubler Module (6 GHz unit only)
- Switched Tripler Module (9 GHz unit only)

The 10 MHz to 3 GHz signal from the Source Module is routed to the Non-Reversing Module. For operation between 3 to 6 GHz, the signal frequency is doubled in the Switched Doubler Module prior to sending it to the Non-Reversing Module.

In the Non-Reversing Module, one coupler provides a signal path that feeds the Reference input of the Down Conversion Module and another coupler provides a signal path for the built-in level detector that provides a DC signal for the ALC circuits located in the Source Module.

The stimulus signal is then output to the DUT via the Port 1 Module mounted directly to the Port 1 front panel connector. The Port 1 stimulus signal can be attenuated in 10 dB steps via the optional 0 to 70 dB Step Attenuator that is part of the Port 1 source signal path.

The reflected and transmitted device-under-test (DUT) signals are received via Port 1 and Port 2 connectors simultaneously. The reflected signal is routed via the coupled arm of the coupler in the Port 1 module to the Down Conversion Module. The transmitted signal is attenuated to a proper level by the 20 dB fixed attenuator at the Port 2 signal path and is then routed to the Down Conversion Module.

Receiver Module Configurations, MS462XB

The basic front end consists of the following items:

- Auto-Reversing Module
- Port 1 Module
- Port 1 Step Attenuator
- Port 2 Module
- Primary Switched Doubler Module

The 10 MHz to 3 GHz signal from the Source Module is routed to the Auto-Reversing Module. For operation above 3 GHz, the signal is doubled in 6 GHz models or tripled in 9 GHz models prior to sending it to the Auto-Reversing Module.

In the Auto-Reversing Module, a coupler provides a signal path for the built-in level detector that provides a DC signal for the ALC circuits located in the Source Module. Then the source signal is switched between two paths and routed to the front panel Port 1 and Port 2 connectors, respectively. The switching is controlled by the Central Processor Module to set the direction of the signal flow for the desired test:

Port 1 = Forward

Port 2 = Reverse

Two couplers on these two paths provide samples of the Forward or Reverse signals that feed the Reference input of the Down Conversion Module.

The stimulus signal is then output to the DUT via the Port 1 and Port 2 Modules mounted directly to the Port 1 and Port 2 front panel connectors.

Both Port Modules have integrated bias tees that accept user supplied DC bias signals for Port 1 and Port 2 from the rear panel input connectors. The bias signals are injected onto the center conductors of the Port 1 and Port 2 connectors along with the stimulus signal on either Port 1 and Port 2, as appropriate for Forward/Reverse operation.This feature can be used for test devices that require bias on their connector center conductors. The MS462XX allows the bias signals and the RF stimulus signals to be independently turned off while in Hold operating mode.

The Port 1 stimulus signal can be attenuated in 10 dB steps via the 0 to 70 dB Step Attenuator that is part of the Port 1 source signal path. The stimulus signal cannot be attenuated when routed out of Port 2.

The reflected and transmitted DUT signals via the directional couplers in the Port 1 and Port 2 Modules, along with a sample of the output RF stimulus (reference) signal, are sent to the Down Conversion Module.

Receiver Module Configurations, MS462XC

The front end consists of the following items:

- Auto-Reversing Module
- Switch Module
- Port 1 Step Attenuator
- Source 1 Switched Doubler Module (6 GHz units) or Source 1 Switched Tripler Assembly (9 GHz units)
- Port 3 Step Attenuator (Option 3C and 3D only)
- Port 3 Module (Option 3C and 3D only)

The 10 MHz to 3 GHz signal from the Source Module is routed to the Auto-Reversing Module. For operation above 3 GHz, the signal is doubled in 6 GHz models or tripled in 9 GHz models prior to sending it to the Auto-Reversing Module.

In the Auto-Reversing Module, a coupler provides a signal path for the built-in level detector that provides a DC signal for the ALC circuits located in the Source Module. Then, the source signal is switched between two paths and routed to the respective front panel Port 1 and Port 2 connectors. The switching is controlled by the Central Processor Module.

The port 1 stimulus signal can be attenuated in 10 dB steps via the 0 to 70 dB Step Attenuator that is a part of the Port 1 source signal path.

Reference signals, al and a2, are multiplexed to the Reference signal input of the Down Conversion Module.

Test signals, bl and b2, are sent directly to the Test signal inputs of the Down Conversion Module.

Receiver Module Configurations, MS462XD

The front end consists of the following items:

- Auto-Reversing Modules (two each)
- Port Modules (four each)
- Port 1 Step Attenuator
- Source 1 Switched Doubler Module (6 GHz units only) or Source 1 Switched Tripler Module (9 GHz units only)
- Source 2 Switched Doubler Module (6 GHz units only) or Source 2 Switched Tripler Module (9 GHz units only)
- High Isolation Switch Module

The 10 MHz to 3 GHz signal from the Source 1 Module is routed to the Auto-Reversing Module 1. For operation above 3 GHz, the Source 1 signal is doubled in 6 GHz models or tripled in 9 GHz models prior to sending it to the Auto-Reversing Module 1.

In the Auto-Reversing Module 1, a coupler provides a signal path for the built-in level detector that provides a DC signal for the ALC circuits located in the Source 1 Module. Then the source signal is switched between two paths and is routed to the front panel Port 1 and Port 2 connectors respectively. The switching is controlled by the Central Processor Module.

Two couplers on these two paths provide samples of these stimulus signals that feed the reference input of the Down Conversion Module. The stimulus signals are then output to the DUT via the Port 1 Module and Port 2 Module mounted directly to the Port 1 and Port 2 front panel connectors.

Both Port Modules have integrated bias tees that accept user supplied DC bias signals for Port 1 and Port 2 from the rear panel input connectors. The bias signals are injected into the center conductors of the Port 1 and Port 2 connectors along with the stimulus signal on either Port 1 or Port 2. This feature can be used for test devices that require bias on their connector center conductors. The MS462XX allows the bias signals and the RF stimulus signal to be independently turned off while in Hold operating mode.

The Port 1 stimulus signal can be attenuated in 10 dB steps via the 0 to 70 dB Step Attenuator that is part of the Port 1 source signal path. The stimulus signal cannot be attenuated when routed out of Port 2, Port 3 or Port 4.

The 10 MHz to 3 GHz signal from the Source 2 Module goes through a similar route as the Source 1 Module. The stimulus signal is routed to the Auto-Reversing Module 2. For operation above 3 GHz, the Source 2 signal is doubled in 6 GHz models or tripled in 9 GHz models prior to sending it to the Auto-Reversing Module 2.

In the Auto-Reversing Module 2, a coupler provides a signal path for the built-in level detector that provides a DC signal for the ALC circuits located in the Source 2 Module. Then the source signal is switched between two paths and routed to the front panel Port 3 and Port 4 connectors, respectively. Two couplers on these two paths provide samples of these stimulus signals that feed the reference input of the Down Conversion Module via J5 of the Auto-Reversing Module 1. The stimulus signals are then output to the DUT via the Port 3 Module and Port 4 Module mounted directly to the Port 3 and Port 4 front panel connectors.

The reflected and transmitted DUT signals of the directional couplers in the Port 1 and Port 2 Modules, along with a sample of the output RF stimulus (reference) signal, are sent to the Down Conversion Module.

The reflected and transmitted DUT signals of the directional couplers in the Port 3 and Port 4 Modules are first sent to the High Isolation Switch, then they are sent to the Down Conversion Module along with a sample of the output RF stimulus (Reference) signal. This is due to the Down Conversion Module having a limited number of test signal inputs.

Option 3—Second Source

Option 3 adds the items listed below to the basic Receiver Module:

- Port 3 Module
- Port 3 Step Attenuator
- Secondary Switched Doubler or Tripler Module

The 10 MHz to 3 GHz signal from the Secondary Source Module is routed to the Port 3 Module. For operation above 3 GHz, the signal is doubled in 6 GHz models or tripled in 9 GHz models prior to sending it to the Port 3 Module.

The MS462XB Port 3 Module serves many functions. In addition to providing a directional coupler for receiving the Port 3 test signal, the Port 3 Module provides a DC signal for the ALC circuits located in the Secondary Source Module and a sample of the Reference signal from the Secondary Source Module for the Down Conversion Module. It also handles the signal switching of Port 2 and Port 3 Test signals for the Down Conversion Module.

For the MS462XC, the Port 3 Module provides a DC signal for the ALC circuits located in the Secondary Source Module.

The Port 3 stimulus signal can be attenuated in 10 dB steps via a 0 to 70 dB Step Attenuator that is part of the Port 3 source signal path.

Option 4—Noise Figure Measurement Capability

Option 4 adds the items listed below to the basic Receiver Module:

- Port 1 Switch Module
- Port 2 Switch Module
- Low Noise Pre-Amplifier Assembly

The Port 1 and Port 2 Switch Modules are of the same part, which is a bidirectional single pole double throw switch.

In the Port 1 source path, the Port 1 Switch Module allows the injection of the Noise signal to the DUT via the Port 1 connector from an external noise source when operating in the Noise Figure Measurement mode.

The Port 2 Switch Module switches the Noise Figure test signal via a Low Noise Pre-Amplifier Assembly so that the signal is at the proper level prior to being sent to the Down Conversion Module.

Option 6—Third Test Port

Option 6 adds only the Port 3 Module to the basic Receiver Module.

2-6 OPTION MODULES

The Options Board Assembly provides several required functions:

- Wideband Noise Figure Measurements
- Frequency Translating Group Delay Measurements

Apart from the power supply and digital interface circuits, the board consists of a noise figure receiver (high and variable gain, ~6 MHz wide scalar detection channel) and a group delay receiver (limiting quadrature wideband FM receiver) multiplexed to the same input (J22 on the Receiver Assembly) and output (J20 on the Receiver Assembly) ports.

A simple synthesizer, locked to the 10 MHz reference, generates the 453.125 kHz modulating signal for frequency translating group delay.

When the option assembly is activated, the Source Module will output a local oscillator signal 10.7 MHz above the RF when using Group Delay and 25 MHz above the RF frequency when using the Noise Figure option. The main source is locked at 3 GHz or 2 GHz when in the noise figure measurement mode in order to minimize leakage effects. The Noise source is external and plugs in to a 28 volt pulsed supply on the Rear Panel. The Noise Source is a purchased part, for example, Noise Com NC346B or similar. Any 28 volt Noise Source can be technically be used but 346 class sources (Noise Com, Micronetics, and HP) are strongly recommended for accuracy reasons.

In normal Transmission/Reflection Measurements, the local oscillator is 125 kHz above the RF output.

There are three main paths:

- 25 MHz Noise Figure Receiver path
- 10.7 MHz Frequency Translating Group Delay Receiver (FTGD)
- Frequency Translating Group Delay (FTGD) Synthesizer

The PCB assembly is an open PCB assembly with covers over the sensitive circuits.

General

The digital/modulation synthesizer section and the two receiver sections have their own dedicated supplies in order to maintain the noise performance in the receiver sections.

Current draw is minimal on the board (<100 mA at +5 volts, a few hundred mA on ±12 volts) so three port regulators are used. A low dropout regulator is used for the +5V supply.

The digital section employs two addresses only. Latches provide access to the 16-bit data bus for address 0, which controls everything except the analog monitor. Another latch, address 1, provides access to the data bus for the analog monitor.

The input and output of the two receiver sections is shared (since the Intermediate Frequency ports are shared). The front-end consists of a switched attenuator (0 and 25 dB) and a switched gain amplifier (10, 20 and 30 dB gain). These are primarily used by the noise figure receiver but will be used by group delay for extended gain ranging.

An analog monitor section allows system monitoring of several key power supply voltages, the lock status of the frequency translation group delay synthesizer, and the board revision. This is used during self test.

Frequency Translating Group Delay (FTGD) Synthesizer

The FTGD synthesizer circuit is used to generate the 453.125 kHz modulating signal for the frequency translating group delay measurements. The purity requirements are < 40 dBc harmonics and the frequency accuracy requirements are ± 1 Hz. The signal is generated with a simple PLL with a single pole loop filter and a synthesizer VCO.

The signal is filtered with a ceramic element and split providing reference signals that go to the Mod input, J5 on the Source and REF IF input and J17 on the Receiver assembly. The output amplitude is adjusted based on the band of the source. This is required to maintain a modulation index with frequency and is accomplished with a simple 4-state voltage divider. The main source mod drive is summed into the main source tune line within the Source Module.

Source Range (MHz)	State Relative to Through Band	Normalized Modulation Signal Amp
10-400	heterodyned	1
400-800	divided	2
800-1600	through band	1
1600-3200	doubled	0.5
3200-6000	doubled twice	0.25

The 10 MHz reference input is shaped and level shifted to minimize problems at the first divider stage. The logic families within the loop are quite mixed based on current technology.

The 453.125 kHz modulation frequency is chosen to match a valid under sampled Intermediate Frequency of the Analog to Digital system. It is sufficiently high to allow reasonable group delay resolution and requires no additional down conversions for detection.

Frequency Translating Group Delay Receiver

The main group delay receiver starts with a 10.7 MHz bandpass filter, which is the approximate carrier frequency for this measurement (output of down converter should be a 10.7 MHz carrier with 453.125 kHz FM at a modulation index of 0.1 to 0.3). The filter is quite broad because of the large modulation bandwidth and the possibility of changing the carrier frequency slightly based on calibration. A transformer provides impedance matching to the next stage.

The signal is then fed into a pair of wideband FM processing chips whose job is to do the following:

- Perform limiting amplification to reduce AM sensitivity
- Provide an estimate of signal strength: Received Signal Strength Indicator (RSSI)
- Perform FM demodulation

Two chips are required to get enough IF gain to sufficiently limit the signal. A coupling network is used to ensure stability and flatten the RSSI characteristic.

The RSSI signal is combined from the two chips, shifted/scaled, and sent to the ADC direct input. The base RSSI signal runs from 0 to –5V, which needs to be inverted and scaled for the –2.75 to +2.75 Volt ADC range. A unity gain follower is used to provide impedance matching from the RSSI output of the FM processing chip. This signal is used to gauge the power levels for calibration purposes.

The FM demodulation is via a quadrature technique using the tank of the RLC circuitry. The Q is fairly low (4 to 5) to accommodate the large modulation bandwidth and some carrier frequency flexibility. The balanced output of the demodulation is converted to single-ended, then it is amplified and filtered by a ceramic filter. The signal is amplified again before being multiplexed with the RSSI output.

Wideband Noise Figure Receiver

The front end mentioned above provides the initial gain ranging for the 25 MHz noise signal. The measurement is performed using the usual Y-factor hot and cold measurements, so the function of the circuit is simply filter-amplify-detect. In the field of Noise Figure Measurements, the term Y Factor is defined as:

$$\frac{\text{Power Measured with Noise Source on (hot)}}{\text{Power Measured with Noise Source off (cold)}}$$

After being demultiplexed, the signal enters a sequence of three filter-amplifier pairs. The filters are all centered at 25 MHz with about 6 MHz of bandwidth. The amplifiers all provide approximately 20 dB of gain and nominal 50 ohm impedance levels for the filters. Because of the high gain present in this chain, relatively high levels of feedback are used to maintain good stability.

After the filter-amplifier chain, the signal enters a 0 to 30 dB switched attenuator for gain ranging prior to detection. A comparator tree is used to supply the control voltages required by this attenuator. While the attenuator appears to have quite repeatable and stable attenuation values, the absolute values from attenuator to attenuator vary substantially. This is not surprising based on the manufacturer's accuracy specifications of approximately ± 0.2 to 1 dB (depending on attenuation setting). Since the attenuation value is used in insertion gain calculations, the absolute accuracy can be somewhat important, particularly for slightly lossy DUTs. It is estimated that an attenuation accuracy of 0.1 to 0.2 dB is required to meet system accuracy expectations, hence some additional calibration is required.

A factory BACK-END ATTENUATOR CAL has been developed to perform this task and is similar to an ALC calibration in how it is performed and stored in nonvolatile memory.

During this calibration, a throughline is connected from Port 1 to Port 2 and the system is automatically tuned to generate an IF of 25 MHz. The level of this signal is adjusted using the ALC and the step attenuator to get it into an appropriate range for the noise detector. The attenuator is then moved a single 2 dB step and the difference in detected power is measured. The sinusoidal power is then again adjusted for the detector dynamic range and the process is repeated for all attenuator steps. These attenuator values are stored for later use in insertion gain calculations.

The power detector is a simple Schottky diode. Because of dynamic range concerns, the detector is driven current mode and impedance transformation (50 ohms to a few kilohms) circuitry is added. A bias circuit is used to turn on the main detector while keeping it temperature stable.

Shielding is important in this circuit, as might be expected because of the small signal levels involved and the large amount of gain present on the chain (up to 90 dB).

2-7 CENTRAL PROCESSOR MODULE

The Central Processor Module (Figure 2-1, following page) contains most of the digital functionality of the MS462XX, and consists of three major sections, each of which contains its own processor:

- Main CPU
- DSP Core
- Graphics Core

The Main CPU section is a MC68040 with a primary cache and includes a local system memory (16 MB Fast Page Mode DRAM upgradable to 64 MB, 4 MB Battery Backed SRAM, 10 MB Flash, 512 KB Boot EPROM, 128 KB NVRAM), Ethernet interface, GPIB master/slave interfaces, parallel printer port, 2 serial ports, interfaces to the front panel keypad, front panel floppy disk drive, an external keyboard, and an interface to the external SCSI-2 drive.

The DSP core is for calculating the sweeping S-parameter measurements and includes the TMS320C44 DSP, local system memory (2 MB SRAM, 32 KB Boot EPROM), global system memory (128 KB SRAM) used as dual access memory to the 68040 CPU, and an interface to the A/D converters located on the Receiver Module.

The BBRAM chip has a rated life span of 10-years, and the SRAM backup battery has a worst-case life span of 2-years at 25°C when the instrument is stored (always off). Exposure to temperatures above 60°C will dramtically reduce this worst-case life span. The SRAM backup battery should be replaced every three years.

The Graphics core is for driving the front panel color LCD and external VGA monitor with the instrument display measurements, and it includes the TMS34020 graphics processor, local system memory (1 MB DRAM, 1 MB Video RAM), a video palette, drivers for the VGA interface, an LCD controller, and an interface to the color LCD module through the Flex Cable (part number D43020).

All the signals that go on or off the board go to one of three destinations. They can be described as connections that go to the rear panel, the front panel, or the system motherboard. Only the rear panel connections are directly accessible.

2-8 RECEIVER MODULE BLOCK DIAGRAMS

There are 20 different configurations of receiver modules, based on model and option number. Block diagrams of these configurations are shown in the foldout Figures 2-2 through 2-22, on the following pages.

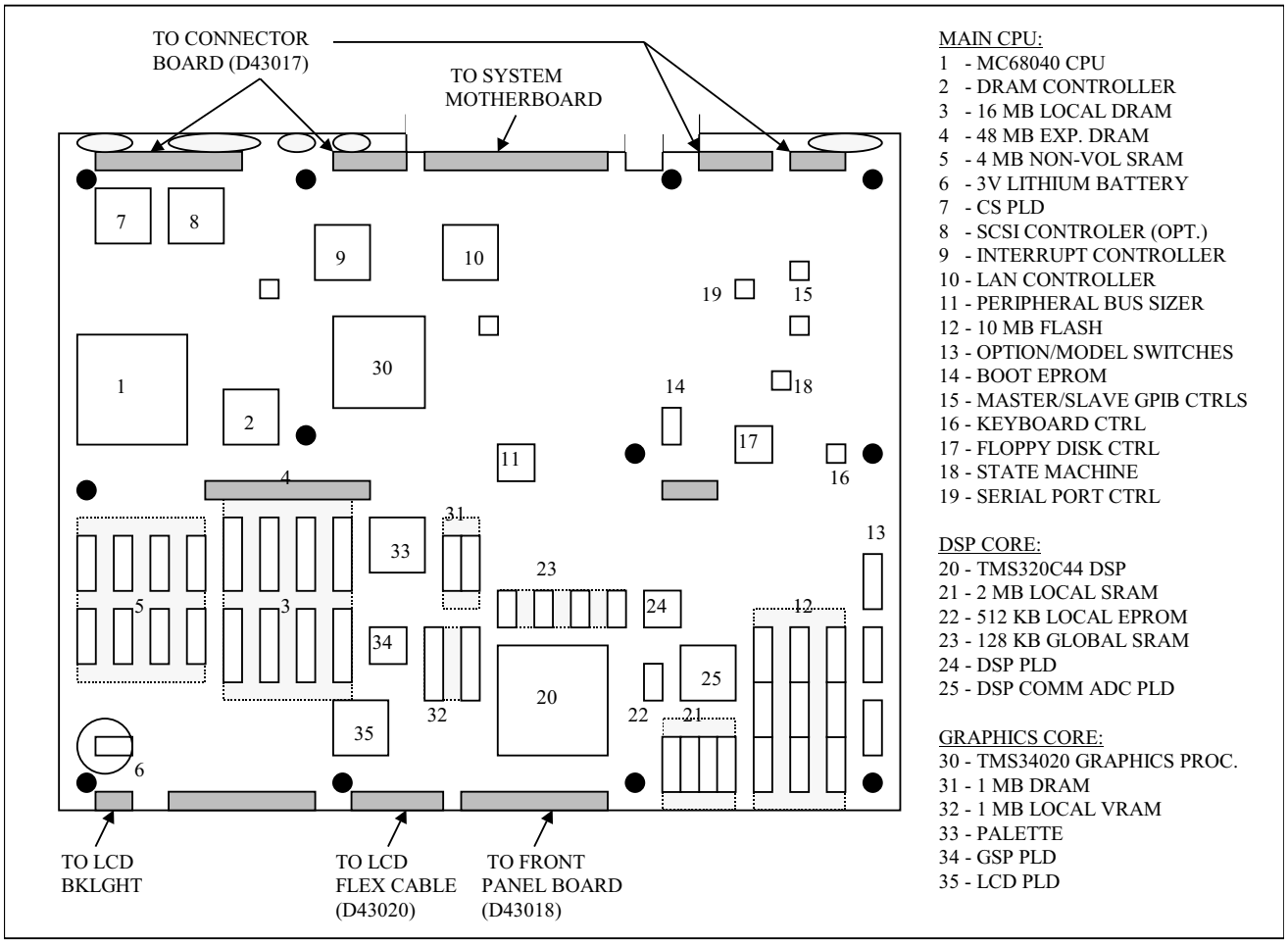

Figure 2-1. *CPU Module Block Diagram*

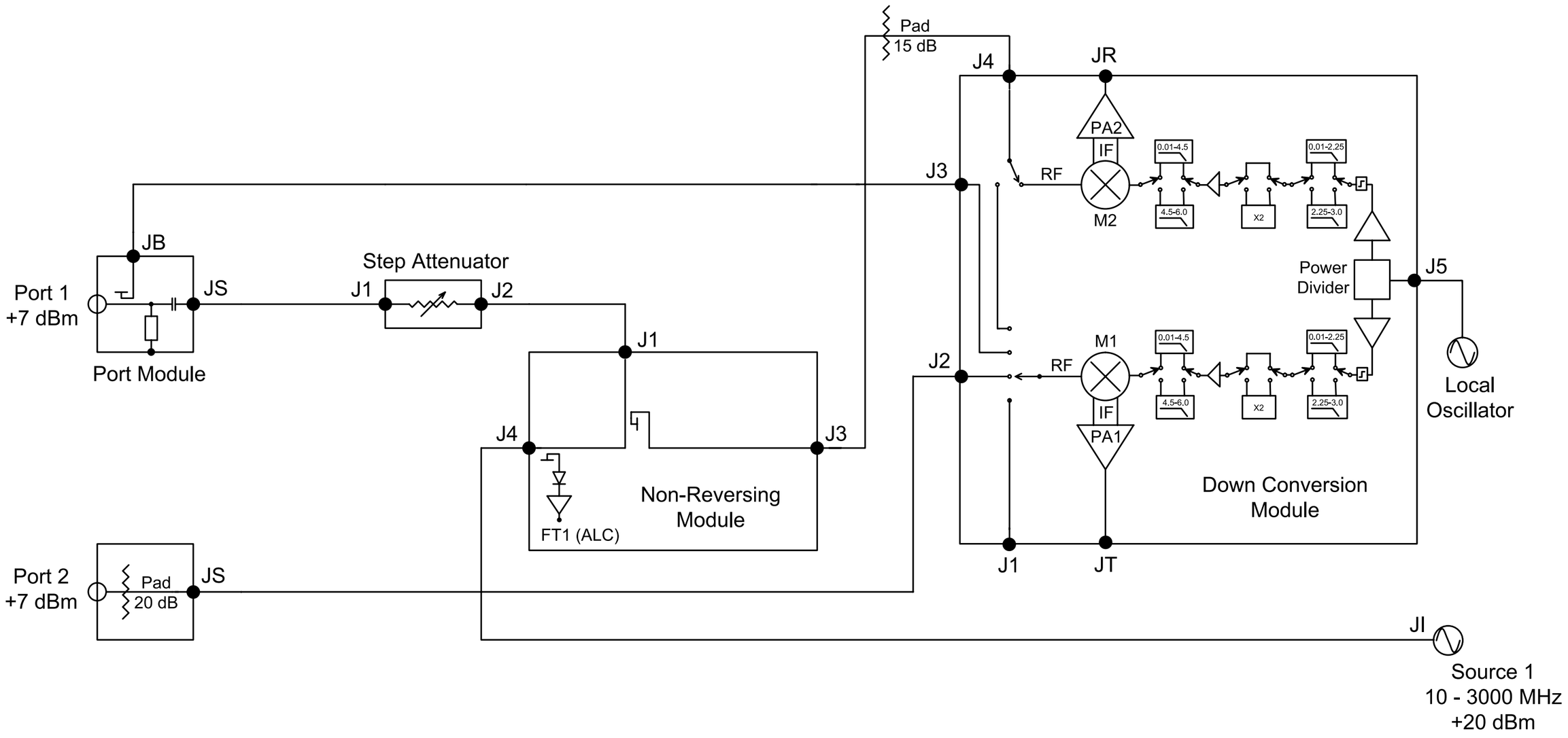

Figure 2-2. *Model MS4622A, Option 7, Transmission/Reflection, Step Attenuator*

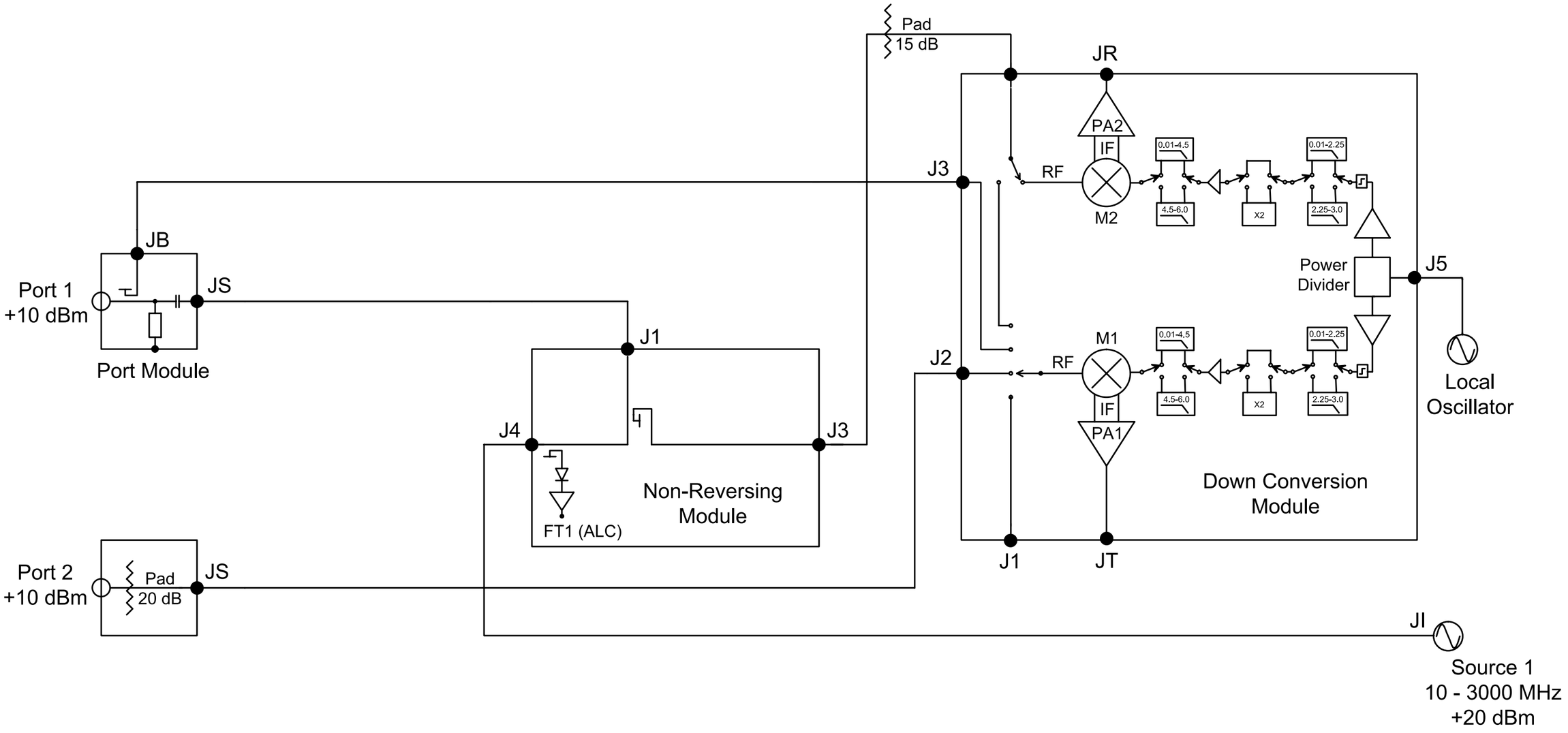

Figure 2-3. *Model MS4622A, Transmission / Reflection*

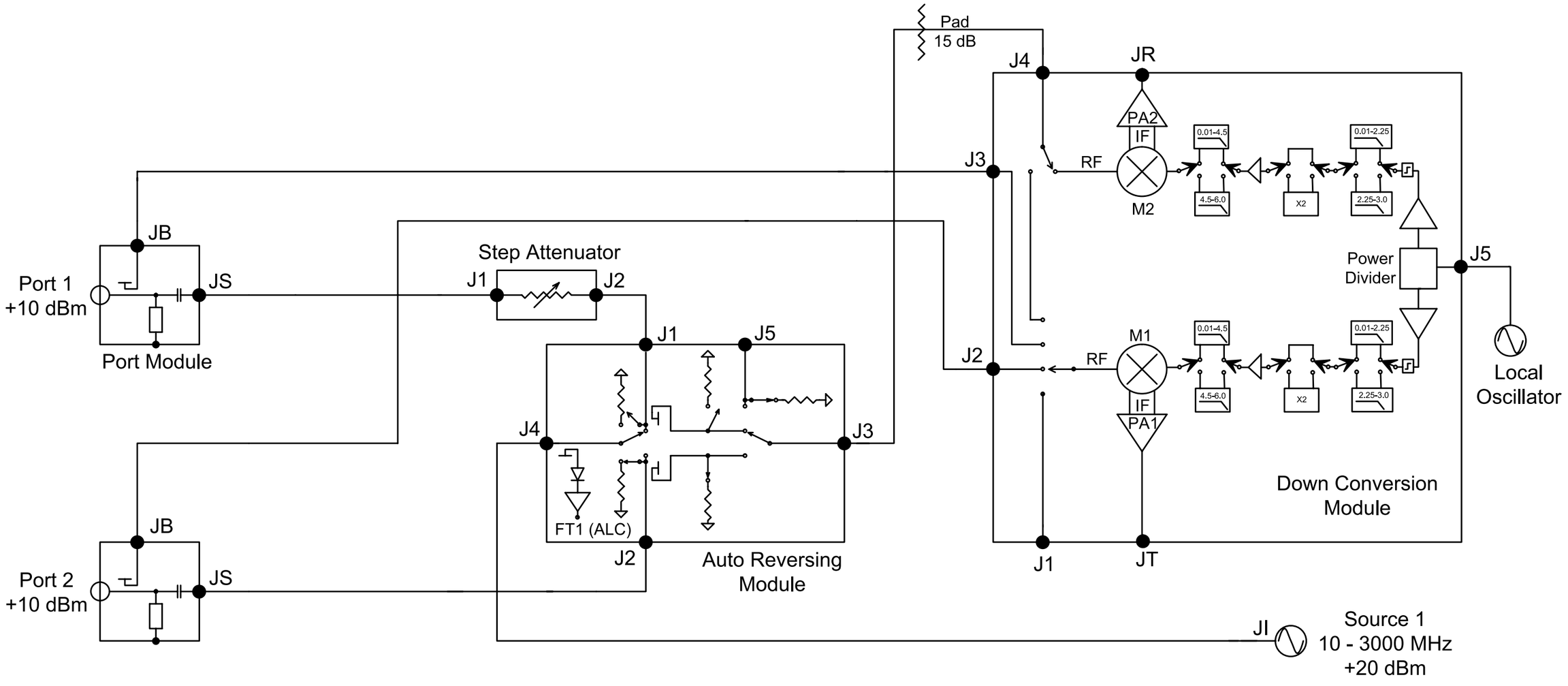

Figure 2-4. *Model MS4622B, Auto-Reversing*

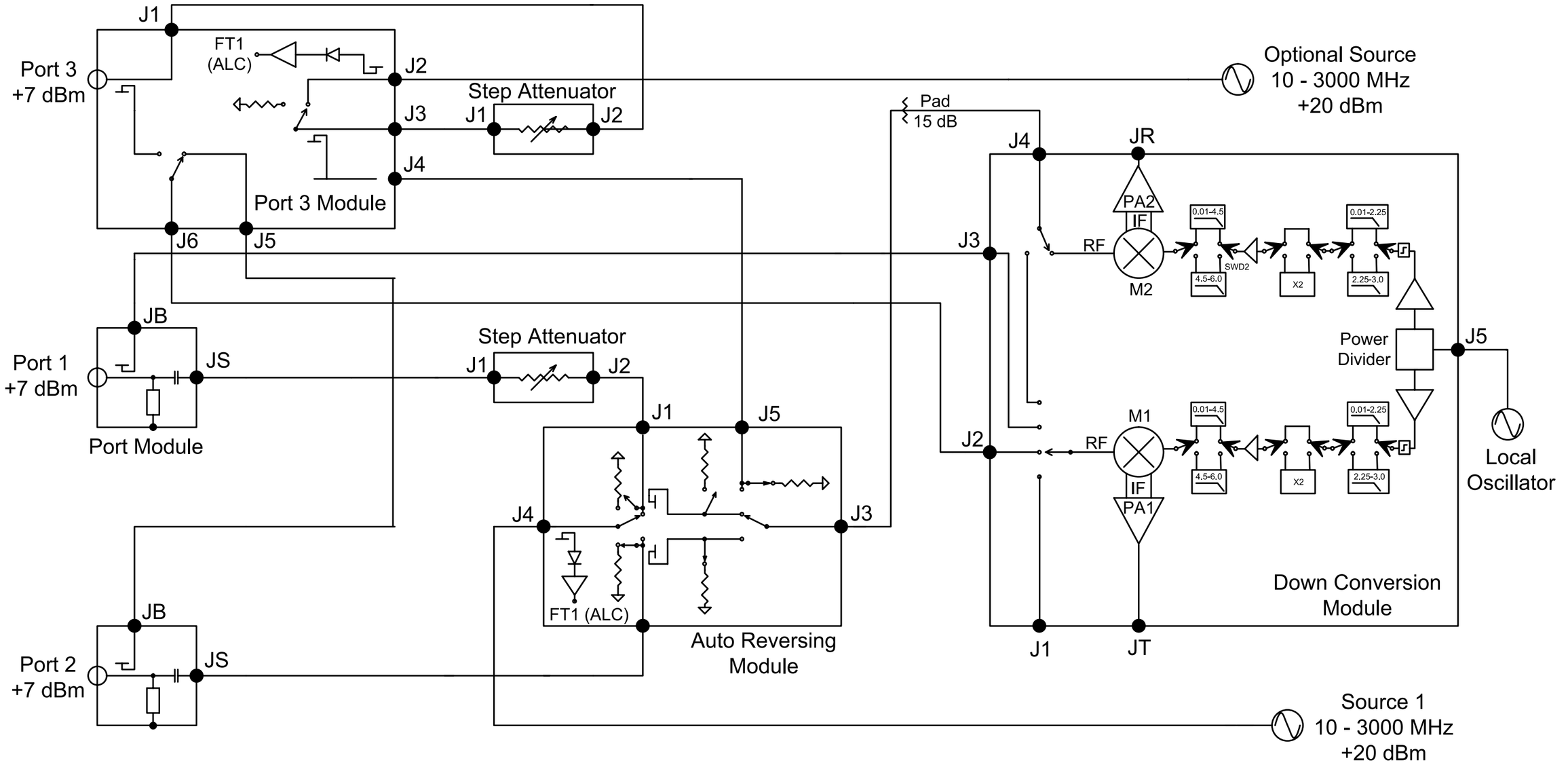

Figure 2-5. *Model MS4622B, Auto-Reversing, 3-Port*

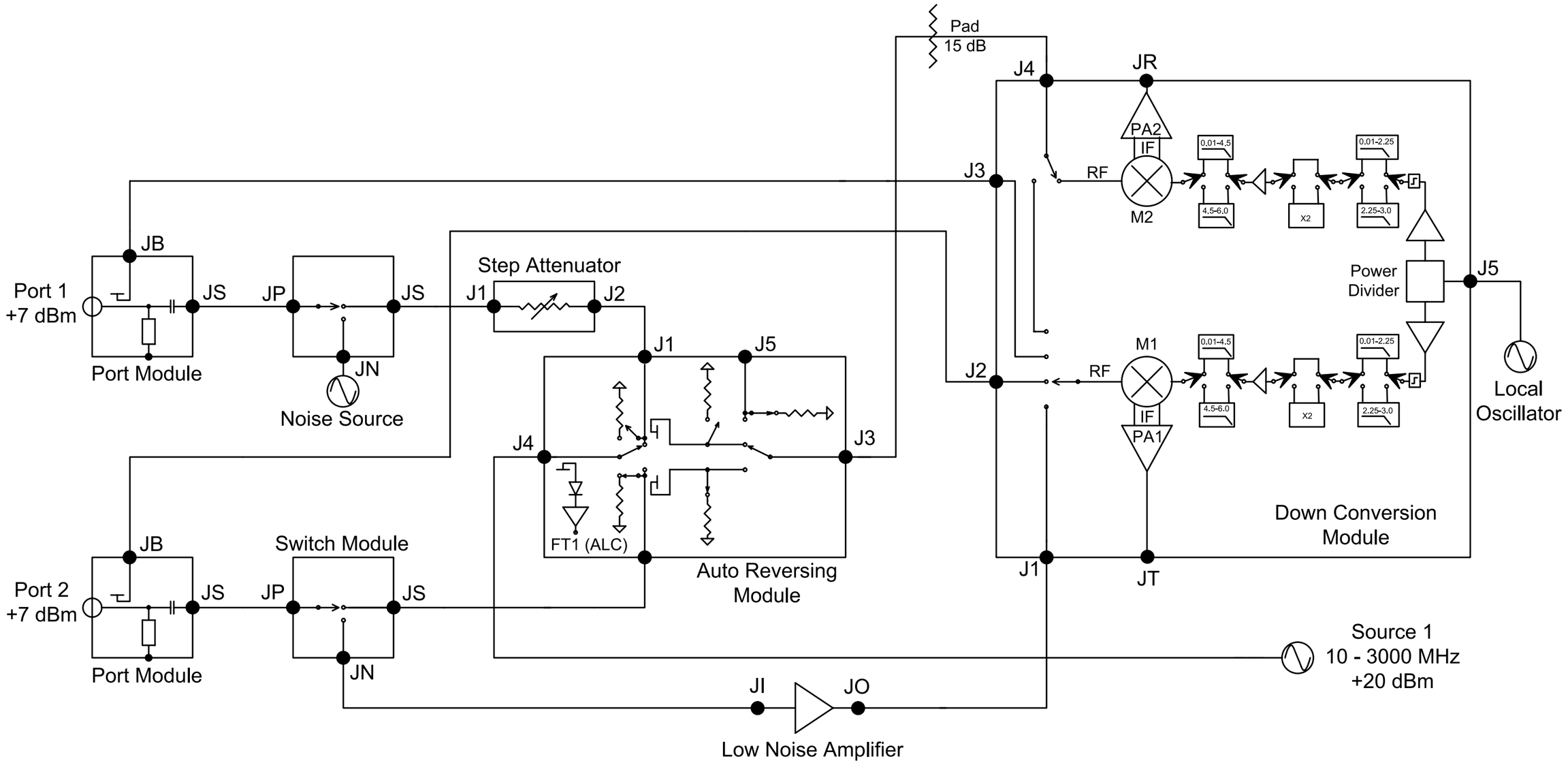

Figure 2-6. *Model MS4622B, Auto-Reversing, Option 4 Noise Figure*

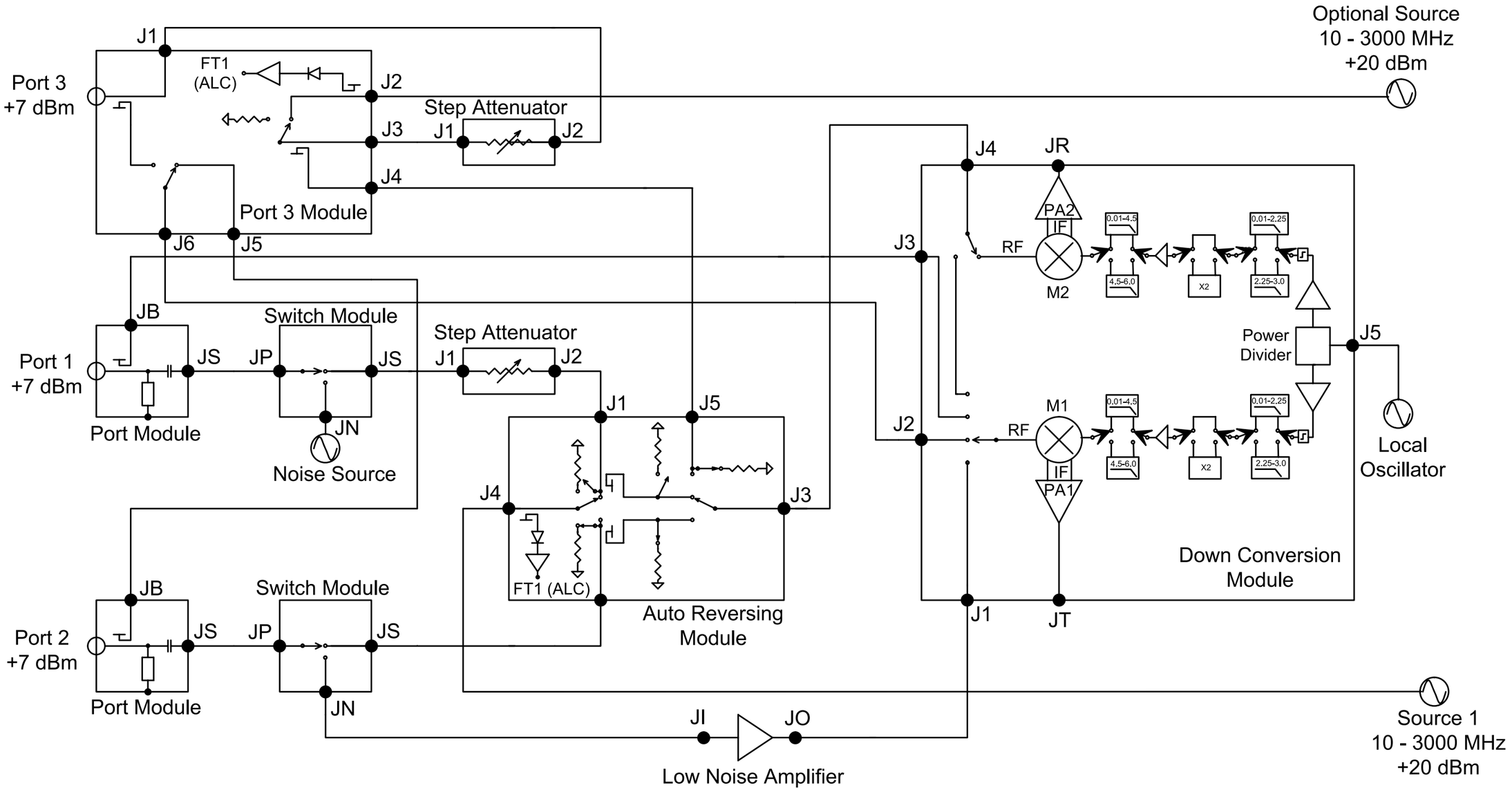

Figure 2-7. *Model MS4622B, Auto-Reversing, Options 3A and 4*

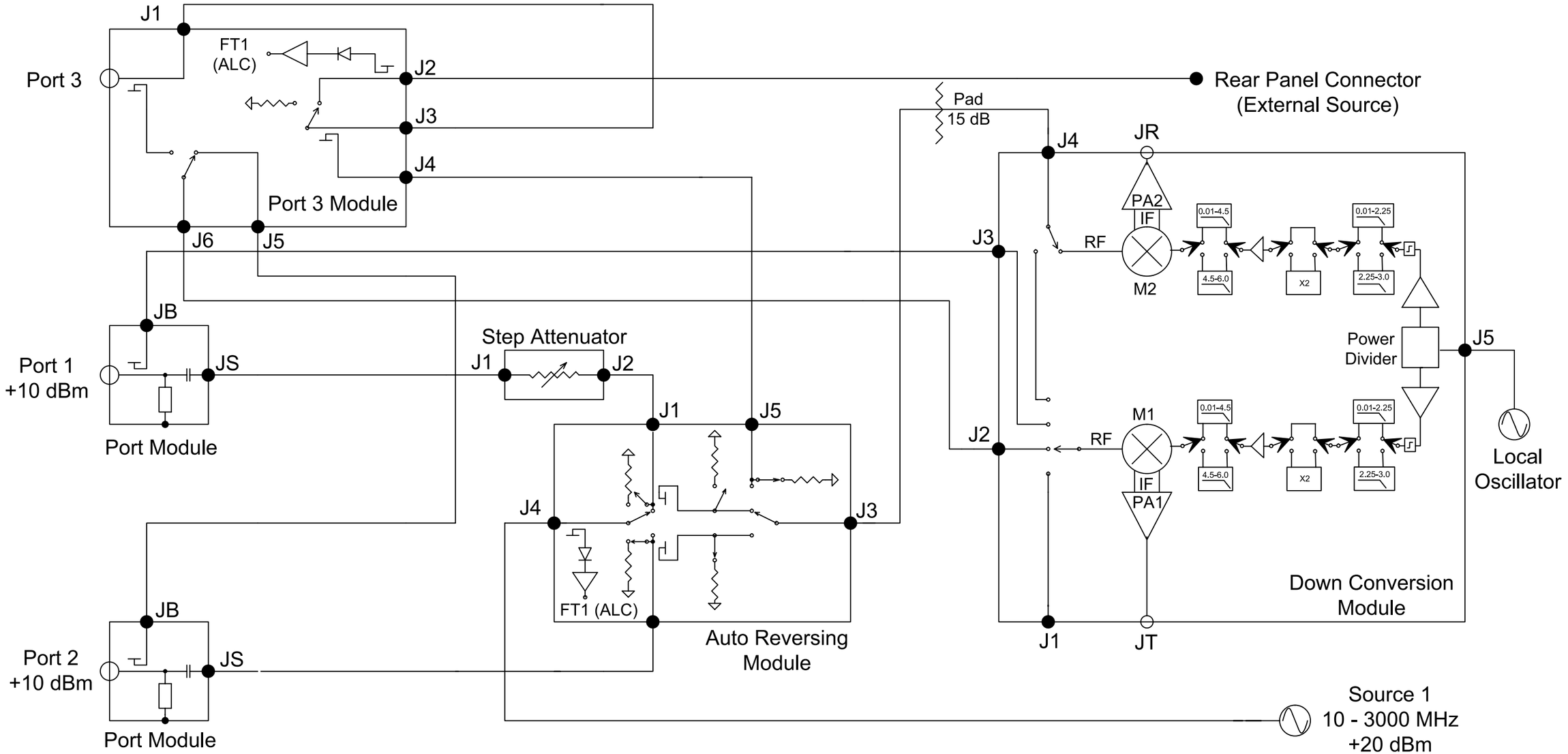

Figure 2-8. *Model MS4622B, Auto-Reversing, Option 6, 3-Port*

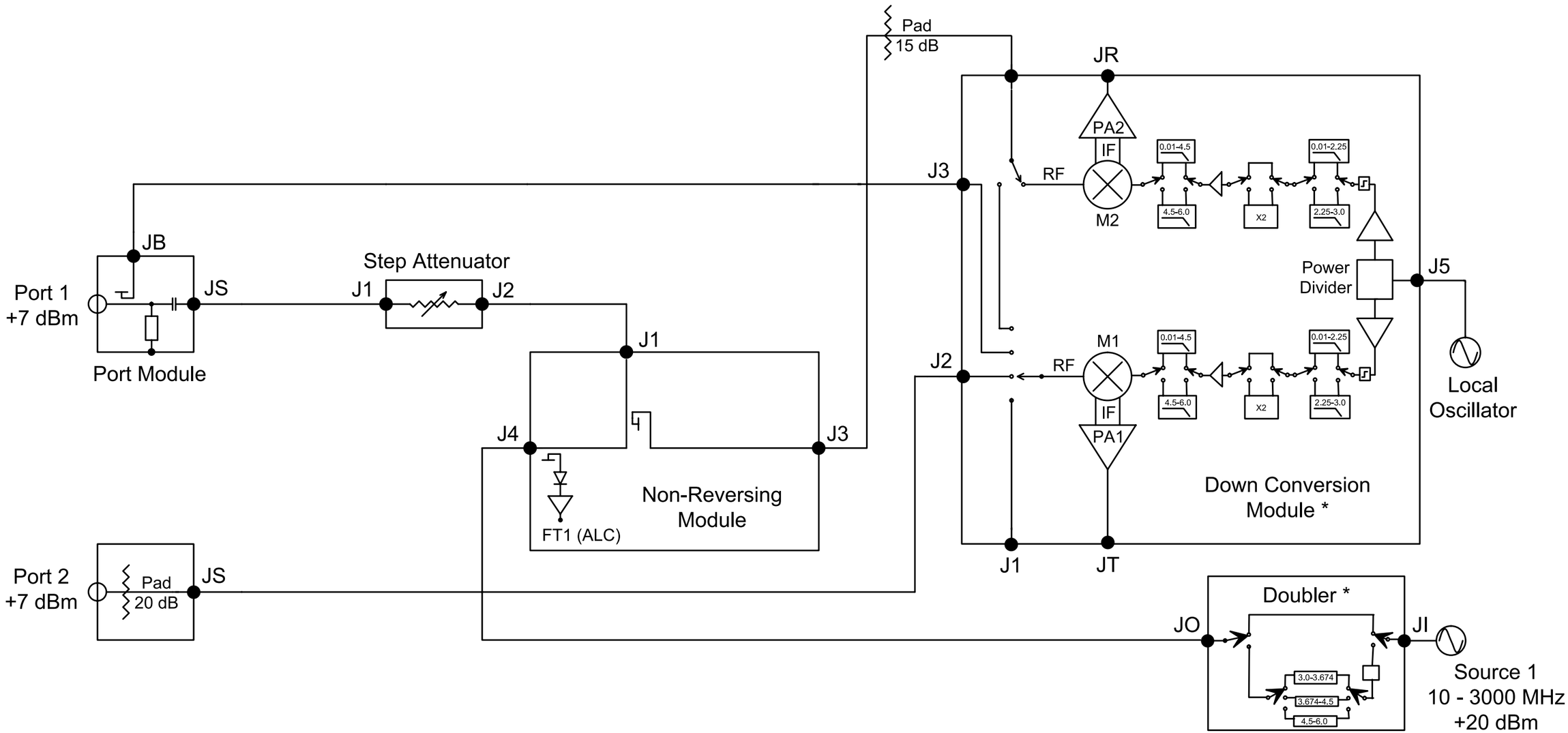

Figure 2-9. *Model MS4623A/MS4624A, Transmission/Reflection, Step Attenuator, Option 7*

***** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624A.

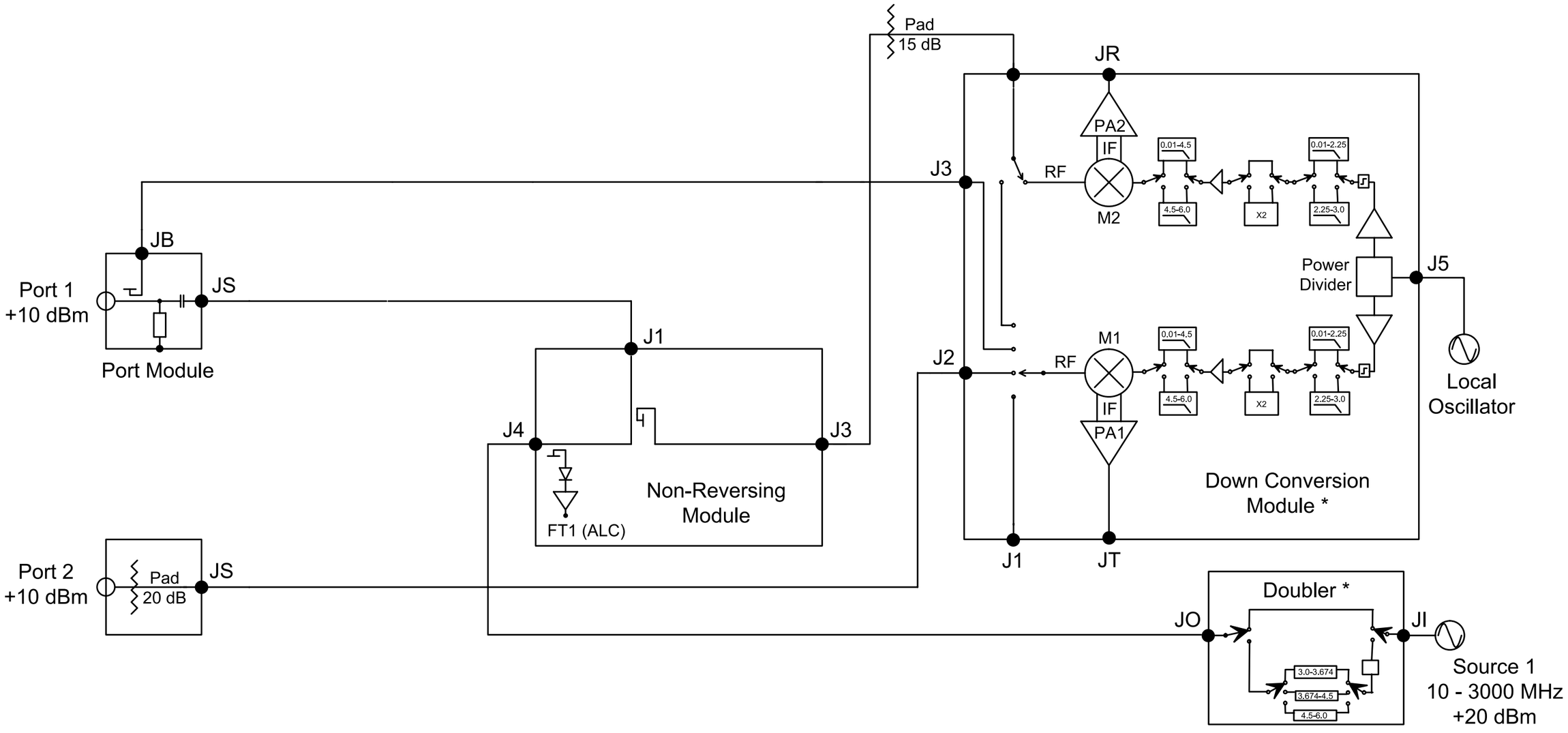

Figure 2-10. *Model MS4623A/MS4624A, Transmission/Reflection*

***** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624A.

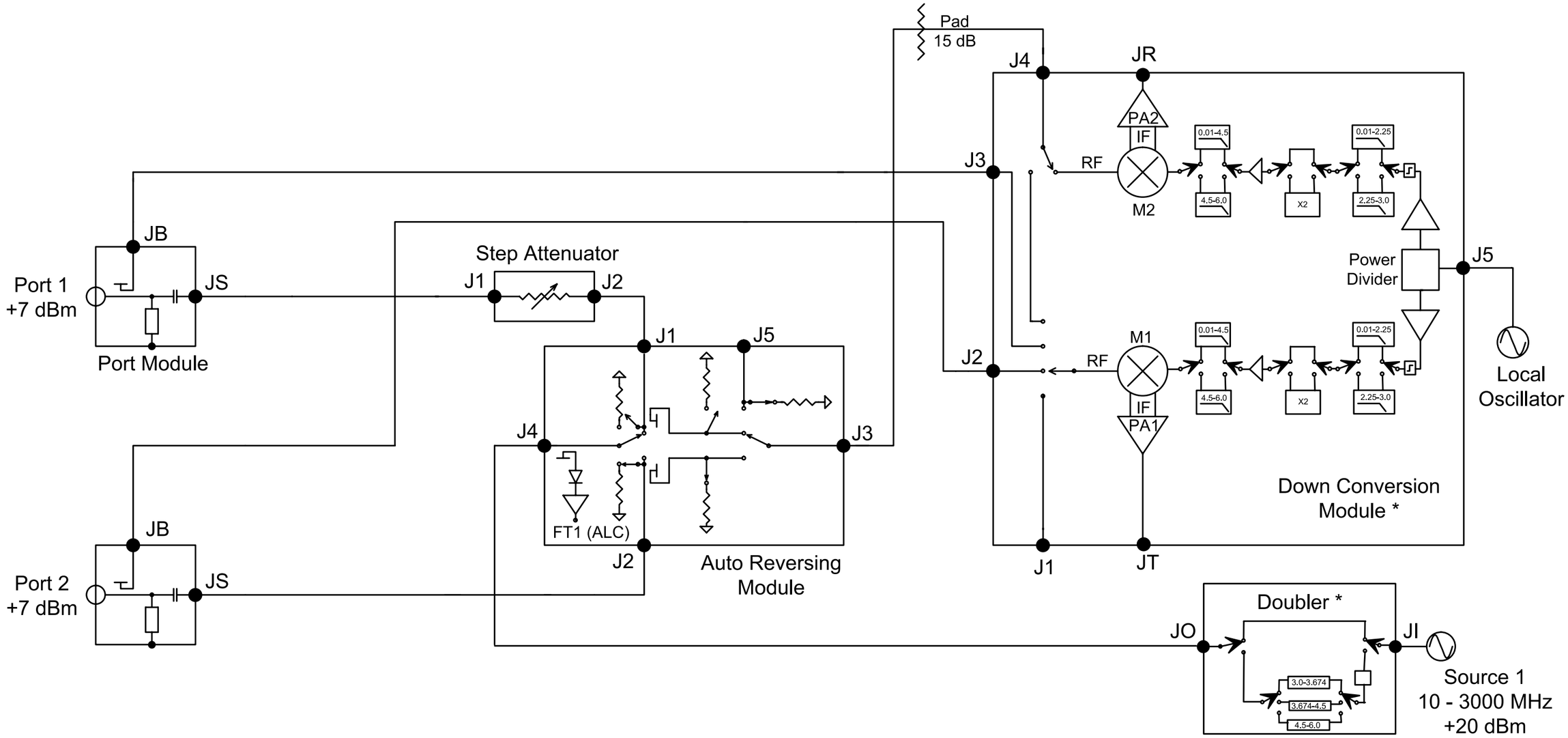

Figure 2-11. *Model MS4623B/MS4624B, Auto-Reversing*

***** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624B.

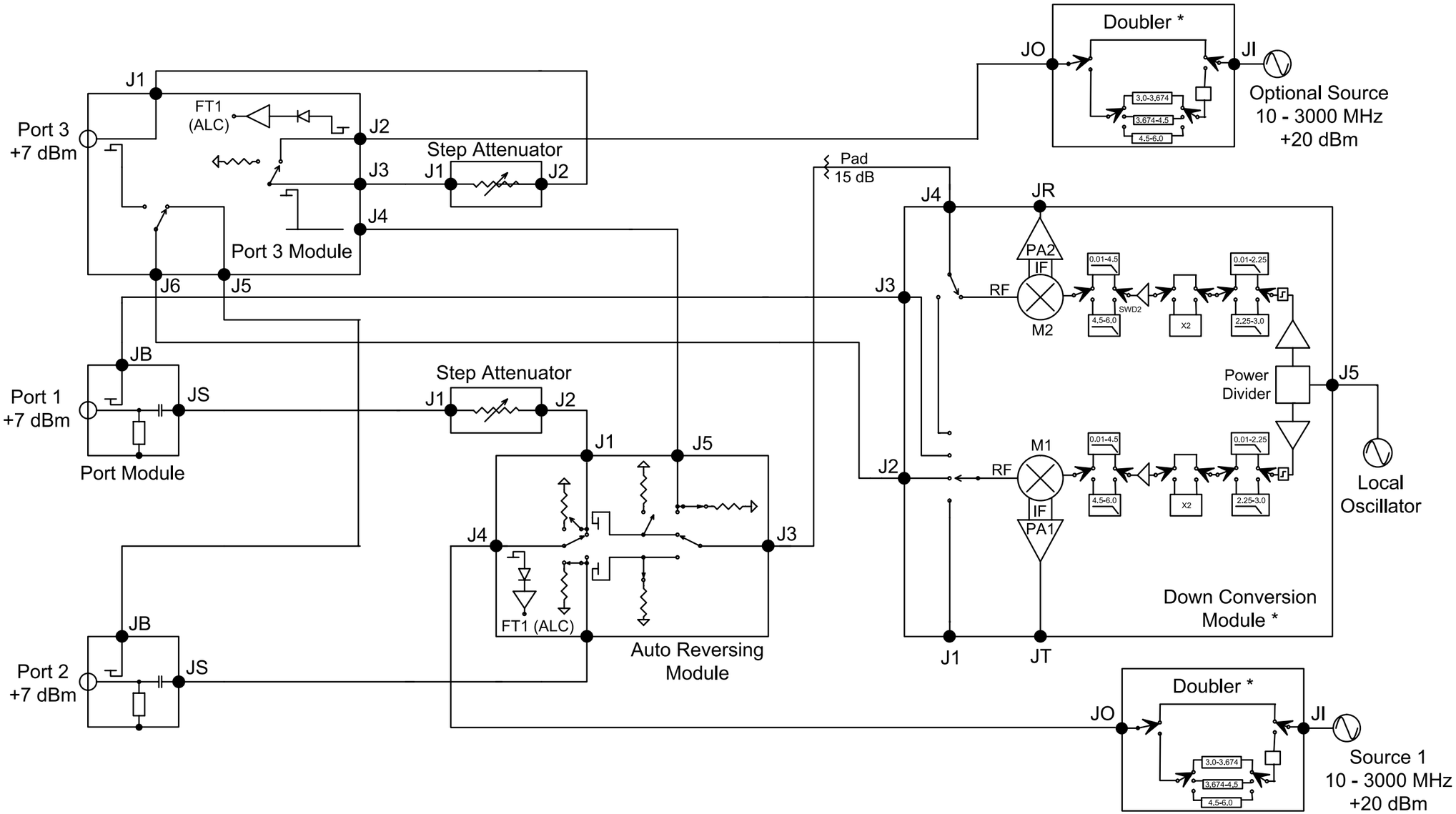

Figure 2-12. *Model MS4623B/MS4624B, Auto-Reversing, Option 3B, 2nd Internal Source and 3rd Test Port*

***** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624B.

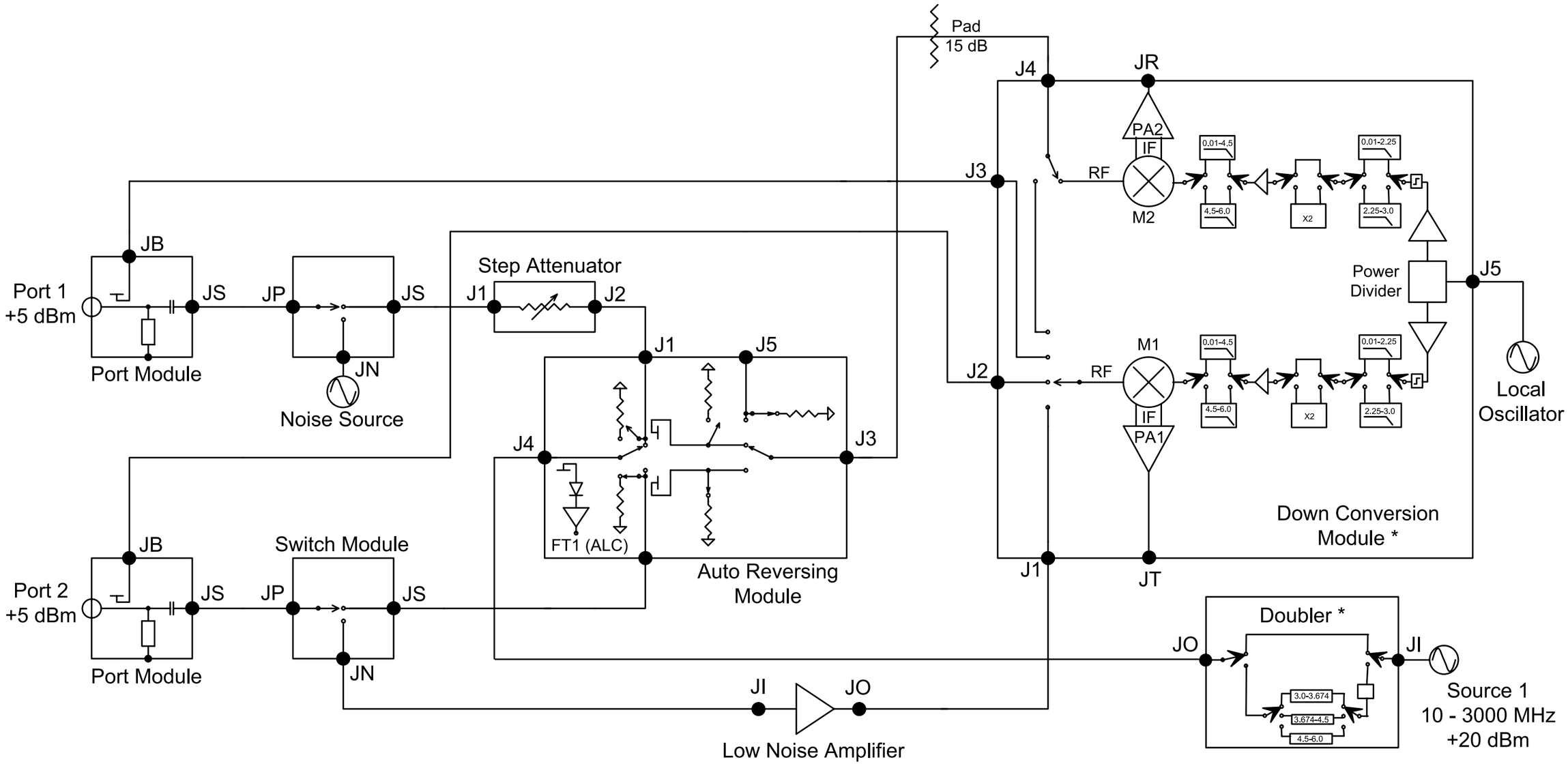

Figure 2-13. *Model MS4623B/MS4624B, Auto-Reversing, Option 4, Noise Figure*

***** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624B.

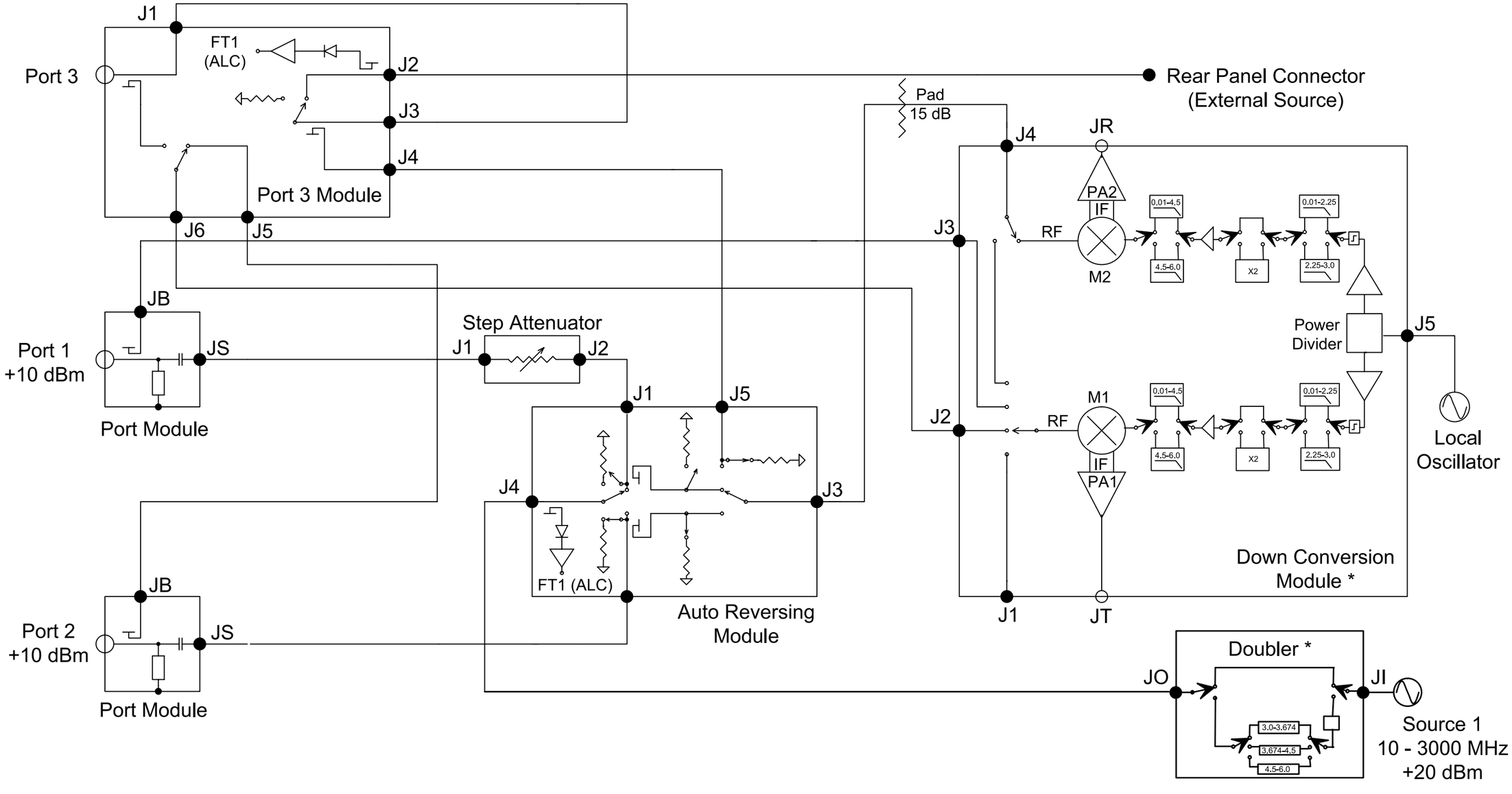

Figure 2-14. *Model MS4623B/MS4624B, Auto-Reversing, Option 6, 3rd Test Port*

***** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624B.

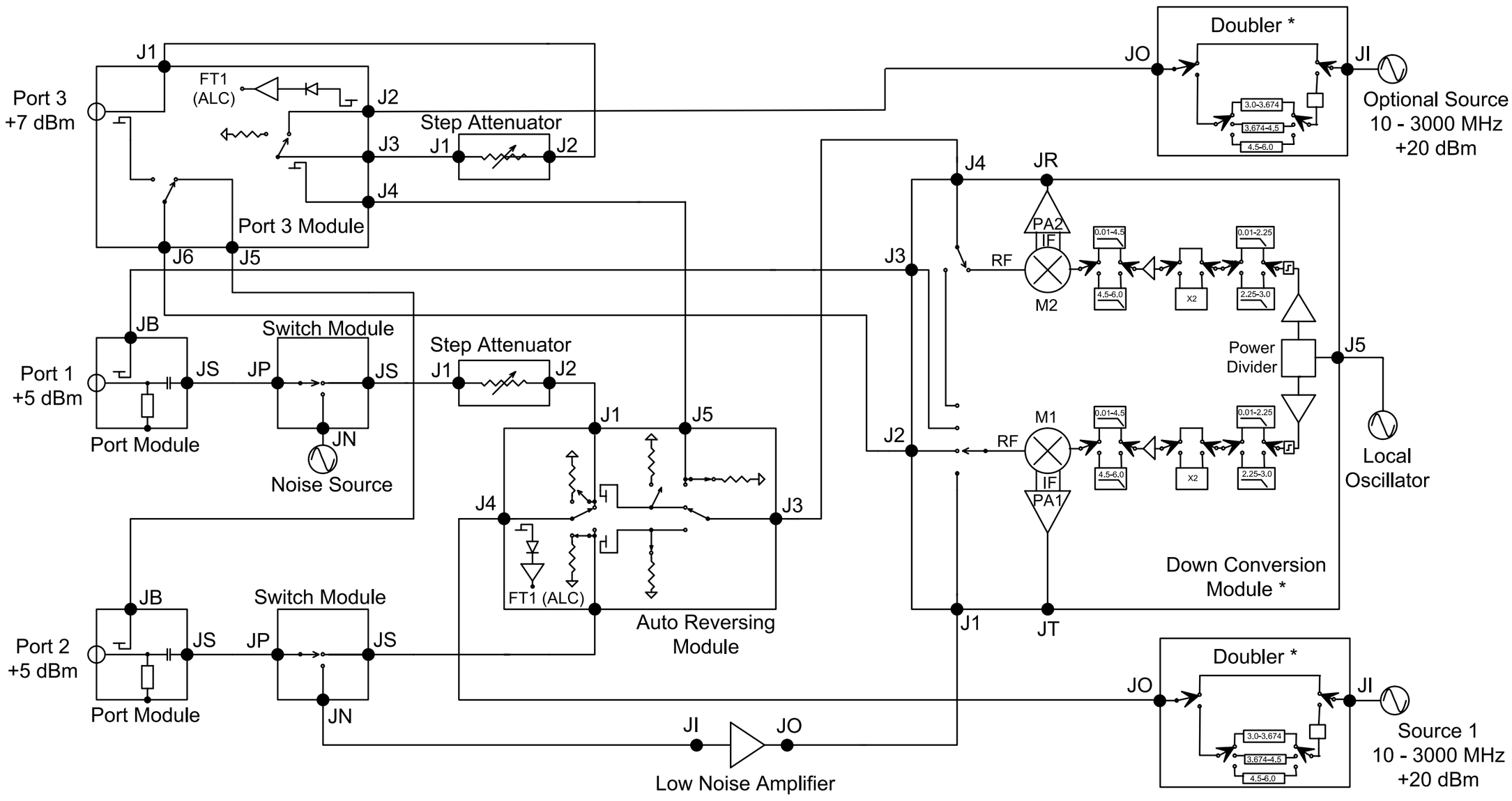

Figure 2-15. *Model MS4623B/MS4624B, Auto -Reversing, Options 3B and 4*

***** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624B.

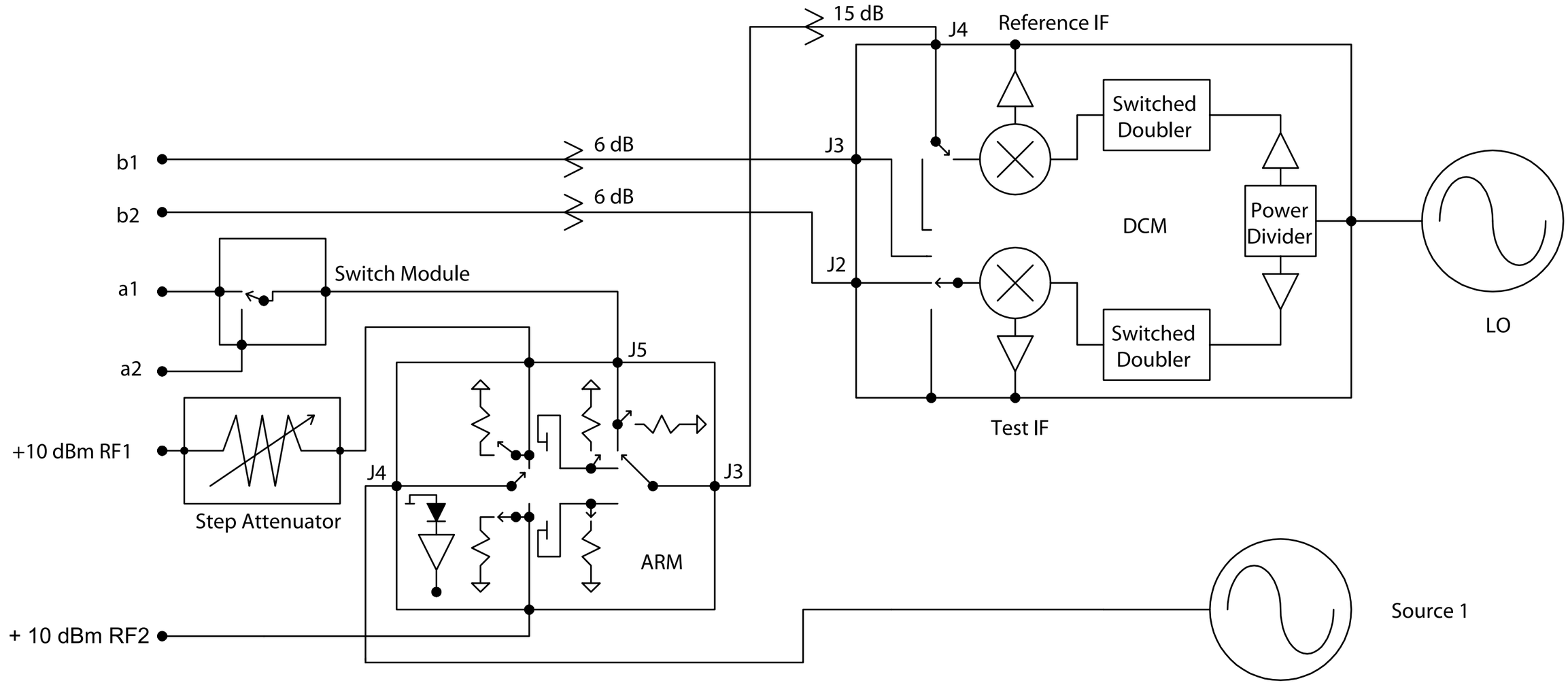

Figure 2-16. *Model MS4622C, Direct Access Receiver*

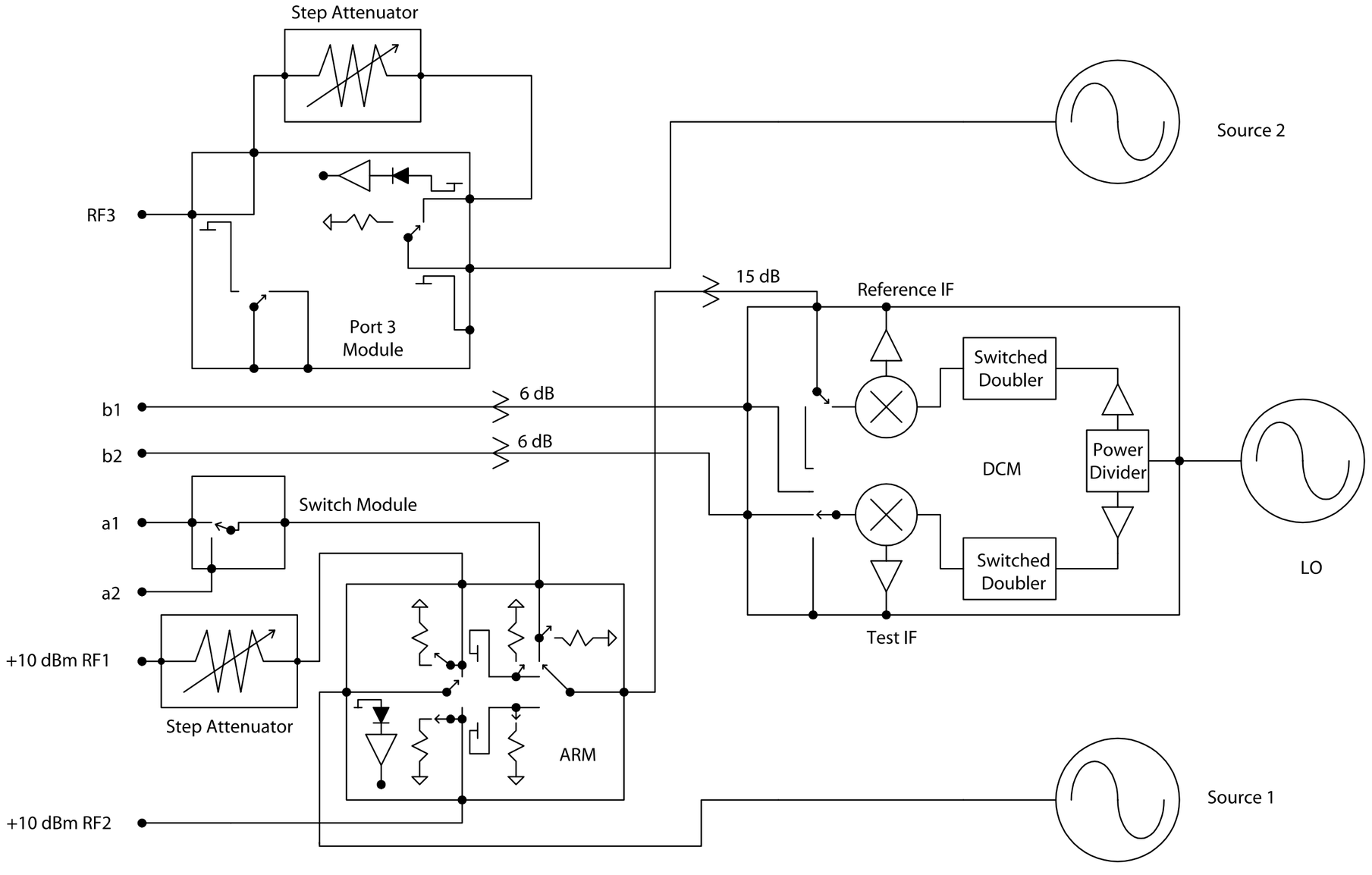

Figure 2-17. *Model MS4622C, Option 3 Direct Access Receiver*

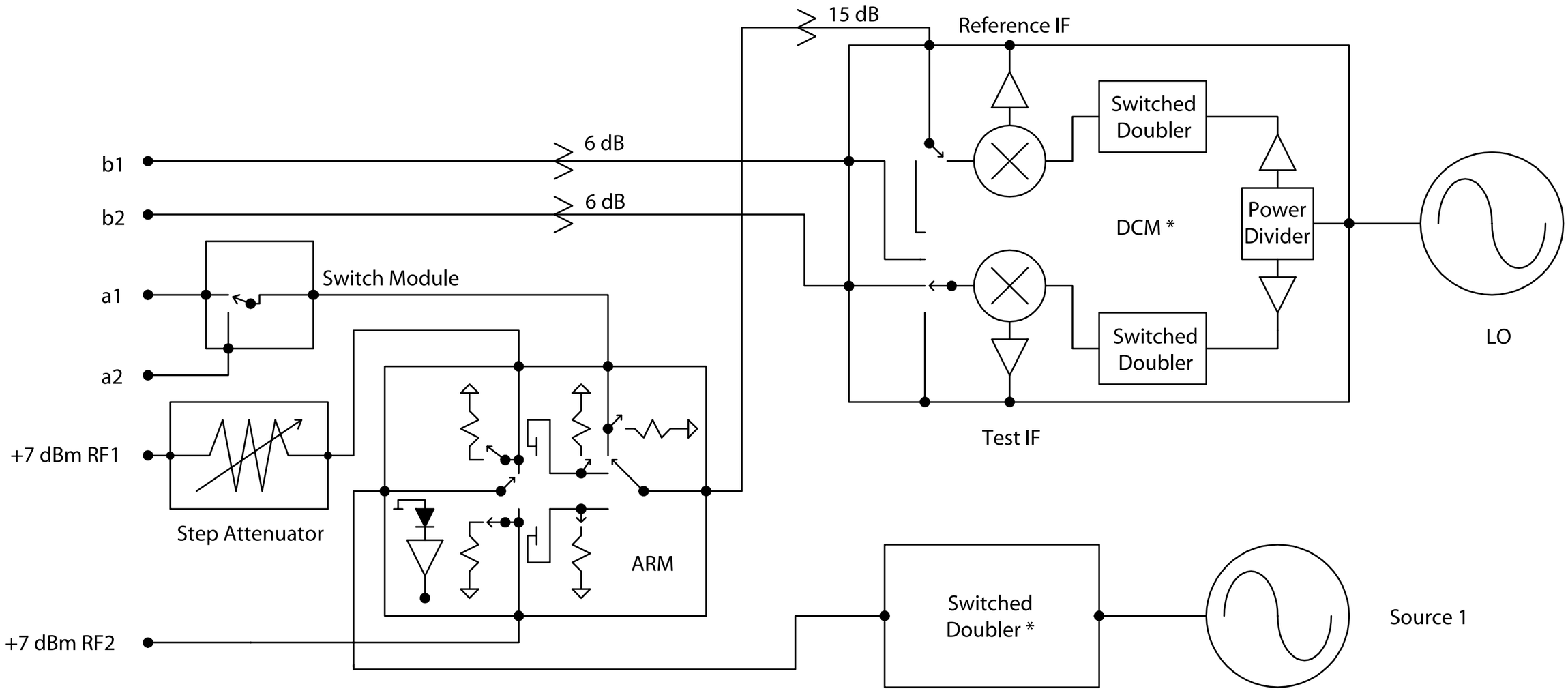

Figure 2-18. *Model MS4623C/MS4624C, Direct Access Receiver*

** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624C.*

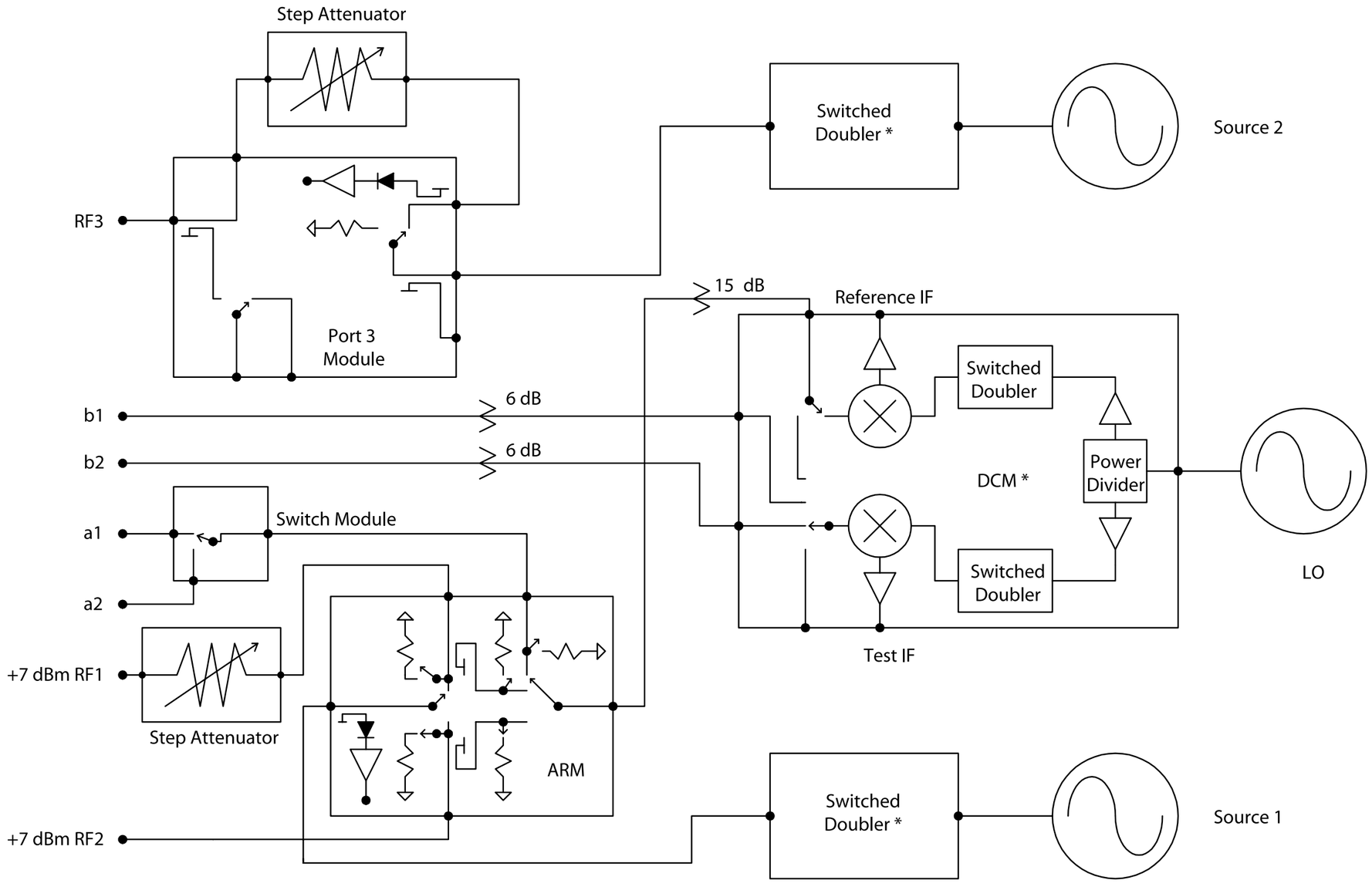

Figure 2-19. *Model MS4623C/MS4624C, Option 3 Direct Access Receiver*

** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624C.*

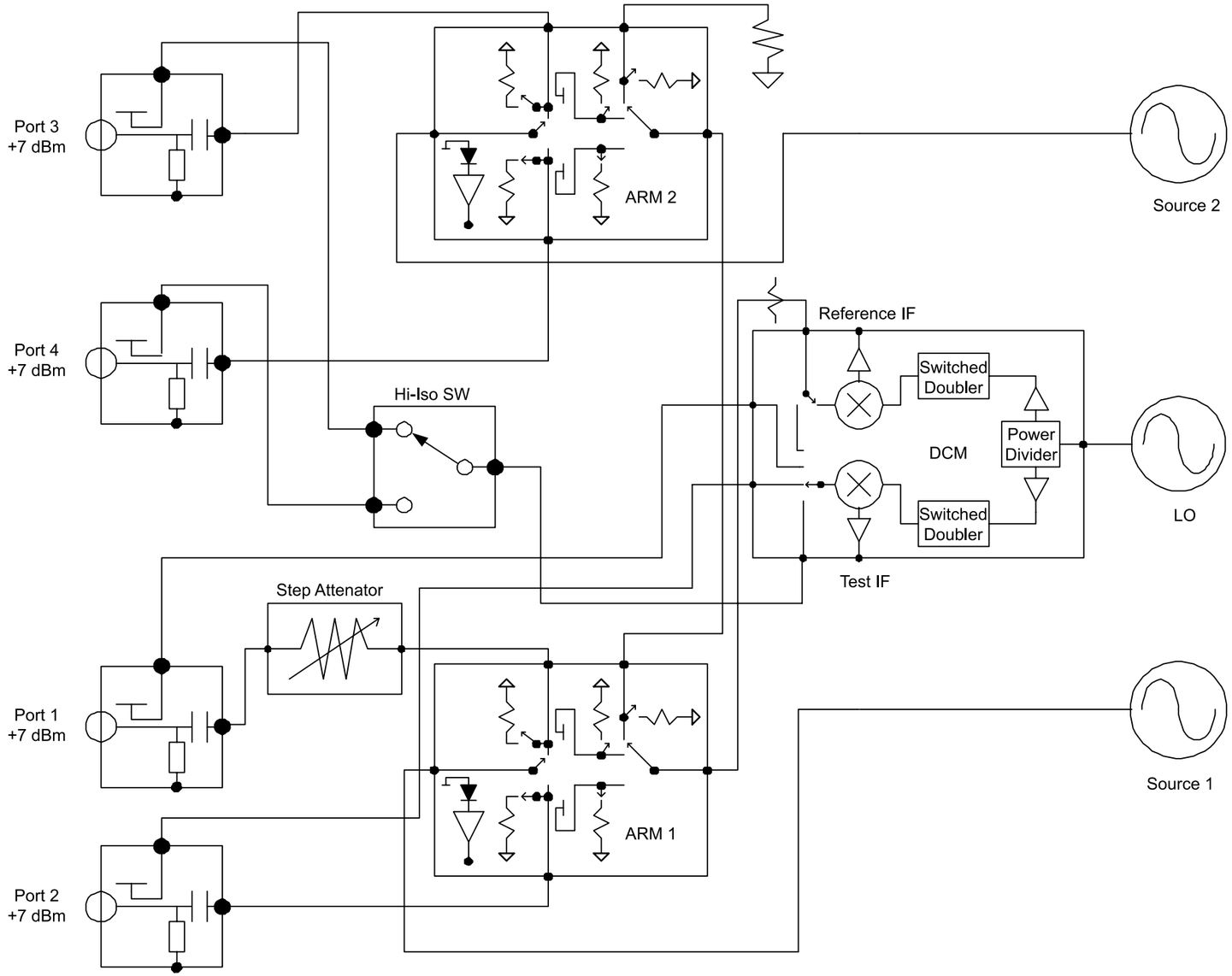

Figure 2-20. *Model MS4622D 4-Port Receiver*

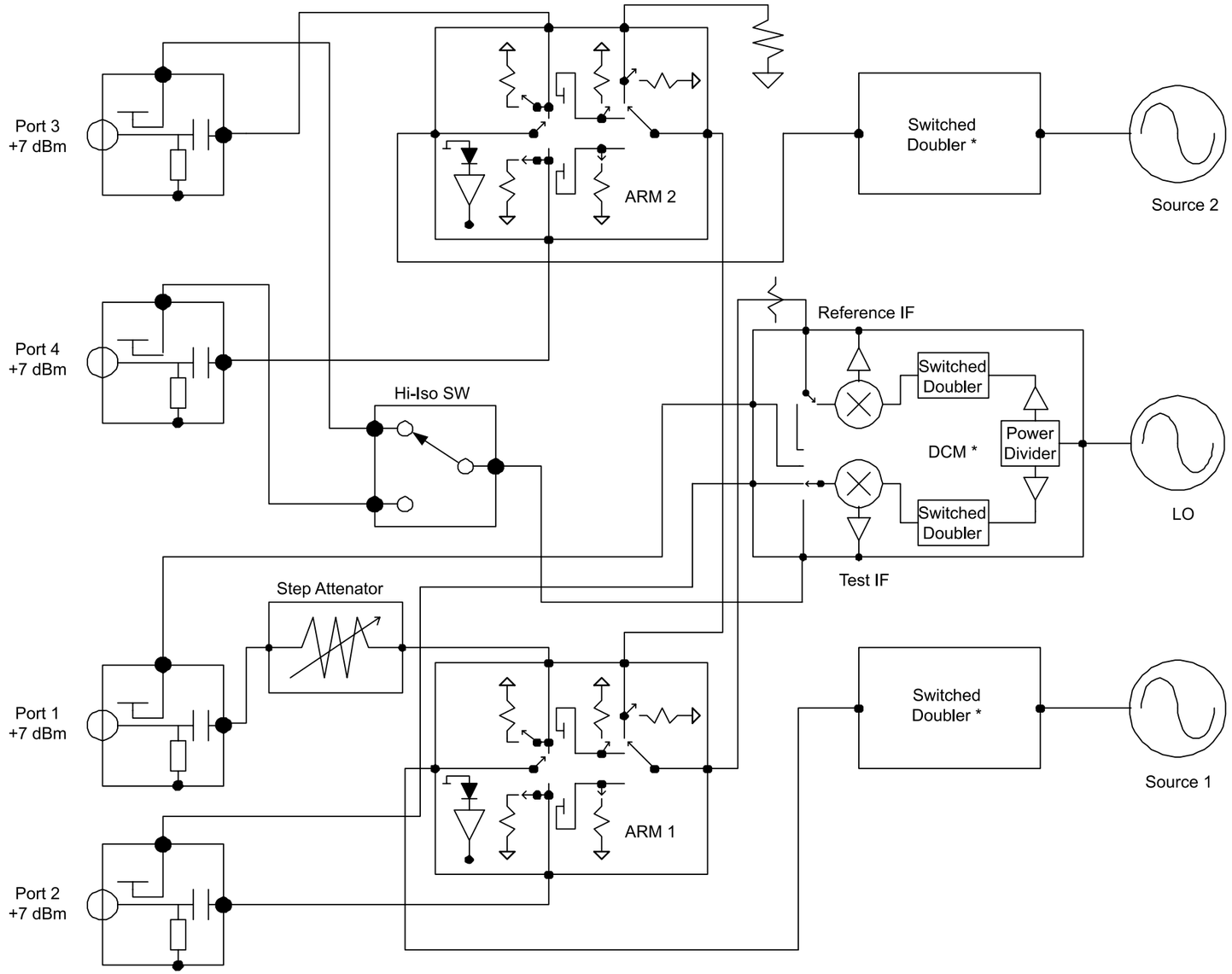

Figure 2-21. *Model MS4623D/MS4624D 4-Port Receiver*

** Refer to Figure 2-22 (page 2-47) for a functional block diagram of the Source Tripler and 9 GHz Down Conversion Module used on the model MS4624D.*

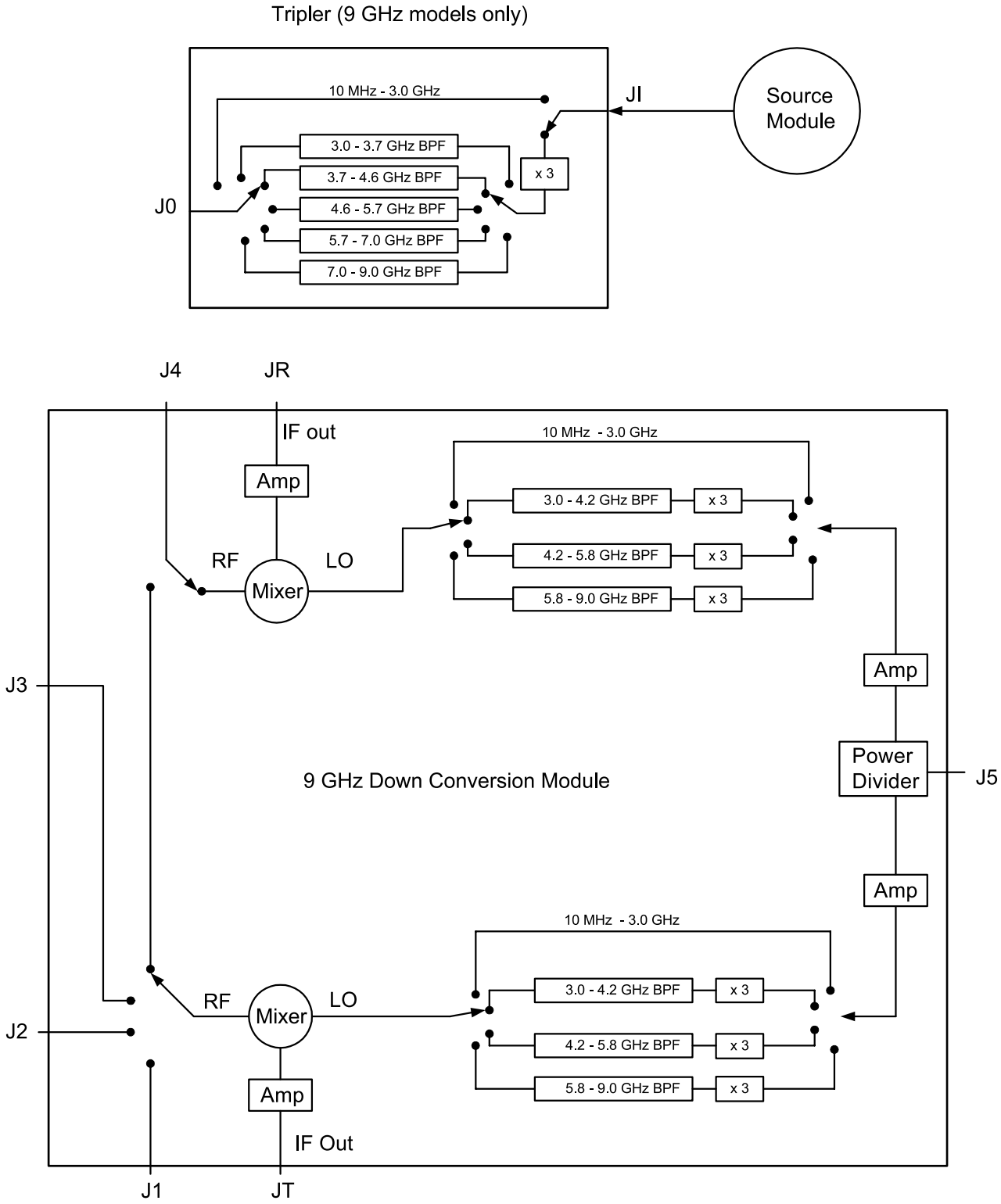

Figure 2-22. *Switched Tripler and 9 GHz Down Conversion Module Functional Block Diagrams*

Chapter 3
Operational Performance Tests

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Chapter 3
Operational Performance Tests

3-1 INTRODUCTION

The tests in this chapter provide a means of partially testing the MS462XX system for proper operation. These tests should be performed in their entirety at least once annually. For best results, the tests should be performed in the sequence presented.

> ***NOTE***
>
> The procedures in this chapter, along with the Verification Tests in Chapter 4, will fully test the operational status of the MS462XX.

3-2 CHECKING THE SERVICE LOG/SELF-TEST

Checking the service log consists of viewing the entries written into the log.

> ***CAUTION***
>
> The service log contains historical information about instrument condition and any failures that may have occurred. It should be cleared only by a qualified service personnel. Such clearing should be accomplished only upon determining that the errors need not be saved to disk, or printed out for service purposes.

Procedure:

1. Press the Utility key.

CAUTION

The CLEAR LOG soft key selection will immediately and permanently clear all the error message entries from the service log. (However, it will not clear the header information.)

2. Select:

   DIAGNOSTICS

   SERVICE LOG

The MS462XX will now display the contents of the service log. The display consists of a header and an error listing. The header contains a variety of system service information. The error listing contains error messages for failures that may have occurred during operation.

3. Select:

   SELF TEST

The self test performs a series of tests that verify that various internal MS462XX circuits are functional and operating properly.

4. Press the Utility key.

5. Select:

   DIAGNOSTICS

   START SELF TEST

6. Wait for the test sequence to complete.
   Once invoked, this test requires no user interaction or external equipment.

Upon completion, the net pass/fail result of the self test is shown on the LCD display. If the MS462XX is in remote-only operation, the results are reported via the GPIB output buffer. If the self test fails, detailed error messages will be written into the service log.

NOTE

The self-test does not check the RF signal path in the VNMS. RF signals must be tested manually as described in the following sections of this chapter.

If the self test fails:

- ❑ Check the service log to view the failure messages.
- ❑ Proceed to Chapter 6—Troubleshooting.

3-3 VERIFYING OUTPUT POWER ACCURACY

These procedures use the Power ALC Verification built-in function of the MS462XX Basic Measurement Software. The Standard Conditions and Special Precautions described in Section 4-2 should be observed when performing these procedures.

Equipment Required:

The following test equipment is required:

- Anritsu ML243XA Power Meter
- Anritsu MA247XA Power Sensor
- Anritsu 2100-2 GPIB Cable
- Various Adapters

Procedure:

1. Set up the equipment as shown in Figure 3-1 below.

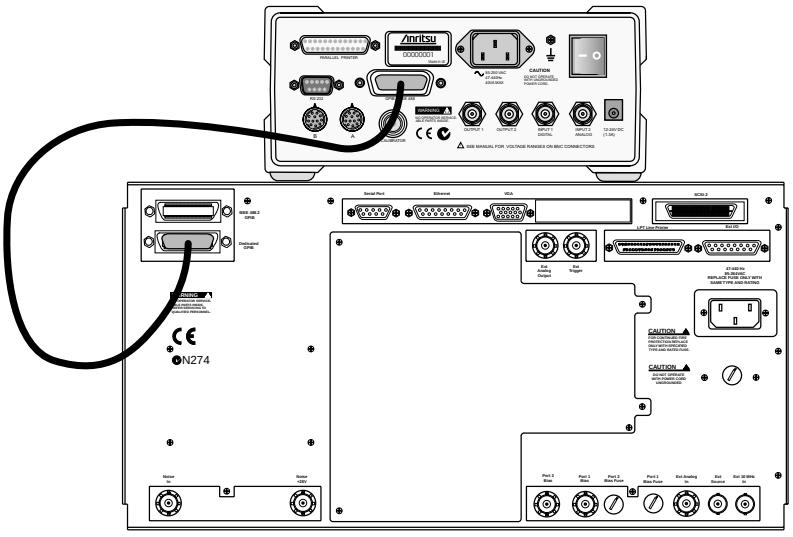

Figure 3-1. *ML2430A Series Power Meter GPIB connection to the MS462XX Vector Network Measurement System*

2. Turn on the instrument and allow it to warm-up (refer to Section 2-2 for more explanation).
3. Press the Utility key
4. Select:

   DIAGNOSTICS
   TROUBLESHOOTING
   MORE
   VERIFY ALC CALIBRATION
5. Calibrate and zero the power sensor.
6. Connect the power sensor to Port 1 and select the START VERIFICATION soft key.

7. Verify that the instrument passes this test.

8. If the instrument is a MS462XB/C with Option 3 installed or a MS462XD, press the SELECT SOURCE soft key to select source 2.

9. Connect the power sensor to Port 3 and select the START VERIFICATION soft key.

10. Verify that the instrument passes this test.

11. Select the menu soft key as follows to exit the TROUBLESHOOTING mode:

    RETURN

    RETURN

    FINISHED, RECOVER FROM TROUBLESHOOTING

> ***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 the Service Log.

> ***CAUTION***
>
> The TROUBLESHOOTING function must be properly exited to restore normal system operation.

3-4 NON-RATIO PARAMETER TEST (MS462XA/C/D)

One of the most useful tests for troubleshooting RF component problems in the Receiver Module is the non-ratio parameter test. This test verifies that each individual receiver channel operates properly as well as provides clues to where a problem is located.

> ***NOTE***
> The non-ratio parameter test is not available for the MS462XC.

Test Setup:

Connect the test equipment as described below.

- Connect Ports 1 and 2 together using a high quality throughline.
- Press the Default key, then the 0 key to reset the MS462XX to its factory-default settings.

Test Procedure:

Display the non-ratio parameters as follows:

1. Press the Display key and select:

   GRAPH TYPE
   LOG MAGNITUDE
   RETURN
   SCALE
   RESOLUTION
   5 X1
   RETURN
   DISPLAY MODE
   SINGLE CHANNEL

2. Press the Meas key and select:

   S21, TRANS b2/a1
   USER DEFINED

3. Press S21/USER X to activate USER X.
   USER X becomes red (the actual user number "X" is not significant).

4. Select:

   CHANGE RATIO
   a1 (Ra) as the numerator
   1 (UNITY) as the denominator

5. For the model under test, ensure that the minimum value of the RF display is greater than the minimum level shown for a1/1 in Table 3-1 (page 3-8). Figure 3-2 on page 3-9 shows an example of a typical non-ratio display.

6. Change the user defined ratio by selecting:

   CHANGE RATIO

   MORE

   b2 (Tb) as the numerator

   1 (UNITY) as the denominator

7. Ensure thta the minimum level of b2/1 is above the level shown in Table 3-1.

Table 3-1. *Minimum Amplitude Specifications*

Model	Beginning S-Parameter	Device to Install	User Defined Ratio	Minimum Level
MS4622A	S21	Thru from Port 1 to Port 2	a1/1	-6 dB
	S21		b2/1	-12 dB
MS4623A	S21		a1/1	-8 dB
	S21		b2/1	-13 dB
MS4624A	S21		a1/1	-15 dB
	S21		b2/1	-15 dB
MS4622B	S21	Thru from Port 1 to Port 2	a1/1	-7 dB
	S21		b2/1	-18 dB
	S12		a2/1	-7 dB
	S12		b1/1	-18 dB
	S33	Short on Port 3	a3/1	-7 dB
	S33		b3/1	-18 dB
MS4623B	S21	Thru from Port 1 to Port 2	a1/1	-8 dB
	S21		b2/1	-15 dB
	S12		a2/1	-8 dB
	S12		b1/1	-10 dB
	S33	Short on Port 3	a3/1	-8 dB
	S33		b3/1	-11 dB
MS4624B	S21	Thru from Port 1 to Port 2	a1/1	-15 dB
	S21		b2/1	-20 dB
	S12		a2/1	-15 dB
	S12		b1/1	-15 dB
	S33	Short on Port 3	a3/1	-15 dB
	S33		b3/1	-15 dB
MS4624D	S21	Thru from Port 1 to Port 2	a1/1	-15 dB
	S21		b2/1	-15 dB
	S12		a2/1	-15 dB
	S12		b1/1	-15 dB
	S33	Short on Port 3	a3/1	-15 dB
	S33		b3/1	-20 dB
	S44	Short on Port 4	a4/1	-15 dB
	S44		b4/1	-20 dB

NOTE

If desired, use the Readout Markers function (Marker key and Readout Marker soft key) to obtain precise frequency and amplitude values.

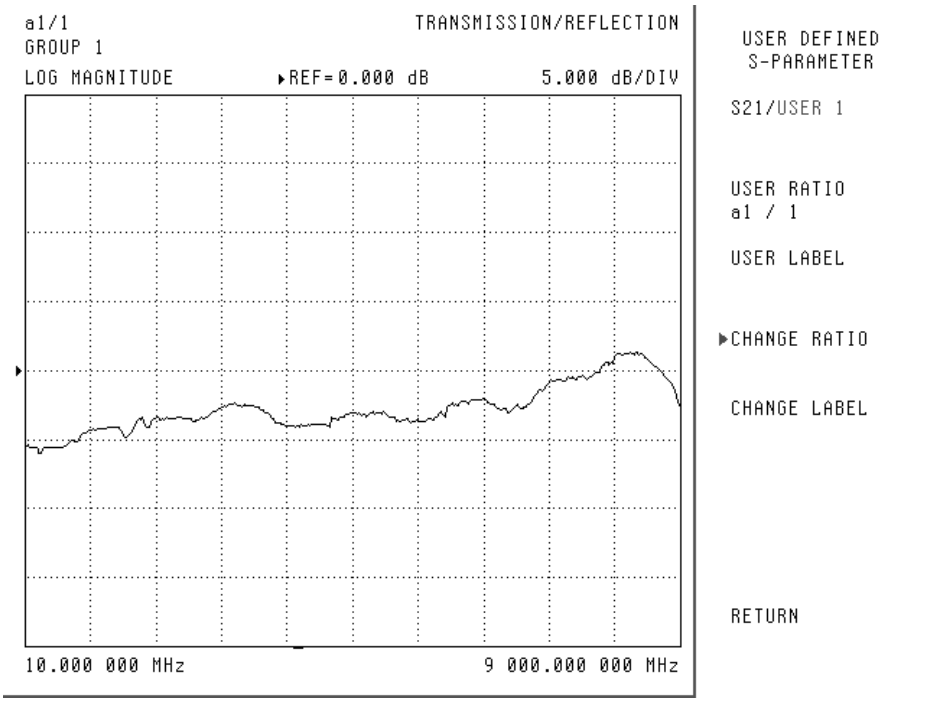

Figure 3-2. *Non-Ratioed Parameters Waveforms*

8. Measure all other non-ratio parameters shown in Table 3-1 by selecting the S-parameters S12, S33 or S44 and setting up the user defined ratios as described in Steps 2 through 6. Also, install a short on Ports 3 and 4 as indicated in Table 3-1.

NOTE

Viewing Port 3 and Port 4 with a short attached will cause a significant ripple on the RF display. This is normal.

The non-ratio parameters test results reveal where the fault may be located.

For example, if the non-ratio parameters test results for a MS462XB shows that b2/1 has a glitch appearing on the frequency response trace, but a1/1 and b1/1 are okay, then the fault is possibly in the Port 2 module or the cable connected between the Port 2 module and the Down Conversion Module.

3-5 SYSTEM DYNAMIC RANGE TEST (MS462XA/B/D)

This section verifies that the VNMS has a dynamic range consistent with factory specifications. A full 12-term calibration (with isolation) must be performed.

Equipment Required:

The following equipment is required:

- Anritsu Calibration kit intended for use with the instrument under test
- RF cables or Anritsu throughlines suitable for use with the instrument

Procedure:

1. Set the instrument to the factory default parameters by pressing the Default key, then the 0 key.
2. Install a cable or throughline to Port 1.
3. If the Cal Kit has a coefficient disk, insert the disk into the floppy drive of the VNMS.
4. Load the coefficients into the VNMS by pressing the CAL key and selecting:

   MORE
   COMPONENT UTILITIES
   INSTALL KIT INFO FROM DISK
5. Press the CAL key, then select:

   MANUAL CAL
   2 PORT
   NEXT CAL STEP
   FULL 12-TERM
   INCLUDE ISOLATION (STANDARD)
   N-DISCRETE FREQUENCIES
6. Enter a start frequency of 100 MHz, an increment of 100 MHz, and the number of points of 30 (3 GHz units), 60 (6 GHz units), or 90 (9 GHz units).
7. Select:

   FILL THE RANGE
   INDIVIDUAL FREQ INSERT
   INSERT NEXT FREQUENCY
   RETURN
8. Select NEXT CAL STEP to resume the calibration.

9. Ensure the correct test port connector types are selected. If not, select the port connection displayed and choose the correct type from the list.

10. Select START CAL and continue to use the default settings for the calibration.

11. Before measuring the isolation devices (50 Ω terminations), press the Avg key.

12. Select DATA AVERAGE and enter 10 (followed by the X1 key).

13. Select:

    I.F. BANDWIDTH

    I.F. BW 10 Hz

14. Install the isolation devices (50 Ω terminations) from the Cal Kit to Port 1 and Port 2.

15. Select the MEASURE BOTH PORTS soft key.

16. Continue the calibration by following the on-screen directions and by selecting the following soft keys until the calibration is complete:

    NEXT CAL STEP

    MEASURE BOTH PORTS or

    MEASURE DEVICE(S)

17. The calibration is complete when the following message is displayed (press the Enter key):

    PRESS <ENTER> TO PROCEED

18. Install the 50 ohm terminations from the Cal Kit to Port 1 and Port 2.

19. Press the Avg key and set the number of averages to 10 and the I.F. BW to 10 Hz by selecting:

    AVERAGE ON

    DATA AVERAGE

    10

    X1

    SELECT I.F. BANDWIDTH

    I.F. BW 10 Hz

20. Press the Display key and select:

    GRAPH TYPE
    LOG MAGNITUDE
    RETURN
    SCALE
    RESOLUTION

21. Enter 10 and press the X1 key.

22. Select REFERENCE VALUE and enter -70, then press the X1 key. Reference line 7 and select RETURN.

23. Select:

    DISPLAY MODE
    SINGLE CHANNEL

24. Press the Meas key and select:

    S21, TRANS b2/a1

25. Press the Marker key and select:

    DISPLAY MARKERS ON
    READOUT MARKERS

26. Set the markers as follows:

    MARKER 1: 10MHz
    MARKER 2: 400 GHz
    MARKER 3: 3 GHz
    MARKER 4: 6 GHz
    MARKER 5: 9 GHz
    MARKER 6: Any frequency

27. Allow the instrument to complete a full sweep. Using the knob to move Marker 6, view the Marker 6 readout and find the highest point between subsequent markers. Ensure that the values of the highest points are below the values shown in Table 3-2.

28. If the instrument has two ports, the Dynamic Range test is finished.

29. If the instrument has three or four ports, calibrate for S13 as follows:

30. Press the Cal key, then select:

    MANUAL CAL
    3 PORT
    NEXT CAL STEP

31. Set up the calibration using all default parameters.

32. Before measuring the Isolation Devices, press the Avg key and select 10 averages and 10 Hz I.F. BW (as in Steps 12 and 13). Measure the Isolation Devices.

33. Finish the calibration and install terminations to Ports 1 and 3.

34. Press the Meas key and select S13.

35. Press the Avg key, ensure that averaging is ON and select:

    AVERAGES=10

    IF BANDWIDTH=10 Hz.

36. Allow the instrument to complete a full sweep. Move Marker 6 to find the highest points in the RF display and ensure that the specifications in Table 3-2 for S13 are met.

37. If the instrument has 3 ports, the test is finished.
    If the instrument has 4 ports, press the Cal key and perform a 4 port calibration using all default parameters.

38. Before measuring the isolation devices, press the Avg key and select:

    AVERAGES=10

    I.F. BANDWIDTH =10 Hz

39. After the calibration is finished, install the terminations on Ports 1 and 4. Press the Meas key and select S14.

40. Repeat Steps 35 and 36 for S14, and verify that the specifications shown on Table 3-2 are met.

Table 3-2. *Dynamic Range Specifications for 10Hz IF Bandwidth*

Model	S-Parameter	10 MHz to 400 MHz	400 MHz to 3 GHz	3 GHz -to 6 GHz	6 GHz to 9 GHz
All A, B, D Models	S21	-90 dB *	-100 dB	-90 dB	-90 dB
All A, B, D Models	S13	-90 dB *	-100 dB	-90 dB	-90 dB
All A, B, D Models	S14	-90 dB *	-100 dB	-90 dB	-90 dB
* On 9 GHz models, -80 dB is typical at 10 MHz					

The system dynamic range operational check is complete.

3-6 SYSTEM DYNAMIC RANGE TEST (MS462XC)

This test verifies the System Dynamic Range of the test channels of the receiver.

Test Setup: Set up the equipment as shown below and allow the instruments to warm-up for at least one hour.

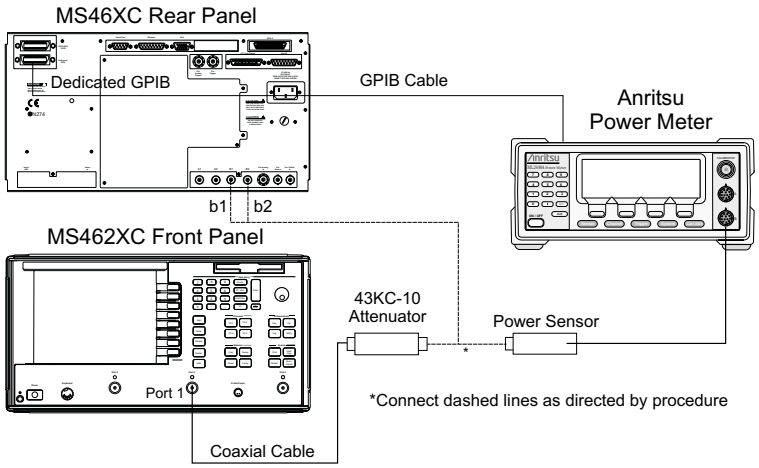

Figure 3-3. *Test Equipment Setup for System Dynamic Range Test*

Procedure:

1. Press the Default key, then the 0 key to reset the MS462XC.
2. Press the Ch 3 key, then the Display key and select:

   DISPLAY MODE
   SINGLE CHANNEL
   RETURN
   GRAPH TYPE
   LOG MAGNITUDE
3. Press the Config key.
4. Select DATA POINTS and change the value to 51MAX PTS.
5. Press the Power key and select:

   SOURCE 1 SETUP
   FLAT TEST PORT POWER CAL
6. Change POWER TARGET to –10 dBm.
7. Zero and calibrate the power meter. Then connect the power sensor to the unterminated end of the model 43KC-10 fixed attenuator.

8. Press the BEGIN CAL soft key to start calibration.

9. After the Flat Test Port Power Cal is completed, disconnect the power sensor from the unterminated end of the 43KC-10 attenuator and connect the attenuator with the coaxial cable to b1 input on the rear panel of MS462XC.

10. Press the Avg key and select:

    SELECT I.F. BANDWIDTH

    I.F. BW 10 Hz

11. Press the Meas key and select:

    USER DEFINED

    CHANGE RATIO

    b1 (Ta)

    1 (UNITY)

12. Press the S21/USER 1 soft key to select USER 1.

13. Press the Display key and select the TRACE MEMORY soft key.

14. Allow two complete sweeps to occur, the select:

    STORE DATA TO MEMORY

    DATA (/) MEMORY

    RETURN

    SCALE

15. Disconnect the 43KC-10 attenuator with the cable from the receiver input. Then connect a termination to the receiver input.

16. Change the REFERENCE VALUE to – 97 dB.

17. Allow one full sweep to occur, then press the Hold key.

18. Verify that the trace is below the REFERENCE VALUE.

19. Press the Meas key and select:

    USER DEFINED

    CHANGE RATIO

    b2 (Tb)

    1 (UNITY)

20. Remove the 43K-10 Attenuator with the coaxial cable from b1 input and connect to b2 input.

21. Repeat Steps 13 to 18.

3-7 COMPRESSION LEVEL TEST (MS462XC)

This test verifies the compression magnitude levels of the MS462XC Vector Network Measurement System receiver.

Test Setup: Set up the equipment as shown below and allow the instruments to warm-up for at least one hour.

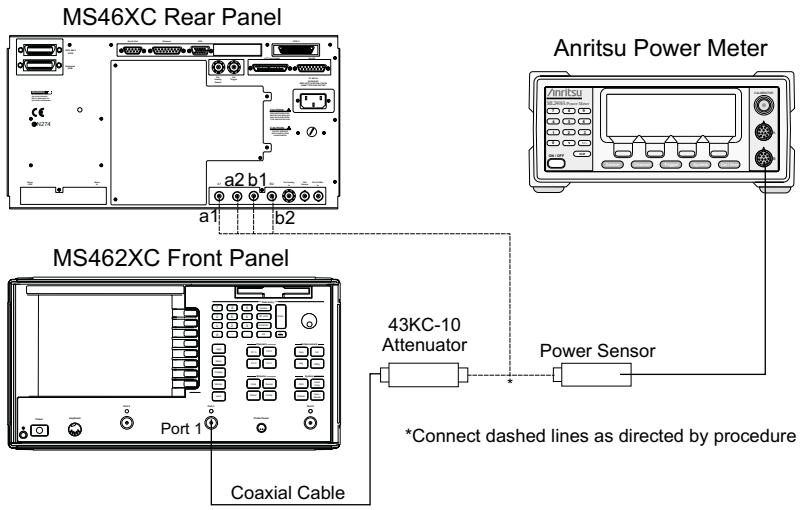

Figure 3-4. *Test Equipment Setup for Compression Test*

Procedure:

1. Press the Default key, then the 0 key to reset the instrument.
2. Press the Ch 3 key, then the Display key.
3. Select:

   DISPLAY MODE
   SINGLE CHANNEL
   RETURN
   GRAPH TYPE
   LOG MAGNITUDE
4. Press the Freq key.
5. Select:

   DISCRETE FILL
   INDIVIDUAL FREQ INSERT
6. Select AUTO INCR to turn this function off.
7. Select the NEXT FREQUENCY soft key. Enter 50 MHz and select the INSERT NEXT FREQUENCY soft key.

8. Select the NEXT FREQUENCY soft key, then enter the following frequencies:
   - MS4622C—1 GHz, 2 GHz, and 3 GHz
   - MS4623C—1 GHz, 2 GHz, 4 GHz, and 6 GHz
   - MS4624C—1 GHz, 2 GHz, 4 GHz, 6 GHz and 9 GHz
9. Select:

   RETURN

   RETURN to exit this setup menu.
10. Select the C.W. MODE soft key to turn C.W. mode ON.
11. Change the C.W. frequency to 50 MHz.
12. Press the Config key and select the DATA POINTS soft key. Change POINTS DRAWN IN C.W. to 51 POINT(S).
13. Press the Meas key and select USER DEFINED.
14. Select:

    CHANGE RATIO

    b1 (Ta)

    1 (UNITY)
15. Press the S11/USER 1 soft key to select USER 1.
16. Press the Marker key.
17. Select:

    MARKER READOUT
18. Select the marker soft key to turn on Marker 1, then use the numeric data entry key to change POINT to 25.
19. Press the Marker key again.
20. Select the SCREEN DISPLAY soft key to ON.
21. Zero and calibration the power sensor.
22. Set the power sensor CAL FACTOR for the frequency being measured; that is, 50 MHz, 1 GHz etc.
23. Connect the power sensor to the unterminated end of the 43KC-10 fixed attenuator with cable linked to Port 1.
24. Press the Power key and select SOURCE 1 SETUP. Adjust SOURCE 1 POWER so that the power meter reads –10 dBm ±0.01 dB.

> ***NOTE***
>
> Select the INSERT NEXT FREQUENCY soft key to store the entered frequency value to memory.

25. Record the SOURCE 1 POWER setting in the corresponding space in Table 3-4 (page 3-23) for MS4622C, Table 3-5 (page 3-24) for MS4623C, or Table 3-6 (page 3-25) for MS4624C.

26. Adjust SOURCE 1 POWER so that the power meter reads –20 dBm ± 0.01 dB.

27. Record the SOURCE 1 POWER setting to the corresponding space in Table 3-4 for MS4622C, Table 3-5 for MS4623C, or Table 3-6 for MS4624C.

28. Connect the unterminated end of the fixed attenuator (with cable linked to Port 1) to b1 input.

29. Press the Display key and select the TRACE MEMORY soft key.

30. Allow two complete sweeps to occur.

31. Select:

    STORE DATA TO MEMORY

    DATA (/) MEMORY

    RETURN

32. Press the Power key and select SOURCE 1 SETUP. Set the SOURCE 1 POWER to the level recorded in Step 25., 25.

33. Verify that: 10 dB - Marker 1 Readout ≤ 0.1 dB

34. Set the SOURCE 1 POWER to the level recorded in Step 27., 27.

35. Repeat Steps 28 through 33 for b2, a1, and a2 inputs.

> ***NOTES***
>
> Move the fixed attenuator with cable linked to Port 1 to the next receiver input (i.e., b2, a1, or a2).
>
> Change the USER DEFINED setting the corresponding user defined ratio (i.e., b2/1, a1/1 or a2/1).

36. Repeat Steps 23 through 34 for the next frequency point as listed in Table 3-4 for MS4622C, Table 3-5 for MS4623C, or Table 3-6 for MS4624C.

3-8 RECEIVER MAGNITUDE DISPLAY LINEARITY TEST (MS462XC)

This test verifies the magnitude linearity of the MS462XC receiver.

Test Setup: Set up the equipment as directed in the procedure below and allow the instruments to warm-up for at least one hour.

Procedure:

1. Press the Default key and then 0 key to reset the instrument.
2. Press the Ch 3 key and then Display key.
3. Select:

   DISPLAY MODE
   SINGLE CHANNEL
   RETURN
   GRAPH TYPE
   LOG MAGNITUDE
4. Press the Freq key and select the START FREQUENCY soft key.
5. Change START FREQUENCY to 50 MHz.
6. Select the C.W. MODE soft key to turn C.W. mode ON.
7. Verify that the C.W. frequency is 50 MHz.
8. Press the Config key and select the DATA POINTS soft key. Change POINTS DRAWN IN C.W. to 51 POINT(S).
9. Press the Avg key.
10. Select:

    SELECT I.F. BANDWIDTH
    I.F. BW 10 Hz
11. Press the Meas key and select USER DEFINED.
12. Select:

    CHANGE RATIO
    b1 (Ta)
    1 (UNITY)
13. Press the S21/USER 1 soft key to select USER 1.
14. Press the Marker key.

15. Select:

    MARKER READOUT

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

17. Press the Marker key again.

18. Select the SCREEN DISPLAY soft key to ON.

19. Zero and calibrate the power sensor.

20. Set the power sensor CAL FACTOR for the frequency being measured.

21. Connect the power sensor to the BNC male end of the adapter connected to the 43KC-10 fixed attenuator (Figure 3-5).

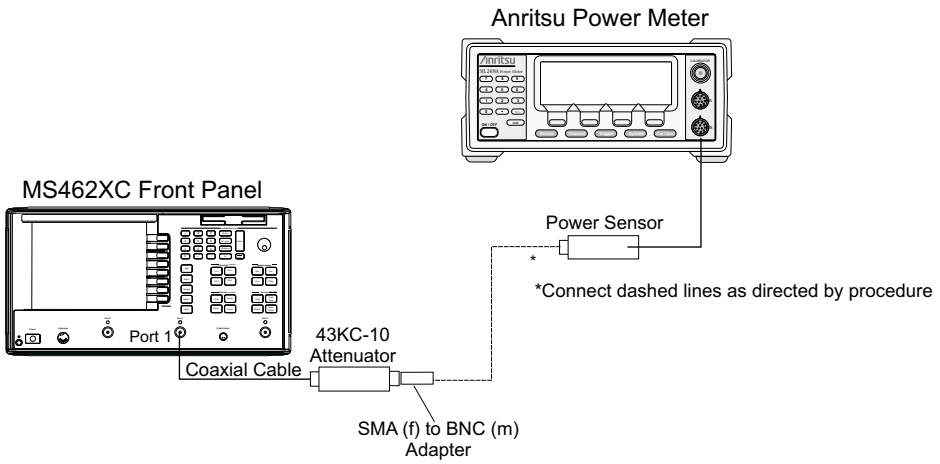

Figure 3-5. *Test Equipment Setup for Receiver Magnitude Display Linearity Test Calibration Setup 1*

22. Press the Power key and select SOURCE 1 SETUP. Adjust SOURCE 1 POWER so that the power meter reads –15 dBm ±0.1 dB.

23. Disconnect the power sensor from the BNC male end of the adapter that is connected to the 43KC-10 fixed attenuator (Figure 3-6).

24. Insert a BNC female to BNC female adapter between the two BNC male ports, as shown in Figure 3-6.

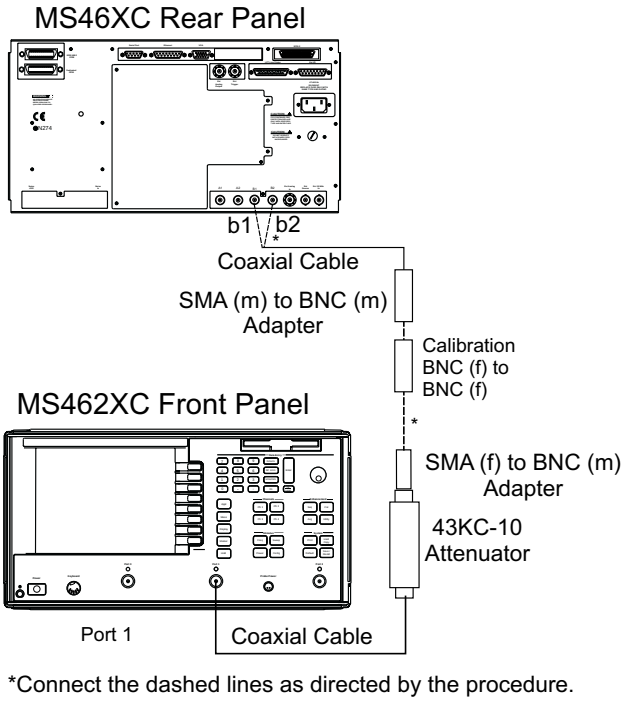

Figure 3-6. *Receiver Magnitude Display Linearity Calibration Setup 2*

25. Press the Display key and select the TRACE MEMORY soft key.

26. Allow two complete sweeps to occur.

27. Select:

    STORE DATA TO MEMORY
    DATA (/) MEMORY
    RETURN

28. Remove the BNC female to BNC female adapter and install the step attenuator in its place, as shown in Figure 3-7. Then set the attenuation to 10 dB.

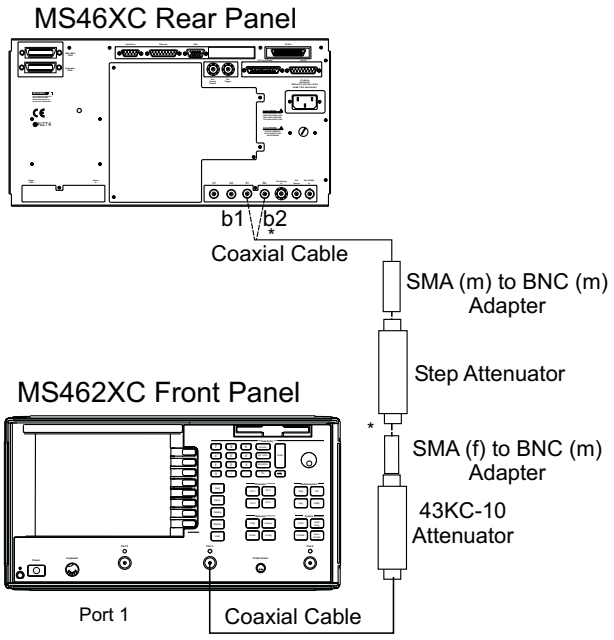

Figure 3-7. *Receiver Magnitude Display Linearity Calibration Setup 3*

29. Verify that the difference of the Marker 1 readout and the calibrated value of the step attenuator is within specification (refer to Table 3-3).

30. Set the step attenuator to other settings listed in Table 3-3 at the end of this chapter and repeat Step 29.

31. Press the Meas key and select USER DEFINED.

32. Select:

    CHANGE RATIO

    b2 (Tb)

    1 (UNITY)

33. Press the S21/USER 1 soft key to select USER 1.

34. Remove the connection at b1 input and re-connect to b2 input.

35. Remove the Step Attenuator from the set up.

36. Repeat Steps 24 through 30.

Table 3-3. *Attenuator Write-In Values*

Attenuator Setting (dB)	Attenuator Calibrator Value	Marker 1 Readout Value of b1*	Δ of Atten Cal Value and Marker 1 Readout Value of b1	Marker 1 Readout Value of b2*	Δ of Atten Cal Value and Marker 1 Readout Value of b2	Δ Value Specification (dB)
10						≤0.35
20						≤0.35
30						≤0.35
40						≤0.35
50						≤0.35

* Absolute value of Marker 1 Readout.

Table 3-4. *MS4622C Source 1 Power Write-In Values*

C.W. Freq (MHz)	Source 1 Power Setting		Marker 1 Readout Value	10 dB – Marker 1 Readout	Specification
	–10 dBm	–20 dBm			
b1 input 50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
3000					≤0.1 dB
b2 input 50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
3000					≤0.1 dB
a1 input 50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
3000					≤0.1 dB
a2 input 50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
3000					≤0.1 dB

Table 3-5. *MS4623C Source 1 Power Write-In Values*

C.W. Freq (MHz)	Source 1 Power Setting		Marker 1 Readout Value	10 dB – Marker 1 Readout	Specification
	–10 dBm	–20 dBm			
b1 input					
50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
4000					≤0.1 dB
6000					≤0.1 dB
b2 input					
50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
4000					≤0.1 dB
6000					≤0.1 dB
a1 input					
50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
4000					≤0.1 dB
6000					≤0.1 dB
a2 input					
50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
4000					≤0.1 dB
6000					≤0.1 dB

Table 3-6. *MS4624C Source 1 Power Write-In Values*

C.W. Freq (MHz)	Source 1 Power Setting		Marker 1 Readout Value	10 dB – Marker 1 Readout	Specification
	–10 dBm	–20 dBm			
b1 input					
50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
4000					≤0.1 dB
6000					≤0.1 dB
9000					≤0.1 dB
b2 input					
50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
4000					≤0.1 dB
6000					≤0.1 dB
9000					≤0.1 dB
a1 input					
50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
4000					≤0.1 dB
6000					≤0.1 dB
9000					≤0.1 dB
a2 input					
50					≤0.1 dB
1000					≤0.1 dB
2000					≤0.1 dB
4000					≤0.1 dB
6000					≤0.1 dB
9000					≤0.1 dB

3-9 NOISE FIGURE MEASUREMENT CAPABILITY (OPTION 4)

This procedure is intended to verify the functionality of the noise figure measurement hardware and the validity of the internal extension table file stored on hard disk (SRAM disk). Perform this procedure only if the instrument has Option 4X installed.

This Performance Test procedure consists of three steps. They are:

- Noise Figure Assurance Check
- Raw Receiver Noise Figure Check
- Noise Figure Measurement Confidence Check

Noise Figure Assurance Check

This test assesses the instrumentation uncertainty for wideband noise figure measurement.

Procedure:

Allow the instrument to warm up at least 60 minutes.

1. Press the Appl key.
2. Select:

   CHANGE APPLICATION SETUP

   MEASUREMENT TYPE/NOISE FIGURE
3. Press the Utility key
4. Select:

   DIAGNOSTICS

   NOISE FIGURE ASSURANCE
5. Connect a throughline between Port 1 and Port 2.
6. Select the PERFORM ASSURANCE soft key to start the test.
7. Observe the test results and compare NB to SB. The differences should be less than 0.15 dB (see below).
8. If the test fails, proceed to Chapter 6—Troubleshooting.

Raw Receiver Noise Figure Check

This test can detect hardware faults such as switch failures, loose connector on internal routing, oscillating preamp under certain load conditions, and similar problems. This test also validates the internal extension table file that is stored on the battery backed RAM.

Equipment Required:

The following test equipment is required:

- Anritsu NC346B 15 dB ENR Noise Source or Equivalent
- Anritsu 3670 Series Throughlines and Various Adapters
- BNC Male to Male Cable (1m, 3.3 ft. length)

Preliminary Setup:

Allow the instrument to warm up at least 60 minutes.

1. Press the Default key, then the 0 key to reset the instrument.
2. Press the Appl key.
3. Select:

   CHANGE APPLICATION SETUP
   MEASUREMENT TYPE/NOISE FIGURE
4. Load the Noise Source ENR file as follows:
5. Select:

   NOISE FIGURE SETUP
   ENR TABLE OPERATION
   LOAD ENR TABLE
   FROM HARD DISK/VENDOR ENR TABLE
6. If the Internal Noise Source Signal path has not been re-characterized, refer to Section 5-8, Noise Source Signal Internal Through Path Characterization for a procedure.

   Load the internal ENR extension table file as follows:
7. Select:

   FROM HARD DISK/INTERNAL ENR EXTENSION TABLE

NOTE

If noise source ENR table file is stored on a floppy disk, select FROM FLOPPY DISK/VENDOR ENR TABLE instead. Refer to Section 7-6 of the MS462XX Scorpion Measurement Guide (P/N 10410-00213) for instructions on how to create a noise source ENR table file.

CAUTION

It is very important to load these ENR table files into the instrument. The data included in these files is used by the instrument to perform noise Figure measurements.

Test Procedure:

1. Press the Appl key.
2. Select:

   DUT BANDWIDTH/WIDE
   NOISE FIGURE SETUP
   NOISE SOURCE/EXTERNAL
3. Press the Display key.
4. Select:

   DISPLAY MODE/SINGLE CHANNEL
   RETURN
   GRAPH TYPE/LOG MAGNITUDE

5. Press the Config key.
6. Select:

   DATA POINTS/51 MAX PTS
7. Connect the 15 dB ENR Noise Source to Port 2.
8. Verify that the measured Noise Figure is within the range specified in Table 3-8.

Table 3-8. *Noise Figure Specifications*

Model	Lower Limit (dB)	Upper Limit (dB)
MS4622B 50 MHz to 3 GHz	1.75	7.00
MS4623B 50 MHz to 3 GHz 3 GHz to 6 GHz	1.75 1.75	7.00 8.75
MS4624B 50 MHz to 3 GHz 3 GHz to 6 GHz	1.75 1.75	7.00 10.75
All D Models 50 MHz to 3 GHz 3 GHz to 6 GHz	1.75 1.75	11.00 14.00

9. Press the Display key.
10. Select:

    TRACE MEMORY

    STORE DATA TO MEMORY

    VIEW DATA AND MEMORY
11. Press the Appl key.
12. Select:

    NOISE Figure SETUP

    NOISE SOURCE/INTERNAL
13. Connect the noise source to the Noise In connector on the rear panel.

14. Connect a 3670 Series throughline between Port 1 and Port 2. Verify that there is no glitch displayed on the LCD display (see below).

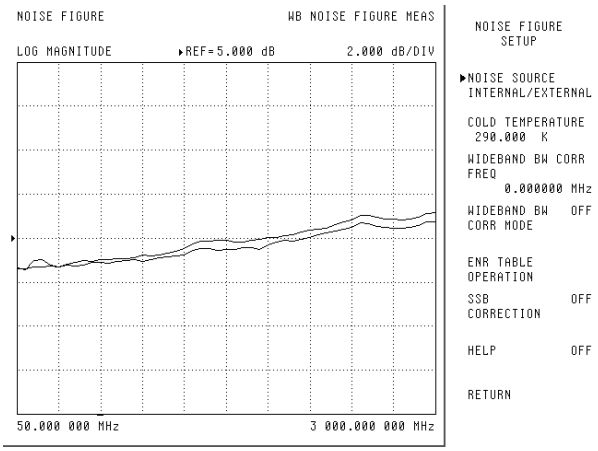

Figure 3-10. *Noise Figure Trace Display*

15. Press the Display key.

16. Select:

    TRACE MEMORY

    VIEW DATA (/) MEMORY

17. Set the Reference Scale to 0 dB with a Resolution of 0.5 dB. Verify that the trace is within a 1 dB window (see below).

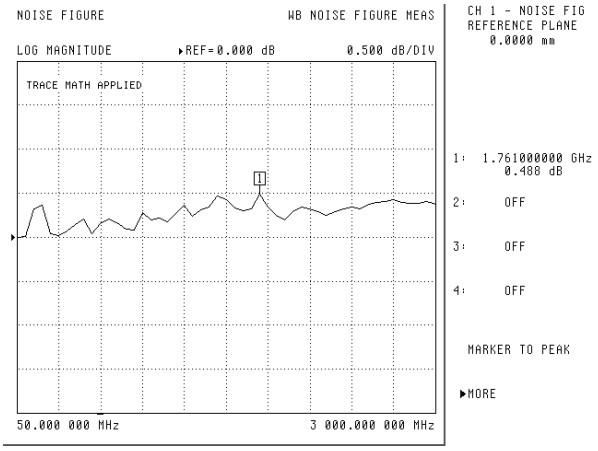

Figure 3-9. *Noise Figure Trace Display*

18. If the test fails, proceed to Chapter 6—Troubleshooting.

3-10 NOISE FIGURE MEASUREMENT CONFIDENCE CHECK

This test checks the Y-factor dynamic range of the instrument.

Equipment Required:

- Anritsu NC346B 15 dB ENR Noise Source or Equivalent
- Anritsu 3750R 3.5 mm/SMA Calibration Kit or Equivalent
- Anritsu 3670 Series Throughline
- Mini-Circuits ZJL-4G Amplifier, for 3 GHz Noise Figure or ZJL-6G for 6 GHz Noise Figure
- +12 volt DC Power Supply (100 mA minimum)
- Various Adapters
- BNC Male to Male Cable (1 m, 3.3 ft. length)

Preliminary Setup:

Allow the instrument to warm up for at least one hour.

1. Press the Appl key.
2. Select:

   CHANGE APPLICATION SETUP

   MEASUREMENT TYPE/NOISE Figure
3. Load the Noise Source ENR file as follows:
4. Select:

   NOISE Figure SETUP

   ENR TABLE OPERATION

   LOAD ENR TABLE

   FROM HARD DISK/VENDOR ENR TABLE
5. Load the internal ENR extension table file as follows:

> ***NOTE***
>
> If noise source ENR table file is stored on a floppy disk, select FROM FLOPPY DISK/VENDOR ENR TABLE instead. Refer to Section 7-6 of the MS462XX Scorpion Measurement Guide (P/N 10410-00213) for instructions on how to create a noise source ENR table file.

6. Select:

   FROM HARD DISK/INTERNAL ENR EXTENSION TABLE

> ***CAUTION***
>
> It is very important to load these ENR table files into the instrument. The data included in these files is used by the instrument to perform noise Figure measurements.

Test Procedure:

Press the Appl key.

1. Select:

   CHANGE APPLICATION SETUP

   MEASUREMENT TYPE/TRANSMISSION AND REFLECTION

2. Install the cables and adapters as shown in Figure 3-11.

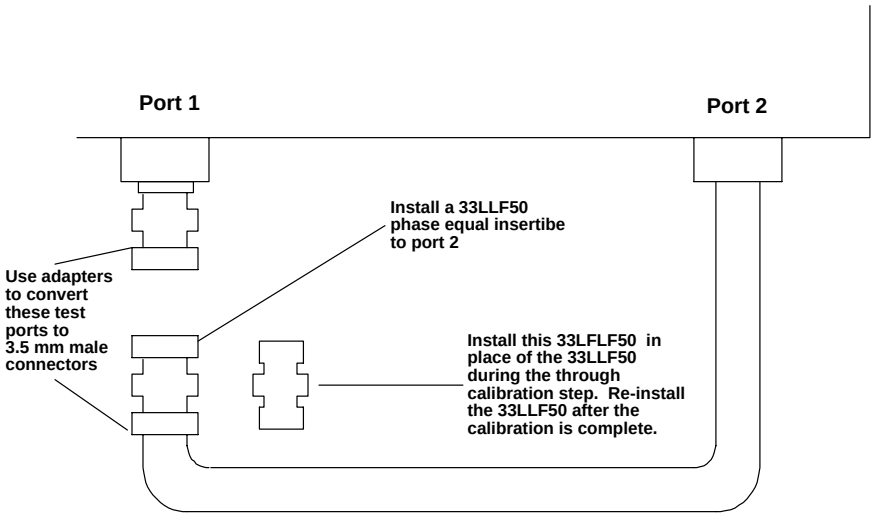

Figure 3-11. *Noise Figure Calibration Setup*

> ***NOTE***
>
> If the internal ENR extension table file is stored on a floppy disk, select FROM FLOPPY DISK/INTERNAL ENR EXTENSION TABLE instead. Refer to Section 3-7 of this manual.

3. Press the Cal key to begin measurement calibration.

4. Follow the selection menu and use the corresponding soft key to make the appropriate selections as listed below:

   PERFORM CAL: 2 PORT

   CAL METHOD: STANDARD

   LINE TYPE: COAXIAL

   SELECT CALIBRATION TYPE: 12 TERM

   USE OF ISOLATION IN CALIBRATION: EXCLUDE

   FREQUENCY RANGE OF CALIBRATION: 50 MHz to 3000 MHz (50 MHz to 6000 MHz for Option 4B)

   SELECT CALIBRATION DATA POINTS: NORMAL

   DATA POINTS: 51 POINTS

   PORT 1 CONNECTOR TYPE: SMA (M)

   PORT 2 CONNECTOR TYPE: SMA (M)

   LOAD TYPE: BROADBAND LOAD

   TEST SIGNAL/PORT 1 POWER: -15 dBm

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

6. Install the calibration device per the instructions on the display. Select the appropriate soft key to measure the calibration device.

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

8. Press the Display key, then select:

   DISPLAY MODE

   SINGLE CHANNEL

9. Press the Ch 1 key, select DISPLAY/GRAPH TYPE, and change the graph type to LOG MAGNITUDE display.

10. Press the Meas key, select S-PARAMETER/S21.

11. Install a ZJL-4G or ZJL-6G Amplifier between Port 1 and Port 2.

12. Press the Display key and allow two sweeps to complete.

13. Select:

    TRACE MEMORY

    STORE DATA TO MEMORY

    DISK OPERATIONS

    SAVE MEMORY TO HARD DISK

    CREATE NEW FILE

NOTE

When measuring the throughline, replace the 33LLF50 insertable with a 33LFLF50 insertable. After the throughline is measured, replace the 33LFLF50 insertable with the 33LLF50 insertable.

14. Use the rotary knob to enter SGAIN as the filename. Use the rotary knob to highlight DONE. Press the ENTER key to save the data. This is the gain data of the Amplifier.

15. Remove the Amplifier and throughlines from the instrument.

16. Press the Appl key.

17. Select:

    DUT BANDWIDTH/WIDE

    NOISE SETUP

    NOISE SOURCE/EXTERNAL

18. Connect the Noise Source to Port 2. Use adapters as needed.

19. Press the Cal key.

20. Select:

    PERFORM CAL/NOISE FIGURE ONLY

    MEASURE DEVICE(S)

21. Verify that the calibrated Noise Figure is between +0.5 dB and –0.5 dB (see below).

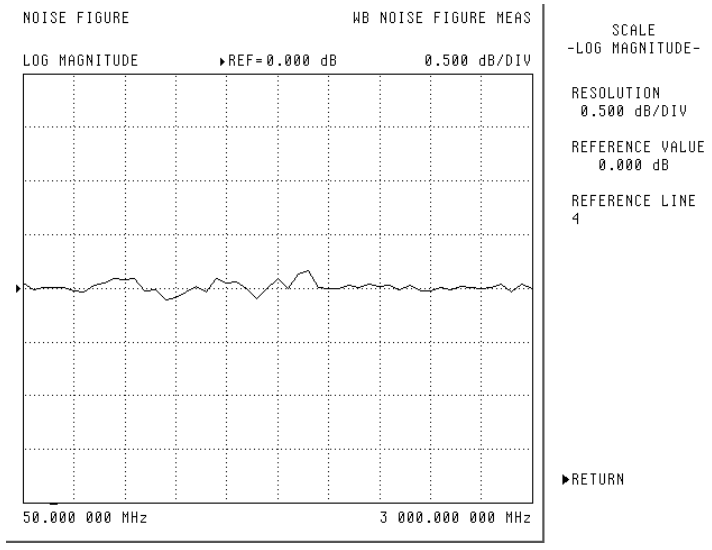

Figure 3-12. *Calibrated Noise Figure Trace Display*

22. Install a ZJL-4G or ZJL-6G Amplifier between the Noise Source and Port 2.

23. Verify that the measured Noise Figure of the Amplifier is between 4.5 dB and 6.5 dB.

24. Press the Appl key.

25. Select:

    DISPLAY SELECTION

    INSERTION GAIN

26. Allow two sweeps to complete. This is the insertion gain data of the Amplifier. Press the DISPLAY key, then select:

    TRACE MEMORY

    DISK OPERATIONS

    RECALL MEMORY FROM HARD DISK

    Press the soft key next to SGAIN.NRM to recall the file.

27. Select:

    RETURN

    DATA AND MEMORY

28. Compare the insertion gain data with the gain data taken at the beginning of this procedure and verify that the difference is within a 1 dB window.

29. If the test fails, proceed to Chapter 6—Troubleshooting.

3-11 FREQUENCY TRANSLATING GROUP DELAY (OPTION 5)

This procedure is intended to verify the functionality of the Frequency Translating Group Delay measurement hardware. Perform this procedure only if the instrument has Option 5 installed.

Procedure:

Allow the instrument to warm up for at least 60 minutes.

1. Press the Default key, then the 0 key to reset the instrument to a factory preset state.
2. Press the Appl key.
3. Select:

   CHANGE APPLICATION SETUP

   MEASUREMENT TYPE/
   FREQUENCY TRANSLATION GROUP DELAY
4. Press the Display key.
5. Select:

   SINGLE CHANNEL

   RETURN
6. Press the POWER key.
7. Select:

   SOURCE 1
8. Set Port 1 Power to 5 dBm.
9. Connect a throughline between Port 1 and Port 2.
10. Press the Cal key.
11. Select:

    PERFORM CAL
12. After the calibration is complete, press the Display key.
13. Select:

    SCALE
14. Change the setup as follows:

    RESOLUTION = 1 ns/div

    REFERENCE VALUE = 0 ns

    APERTURE = 0.25 %
15. Wait until one full sweep is complete.

16. Verify that the trace is within ± 3 ns. Refer to Figure 3-13.

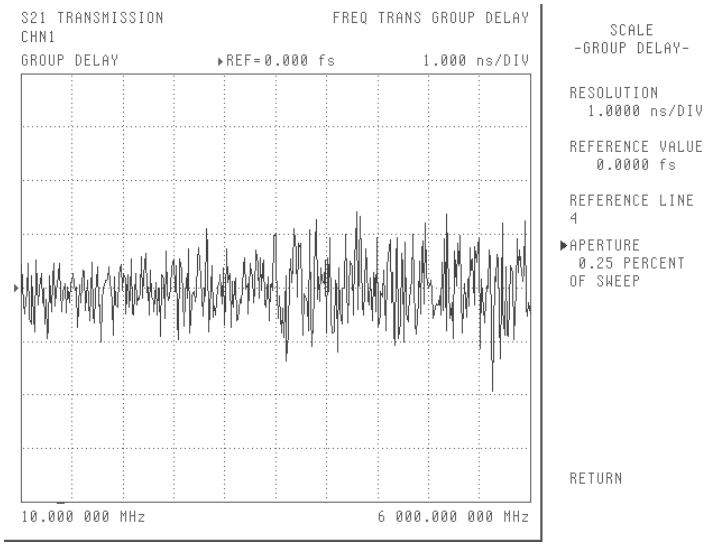

Figure 3-13. *Frequency Translating Group Delay*

17. If the test fails, proceed to Chapter 6—Troubleshooting.

3-12 37SF50 PHASE HARMONIC STANDARDS OPERATIONAL CHECK

The 37SF50 Phase Harmonic Standard can be checked using the following procedures. This procedure has two parts:

- ❑ Input and output return loss check
- ❑ Harmonic output check

Input and Output Return Loss Check

This procedure checks the return loss of the input and output circuits.

Equipment Required:

- ❑ Anritsu MS462XB Vector Network Measurement System
- ❑ Anritsu Calibration Kit, Model 3650 or Equivalent
- ❑ Anritsu Throughlines, Model 3670K50-1 (2 each), or 3670K50-2
- ❑ Various Adapters

Procedure:

1. Install the cables and adapters as shown in Figure 3-14.

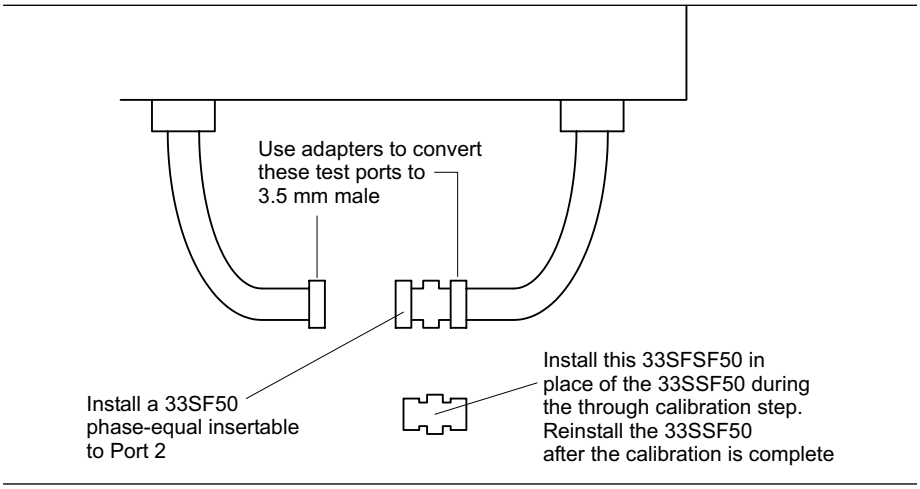

Figure 3-14. *Phase Harmonic Calibration Setup*

> ***NOTE***
>
> When measuring the throughline, replace the 33SSF50 insertable with a 33SFSF50 insertable. After the throughline is measured, replace the 33SFSF50 insertable with the 33SSF50 insertable.

2. Press the Cal key to begin the measurement calibration.

3. Follow the selection menu and use the corresponding soft key to make the appropriate selections as listed below:

   PERFORM CAL: 2 PORT

   CAL METHOD: STANDARD

   LINE TYPE: COAXIAL

   SELECT CALIBRATION TYPE: 12 TERM

   USE OF ISOLATION IN CALIBRATION: EXCLUDE

   FREQUENCY RANGE OF CALIBRATION: 10 MHz TO 3000 MHz (or 6000 MHz)

   SELECT CALIBRATION DATA POINTS: NORMAL

   DATA POINTS: 401 POINTS

   PORT 1 CONNECTOR TYPE: SMA (M)

   PORT 2 CONNECTOR TYPE: SMA (M)

   LOAD TYPE: BROADBAND LOAD

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

5. Install the calibration device per the instructions on the display. Select the appropriate soft key to measure the calibration device. See the Note to left.

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

7. Press the Display key, then select:

   DISPLAY MODE

   SINGLE CHANNEL

8. Press the Ch 1 key and select:

   DISPLAY

   GRAPH TYPE

   LOG MAGNITUDE

9. Install the 37SF50 Phase Harmonic Standard between Port 1 and Port 2. Measure the input return loss of the Phase Harmonic Standard. Specifications are shown below.

Frequency range	Input	Output
<100 MHz	6 dB minimum	6 dB minimum
>100 MHz	10 dB minimum	10 dB minimum

10. Press the Ch 4 key and select:

    DISPLAY

    GRAPH TYPE

    LOG MAGNITUDE

11. Measure the output return loss of the Phase Harmonic Standard. Specifications are shown in the table in Step 9, above.

3-13 HARMONIC OUTPUT CHECK

This procedure checks the harmonic output.

Equipment Required:

- Anritsu Spectrum Analyzer Model MS2602A
- Anritsu 68x47B or 69x47A Synthesized Generator
- Anritsu ML243XA Power Meter and Associated Power Sensor

Procedure:

Set up the Synthesized Generator to output a CW RF signal at the frequency shown below:

At CW Frequency Generator Output Level	600 MHz Phase Harmonic Standard 2nd and 3rd Harmonic Outputs	2000 MHz Phase Harmonic Standard 2nd and 3rd Harmonic Outputs
0 dBm	–20 dBc ≤ X ≤ –50 dBc	–20 dBc ≤ X ≤ –50 dBc
+ 5 dBm	–20 dBc ≤ X ≤ –45 dBc	–20 dBc ≤ X ≤ –45 dBc
+ 10 dBm	–20 dBc ≤ X ≤ –45 dBc	–20 dBc ≤ X ≤ –45 dBc

Chapter 4
System Performance Verification

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Chapter 4
System Performance Verification

4-1 INTRODUCTION

This chapter provides specific procedures to be used to verify that the MS462XX is making accurate S-parameter measurements. You should perform these verification procedures at least once annually.

It is suggested that the tests in the preceding chapter (Operational Performance Tests) be performed prior to performing the tests described in this chapter. The operational performance tests are designed to verify the instrument performance in a wide variety of operating modes that may only be partially tested in this chapter.

Performance verification for all MS362XX VNMS instruments (excluding C model-based measurement systems) is accomplished solely by use of a software program used in conjuction with Anritsu Calibration and Verification kits. This process is described in Section 4-3.

Performance verification for the C model-based measurement systems as a stand-alone instrument is found in Sections 3-6 and 3-7. The MS462XC instrument may be contained within a larger measurement system that includes a test set and a PC with software (for example, the ME7840A Power Amplifier Test System, the ME7842B Tower Mounted Amplifier Test System, or the ME7840/4 Handset Amplifier Test System). If such a system requires verification, the MS462XC may be verified using the instructions in Sections 3-6 and 3-7 of this manual and the remainder of the system must be verified using the instructions found in other Maintenance Manuals created for those systems.

A NIST-Traceability description and VNMS Measurement Uncertainty charts are found in section 4-4.

4-2 CALIBRATION AND MEASUREMENT CONDITIONS

The surrounding environmental conditions and the stability and condition of the test port connectors, throughline, and calibration kit determine system measurement integrity to a large extent.

These are all user controlled conditions, and as such, should be evaluated periodically for impact on system performance. If these conditions vary significantly with time, the system verification procedures should be performed more often than the recommended annual cycle.

Standard Conditions

The standard conditions specified below must be observed when performing any of the operations in this chapter—both during calibration and during measurement.

- Warm-up time: 90 minutes minimum
- Environmental Conditions:
  Temperature: 23 ±3 Degrees C
  Relative Humidity: 20 to 50% (recommended)

Special Precautions

When performing the procedures in this chapter, observe the following precautions:

- Prevent any vibration and movement of the system, attached components, and throughline.
- Check pin depth and condition of all adapters, throughlines, and calibration components. Clean as required.
- Pre-shape the throughlines so as to minimize their movement during calibration and measurement activities.

4-3 PERFORMANCE VERIFICATION FOR THE MS462XA/B/D MODELS

Verification of these instruments is accomplished by use of Anritsu software part number 2300-482. This software, along with an Anritsu Calibration and Verification Kits, will verify that the VNMS is capable of making accurate S parameter measurements to within the uncertainty guidelines shown in section 4-5. This software does not verify the accuracy of installed options. Refer to the previous chapter for operational tests for the VNMS options.

2300-482 Software Requirements

- Windows-based PC having an Operating System of Windows 95 or above.
- National Instruments GPIB software and hardware interface, such as the PCMCIA package.
- One standard GPIB cable, such as an Anritsu 2100-1 or 2100-2.
- Anritsu Calibration Kit Model 375XLF or 375XR that has connectors identical to the type installed on the VNMS. These kits may need additional options to support verifications of 3 and 4 Port VNMS models.
- Anritsu Verification Kit Model 366XLF or 366XR that has connectors identical to the connector type installed on the VNMS.
- High quality RF cables that match the VNMS connectors, such as the Anritsu 3670X50-2 cable. The quantity of cables required varies according to the number of test ports found on the VNMS as follows:
  - 2 Ports: one cable required
  - 3 Ports: two cables required
  - 4 Ports: three cables required
- High quality adapters (male-to-male or female-to-female) may be needed depending on sexes of cables and test ports installed on the VNMS.

> ***NOTE***
> SMA type cables or adapters having white 'teflon' dielectric are generally not of acceptable quality and may cause the verification process to fail.

- Torque wrench (8 in/lbs) to match the connector dimensions of the calibration and verification kit devices.

2300-482 Verification Software Overview

The 2300-482 verification software package is included with the 366X verification kit and it is also available separately. Complete setup and operating instructions are packaged with the software in a software user guide in Acrobat pdf format.

This software supports all 2, 3, and 4 Port VNMS instruments (A, B, and D models) operating up to 9 GHz. The model and serial number of all of the equipment used will be collected and recorded on electronic test records. A 12-term (or higher) calibration will be performed under program control.

> ***NOTE***
> Special GPIB settings are required for software control. Refer to the software user guide for complete setup information.

All devices from the verification kit will be measured under local lockout using graph types of Log Magnitude, Phase, Linear Magnitude, and Real. All possible S-parameters for the given VNMS are tested with each device.

Data received from the VNMS for each device will be compared to the characterization data stored on the floppy diskette for your kit. Each measurement point will be checked for a value that is within the computed allowable uncertainty range. Any data point that falls outside of the allowable range will be clearly designated as a failed data point.

All measurement data, standard device characterization data, and allowable uncertainties are viewable after the device is measured and the data is saved as a text file. This text file may be printed from within the program environment and is saved on the hard drive of the PC.

For more details on this software or the verification process, refer to the software user guide that is packaged with the software.

4-4 VNMS TRACEABILITY

According to the *International Vocabulary of Basic and General Terms in Metrology (VIM), BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML*, 2nd ed., 1993, definition 6.10, traceability is defined as the property of the result of a measurement or the value of a standard that can be related to *stated references* through an *unbroken chain of comparisons* all having *stated uncertainties.*

The *stated references* are *stated reference standards. Stated* means explicitly set forth in supporting documentation. *Reference standard* is a standard generally having the highest metrological quality available at a given location or in a given organization from which measurements are derived. The *stated references* are usually national or international standards.

The *unbroken chain of comparisons* are the complete, explicitly described, and documented series of comparisons that successively link the value and uncertainty of a result of a measurement with the values and uncertainties of each of the intermediate reference standards to the highest reference standard of which traceability for the result of measurement is claimed.

The *stated uncertainties* are the uncertainties of measurement that fulfill the VIM definition as the parameter and is associated with the result of a measurement that characterizes the dispersion of values that could reasonably be attributed to the measurand. The stated uncertainty is evaluated and expressed according to the general rules given in the *ISO Guide to the Expression of Uncertainty in Measurement*.

The Vector Network Measurement System (VNMS) is one of the most modern and accurate measurement tools for microwave and RF applications, but VNMS requires calibration to enhance its measurement accuracy. There are many ways to define proper measurement traceability for the VNMS in lieu of its system complexity and calibration schemes. Scattering Parameters (S-Parameters) are the most common measurands of the vector network analyzer.

In the chart below, a widely used traceability path for making scattering parameter measurements is presented. The basic elements in this chart include a calibration kit, a VNMS, and a verification kit for each user. The calibration kit is characterized and traceable mainly through impedance standards, for example airlines and proper circuit modeling.

The vertical path is a process that is used by most of the manufacturers and primary standards laboratories. It is impractical for regular users to demonstrate the system traceablity before every use; therefore, a verification kit consisting of an airline, mismatch airline, and two fixed attenuators was introduced to perform a routine check for the calibrated system. These components were characterized by their manufacturers or by a standards laboratory, and they have excellent repeatability characteristics.

The horizontal path shows the conventional traceability chain for the verification kit. The stated uncertainty in the verification program comes from three major sources:

- NIST Report
- Anritsu Reference Standards
- Device-under-test

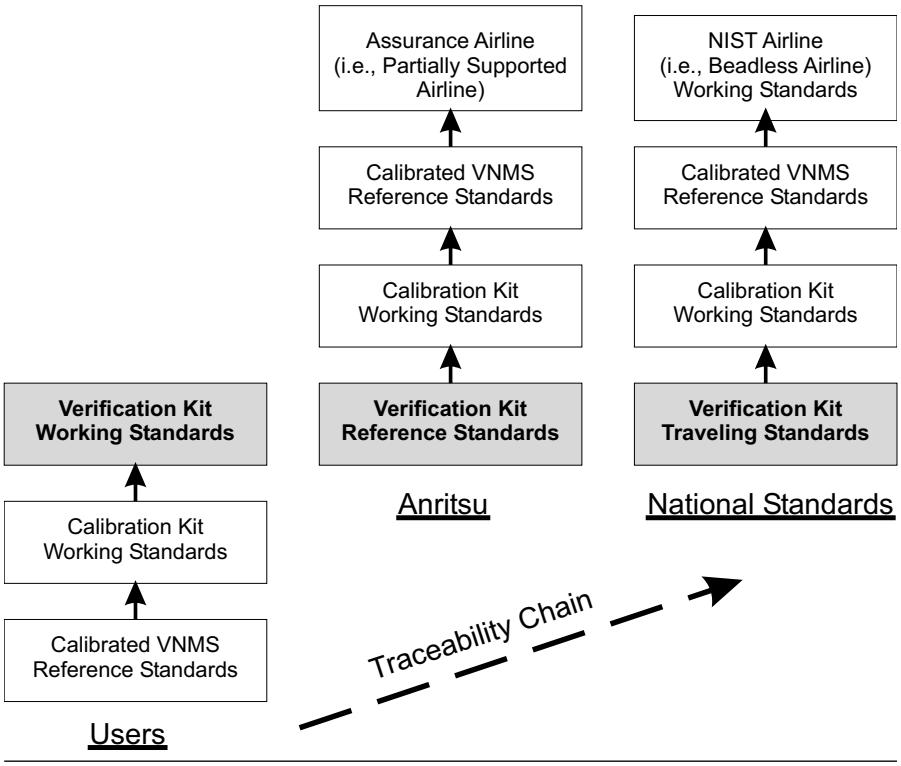

Figure 4-1. *VNMS Traceability Chart*

Chapter 5
Adjustments

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Chapter 5
Adjustments

5-1 INTRODUCTION

This chapter provides calibration procedures to be performed as specified below:

1. Perform the 10 MHz calibration procedure if:

   - ❑ The CPU module is replaced and the instrument's Basic Measurement Software is version 1.14 or later
   - ❑ The receiver PCB is replaced

   > ***NOTE***
   > The 10 MHz calibration capability is not available in Basic Measurement Software versions earlier than 1.14. The Basic Measurement Software must be updated to version 1.14 or later prior to performing the 10 MHz calibration.

2. Perform the ALC adjustment procedure if:

   - ❑ The ALC calibration verification test or the output power accuracy test fails.
   - ❑ Other testing or troubleshooting reveals a possible problem with RF power accuracy or the ALC Loop.
   - ❑ Any of the following assemblies are replaced:
     Source Module Assembly
     Option Source Module Assembly
     Auto-Reversing Module
     Non-Reversing Module
     Port 1 or Port 3 Module
     Port 1 or Port 3 Source Step Attenuator
     Switched Doubler Module
     Switched Tripler Module
     Switch Module

3. Perform the Back-end Attenuator calibration procedure if the instrument has Option 4X installed and the Option Module Assembly is replaced.

4. Characterize the Noise Source Signal Through Path if the instrument has Option 4X installed and if any of the following assemblies are replaced:

   - ❑ Switch Module
   - ❑ Port 1 Module
   - ❑ CPU Module

5-2 RECOMMENDED TEST EQUIPMENT

The following test equipment is required to perform the procedures in this chapter:

- Anritsu ML2430A Series Power Meter
- Anritsu MA2472A Power Sensor
- Anritsu MF2412B Frequency Counter or Equivalent
- Anritsu 3670 Series Throughline

5-3 TEST CONDITIONS

The equipment must be operated under controlled conditions of temperature and humidity in order to meet its specified precision and stability.

Refer to Section 4-2 for temperature and humidity requirements.

5-4 PRE-TEST SETUP

1. Prior to making any precision measurements, allow the equipment to warm up for at least one hour from power on. If the power supply is interrupted for any reason, allow a similar settling period.

2. Verify that the power meter GPIB address is 13 (default). Refer to the *ML2430A Series Power Meter Operation Manual* (10585-00001).

5-5 10 MHz CALIBRATION PROCEDURE

This procedure guides the operator through the automatic calibration routine (when an EIP frequency counter is used) or the manual calibration routine (when an Anritsu frequency counter is used) for the MS462XX Vector Network Measurement System. The 10 MHz calibration is used to tune the internal 10 MHz reference oscillator to be within the required tolerance.

This procedure uses the MS462XX internal diagnostics and calibration menus in conjunction with a suitable frequency counter and an external 10 MHz reference source.

> ***NOTE***
> The internal 10 MHz reference of the frequency counter can be used if it has a high stability oscillator option installed.

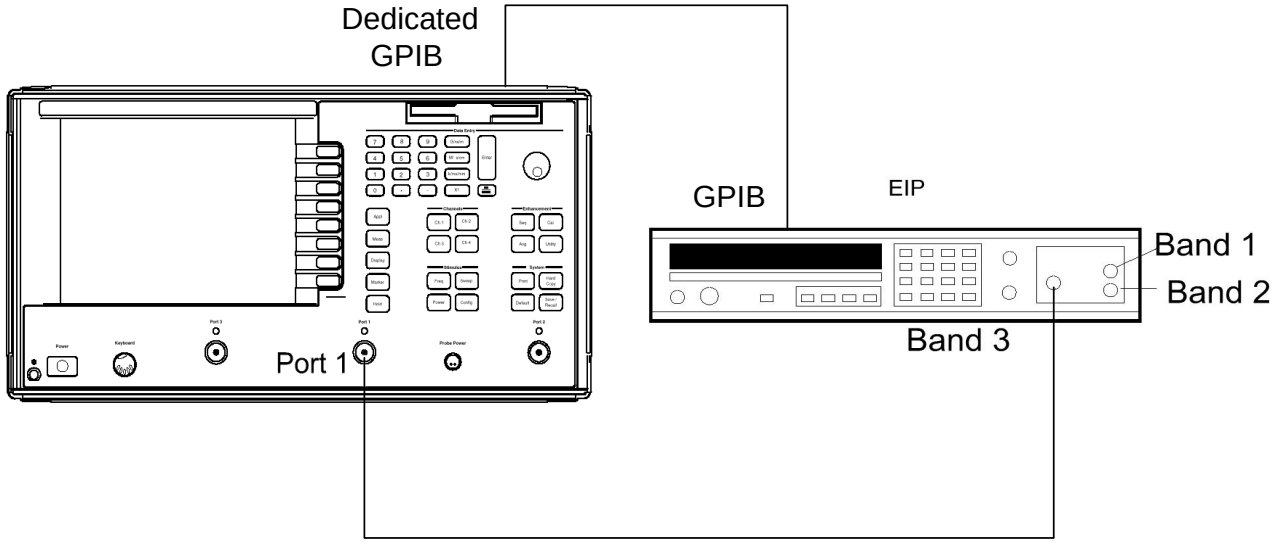


Figure 5-1. *Automatic 10 MHz Calibration Setup*

Automatic Calibration Procedure:

1. Connect a GPIB cable (Anritsu 2100-2) between the EIP frequency counter GPIB connector and the MS462XX dedicated GPIB connector, as shown in Figure 5-1.

> ***NOTE***
> If the EIP Frequency Counter does not have the High Stability internal 10 MHz Reference Time Base option installed or the EIP Frequency Counter internal 10 MHz Reference Time Base has not been calibrated, apply a high stability 10 MHz reference source to the Frequency Counter instead of using the internal 10 MHz Reference.

2. On the MS462XX, press the UTILITY front panel key.

3. Select the menu soft keys as follows:

   DIAGNOSTICS

   HARDWARE CAL (SERVICE USE ONLY)

   10 MHz CAL AUTOMATIC

4. Connect a coaxial RF cable between the Band 3 Input connector of the frequency counter and the Port 1 connector of the MS462XX.

5. Press the START CAL soft key to begin the calibration. Refer to Figure 5-2 on the following page.

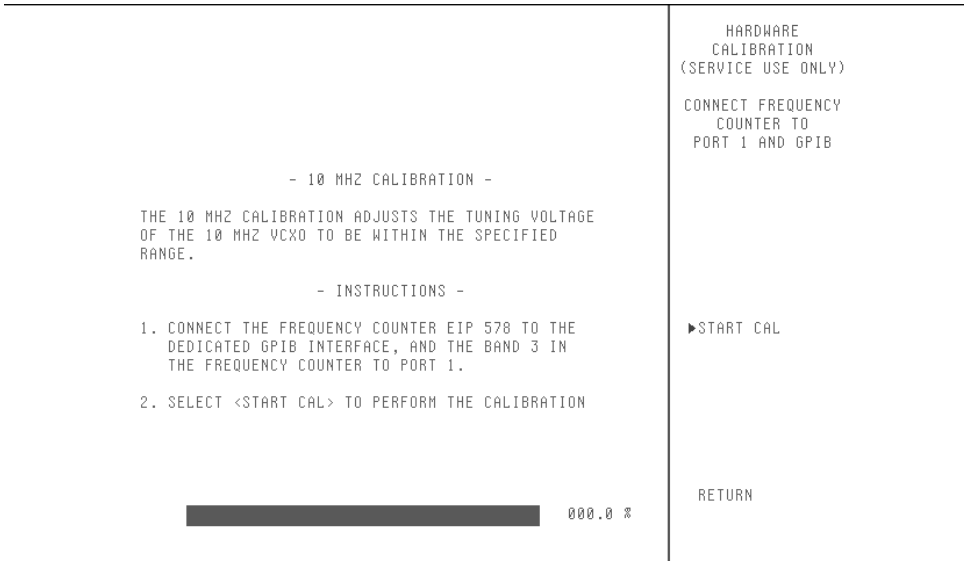


Figure 5-2. *Automatic 10 MHz Calibration*

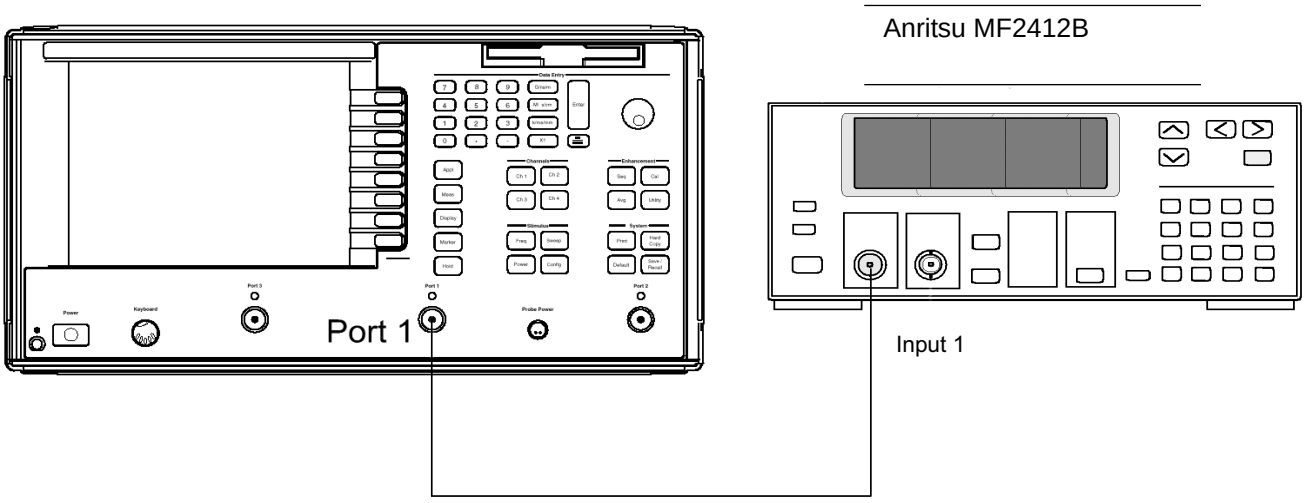


Figure 5-3. *Manual 10 MHz Calibration Setup*

Manual Calibration Procedure:

1. On the MS462XX, press the UTILITY front panel key.

2. Select the menu soft keys as follows:

   DIAGNOSTICS
   HARDWARE CAL (SERVICE USE ONLY)
   10 MHz CAL MANUAL

3. Connect a coaxial RF cable between the Input connector of the frequency counter and Port 1 connector of the MS462XX, as shown in Figure 5-3 (previous page).

> ***NOTE***
> If the frequency counter internal 10 MHz reference time base has not been calibrated, apply a high stability 10 MHz reference source to the frequency counter instead of using the internal 10 MHz reference.

4. Use the rotary knob to change the DAC value until the frequency counter measurement reading is 3 GHz ± 400 Hz.

5. Press the SAVE soft key to save the calibration. Refer to Figure 5-4.

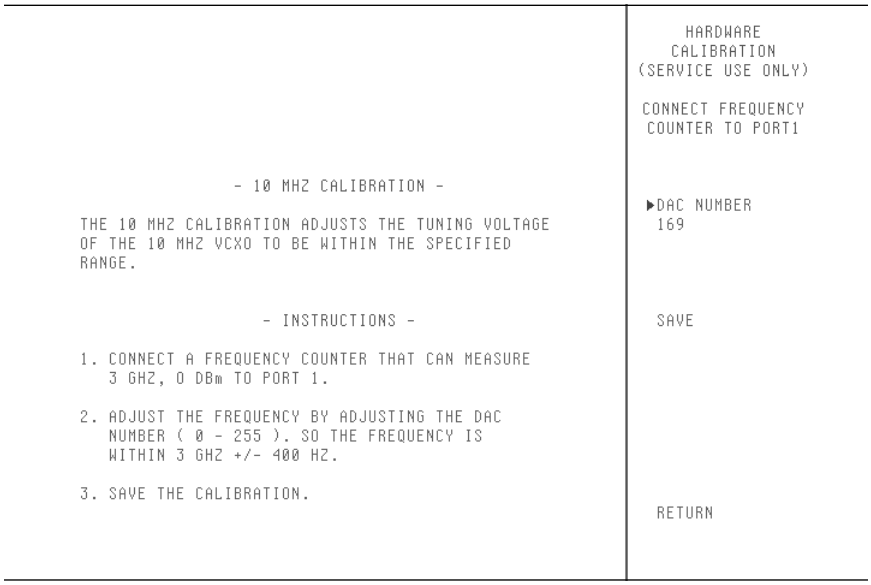


Figure 5-4. *Manual 10 MHz Calibration*

5-6 ALC ADJUSTMENT PROCEDURE

This procedure guides the operator through the Automatic Level Control (ALC) calibration routine for the MS462XX Vector Network Measurement System. The ALC calibration is used to restore the calibration of the MS462XX signal sources. Use this procedure after various signal source related assemblies have been removed or replaced due to troubleshooting or repair activities.

This procedure uses the MS462XX internal diagnostics and calibration menus, in conjunction with a suitable power meter and power sensor, to adjust the output power level of the signal source throughout the range of the MS462XX model being calibrated. The Source ALC calibration consists of several sub-calibrations that ensure accurate output power and overall system stability.

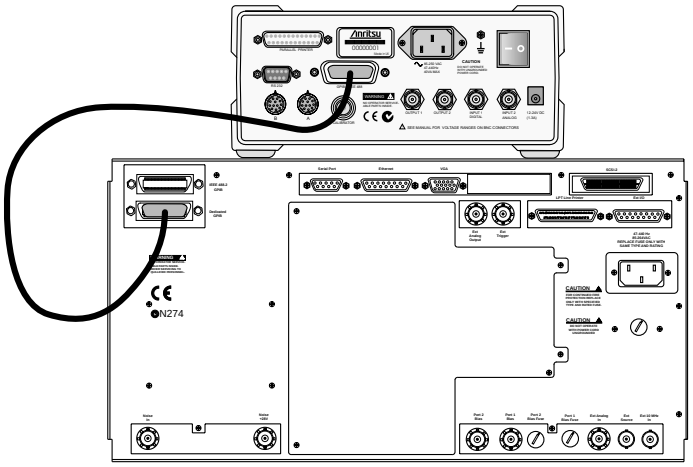


Figure 5-5. *ML2430A Series Power Meter GPIB connection to the MS462XX Vector Network Measurement System*

Procedure:

1. Connect a GPIB cable (Anritsu 2100-2) between the power meter GPIB connector and the MS462XX dedicated GPIB connector, as shown in Figure 5-5.
2. On the MS462XX, press the Utility front panel key.
3. Select the menu soft keys as follows:

   DIAGNOSTICS

   HARDWARE CAL (SERVICE USE ONLY)

   SOURCE ALC CAL
4. Reset the power meter to factory settings. On the Anritsu MA2430A power meter, select:

   System | Setup | -more- | PRESET | FACTORY
5. Follow the instructions in the power meter manual to perform a Zero and a 0 dBm Cal of the power sensor. Calibrate Sensor A or Sensor B as required.

> ***NOTE***
>
> Correction and Cal Factor tables are resident in the Anritsu MA24XXA Series Power Sensors.

6. Press the menu soft key to select the source to be calibrated:

   Select Source 1/2

7. Connect the power sensor to the selected port (Port 1 for Source 1, Port 3 for Source 2).

8. Select:

   START CAL

9. After the ALC calibrations are complete, back up the calibrations by selecting SAVE TO HARD DISK.

If the calibration fails:

- Verify that the power meter and sensor are functioning correctly, the GPIB cables are in good condition, and all connections are secure.
- Note the failed step in the calibration procedure from the screen message.
- Repeat the calibration.

If it still fails, proceed to Chapter 6—Troubleshooting.

5-7 BACK-END ATTENUATOR CALIBRATION (OPTION 4X ONLY)

The Back-end Attenuator calibration is used to characterize the attenuator in the Option Module for use in insertion gain calculations. Perform this procedure after the Option Module assembly has been removed or replaced due to troubleshooting or repair activities.

This procedure uses the MS462XX internal diagnostics and calibration menus.

Procedure:

1. Allow the instrument to warm up for a period of at least 60 minutes from power on. If the power supply is interrupted for any reason, allow a similar settling period.
2. On the MS462XX, press the Utility front panel key.
3. Select the menu soft keys as follows:

   DIAGNOSTICS

   HARDWARE CAL (SERVICE USE ONLY)

   BACK-END ATTENUATOR CAL
4. Connect a throughline (Anritsu 3670 Series) between Port 1 and Port 2.
5. Select:

   START CAL

5-8 NOISE SOURCE SIGNAL INTERNAL THROUGH PATH CHARACTERIZATION (OPTION 4X ONLY)

This procedure provides steps for characterizing the Noise Source Signal Internal Through Path. A file known as the "Internal ENR Extension Table" will be created having the extension "EXT."

Perform this procedure after the Port 1 Switch Module, Port 1 Module, associated RF cables, connectors and/or rear panel Noise Source Input Connector have been replaced or disturbed due to troubleshooting or repair activities. Also, perform this procedure after the CPU module has been replaced.

Equipment Required:

The following equipment is required to perform this adjustment:

- Anritsu 37000 Series VNA or MS462XX Series VNMS
- Anritsu 3750R or 3750LF Calibration Kit
- Anritsu 3670K50-2 Throughline
- Appropriate Adapters (Anritsu 34NK50, 34NFK50, 34AS50, 33LL50)

Procedure:

1. For MS462XX units with Option 4, 4D, or 4F, set up the 37000 VNA or MS462XX VNMS for a Start Frequency of 50 MHz, Stop Frequency of 3 GHz, and Data Points to 101. For MS462XX units with Option 4B, 4E, or 4G, set the Stop Frequency to 6 GHz and Data Points to 201. Set up the test port connectors as follows: Port 1 for 3.5 mm male and Port 2 for 3.5 mm female.

> ***NOTE***
>
> The MS462XX VNMS mentioned above is not the same instrument that is being tested in this procedure. This instrument is used to measure the MS462XX and is hereafter called the Measurement unit. The MS462XX under test is hereafter called UUT.

2. Attach the throughline to both Port 1 and Port 2 of the Measurement unit (Figure 5-6).

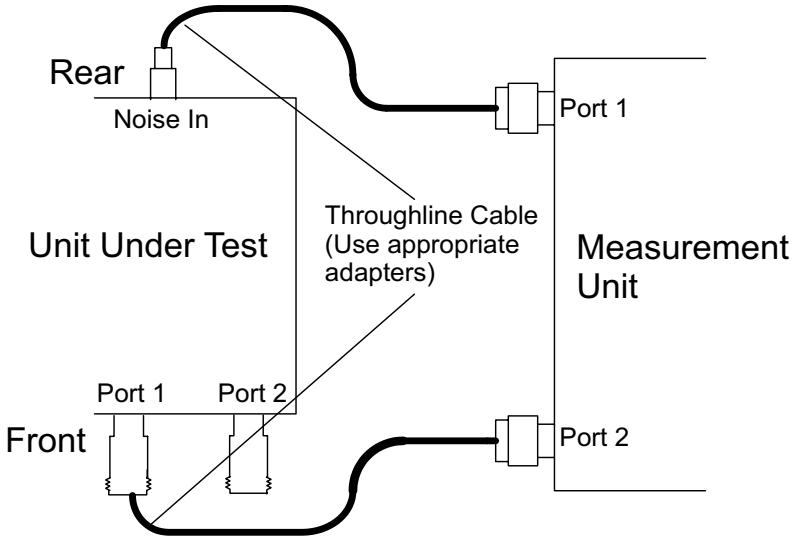


Figure 5-6. *Throughline Cables*

3. Perform a 2-Port, 12-Term calibration on the Measurement unit.

4. After performing the calibration, connect Port 1 of the Measurement unit to Noise In on the rear panel of the UUT and Port 2 of the Measurement unit to Port 1 of the UUT. Use adapters as needed.

5. Press the Appl key on the front panel of the UUT.

6. Select:

   CHANGE APPLICATION SETUP/MEASUREMENT TYPE

   NOISE FIGURE

   NOISE FIGURE SETUP

   INTERNAL

7. Verify S12 and S21 on the Measurement unit are approximately –3 dB.

8. Set up all four channels on the Measurement unit for a Real & Imaginary graph type. Also, set up Ch 2 for S21 measurement and Ch 3 for S12 measurement.

9. Save the data onto a floppy disk as a Text file (Print Output Device = Disk File). Name the file as follows: Nxxxxxx where xxxxxx is the serial number of the UUT. The operating software of the Measurement unit will automatically append the ".txt" extension to the file name.

Hint: Press the Hard Copy key to access this output function if the Measurement unit is a MS462XX VNMS. Press the Menu key under the Hard Copy group if the Measurement unit is a 37000 VNA.

> ***NOTE***
> The MS462XX VNMS and the 37000 VNA save text files with the "Read-Only" attribute turned on. Use the File/Properties feature of Windows Explorer to disable the "Read-Only" attribute.

10. Open the text file (nxxxxxx.txt) with the *Notepad* program (supplied with Microsoft Windows). Make sure the data is in the format and order shown below:

    - ❑ S11 (real & imaginary)
    - ❑ S21 (real & imaginary)
    - ❑ S12 (real & imaginary)
    - ❑ S22 (real & imaginary)

    Then delete the header information and save it as a text file again.

11. Use Port 2 of the Measurement unit to measure the input match of the Noise Source to be used with the UUT.

> ***NOTE***
>
> No bias is applied to the noise source and the S22 data must be in real and imaginary format.

Hint: Set up the Measurement unit for Single Channel display and measure S22.

12. Save the S22 data onto a floppy disk. Name the file as follows: NS.

13. Using the *Notepad* text editor, open the text file (ns.txt), delete the header information, and save it as a text file again.

14. Import the data contained in the Nxxxxxx.txt file into an Excel spreadsheet. Delete the entire first column that has the row number 1, 2, 3, etc.

15. Add the real and imaginary columns of the match data of the noise source from the ns.txt file to the last two columns of the spreadsheet. Refer to the example in Figure 5-7, following page.

16. Now select all the cells of the spreadsheet and format them from the "scientific" form to the "general" form with five decimal places.

17. Save the spreadsheet as a text file by typing the following file name: "Nxxxxxx.ext" where xxxxxx is the serial number of UUT. This is the Noise Figure Internal ENR Extension Table file.

> ***NOTE***
> The quotation marks are required in Excel for saving a file with a specific filename.

18. Copy this file to a floppy diskette.

19. Insert the floppy diskette into the UUT floppy disk drive.

20. Press the Appl key and then select the following:

    CHANGE APPLICATION SETUP

    NOISE FIGURE SETUP

    LOAD ENR TABLE
    FROM FLOPPY DISK

    INTERNAL ENR EXTENSION TABLE

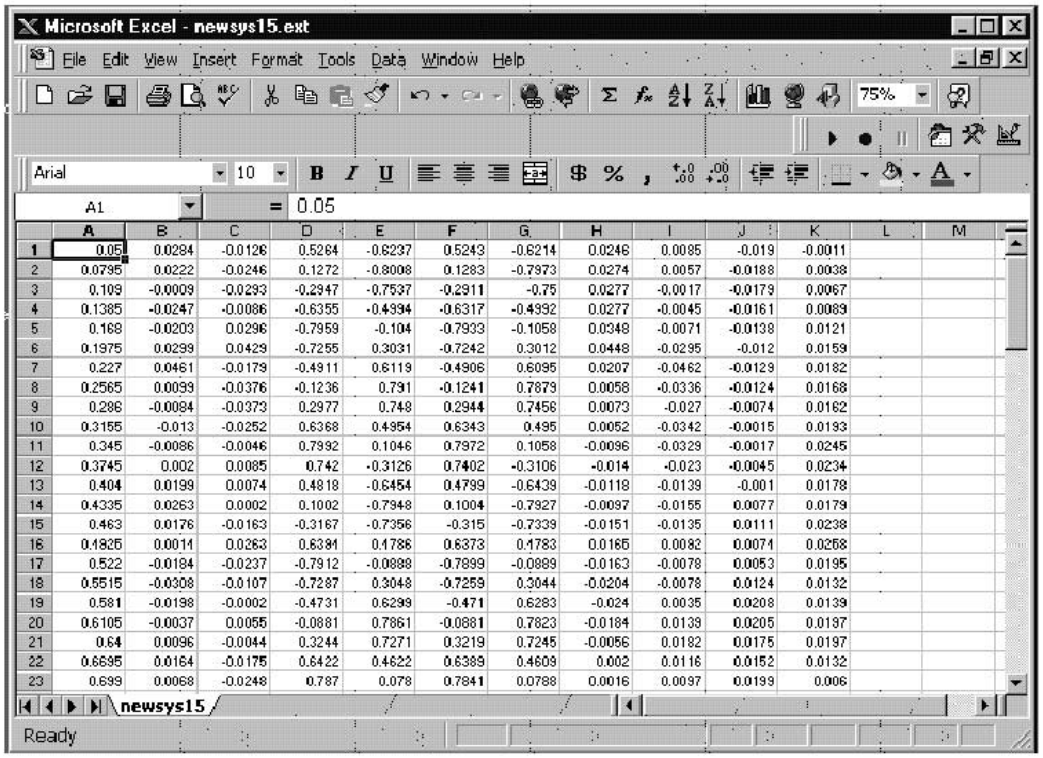
    RETURN

21. Save the Internal ENR Extension table to hard disk: select the following:

    SAVE ENR TABLES
    TO HARD DISK

    INTERNAL ENR EXTENSION TABLE

    RETURN



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	0.05	0.0284	-0.0126	0.5284	-0.8237	0.5243	-0.8214	0.0246	0.0085	-0.019	-0.0011		
2	0.0795	0.0222	-0.0246	0.1272	-0.8008	0.1283	-0.7973	0.0274	0.0057	-0.0188	0.0038		
3	0.109	-0.0009	-0.0293	-0.2947	-0.7537	-0.2911	-0.75	0.0277	-0.0017	-0.0179	0.0067		
4	0.1385	-0.0247	-0.0086	-0.6355	-0.4934	-0.6317	-0.4932	0.0277	-0.0045	-0.0161	0.0089		
5	0.168	-0.0203	0.0296	-0.7959	-0.104	-0.7933	-0.1058	0.0348	-0.0071	-0.0138	0.0121		
6	0.1975	0.0299	0.0429	-0.7255	0.3031	-0.7242	0.3012	0.0448	-0.0295	-0.012	0.0159		
7	0.227	0.0461	-0.0179	-0.4911	0.6119	-0.4906	0.6095	0.0207	-0.0462	-0.0129	0.0182		
8	0.2565	0.0093	-0.0376	-0.1236	0.791	-0.1241	0.7879	0.0058	-0.0336	-0.0124	0.0168		
9	0.286	-0.0084	-0.0373	0.2977	0.748	0.2944	0.7458	0.0073	-0.027	-0.0074	0.0162		
10	0.3155	-0.013	-0.0252	0.6368	0.4954	0.6343	0.495	0.0052	-0.0342	-0.0015	0.0193		
11	0.345	-0.0086	-0.0046	0.7992	0.1046	0.7972	0.1058	-0.0096	-0.0329	-0.0017	0.0245		
12	0.3745	0.002	0.0085	0.742	-0.3126	0.7402	-0.3106	-0.014	-0.023	-0.0045	0.0234		
13	0.404	0.0199	0.0074	0.4818	-0.6454	0.4799	-0.6439	-0.0118	-0.0139	-0.001	0.0178		
14	0.4335	0.0263	0.0002	0.1002	-0.7948	0.1004	-0.7927	-0.0097	-0.0155	0.0077	0.0179		
15	0.463	0.0176	-0.0163	-0.3167	-0.7356	-0.315	-0.7339	-0.0151	-0.0135	0.0111	0.0238		
16	0.4825	0.0011	0.0263	0.6381	0.1786	0.6373	0.1783	0.0165	0.0082	0.0071	0.0268		
17	0.522	-0.0184	-0.0237	-0.7912	-0.0888	-0.7899	-0.0889	-0.0163	-0.0078	0.0053	0.0195		
18	0.5515	-0.0308	-0.0107	-0.7287	0.3048	-0.7259	0.3044	-0.0204	-0.0078	0.0124	0.0132		
19	0.581	-0.0198	-0.0002	-0.4731	0.6299	-0.471	0.6283	-0.024	0.0035	0.0208	0.0139		
20	0.6105	-0.0037	0.0055	-0.0881	0.7861	-0.0881	0.7823	-0.0184	0.0139	0.0205	0.0137		
21	0.64	0.0096	-0.0044	0.3244	0.7271	0.3219	0.7245	-0.0056	0.0182	0.0175	0.0197		
22	0.6695	0.0164	-0.0175	0.6422	0.4622	0.6389	0.4609	0.002	0.0116	0.0152	0.0132		
23	0.699	0.0068	-0.0248	0.787	0.078	0.7841	0.0788	0.0016	0.0097	0.0199	0.006		

Figure 5-7. Match Data Example

Chapter 6
Troubleshooting

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Chapter 6
Troubleshooting

6-1 INTRODUCTION

CAUTION

The procedures in this chapter should be performed by qualified technical personnel only. These procedures may require access to internal components, and care should be taken to avoid contact with potentially hazardous voltages.

It is strongly recommend that any MS462XX Vector Network Measurement System repair be performed by qualified technical personnel only.

Refer to Section 1-8 for a listing of spare parts mentioned in this chapter. Contact your nearest Anritsu Customer Service or Sales Center for price and availability information. See Chapter 7 for specific module removal and replacement instructions. Refer to the *MS462XX Vector Network Measurement System Operation Manual* (10410-00203) for the specific operating instructions referred to in these procedures.

This chapter provides procedures to accurately define and isolate the fault to a specific assembly or module.

An aide to troubleshooting instrument failures is a good understanding of the system and subassembly operation. Refer to the descriptions of system and subassembly operations and block diagrams located in Chapter 2—Theory of Operation.

Accurately defining a fault is the most important step in troubleshooting an instrument. The fault symptoms should be noted by performing a functional test on the system, as explained in Chapter 3—Operational Performance Tests.

Faults can be categorized as the following:

- Hardware problems
- Software problems
- Measurement problems

6-2 SELF TEST

The VNMS has two self tests:

- Short self test at initial bootup
- Extended self test within the Diagnostics menu.

Both self tests display either Pass or Fail on the VNMS display upon completion Each self test failure will add the appropriate failure information to the Service Log.

The short self test at bootup performs the following tests:

- Communication with the Source(s), Options board, and Receiver Board
- CPU power supply voltage regulation
- Test of CPU lithium battery (found only on BMS software version 1.16 and above)

The extended self test is initiated by pressing the Utility key, then selecting:

Diagnostics

Start Self Test

The extended self test performs extensive tests on the entire instrument, but the RF signal paths and components are minimally tested. Only the Down Converter Module and the Receiver PCB 125KHz IF signal paths are tested during the extended self test.

6-3 TROUBLESHOOTING TOOLS FOR THE CPU MODULE

The MS462XX Vector Network Measurement System has built-in diagnostic tools to aid in troubleshooting the CPU Module. They are accessed from the Utility key in the enhancement key group on the front panel.

Entering the Troubleshooting Menu

1. On the MS462XX Vector Network Measurement System, press the Utility front panel key.
2. Select the menu soft keys as follows:

   DIAGNOSTICS

   TROUBLESHOOTING

   MORE

   MORE

Exiting the Troubleshooting Menu

The MS462XX Vector Network Measurement System must be properly exited from the Troubleshooting function in order to restore normal system operation. To exit the troubleshooting menu:

1. Select the menu soft keys as follows:

   FINISHED, RECOVER FROM TROUBLESHOOTING

2. If the system still does not function properly, select the menu soft keys as follows:

   UTILITY

   DIAGNOSTICS

   TROUBLESHOOTING

   FINISHED, RECOVER FROM TROUBLESHOOTING

The Troubleshooting Menu

The Troubleshooting menu is shown in the graphic screen capture below. Descriptions of the menu selections follow.

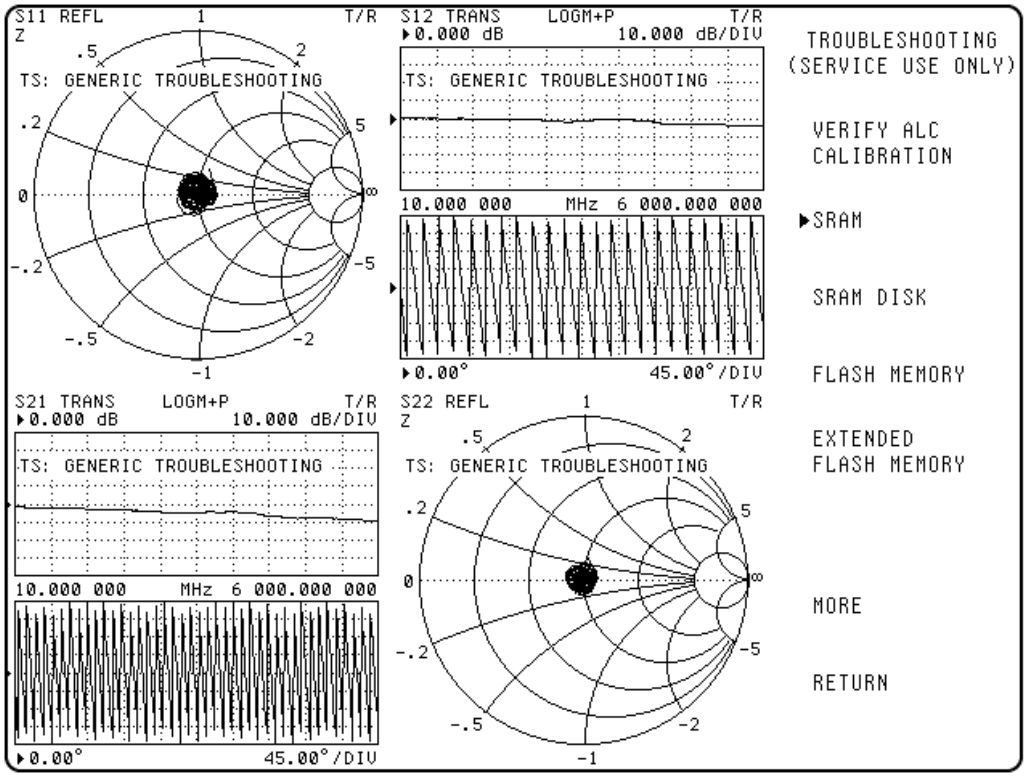


Figure 6-1. *Troubleshooting Menu*

SRAM This test verifies whether the internal SRAM is functioning properly. If this test fails, the instrument beeps and the Front Panel LEDs flash. The instrument will automatically reboot after this test is complete.

> ***CAUTION***
>
> The SRAM test overwrites all front panel setups (including internal), Cal coefficients and the Service Log.

SRAM DISK This test verifies whether the internal SRAM disk is functioning properly. The SRAM disk is also known as the hard disk when no external hard disk is connected to the SCSI-2 port. If the test fails, the instrument will beep and the Front Panel LEDs will flash.

> ***CAUTION***
>
> The SRAM disk test overwrites the Harmonic Cal coefficients and all the contents of the SRAM disk. The SRAM disk must be reformatted after the test is complete.

To reformat the SRAM disk:

1. Press the Utility front panel key.
2. Select the menu soft keys as follows:

   GENERAL DISK UTILITIES

   FORMAT HARD DISK

FLASH MEMORY This test verifies whether the internal Flash Memory is functioning properly.

> ***CAUTION***
>
> This test overwrites the instrument control software. Basic Measurement Software must be re-loaded from floppy diskette after this test is complete and the instrument is turned off.

EXTENDED FLASH MEMORY This test verifies whether the internal Extended Flash Memory is functioning properly.

> ***CAUTION***
>
> This test overwrites the instrument control software. Basic Measurement Software must be re-loaded from floppy diskette after this test is complete and the instrument is turned off.

DRAM This test verifies whether the internal DRAM is functioning properly. The display will go blank when this test begins. If the test fails, the instrument will beep four times and the Front Panel LEDs will flash.

GRAPHICS VRAM This test verifies whether the Graphics VRAM is functioning properly. The display will go blank when this test begins. If the test fails, the instrument will beep four times and the front panel LEDs will flash.

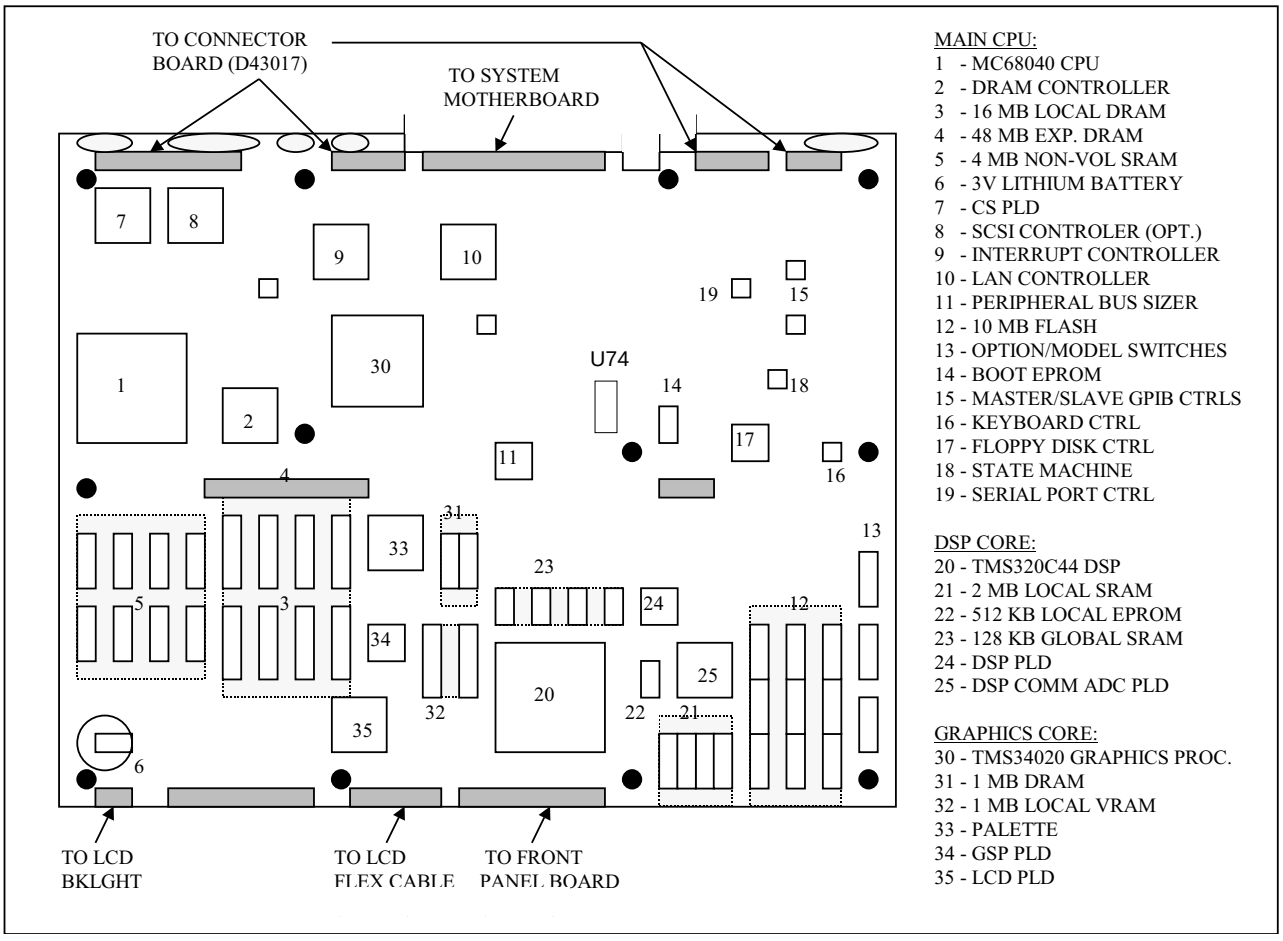


Figure 6-2. *CPU Assembly Part Locator*

GRAPHICS DRAM This test verifies whether the Graphics DRAM is functioning properly. The display will go blank when this test begins. If the test fails, the instrument will beep four times and the front panel LEDs will flash.

DSP SRAM This test verifies whether the DSP SRAM is functioning properly. The display will go blank when this test begins. If the test fails, the instrument will beep four times and the front panel LEDs will flash.

6-4 HARDWARE TROUBLESHOOTING

The Scorpion Vector Network Measurement System hardware includes the following:

- CPU Module
- Source Module(s)
- Receiver Module
- Power Supply (PDU) Module
- Front Panel Assembly
- Option Module (for units equipped with Option 4 or 5 only)

CPU MODULE

CPU module-related system failures include:

- System does not boot up
- Display problems
- Printer Problems
- GPIB Interface Problems

System Boot-up Problem

This condition can be a result of a failure of the +6.5 volt output of the Power Distribution Unit, failure of the CPU module memory, or a dislodged Lithium Battery mounted on U74 (next to the boot EPROM).

1. Verify that the +6.5 volt output of the Power Distribution Unit is working properly.
2. Verify that the battery mounted on U74 is installed properly. Refer to Figure 6-2 on the previous page for a part location diagram.
3. Replace the CPU Module.

Hard Disk Problem

This condition can be a result of a failure of the Lithium Battery or CPU module.

1. Replace the Lithium Battery (p/n: 633-25) on the CPU as described in Chapter 7 (Removal and Replacement Procedures), page 7-15.
2. If the problem persists, replace the CPU assembly.

Printer Output Problem

This condition can be a result of a failure of the printer, printer cable, or CPU module.

1. Connect a different printer and determine if the instrument works with that printer. If so, replace the printer.
2. Replace the printer cable.
3. Replace the CPU module.

GPIB Interface Problem

This condition can be a result of a failure of the CPU module.

1. Connect a GPIB cable between the IEEE488 port and the Dedicated GPIB port on the rear panel.
2. Press the Utility front panel key.
3. Select the menu soft keys as follows:

   DIAGNOSTICS

   PERIPHERAL TESTS

   GPIB INTERFACE
4. Follow the instructions on the screen until the test is completed.

> ***CAUTION***
>
> Ensure that no other GPIB cables are connected to either of the two rear panel GPIB connectors when performing this test.

5. If the GPIB Interface test fails, replace the CPU Module.

GPIB Address Retention Problem

This condition can be a result of a failure of the Lithium Battery.

Replace the Lithium Battery (p/n: 633-25) on the CPU as described on page 7-15.

SOURCE MODULE

Possible Source Module related system failures include:

- Phase-lock loop failures
- ALC failures
- Insufficient dynamic range
- Excessive high level noise
- Excessive harmonics
- Slow sweep speed

Phase-lock Loop Problem

If the MS462XX detects a Phase-lock loop problem during normal operation, an error code followed by a brief error message will be displayed on the screen. The error code will also be written to the service log along with some of the operating data gathered from the system at the time of failure. Possible causes include:

- 10 MHz Reference Signal missing
- Internal VCO of Source Module failure
- Faulty communication to the Source Module
- Power Supply failure

Troubleshooting tools include:

- *Service Log:* Error codes are written to the service log along with data representing system conditions at the time of failure.
- *Phase-lock Error Codes:* Phase-lock error codes have an alphabetical suffix (code) following the message. This suffix code consists of one or more letters from A to F or from J to L that represent the portion of the source circuits that were not locked. The Phase-lock failure mode suffix codes are listed in the table below:

Suffix	Failure Mode
A	Source 1 DDS Clock Lock Fail
B	HET Lock Fail
C	LO Offset Lock Fail
D	Source 1 Offset Lock Fail
E	LO Main Lock Fail
F	Source 1 Main Lock Fail
J	Source 2 DDS Clock Lock Fail
K	Source 2 Offset Lock Fail
L	Source 2 Main Lock Fail

Depending on the nature of the failures and the frequency band when the failure occurred, more than one failure suffix may be displayed. Suffixes do not necessarily appear in alphabetical order.

Examples:

6100 PHS LCK FAIL FCBALJ

6100 PHS LCK FAIL CBALJ

Both example error messages were caused by the absence of the 10 MHz Reference Time Base Signal. The first message occurred when the instrument was sweeping from 820 MHz to 850 MHz. The second message occurred when the instrument was sweeping from 10 MHz to 6 GHz.

HET OSCILLATOR VOLTAGE

This function (Figure 6-3) allows the user to verify whether the HET oscillator of the Main Source Module is operating properly.

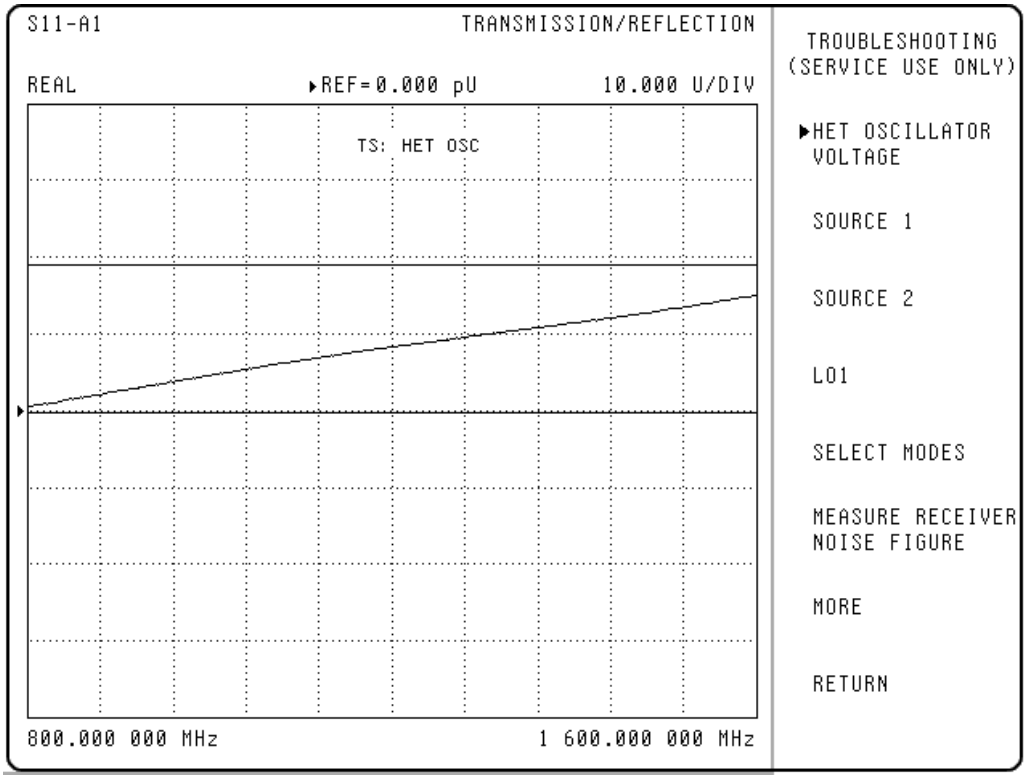


Figure 6-3. *Source Module Troubleshooting Menu*

SOURCE 1 This function allows the user to verify that various parts of the main Source Module are operating properly, and includes the following tests:

DDS REFERENCE CLOCK VOLTAGE

OFFSET VCO VOLTAGE

> ***NOTE***
> Common Offset Mode must be turned off for the OFFSET VCO VOLTAGE function to operate properly. To turn common offset mode off, select RETURN/SELECT MODES/COMMON OFFSET MODE OFF.

MAIN VCO VOLTAGE

LEVEL AMPLIFIER VOLTAGE

LOG AMPLIFIER VOLTAGE

POWER LEVEL DAC VOLTAGE

ALC MODULATOR DRIVE VOLTAGE

SOURCE 2 This function allows the user to verify that the Option Source Module is operating properly. This function includes the following tests:

DDS REFERENCE CLOCK VOLTAGE

OFFSET VCO VOLTAGE

> ***NOTE***
> Common Offset Mode must be turned off for the OFFSET VCO VOLTAGE function to operate properly. To turn common offset mode off, select RETURN/SELECT MODES/COMMON OFFSET MODE OFF.

MAIN VCO VOLTAGE

LEVEL AMPLIFIER VOLTAGE

LOG AMPLIFIER VOLTAGE

POWER LEVEL DAC VOLTAGE

ALC MODULATOR DRIVE VOLTAGE

LO This function allows the user to verify whether the Local Oscillator is operating properly, and includes the following tests:

OFFSET VCO VOLTAGE

MAIN VCO VOLTAGE

Check the Service Log and use the error code suffix table to determine the area where the source module is having the problem.

1. Press the Utility front panel key.

2. Select the menu soft keys as follows:

   DIAGNOSTICS

   SERVICE LOG

3. Check the Power Distribution Unit output voltage.

4. Use a frequency counter or Spectrum Analyzer to verify whether a valid 10 MHz signal is being received at J2 of both the Main Source Module and the Option Module.

5. If the 10 MHz signal is missing, verify whether the instrument is set up to use an external 10 MHz reference.

6. Press the Utility front panel key.

7. Select the menu soft keys as follows:

   REAR PANEL

8. Assure that the INTERNAL setting is selected for REFERENCE FREQUENCY.

9. Use the built-in diagnostic tests to verify whether the source module is operating properly. If the test results indicate an out of limit condition, replace the appropriate source module.

AUTO LEVEL CONTROL (ALC)

If the MS462XX detects an ALC problem during normal operation, an error message will be displayed on the screen. The error code will also be written to the service log along with some of the operating data gathered from the system at the time of failure.

Possible causes of ALC failure include:

- ❑ Insufficient static protection at the VNMS Test Ports
- ❑ Not enough power out of the source module
- ❑ Insufficient ALC modulation depth
- ❑ Broken path to or from the ALC detector
- ❑ Broken path to the instrument port modules
- ❑ Improper switching within components (including the Source Module)
- ❑ Defective ALC detector diode in the Non-Reversing Module, Auto-Reversing Module, or Port 3 Module
- ❑ Path to/from the ALC detector is broken
- ❑ Path to the instrument port modules is broken
- ❑ Source Module failed

Troubleshooting tools include:

- *Service Log:* Error codes will be written to the service log along with some data representing system conditions at the time of failure.

  ALC Error Codes:

ALC1 LVLD FAIL	Source 1 ALC Leveled Failure
ALC2 LVLD FAIL	Source 2 ALC Leveled Failure

- ML243XA Power Meter
- MA247XA Power Sensor

The presence of these error codes do not necessarily indicate an instrument failure. They simply indicate that an RF unleveled condition existed under a specific condition. For example, when the RF output level is set to a value exceeding the maximum power output range, the instrument will display these error codes. However, they do indicate that a failure condition does exist if the RF output level is within the power output range of the instrument.

It is useful to verify the ALC calibration as follows:

1. Connect the GPIB port of the Power Meter to the Dedicated GPIB port of the MS462XX and perform a new ALC calibration.
2. Press the Utility front panel key.
3. Select the menu soft keys as follows:

   DIAGNOSTICS

   HARDWARE CAL

   SOURCE ALC CALIBRATION
4. Check the source module cabling and the cabling to the components on the Receiver Module.
5. Use the a1/1 user defined measurement mode to compare the leveled port power level (0 dBm) and the unleveled port power (+20 dBm).
6. Press the Power front panel key.
7. Select the menu soft keys as follows:

   SOURCE 1 SETUP

   SOURCE 1 POWER

A typical profile of unleveled power is shown in Figure 6-4. If the leveled trace looks like the unleveled trace, it indicates that a problem has occurred in the ALC circuitry. Replace the source module, Non-Reversing Module (MS462XA only), Auto -Reversing Module (MS462XB only), or Port 3 Module (MS462XB with Option 3A or 3B only).

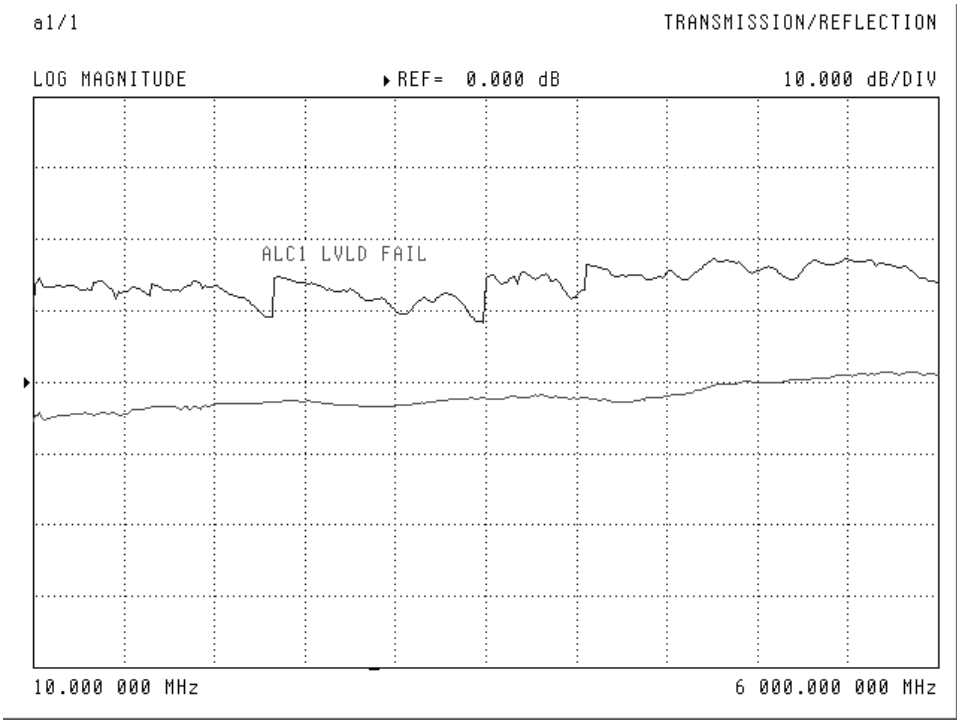


Figure 6-4. *Typical Profile of Unleveled Power*

RECEIVER MODULE

There are four receiver module related system failures:

- 10 MHz Reference Oscillator failures
- ALC failures
- RF Component failures
- Noise Source Power Supply failures

Special fixtures consists of the items listed below:

Part Number	Description	Quantity
D43023-3	Flex Extender PCB Assembly	1
806-89	3- foot flex coax cable	3
49523	2-foot MCX to MCX cable	4

The use of these special fixtures allows the Receiver Module be placed on top of the instrument, which provides easy access to component assemblies for troubleshooting (see Figures 6-5 and 6-6).

NOTE

When the Receiver Module is placed on top of the instrument, use:

- 806-89 coax cables to replace the semi-rigid RF cables connected between the Source Modules and the RF components in the Receiver Module
- 49523 cables to replace the four MCX cables connecting between the Receiver PCB Assembly and the Source Modules

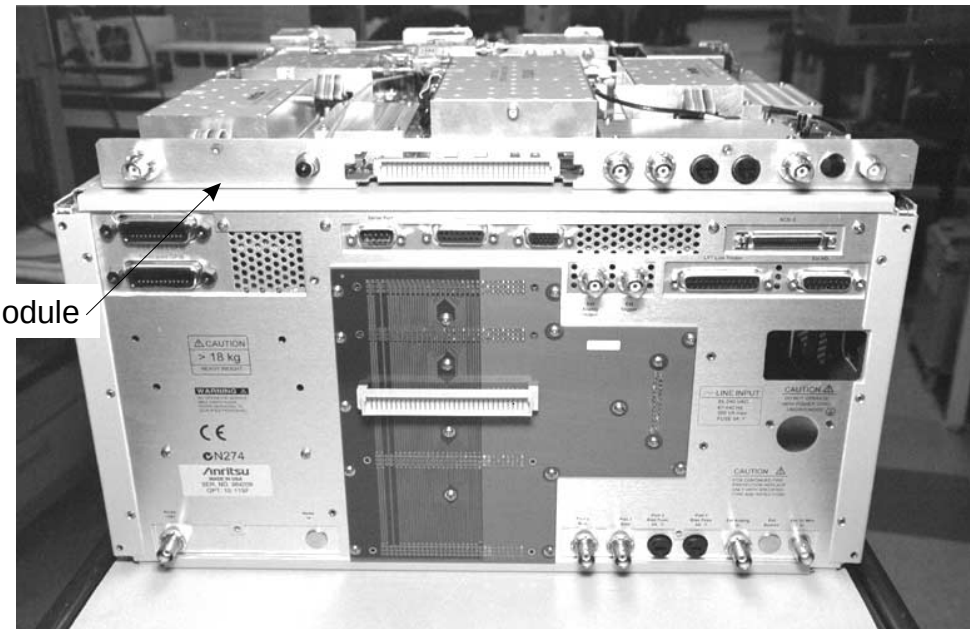


Figure 6-5. *Rear Panel Showing Receiver Module Placed for Easy Access*

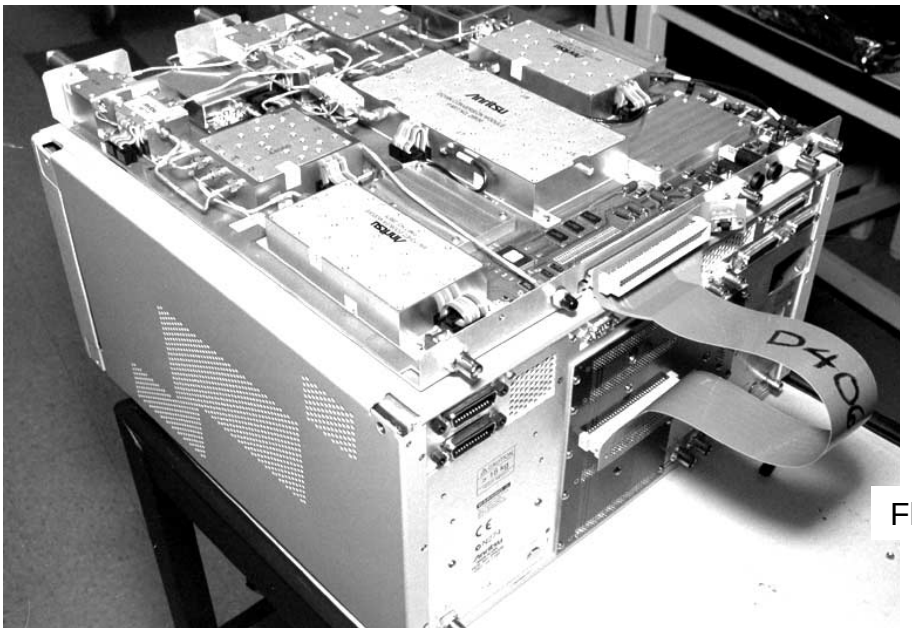


Figure 6-6. *Receiver Module Connected using Flexible Cable*

10 MHz Reference Oscillator Problem

Possible causes are listed below:

- 10 MHz Reference Oscillator failure
- Power Supply failure

Troubleshooting tools include:

- *Service Log:* Since the 10 MHz reference plays an important role in every phase lock circuitry in the instrument, an error message displayed on the screen may include a series of suffixes indicating various phase lock loop failures.

  Error Code Examples:

  100 PHS LCK FAIL FCBALJ

  6100 PHS LCK FAIL CBALJ

Both error messages are caused by the 10 MHz Reference Time Base Signal not being present. The first message occurs when the instrument is sweeping from 820 to 850 MHz. The second message occurs when the instrument is sweeping from 10 MHz to 6 GHz.

1. Check the Service Log. Press the Utility key and select:

   DIAGNOSTICS

   SERVICE LOG

   If there are multiple suffix codes, the problem may be caused by the 10 MHz Reference Oscillator.

2. Check the Power Distribution Unit output voltage.

3. Use a frequency counter or Spectrum Analyzer to verify whether a valid 10 MHz signal is received at J2 of both the Main Source Module and the Option Module.

4. If the 10 MHz signal is missing, verify that the instrument is set up to use an external 10 MHz reference. Press the Utility key and select:

   REAR PANEL (left)

   Assure that the INTERNAL setting is used for the REFERENCE FREQUENCY.

5. If the 10 MHz signal is not present, replace the Receiver PCB Assembly.

REAR PANEL

OUTPUT VOLTAGE ON / OFF

SELECT OUTPUT MODE (XXX)
HORIZONTAL

VERTICAL

DRIVEN PORT

TTL OUTPUT

REFERENCE FREQUENCY
INTERNAL / EXTERNAL

RETURN

Figure 6-7 shows the RF components layout in the Receiver Module. Figure 6-8 shows the system cabling.

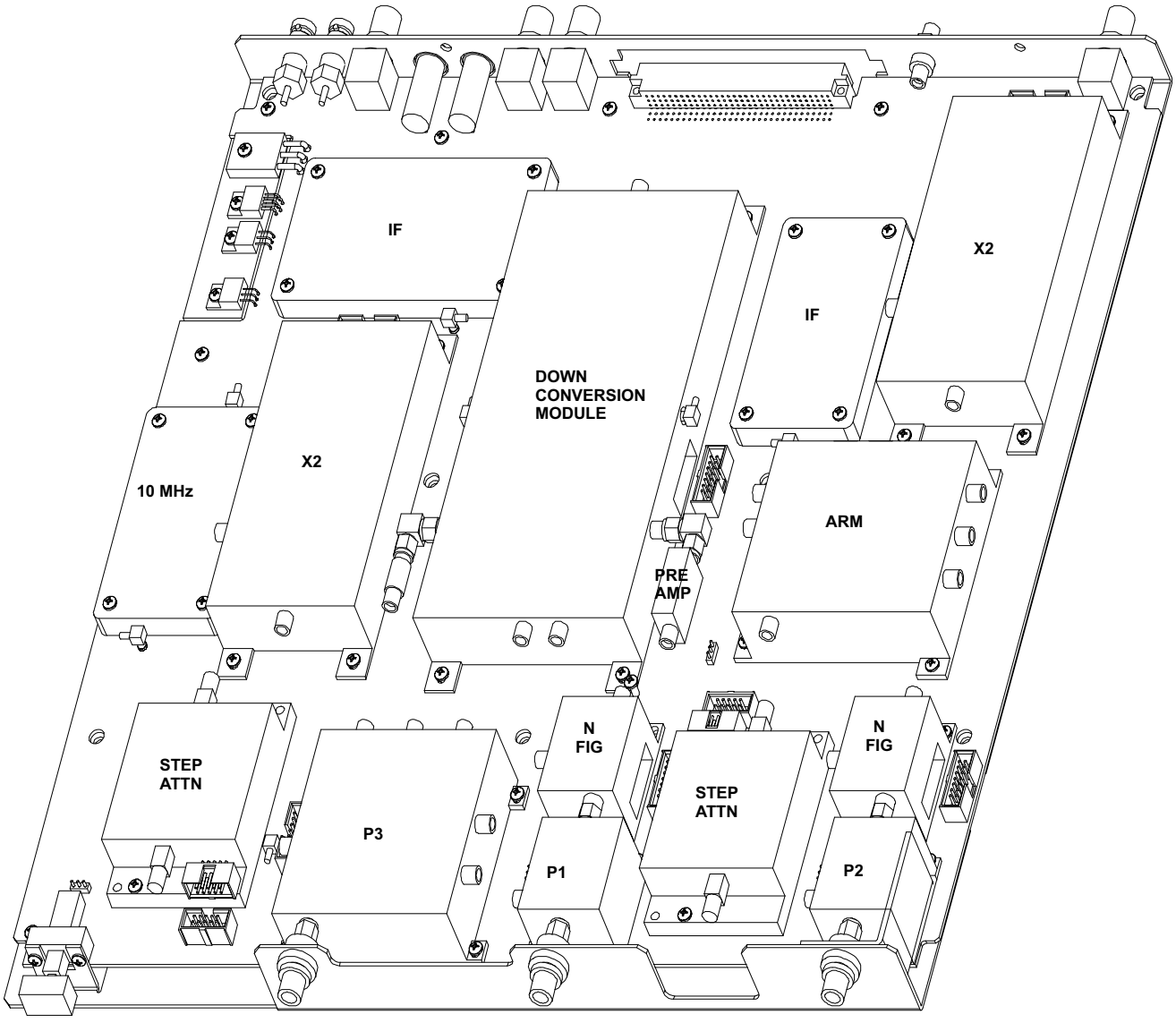


Figure 6-7. *RF Components Layout in Receiver Module*

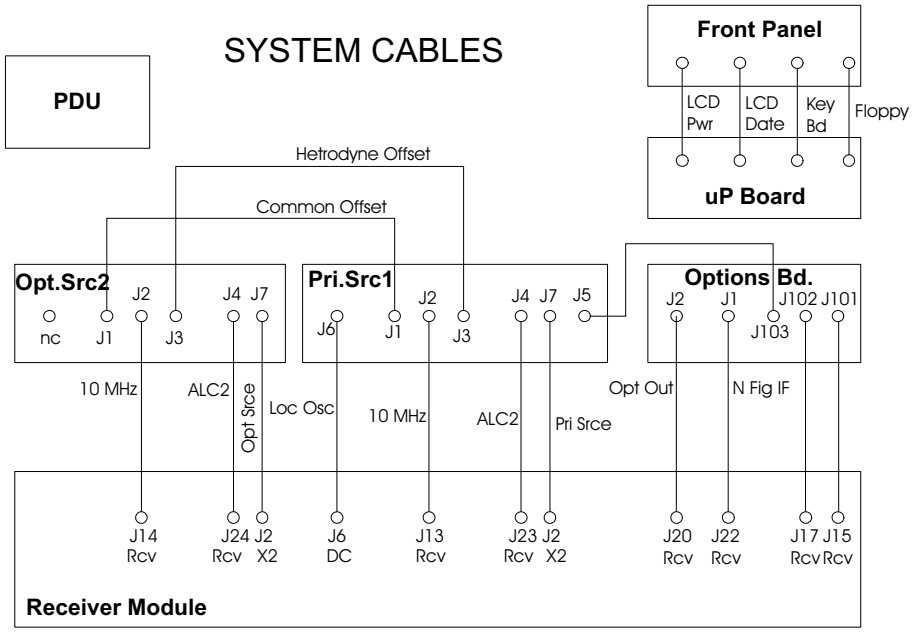


Figure 6-8. *System Cabling*

NOISE SOURCE POWER SUPPLY

The following steps can help isolate noise source power supply failures:

1. Use an oscilloscope to measure the Noise Source power supply output. Connect the probe to the rear panel BNC connector marked "Noise +28 V."
2. Press the Appl key and select the following soft keys:

   CHANGE APPLICATION SETUP

   MEASUREMENT TYPE

   NOISE FIGURE
3. Observe that a pulsed +28 V DC signal appears on the Oscilloscope. If not present, replace the Receiver PCB assembly.

POWER DISTRIBUTION UNIT

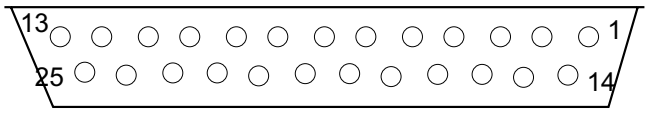
A procedure for troubleshooting the Power Distribution Unit is given below.

The following steps can help isolate power distribution unit failures:

1. Turn the MS462XX off and disconnect the power cord.
2. Remove the Backplane cover (Figure 7-15, page 7-23).
3. Reconnect the power cord and turn the MS462XX on.
4. Use a DMM to measure the power supply output voltages listed in Figure 6-9 at the Back Plane PCB Assembly (refer to Figure 7-16, page 7-24).

NOTE

All voltages are referenced to ground except 5V Float and 5V Float Return terminals that should have 5 volt potential between them.



Voltage	Pins	Common	Pins
+15±3%	7 & 19	Ground	6 & 18
–15±3%	9 & 21	Ground	8 & 20
+6.5±2%	13 & 25	Ground	12 & 24
+28±3%	14	Ground	12 & 24

Figure 6-9. *Backplane Connector Pinout*

5. If any of the DC voltage tests fail, replace the Power Distribution Unit.

FRONT PANEL ASSEMBLY

There are three Front Panel Assembly related failures:

- Non responsive keys
- Non responsive front panel knob
- LCD Display problems

Front Panel Keys/Knobs Problem

The following could cause non-responsiveness:

- Defective keypad
- Corroded key traces on front panel PCB assembly
- Defective front panel knob encoder

To troubleshoot a front panel key or knob problem, use the following procedure:

1. Press the Utility key and select the following soft keys:

   DIAGNOSTICS

   PERIPHERAL TESTS

   FRONT PANEL

2. Follow the instructions on the LCD screen until the test is completed.

3. If the test fails, replace the front panel PCB assembly and keypad.

LCD Problems

To troubleshoot an LCD problem, use the following procedure:

1. Connect an external VGA monitor to the rear panel. If no dislay appears on the VGA display, check the PDU output voltages (see previous page). If the voltages are OK, replace the CPU assembly.

2. If the external VGA display is OK, the following assemblies may have failed and in need of replacement:

   - Backlight Lamp (replaceable on Sharp model LQ9D340 only)
   - Backlight Driver PCB
   - LCD Display (only Anritsu part number 15-100 is available)
   - CPU Assembly

Hint

If the image on the LCD display is upside down, disconnect and then reconnect the LCD flex cable. This should correct the problem.

Floppy Drive Read/Write Problems

The floppy disk drive is not serviceable. If the unit fails to read or write data, the disk drive head may need cleaning. Any standard floppy disk drive cleaning kit may be used to clean the disk drive head. Follow the manufacturer's instructions for using the cleaning kit.

6-5 SOFTWARE PROBLEM

It is important to provide the factory as many details of the conditions immediately preceding the onset of the problem. This important information can provide clues and aid the factory in reproducing the problem. When encountering a software problem, please note the following:

- Measurement mode (S-parameters, noise figure, etc.)
- Frequency range
- Source 1 power level setting
- Source 2 power level setting, if applicable
- Number of data points used
- Number of channels displayed
- Type of graph type displayed
- Sequence of key presses preceding the onset of problem, if applicable
- Data plots showing the problem

Please provide the above information to the Service Support Engineer when contacting the factory.

6-6 MEASUREMENT QUALITY PROBLEM

If the MS462XX measurement quality is suspect, the following paragraphs provide guidelines and hints for determining possible measurement quality problems.

The quality of the MS462XX measurements is determined by the following test conditions and variables:

- Condition of the MS462XX
- Quality and condition of the interface connections and connectors
- Quality and condition of the calibration components, throughlines, adapters, and fixtures
- Surrounding environmental conditions at the time of the measurement
- Selection and performance of the calibration for the DUT being measured

Measurement Conditions Check

When determining possible measurement problems, check the DUT and the calibration conditions:

1. Ensure that the proper calibration was accomplished for the device being measured.

   For high insertion loss device measurements, the calibration should include isolation, high number of averages and lower IF Bandwidth setting during calibration.

   For low-loss device measurements, the calibration should also include a sliding load calibration, if possible.

2. Check DUT mating connector(s) condition and pin depth.
3. Measure an alternate known good DUT, if possible.
4. Check if the environment is stable enough for the accuracy required for the DUT measurement.
5. Check that the system has not been subjected to greater-than-specification variations in temperature.
6. Check that the system has not been placed in direct sun light or next to a changing cooling source, such as a fan or air conditioning unit.
7. Check the calibration using known good components from the calibration kit. If measurements of these devices do not produce good results, perform Steps 8 and 9.
8. Check the throughline cable stability, including condition and pin depth. Replace with a known good cable, if necessary.
9. Check the condition and pin depth of the calibration kit components. Replace them with known good components, if necessary.
10. Check the system performance as follows:
    - Perform the Signal Path Tests that are part of the Operational Test.
    - Perform the Performance Verification Test.

6-7 NOISE FIGURE MEASUREMENT PROBLEM

This section describes some commonly encountered noise figure measurement problems and their solutions.

Problem The NOT ALLOWED error message is displayed when selecting NOISE FIGURE WITH 12 TERM under the PERFORM CAL menu:

Solution Perform a new 12-term S-parameter calibration between 50 MHz and 6 GHz (50 MHz and 3 GHz with Option 4).

Noise Figure is only available between 50 MHz and 6 GHz. S-parameter calibrations outside this frequency range generates the NOT ALLOWED error message.

Problem Negative Noise Figure:

Solution Use the same Source Power setting in both the Transmission/Reflection and Noise Figure setup.

Account for a calibration performed with loss and later removed for the measurement.

Problem NOISE FIGURE OVERLOAD error message displayed:

Solution DUT has too much gain (typically >30 dB). Use an attenuator to reduce the input power to Port 2.

Try using a 5 dB ENR Noise Source.

Problem Significant difference between Internal and External Noise Source measurement:

Solution

1. Check for the presence of the Internal ENR Extension Table file (Nxxxxx.EXT).
2. Check the Nxxxxxx.nfx External ENR Extension Table file if additional length is inserted between Port 1 (Internal ENR Extension Table reference plane) and DUT.
3. If the External ENR Extension Table does not exist, it can be generated internally by measuring the S-parameters of the extension cable, creating a “s2p” file and then changing the file extension to “nfx” by using an external Personal Computer.

Problem Noise Figure response contains irregular discontinuities:

Solution Try the Narrow Bandwidth Measurement Mode.

Perform a Back-end Attenuator calibration (refer to Chapter 5).

> ***NOTE***
> The irregularity may be caused by contamination (other signals) in the environment and the spurious response of the DUT.

Problem Noise Figure response contains too many ripples:

Solution Turn Noise Figure Averaging on.

Try using a 15 dB ENR Noise Source.

> ***NOTE***
> The problem may be caused by the very poor matches of DUT or a passive DUT. The second stage calculations are less accurate when measuring Noise Figure for a passive device.

Problem Fails the Noise Figure Assurance Check:

Solution Perform a Back-end Attenuator calibration (refer to Chapter 5).

Replace the Option Module.

Problem Fails the Raw Receiver Noise Figure Check:

Solution Check the setup connections:

1. Check the Noise Source ENR Table stored on the instrument. Refer to the MS462XX Scorpion Measurement Guide (P/N: 10410-00213) for instructions on how to create a new ENR Table file.

2. Check the Internal ENR Extension Table stored on the instrument. Refer to Chapter 5, Section 5-8 of this manual, for instructions on how to create a new Internal ENR Extension Table file.

3. If the instrument fails this test in Wideband External Noise Source Mode, but passes the Noise Figure Assurance Test, try another Noise Source.

> ***NOTE***
> A new Noise Source Vendor ENR Table must be loaded into the instrument prior to using a new noise source.

4. If the instrument fails this test in Wideband Internal Noise Source Mode, but passes the test in External Noise Source Mode and the Internal ENR Extension Table is okay, replace the Port 1 Switch Module.

Problem Fails the Noise Figure Measurement Confidence Check:

Solution Perform a Back-end Attenuator calibration (refer to Chapter 5).

Replace the Option Module.

Problem Others:

Solution Consult the factory.

When consulting the factory with Noise Figure Measurement problems, please provide the following:

- ❑ S-parameter data
- ❑ Noise Figure and Gain data
- ❑ Y-Factor data
- ❑ Sketch of a block diagram of the test setup
- ❑ DUT specifications
- ❑ Scorpion instrument settings:
  Transmission/Reflection—Frequency, Source Power, IFBW, and Averaging
  Noise Figure—Frequency, DUT Bandwidth, Noise Source Location, Source Power, Noise Figure Averaging

6-8 FREQUENCY TRANSLATING GROUP DELAY MEASUREMENT

The measurement process consists of generating the modulating signal, modulating the source, demodulating the received signal, and performing the phase comparison. The modulating signal is generated in the Option Module and is fixed at 453.125 kHz. The modulating signal is input to J5 of the Source Module 1 to modulate the source signal.

The demodulating of the received signal is done in the Option Module.

The phase comparison is done in the DSP section of the Receiver PCB.

If the instrument fails the Frequency Translating Group Delay test, replace the assemblies in the following order:

1. Option Module
2. Source Module 1
3. Receiver PCB

> ***NOTE***
> The Option Module is also used to perform a Noise Figure Measurement. Perform a Noise Figure Measurement calibration and operational check if the Option Module is replaced.

Chapter 7
Removal and Replacement Procedures

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Chapter 7
Removal and Replacement Procedures

7-1 INTRODUCTION

CAUTION

The procedures in this chapter should be performed by qualified technical personnel only. These procedures may require access to internal components, and care should be taken to avoid contact with potentially hazardous voltages or damage from static electricity.

It is strongly recommended that MS462XX Vector Network Measurement System repair be performed by qualified technical personnel only. The MS462XX Vector Network Measurement System modular design, extensive built-in diagnostics, and automated service tools are designed to support fast exchange of functional assembly level repairs.

Most components in the MS462XX Vector Network Measurement System can be removed and replaced as modules, and are designed to easily slide in and out of the main cabinet. Each component connects to the system through the rear panel back plane PCB connectors, and to other components through coax or other cables. Always make note of the position and orientation of any cables removed when disassembling system components.

Failed assemblies are not field repairable. Once an assembly is found to be faulty, it should be returned to an authorized Anritsu Service Center for exchange.

Always verify the need for a component replacement using the troubleshooting guidelines presented in Chapter 6. Repair or replacement in the field to a level beyond the subassemblies listed in this chapter is not recommended.

Refer to Section 1-8 for a listing of spare parts mentioned in this chapter. Contact your nearest Anritsu Customer Service or Sales Center for price and availability information.

7-2 FRONT PANEL

The MS462XX Vector Network Measurement System front panel assembly contains the following subassemblies (refer to Section 1-8 for a part number listing):

- ❑ Floppy Disk Drive Assembly
- ❑ Front Panel Interface PCB with Keypad
- ❑ LCD Assembly
- ❑ LCD Backlight PCB
- ❑ LCD Backlight Lamp

Tools Required:

- ❑ Phillips screwdriver
- ❑ 5/16” nut driver

Procedure:

1. Remove the AC power cord.
2. Remove the two front panel handles by removing the green screws from both handles using a Phillips screwdriver.

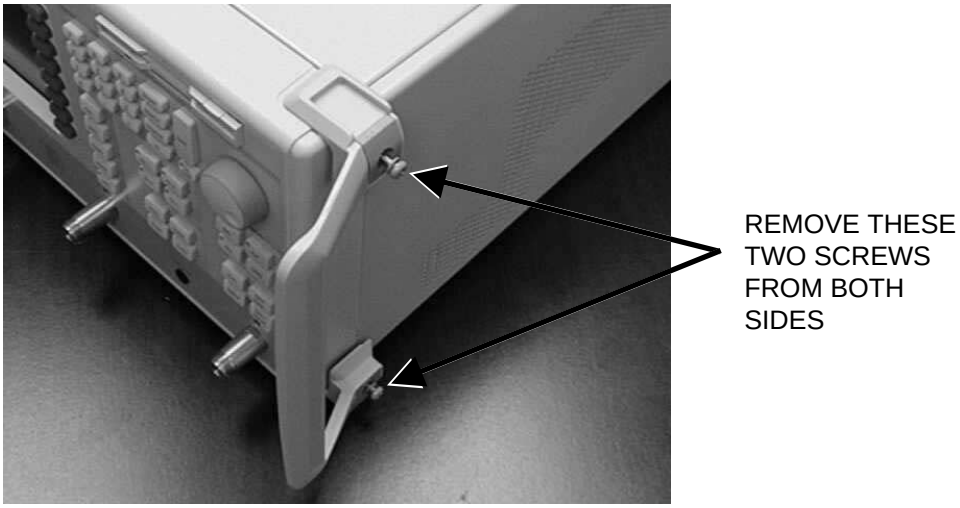

Figure 7-1. *Front Panel Handle Removal*

> ***NOTE***
> The green screws are metric thread screws. Do not attempt to use any other type of screw in these mounting holes.

3. Remove the four front panel mounting screws, two on each side.
4. Carefully pull the Front Panel assembly straight out from the instrument case. Note that there are cables connecting the front panel to the instrument. Do not stress these cables.

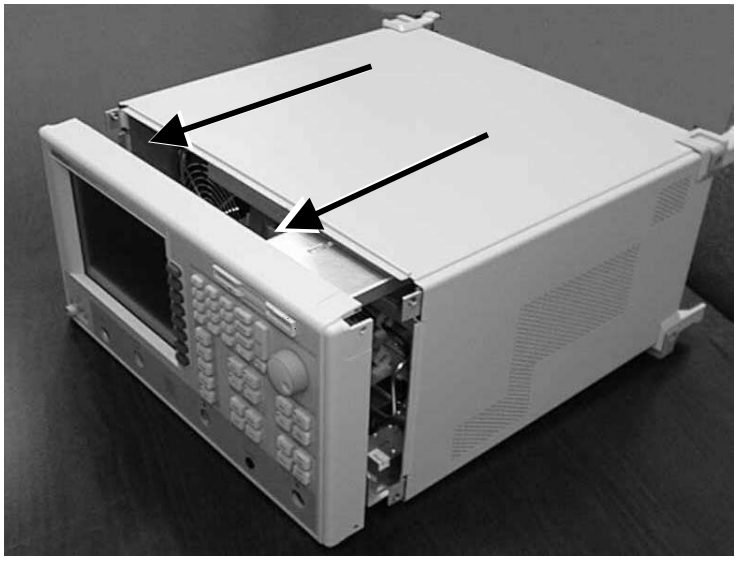

Figure 7-2. *Front Panel Removal*

To completely remove the front panel from the instrument:

5. Disconnect the floppy disk drive interface cable.
6. Disconnect the front panel interface PCB ribbon cable.
7. Disconnect the LCD flex cable from the CPU.

> ***CAUTION***
>
> Connecting and disconnecting the connector at the LCD display interface creates a stress that can cause damage to the LCD display. When connecting or disconnecting the LCD flex cable, place a finger into the gap between the LCD display and the front panel PCB assembly to provide support for the LCD display.

8. Disconnect the LCD Backlight PCB cable.

The front panel subassemblies can now be removed and replaced as necessary, as described in the follow sections.

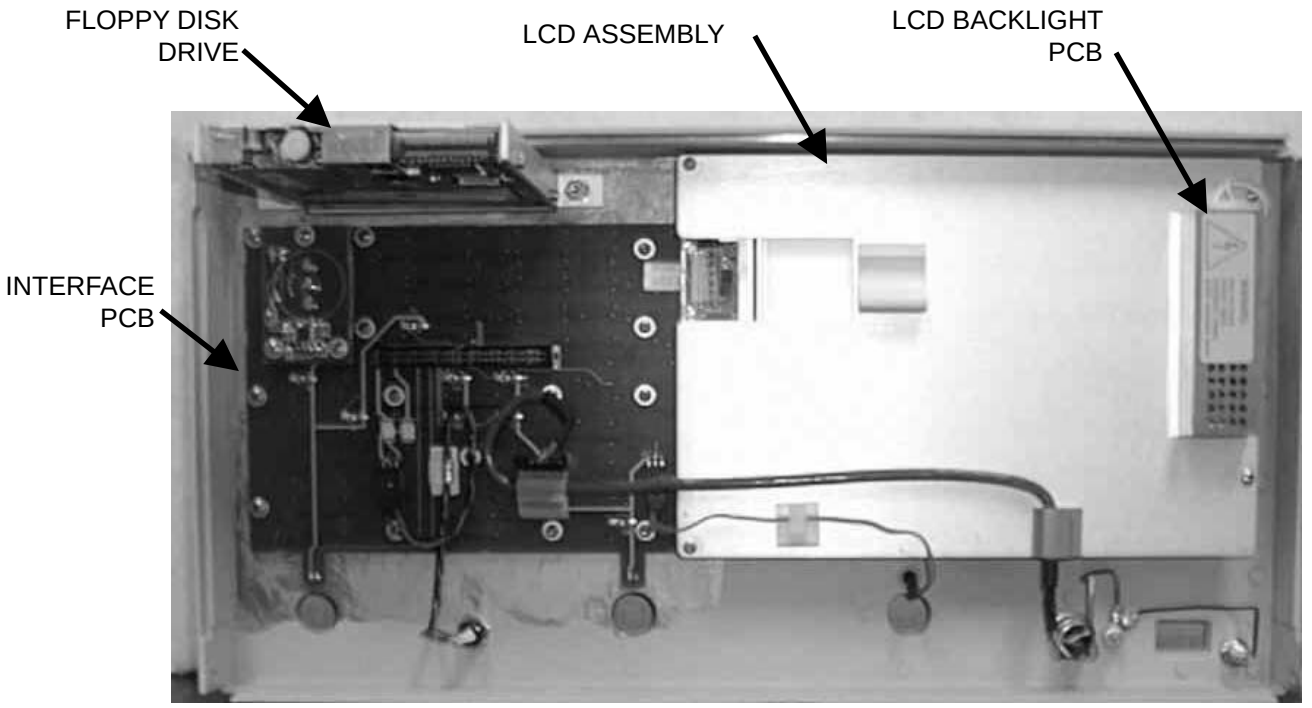

Figure 7-3. *Front Panel Components*

Floppy Disk Drive Assembly

To remove the floppy disk drive, remove the drive with the mounting brackets attached.

9. Using a 5/16” nut driver, remove the two mounting nuts that secure the drive assembly to the front panel.

10. Using a Phillips screwdriver, remove the two side mounting brackets from the drive. Retain the brackets and screws for reuse on the new drive.

Reverse the procedure to install the new drive.

LCD Assembly

The Liquid Crystal Display assembly is secured to the front panel by four Phillips screws. Retain the screws for reuse with the new assembly. The LCD Backlight PCB is secured to the LCD assembly back plate, and is removed with it.

11. Remove the keyboard interface cable and Port 3 LED cable from the routing clips on the display module, if required. Newer instruments have the Port 3 LED located on the Front Panel PCB.

12. Remove the four Phillips screws that secure the LCD assembly to the front panel.

13. Carefully remove the LCD assembly, leaving the LCD window and gasket in place on the front panel.

14. Separate the LCD module from the backing plate. If necessary, remove the LCD backlight PCB from the plate (refer to the procedure below).

Reverse the procedure to install the new LCD assembly.

LCD Backlight Driver PCB

The LCD backlight driver PCB is secured to the LCD assembly back plate, and is removed with it. The LCD assembly must be removed from the front panel before the LCD backlight Driver PCB can be removed and replaced.

15. Remove the LCD assembly (see procedure above).

16. Disconnect the cable from the top end of the LCD backlight driver PCB.

17. Separate the LCD module from the backing plate and remove the LCD backlight driver PCB cover from the plate by releasing the tabs through the back plate.

18. Remove the LCD backlight driver PCB by removing the two Phillips screws that secure the PCB to the back plate.

Reverse the procedure to install the new LCD backlight driver PCB.

Interface PCB

The Interface PCB with the keypad is secured to the front panel with 15 Phillips screws. The LCD assembly must be removed from the front panel before the Interface PCB can be removed and replaced.

19. Remove the front panel encoder knob.

20. Remove the LCD assembly (see procedure above).

21. Remove the 15 screws securing the Interface PCB to the front panel assembly.

22. Carefully remove the Interface PCB and keypad.

Reverse the procedure to install the new Interface PCB.

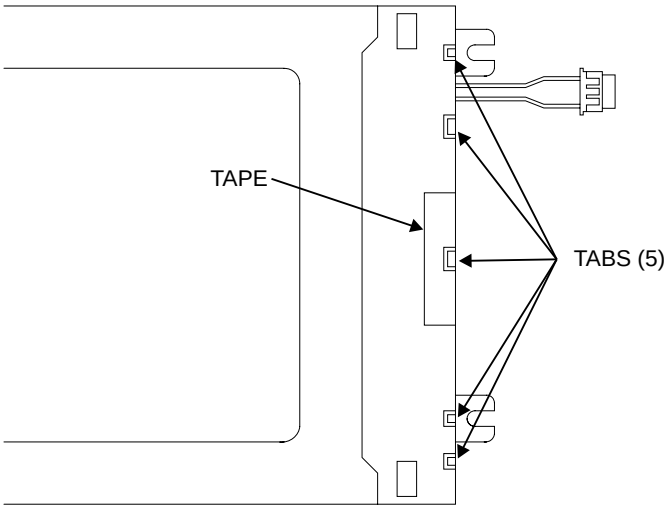

Figure 7-4. *Backlight Lamp Removal*

Backlight Fluorescent Lamp

The Backlight Fluorescent Lamp is secured to the LCD assembly. The LCD assembly must be removed from the front panel before the Backlight Fluorescent Lamp can be removed and replaced. Refer to Section 1-10 for more information on the LCD backlight lamps.

> ***NOTE***
> This procedure is for the Anritsu LCD assembly number 15-92 only (Sharp P/N: LQ9D340). The lamp used in the Anritsu LCD assembly number 15-100 (Sharp LQ084V1DG21) is not replaceable.

> ***CAUTION***
>
> Take care not to damage the tabs, as they can be fragile.

> ***CAUTION***
>
> Use care when installing the lamp. Do not apply pressure to the fragile area where the glass tube and the end caps of the lamp meet.

23. Remove the LCD assembly from the front panel (refer to the procedure above).
24. Separate the LCD module from the backing plate.
25. The backlight fluorescent lamp is held to the LCD assembly by tabs. Peel off the tape that covers the center tab (Figure 7-4).
26. Use a small flat screw driver to push the five holding tabs clear of the notches on the Backlight Lamp cover.
27. Carefully lift the cover while holding all of the tabs clear.
28. Replace the existing Backlight Lamp with a new lamp (part number 632-55).

7-3 POWER DISTRIBUTION UNIT

The PDU is mounted inside the main cabinet and secured using two screws through the rear panel.

Tools Required: Phillips screwdriver

Procedure:

1. Remove the AC power cord.
2. Remove the front panel (refer to Section 7-2).
3. Remove the two Phillips screws that secure the PDU to the system back panel.

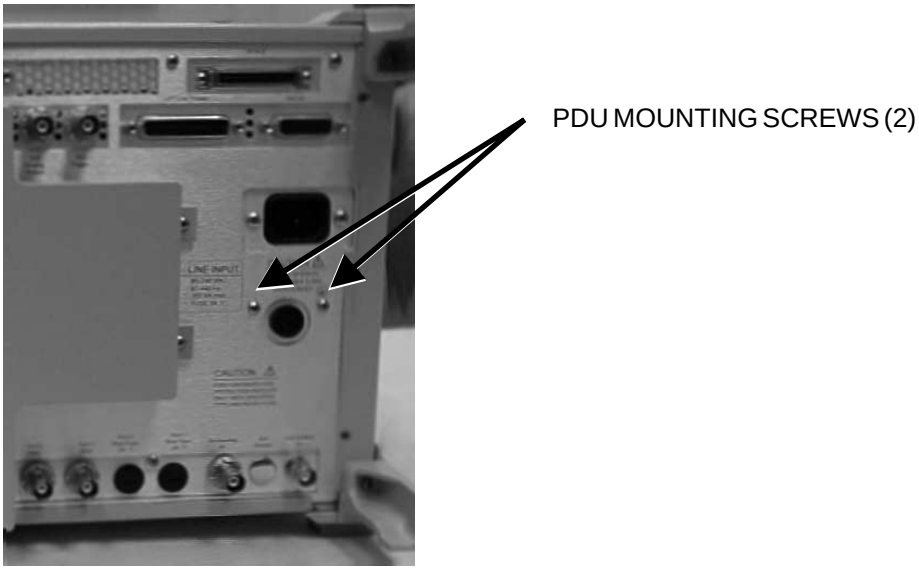

Figure 7-5. *PDU Mounting Screws*

4. Carefully pull the PDU straight out from the front of the unit, as shown in Figure 7-6 on the following page.

Figure 7-6. *PDU Removal*

Replacement is the opposite of removal.

Fan Assembly Replacement: The fan assembly (ND49520) is mounted on the PDU, and can be replaced separately after the PDU is removed from the instrument.

Tools Required: Phillips screwdrivers (straight and right angle offset)

> ***CAUTION***
>
> The PDU fan replacement assembly (ND49520) does not include the safety guard. The safety guard must be removed from the old fan assembly and installed on the new fan assembly. Failure to do so may result in a hazardous condition.

1. Using a straight Phillips screwdriver, remove the 12 screws (4 on each side, 4 along the back) that secure the PDU cover. Remove the PDU cover.
2. Unplug the fan assembly power cord from the PDU connector P2 and remove the tie wraps that secure the fan power cord.
3. Using a right angle offset Phillips screwdriver, remove the four screws that secure the fan assembly to the PDU.
4. Using a straight Phillips screwdriver, remove the four screws and nuts that secure the safety guard to the old fan assembly.
5. Install the safety guard on the new fan assembly using the same screws and nuts removed in the previous step.
6. Plug the new fan assembly power cord into the PDU connector P2 and secure the cord as before.
7. Replace the PDU cover and screws.
8. Install the fan assembly onto the PDU using the screws removed above.

PDU Fuse The MS462XX contains three fuses, two internal and one external. The external, rear-panel-mounted fuse is rated at 5A, 250V, F (quick acting). It is designed to blow first in the event of an over-current condition. Of the two internal fuses, one is rated at 6.3A, 250V, F (quick acting), and the other at 15A, 32Vdc (automotive type). Neither of the internal fuses are replaceable at the field level, as they are mounted inside the power distribution unit. Internal fuse information is provided for reference only.

Procedure:

1. Remove the AC power cord.
2. Remove the fuse holder from the back panel by turning it 1/4-turn counterclockwise.

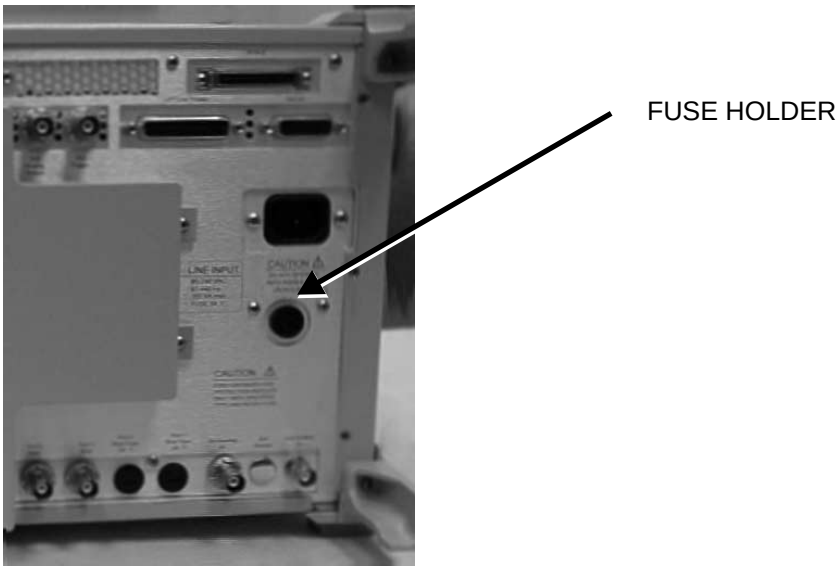

Figure 7-7. *PDU Fuse Location*

3. Replace the fuse and reinstall the fuse holder.

7-4 CPU ASSEMBLY

The CPU assembly is the topmost assembly in the cabinet and is secured by four screws through the rear panel. The front panel must be removed to allow access to the CPU assembly.

Tools Required: Phillips screwdriver

Procedure: Follow the instructions that are packaged with the replacement CPU.

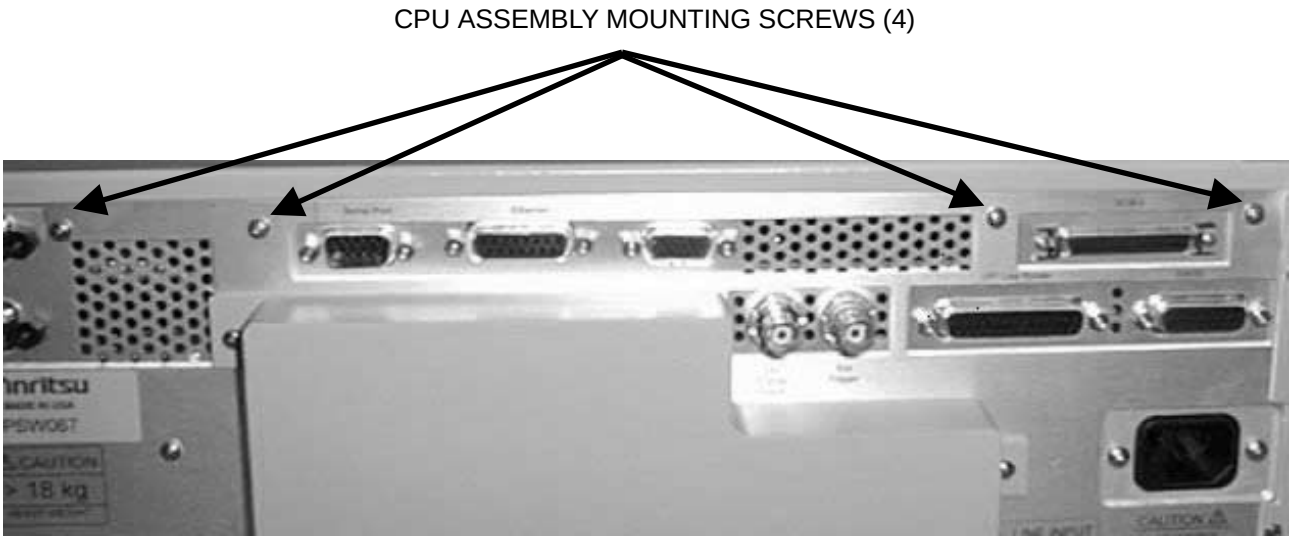

Figure 7-8. *CPU Assembly Mounting Screws*

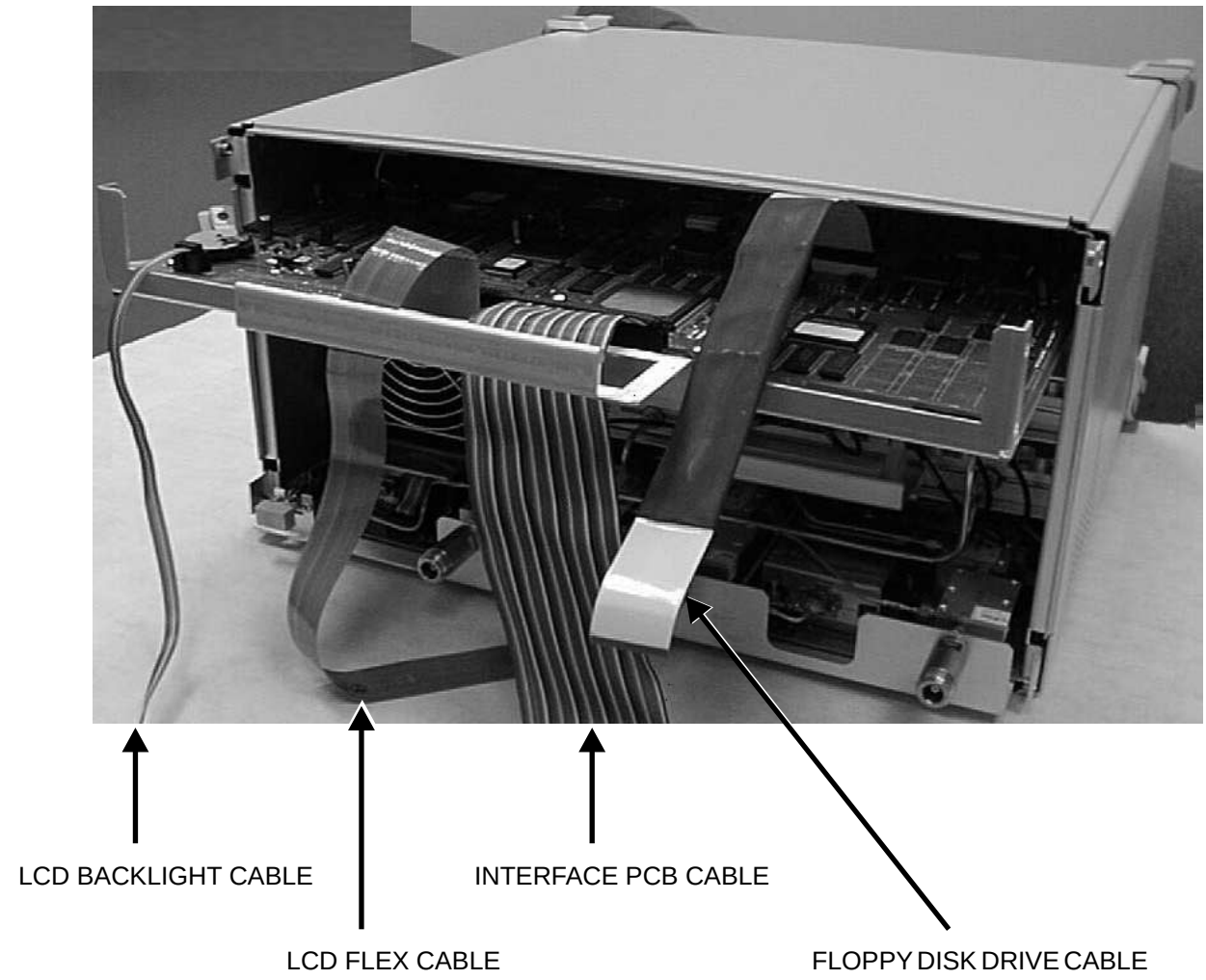

Figure 7-9. *CPU Assembly Removal and Cables*

With the CPU assembly removed from the system, the following subassemblies can be removed and replaced:

System Firmware PROM The system operating firmware is stored in the System Firmware PROM (U75). The PROM may be changed to update or repair the system firmware as necessary.

Tools Required: PLCC IC Removal/Insertion Tool

Procedure: Locate and remove the System Firmware PROM (location 14 below) using the PLCC IC Removal Tool.

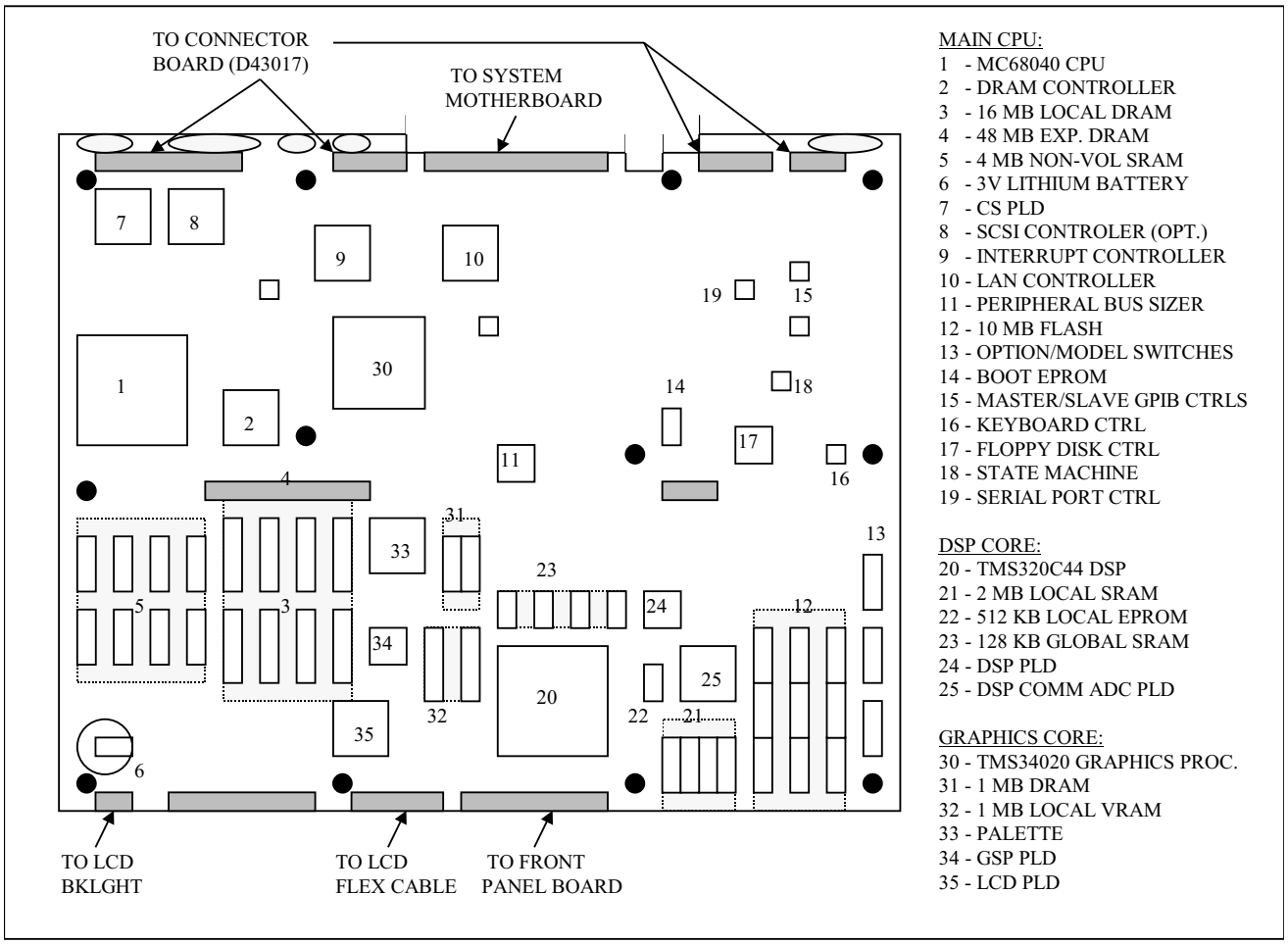

Figure 7-10. *CPU Assembly Part Locator*

Replacement is the opposite of removal.

CPU Heatsink with Fan

The system CPU is protected by a thermal heat sink and fan combination. The heatsink with fan may be replaced as necessary.

Tools Required:

None

Procedure:

Locate and remove the CPU heatsink and fan assembly (location 1, Figure 7-10).

Replacement is the opposite of removal.

Lithium Battery

The system battery should be replaced every three years, or as necessary.

Tools Required:

None

Procedure:

Prior to replacing the CPU battery, it is important to copy all the hard drive files to floppy disks for temporary storage. Generally, one 1.44 MByte floppy disk will be sufficient.

Use the following procedure to copy all the files from the internal hard drive. An external keyboard connected to the MS462XX will make the procedure easier:

1. To view the contents of the internal SRAM disk, press the Utility key, then select:

   GENERAL DISK UTILITIES

   DISPLAY DIRECTORY

   Note if there is any sub-directory.

2. Press the COMMAND LINE soft key.

3. Insert a blank formatted floppy disk into the MS462XX floppy drive.

4. Use the external keyboard to type:

   COPY C:*.* A:

5. Press the Enter key on the external keyboard to execute the copy command.

6. If there is sub-directory on the SRAM disk, type:

   CD C:\directory name

7. Repeat Steps 4 and 5 to copy the files in the sub-directory.

8. If the instrument is fitted with Option 4X, press the Appl key and select:

   CHANGE APPLICATION SETUP

   MEASUREMENT TYPE TRANSMISSION AND REFLECTION

   NOISE FIGURE / NOISE FIGURE SETUP

   ENR TABLE OPERATIONS

   SAVE ENR TABLE

   TO FLOPPY DISK

9. Save the following three files to floppy disk:

   - Vendor ENR Table
   - Internal ENR Extension Table
   - External ENR Extension Table

   NOTES

   Some of the ENR files may have been stored on the hard disk; however, ENR files are not normally stored on the hard disk. The External ENR Extension Table file will only exist if it has been created by the user. To completely backup all the files on the hard disk, it is essential that all of the previous steps be completed.

10. Remove the CPU board from the instrument as described in Section 7-4.

11. Remove the drops of RTV compound which hold the lithium battery in place. Gently slide the battery sideways (gently lift up on the retaining clip only a small since excess lifting will reduce contact pressure on the new battery).

12. Install a new battery and hold it in place with three drops of RTV compound, as before.

13. Reassemble the instrument.

14. Turn the instrument ON and press UTILITY MENU and select FORMAT HARD DRIVE.

15. After formatting the hard drive, reload all files from the floppy disk back onto the hard drive.

16. If the instrument is fitted with Option 4X, press the Appl key, select:

    CHANGE APPLICATION SETUP

    MEASUREMENT TYPE TRANSMISSION AND REFLECTION

    NOISE FIGURE

    NOISE FIGURE SETUP

    ENR TABLE OPERATIONS

    LOAD ENR TABLE

    FROM FLOPPY DISK

17. Load the files that were saved to the floppy disk in Step 9 (Vendor ENR Table, Internal ENR Extension Table, and optional External ENR Extension Table).

> ***NOTE***
> It is not sufficient to simply save these files to the hard drive. They must be loaded using the method described in this section.

The battery replacement operation is complete

7-5 RECEIVER MODULE ASSEMBLY

The receiver assembly is the bottom assembly in the cabinet and is secured by two screws through the rear panel. The front panel must be removed to allow access to the receiver assembly.

Tools Required: Phillips screwdriver

Procedure:

1. Remove the AC power cord.
2. Remove the front panel assembly (refer to Section 7-2).
3. Disconnect any cables connecting the option or source module to the receiver module in the instrument. Make note of the position and orientation for all of the cables removed.
4. Remove the two rear panel mounting screws that secure the receiver module (Figure 7-11).

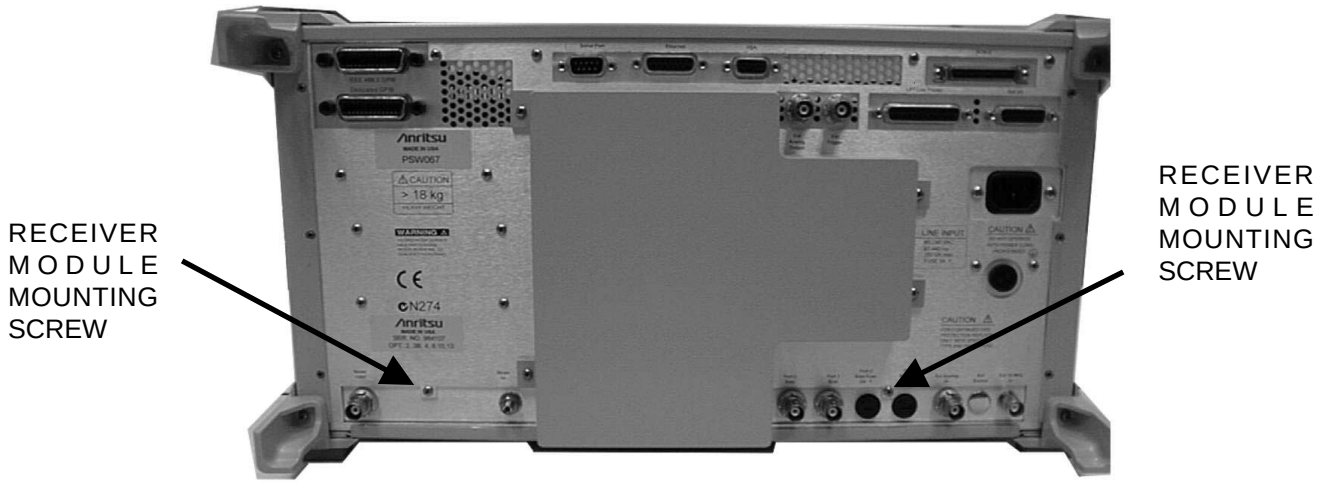

Figure 7-11. *Receiver Module Mounting Screws (2)*

5. Carefully pull the receiver module straight out from the front of the instrument (Figure 7-12).

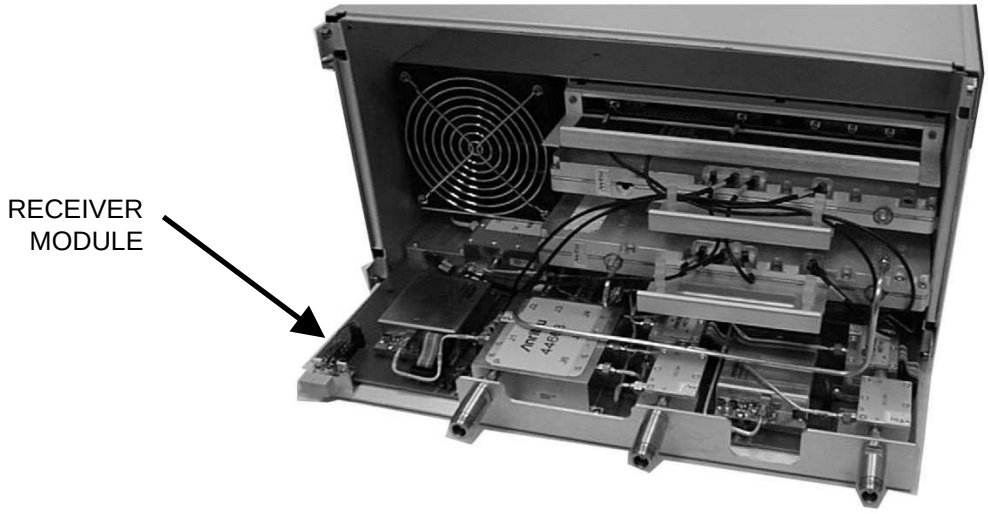

Figure 7-12. *Receiver Module Removal*

Replacement is the opposite of removal.

> ***NOTE***
> Individual modules mounted on the Receiver Assembly may vary according to the configuration of a particular system.

7-6 TEST PORT CONNECTOR AND PORT MODULE

The following procedure describes the proper steps to remove and install the Test Port Connector and Port Module.

Tools Required:

- ❑ Anritsu 01-202 universal adapter wrench
- ❑ 5/8” open end wrench
- ❑ 5/8” open end torque wrench, 120 in-lb
- ❑ 5/16” open end torque wrench, 8 in-lb

Removal Procedure:

1. Remove the Port Module mounting screws from the receiver PCB.
2. Loosen the RF cables connected to the Port Module.
3. Loosen the K connection between the Port Module and the Test Port Connector and carefully slide the Port Module backward. Remove the Port Module.
4. Use the 5/8” open end wrench to loosen the Test Port connector mounting nut. This nut is on the back side of the Test Port connector.
5. Remove the Test Port Connector.

Installation Procedure:

1. Install the Test Port Connector through the D-shape hole on the Receiver metal tray.
2. Install the Test Port connector mounting nut and tighten the nut slightly.
3. Place the Port Module with the “P” port facing the Test Port connector. Connect the Port Module “P” port to the Test Port connector. Make the connection finger tight and then loosen a quarter turn. While making the connection, keep the Port Module flat against the receiver PCB and be careful not to damage the center pin of the Port Module “P” port connector.
4. Install the Port Module mounting screws only far enough to hold the module flat but still allowing some movement front to back.
5. Use the 5/8” wrench on the Test Port connector mounting nut, while using the universal adapter wrench in front to hold the Test Port connector still. Tighten the mounting nut as tight as you can while holding the Port Module flat against the receiver PCB with your other fingers.
6. Use the 5/8” torque wrench to tighten the mounting nut to 120 in-lb.

7. Use the 5/16” torque wrench to tighten the connection between the Test Port connector and the Port Module to 8 in-lb.

8. Tighten the Port Module mounting screws.

7-7 OPTION AND SOURCE MODULES

The MS462XX Vector Network Measurement System option and source modules are secured by Phillips screws through the rear panel. The front panel and the Receiver Module Assembly must be removed to allow removal of the option and source modules. There are three modules referred to in this procedure: The A2 Option Module, the Option Source Module, and the Source Module.

Tools Required: Phillips screwdriver

Procedure:

1. Remove the AC power cord.

2. Remove the front panel assembly (refer to Section 7-2).

3. Disconnect any cables connecting the option or source module to the other modules in the instrument. Make note of the position and orientation of all cables removed.

4. Remove the Receiver Module Assembly (refer to Section 7-5).

5. Remove the rear panel mounting screws for the Option or Source Module to be removed (Figure 7-13 on the following page).

6. For the main Source Module, remove the backplane cover and the two Phillips flat head screws near the backplane PCB.

7. Carefully pull the option or source module straight out from the front of the instrument (Figure 7-14 on the following page).

Replacement is the opposite of removal.

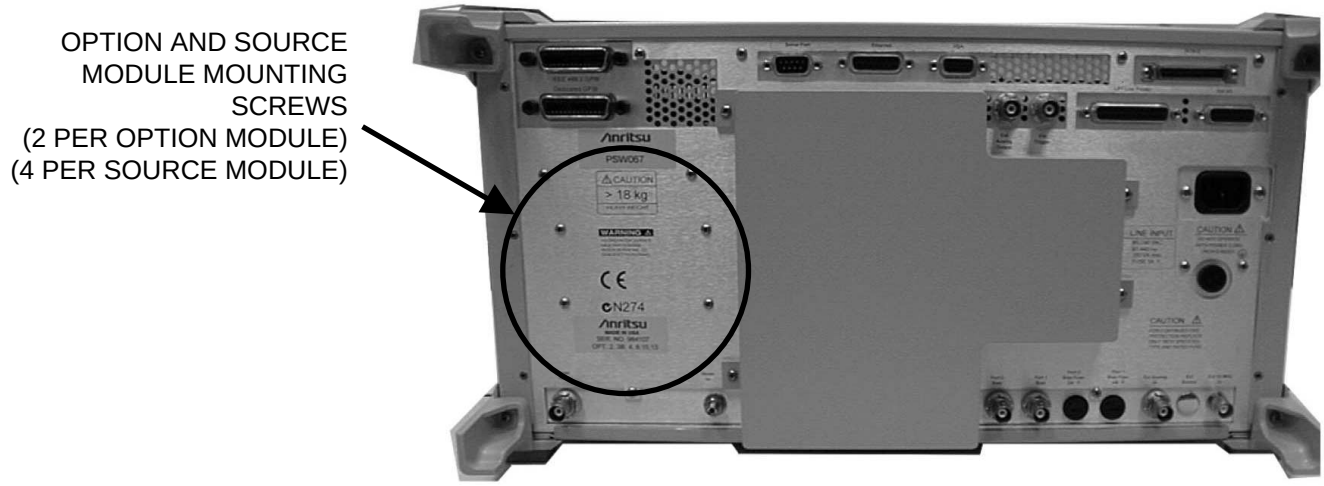

Figure 7-13. *Option and Source Module Mounting Screws*

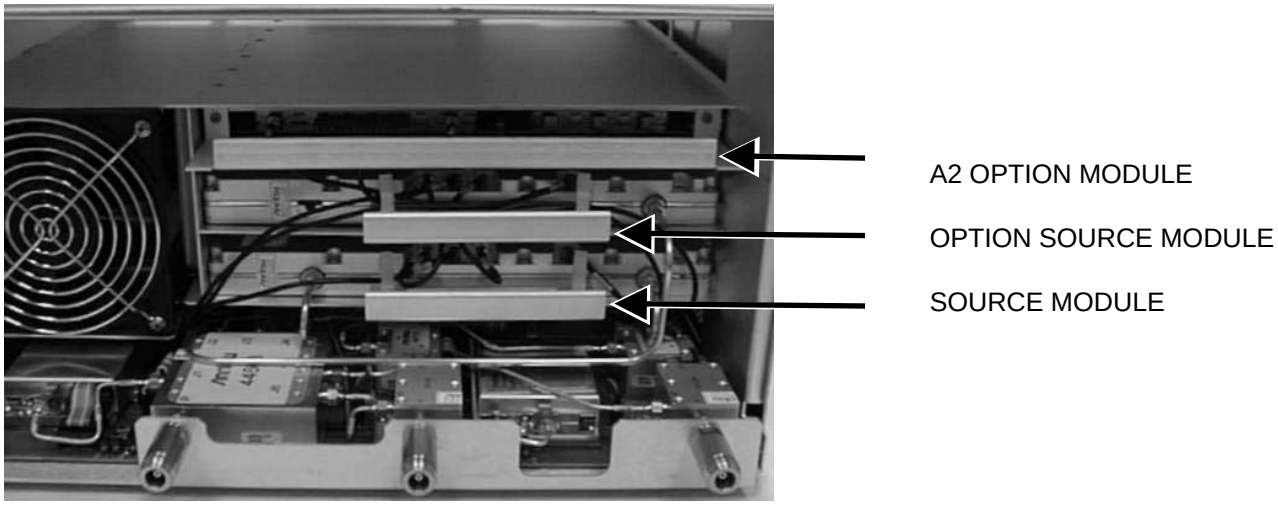

Figure 7-14. *Option and Source Module Removal*

7-8 BACKPLANE PCB ASSEMBLY

The backplane PCB assembly is mounted to the rear panel of the cabinet and is secured by 18 screws. The PCB is protected by the backplane PCB cover that is mounted to the rear panel by four screws. Each of the inside modules plug into the backplane PCB and must be removed before removing the backplane PCB.

Tools Required: Phillips screwdriver

Procedure:

1. Remove the AC power cord.
2. Remove the front panel assembly (refer to Section 7-2).
3. Remove the CPU assembly (refer to Section 7-4), the Power Distribution Unit (refer to Section 7-3), the Option and Source modules (refer to Section 7-7), and the Receiver assembly (refer to Section 7-5).
4. Remove the backplane PCB cover that is mounted to the rear panel by four screws (Figure 7-15).

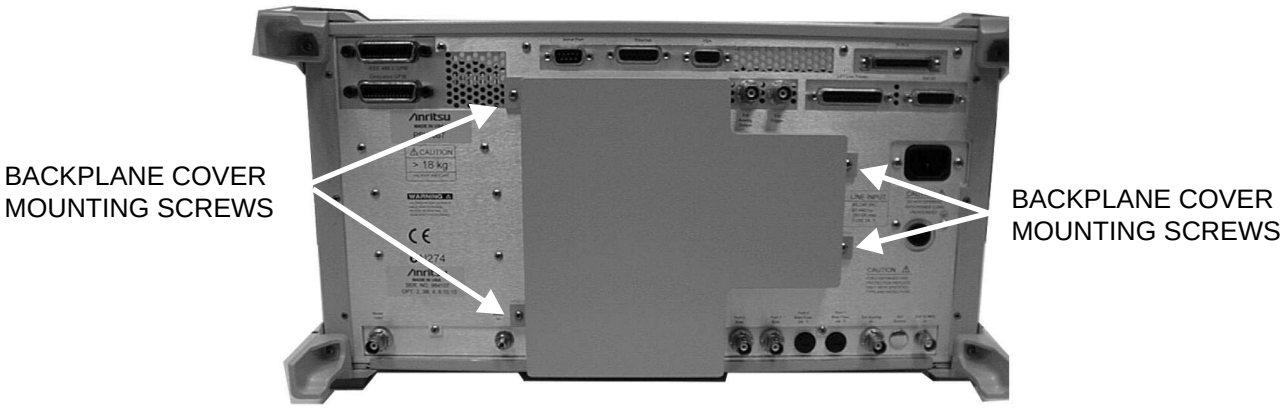

Figure 7-15. *Backplane PCB Cover*

5. Remove the backplane PCB mounting screws (Figure 7-16).

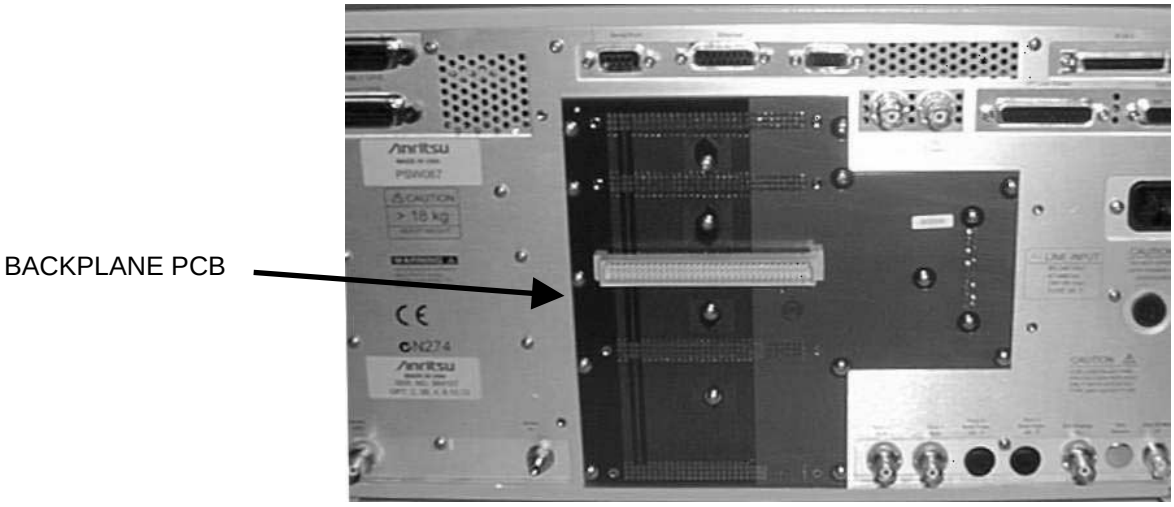

Figure 7-16. *Backplane PCB Removal*

Replacement is the opposite of removal.

Appendix A
Connector Care and Handling

Table of Contents

Appendix A
Connector Care and Handling

A-1 INTRODUCTION

This appendix provides information on the proper care and handling of RF sensor connectors.

A-2 CONNECTOR CARE AND HANDLING

Anritsu Vector Network Measurement Systems are high-quality, precision laboratory devices and should receive the care and respect normally afforded such devices. Follow the precautions listed below when handling or connecting these devices. Complying with these precautions will guarantee longer component life and less equipment downtime due to connector or device failure. Also, such compliance will ensure that Vector Network Measurement System failures are not due to misuse or abuse—two failure modes not covered under the Anritsu warranty.

Beware of Destructive Pin Depth of Mating Connectors.

Based on RF components returned for repair, destructive pin depth of mating connectors is the major cause of failure in the field. When a RF component connector is mated with a connector having a destructive pin depth, damage will usually occur to the RF component connector. A destructive pin depth is one that is too long in respect to the reference plane of the connector (Figure A-1).

The center pin of a precision RF component connector has a precision tolerance measured in mils (1/1000 inch). The mating connectors of various RF components may not be precision types. Consequently, the center pins of these devices may not have the proper depth. The pin depth of DUT connectors should be measured to assure compatibility before attempting to mate them with a Vector Network Measurement System or sensor connectors. An Anritsu Pin Depth Gauge (Figure A-2), or equivalent, can be used for this purpose.

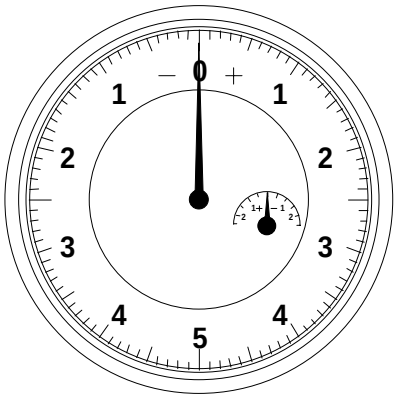

Figure A-1. *Pin Depth Gauge*

If the measured connector is out of tolerance in the "+" region of the outer scale, the center pin is too long (see Table A-1). Mating under this condition will likely damage the precision RF component connector. If the test device connector measures out of tolerance in the "–" region, the center pin is too short. This should not cause damage, but it will result in a poor connection and a consequent degradation in performance.

Table A-1. *Allowable Test Port Connector Pin Depth*

Test Port Connector Type	Pin Depth (Inches)	Pin Depth Gauge Reading* (Inches)
N-Male	0.208 to 0.215	–0.001 –0.008
N-Female	0.204 to 0.207	+0.000 –0.003
3.5 mm Male and Female	0.000 to –0.005	+0.000 –0.005
GPC-7	0.000 to –0.003	+0.000 –0.003

***** N connector readings are based on the Anritsu N-type guage block of 0.207-inches.

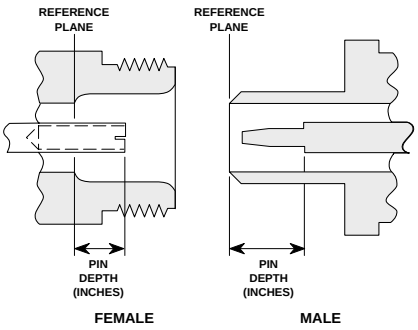

Figure A-2. *N Connector Pin Depth Definition*

Avoid Over-Torquing Connectors

Over-torquing connectors may damage the connector center pin. Finger-tight is usually sufficient for Type N connectors. Always use a connector torque wrench (8 inch-pounds) when tightening 3.5 mm type connectors. Never use pliers to tighten connectors.

Cleaning Connectors

The precise geometry that makes the RF component's high performance possible can be easily disturbed by dirt and other contamination adhering to the connector interfaces. To clean the connector interfaces, use a clean cotton swab that has been dampened with denatured alcohol.

> ***NOTE***
> Most cotton swabs are too large to fit in the smaller connector types. In these cases, it is necessary to peel off most of the cotton and then twist the remaining cotton tight. Be sure that the remaining cotton does not get stuck in the connector. Cotton swabs of the appropriate size can be purchased through a medical laboratory-type supply center.

The following are some important tips on cleaning connectors:

- Use only denatured alcohol as a cleaning solvent.
- Do not use excessive amounts of alcohol as prolonged drying of the connector may be required.
- Never put lateral pressure on the center pin of the connector.
- If installed, do not disturb the Teflon washer on the center conductor pin.
- Verify that no cotton or other foreign material remains in the connector after cleaning it.
- If available, carefully use compressed air to remove foreign particles and to dry the connector.
- After cleaning, verify that the center pin has not been bent or damaged.

Appendix B
Performance Specifications

Click here for the Anritsu documents web page.

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