

Maintenance Manual

LMR Master S412E

**Vector Network Analyzer
500 kHz to 1.6 GHz (6 GHz with Option 16)**

**Spectrum Analyzer
9 kHz to 1.6 GHz (6 GHz with Option 6)**

**Signal Generator
500 kHz to 1.6 GHz**

The Anritsu logo is located in the bottom right corner of the page. It consists of the word "Anritsu" in a bold, sans-serif font. The letter "A" is stylized with a diagonal slash through it. The logo is rendered in a dark blue color.

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DECLARATION OF CONFORMITY

Manufacturer's Name: ANRITSU COMPANY

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

declares that the product specified below:

Product Name: LMR Master

Model Number: S412E

conforms to the requirement of:

EMC Directive: 2004/108/EC
Low Voltage Directive: 2006/95/EC

Electromagnetic Compatibility: EN61326:2006

Emissions: EN55011: 2007 Group 1 Class A

Immunity:	EN 61000-4-2:1995 +A1:1998 +A2:2001	4 kV CD, 8 kV AD
	EN 61000-4-3:2006 +A1:2008	3 V/m
	EN 61000-4-4:2004	0.5 kV S-L, 1 kV P-L
	EN 61000-4-5:2006	0.5 kV L-L, 1 kV L-E
	EN 61000-4-6: 2007	3 V
	EN 61000-4-11: 2004	100% @ 20 ms

Electrical Safety Requirement:

Product Safety: EN 61010-1:2001



Eric McLean, Corporate Quality Director

Morgan Hill, CA

6 DEC 2010

Date

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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 the information carefully *before* operating the equipment.

Symbols Used in Manuals

Danger



This indicates a risk from a very dangerous condition or procedure that could result in serious injury or death and possible loss related to equipment malfunction. Follow all precautions and procedures to minimize this risk.

Warning



This indicates a risk from a hazardous condition or procedure that could result in light-to-severe injury or loss related to equipment malfunction. Follow all precautions and procedures to minimize this risk.

Caution



This indicates a risk from a hazardous procedure that could result in loss related to equipment malfunction. Follow all precautions and procedures to minimize this risk.

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



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



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



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



These indicate that the marked part should be recycled.

For Safety

Warning



Always refer to the operation manual when working near locations at which the alert mark, shown on the left, is attached. If the operation, etc., is performed without heeding the advice in the operation manual, there is a risk of personal injury. In addition, the equipment performance may be reduced.

Moreover, this alert mark is sometimes used with other marks and descriptions indicating other dangers.

Warning



or



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

Warning



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

Caution



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.

Warning



This equipment is supplied with a rechargeable battery that could potentially leak hazardous compounds into the environment. These hazardous compounds present a risk of injury or loss due to exposure. Anritsu Company recommends removing the battery for long-term storage of the instrument and storing the battery in a leak-proof, plastic container. Follow the environmental storage requirements specified in the product data sheet.

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Chapter 1 — General Information

1-1 Introduction

This manual provides maintenance instructions for the Anritsu LMR Master S412E.

The information includes:

- [Chapter 1, “General Information”](#)
- [Chapter 2, “Vector Network Analyzer Verification”](#)
- [Chapter 3, “Spectrum Analyzer Verification”](#)
- [Chapter 4, “CW Signal Generator Verification”](#)
- [Chapter 5, “Option Verification”](#)
- [Chapter 6, “Battery Information and Replacement”](#)
- [Chapter 7, “Assembly Replacement”](#)
- [Chapter 8, “Troubleshooting”](#)
- [Appendix A, “Test Records”](#)

Note

Anritsu recommends that you make a copy of the blank test records to document the measurements each time a Performance Verification is performed. Continuing to document this process each time it is performed provides a detailed history of instrument performance, which allows you to observe trends.

Throughout this manual, LMR Master and S412E are used interchangeably to refer to the instrument.

Familiarity with the basic operation of the front panel keys (for example, how to change measurement mode, preset the unit, or the meaning of submenu key or main menu key) is assumed. Refer to the LMR Master S412E User Guide (Anritsu part number 10580-00318) for basic operation information.

1-2 Product Description

The S412E LMR Master is a portable handheld vector network analyzer (VNA), spectrum analyzer (SPA), and signal generator (SG). The VNA features precise performance and essential RF capabilities. It is designed to conduct accurate vector-corrected 1-port magnitude, phase, and fault location measurements and 2-port magnitude, phase, group delay measurements from 500 kHz to 1.6 GHz for the base unit with an option to extend the upper frequency to 6 GHz. The SPA is capable of providing quick and accurate measurement results for monitoring, measuring, and analyzing signal environments. The SPA offers broad spectrum analysis with frequency coverage to 1.6 GHz for the base unit with the option to extend the upper frequency to 6 GHz. The LMR Master offers impressive dynamic range and excellent phase noise performance. Standard measurements include field strength, occupied bandwidth (OBW), channel power, adjacent channel power ratio (ACPR), and carrier to interference (C/I) ratio. The SG allows the user to generate modulated signals from 500 kHz to 1.6 GHz. The amplitude of the signals range from -130 dBm to 0 dBm.

Frequency Ranges

- VNA, 500 kHz to 1.6 GHz (6 GHz with Option 16)
- SPA, 9 kHz to 1.6 GHz (6 GHz with Option 6)
- SG, 500 kHz to 1.6 GHz

1-3 Related Documents

Other documents are available for the S412E at the Anritsu web site at www.anritsu.com

- LMR Master S412E User Guide, PN 10580-00318
- LMR Master S412E Programming Manual, PN 10580-00319
- LMR Master S412E Technical Data Sheet, PN 11410-00486
- Vector Network Analyzer Measurement Guide, PN 10580-00289
- High Accuracy Power Meter Measurement Guide, PN 10580-00240
- Spectrum Analyzer Measurement Guide, PN 10580-00349
- 3GPP Signal Analyzer Measurement Guide, PN 10580-00234
- WiMAX Signal Analyzer Measurement Guide, PN 10580-00236
- Land Mobile Radio Measurement Guide, PN 10580-00243

1-4 Options

- Option 6 - SPA Frequency Extension to 6 GHz
- Option 10 - Built-in Variable Bias-Tee (+12 V to +32 V in 0.1 V steps)
- Option 15 - Vector Voltmeter
- Option 16 - VNA Frequency extension to 6 GHz
- Option 19 - High Accuracy Power Meter (requires external USB Sensor)
- Option 25 - Interference Analysis
- Option 27 - Channel Scanner
- Option 31 - GPS Receiver (GPS antenna 2000-1528-R sold separately)
- Option 37 - Mobile WiMAX Over the Air Measurement
- Option 46 - Fixed WiMAX RF Measurement
- Option 47 - Fixed WiMAX Modulation Quality
- Option 66 - Mobile WiMAX RF Measurement
- Option 67 - Mobile WiMAX Modulation Quality
- Option 431 - Coverage Mapping
- Option 444 - EMF Measurements
- Option 501 - Distance Domain
- Option 509 - AM/FM/PM Analysis
- Option 521 - P25/P25p2 Analyzer and Sig Gen
- Option 522 - P25/P25p2 Coverage
- Option 531 - NXDN Analyzer and Sig Gen
- Option 532 - NXDN Coverage
- Option 541 - LTE RF Measurements
- Option 542 - LTE Modulation Quality
- Option 546 - LTE Over the Air Measurement
- Option 581 - TETRA Analyzer
- Option 582 - TETRA Coverage
- Option 591 - DMR 2 Analyzer and Sig Gen
- Option 592 - DMR 2 Coverage
- Option 721 - PTC Analyzer and Sig Gen
- Option 722 - PTC Coverage

1-5 Anritsu Customer Service Centers

For the latest service and sales information in your area, please visit the following URL:

<http://www.anritsu.com/contact.asp>

Choose a country for regional contact information.

1-6 Recommended Test Equipment

The following test equipment is recommended for use in testing and maintaining the S412E. [Table 1-1](#) is a list of test equipment that is required for verifying the vector network analyzer functions and associated VNA options. [Table 1-2](#) is a list of test equipment that is required for verifying the spectrum analyzer functions and associated SPA options. [Table 1-3](#) is a list of test equipment that is required to verify the signal generator and [Table 1-4](#) is a list of test equipment that is required to verify the S412E options.

Table 1-1. Recommended Test Equipment for Vector Network Analyzer Verification

Equipment	Critical Specification	Recommended Manufacturer/Model
Frequency Counter	Frequency: 10 Hz to 6 GHz	Anritsu Model MF2412C
Frequency Reference	Frequency: 10 MHz	Symmetricom Model RubiSource T&M
Open/Short/Load	Frequency: DC to 6 GHz Connector: N(m)	Anritsu Model OSLN50-1
Open/Short/Load	Frequency: DC to 6 GHz Connector: N(f)	Anritsu Model OSLNF50-1
RF Coaxial Cable	Frequency: DC to 18 GHz Impedance: 50 Ohm Connector: N(m) to N(m)	Anritsu Model 15NN50-1.5C
6 dB Offset Termination	Frequency: DC to 6 GHz Connector: N(m)	Anritsu Model SC7424
20 dB Offset Termination	Frequency: DC to 6 GHz Connector: N(m)	Anritsu Model SC7423
Coaxial Cable	Connector: BNC(m) to BNC(m) Impedance: 50 Ohm	Anritsu p/n 2000-1627-R
Interface Cable	USB A to USB mini	Anritsu p/n 3-2000-1498
Test Software	VNA Instrument Test Verification Software	Anritsu p/n 2300-535
PC Controller	Microsoft Windows XP or Windows 7, 1 GB RAM, at least 20 MB of free hard disk space, USB 2.0 Type A port with National Instruments VISA ^a Version 3.6 or later loaded	Any

a. National Instrument VISA license is available from National Instruments as a stand-alone software package or as part of National Instruments GPIB adapter hardware package. Please contact National Instruments for details.

Table 1-2. Recommended Test Equipment for Spectrum Analyzer Verification

Equipment	Critical Specification	Recommended Manufacturer/Model
Frequency Reference	Frequency: 10 MHz	Symmetricom Model RubiSource T&M
Synthesized Signal Generator	Frequency: 0.1 Hz to 20 GHz Power Output: +16 dBm Step attenuator installed	Anritsu Model MG3692B or MG3692C with Options 2A, 3, 4 and 22 (Quantity 2)
Power Meter	Power Range: -70 dBm to +20 dBm	Anritsu Model ML2438A
Power Sensor	Frequency: 100 kHz to 18 GHz Power Range: -67 dBm to +20 dBm	Anritsu Model SC7400 (Quantity 2)
Power Sensor	Frequency: 100 kHz to 18 GHz Power Range: -67 dBm to +20 dBm	Anritsu Model MA2442D
Adapter	Frequency: DC to 18 GHz Connector: K(m) to N(f)	Anritsu Model 34RKNF50
Adapter	Frequency: DC to 18 GHz Connector: N(m) to N(m)	Anritsu Model 34NN50A
RF Coaxial Cable	Frequency: DC to 18 GHz Connector: N(m) to N(m)	Anritsu Model 15NN50-1.5C (Quantity 2)
Coaxial Cable	Impedance: 50 Ohm Connector: BNC(m) to BNC(m)	Anritsu Model 2000-1627-R (Quantity 3)
Termination	Frequency: DC to 18 GHz Impedance: 50 Ohm Connector: N(m)	Anritsu Model 28N50-2
Power Splitter	Frequency: DC to 18 GHz Connector: N(f)	Aeroflex/Weinschel Model 1870A
Fixed Attenuator	Frequency: DC to 18 GHz Attenuation: 2 dB	Aeroflex/Weinschel Model 44-2 (Quantity 2)
Fixed Attenuator	Frequency: DC to 18 GHz Attenuation: 6 dB	Aeroflex/Weinschel Model 44-6 (Quantity 2)
Fixed Attenuator	Frequency: DC to 18 GHz Attenuation: 10 dB	Aeroflex/Weinschel Model 44-10
Fixed Attenuator	Frequency: DC to 18 GHz Attenuation: 20 dB	Aeroflex/Weinschel Model 44-20 (Quantity 2)
Tee Adapter	Frequency: 10 MHz Impedance: 50 Ohm Connector: BNC(m) to BNC(f)/BNC(f)	Anritsu part number 3-2600-2 (Quantity 2)
Low Pass Filter	50 MHz Low Pass Filter	Anritsu part number 1030-96

Table 1-3. Recommended Test Equipment for Signal Generator Verification

Equipment	Critical Specification	Recommended Manufacturer/Model
RF Coaxial cable	N(m) to N(m) connectors	Anritsu 15NN50-1.5C
Frequency Counter	1 GHz frequency measurement	Anritsu Model MF2412C

Table 1-4. Recommended Test Equipment for Option Verification

Equipment	Critical Specification	Recommended Manufacturer/Model
Load Test Fixture	Resistance: 105 Ohm Power: 1 Watt	Anritsu Model T3377
Load Test Fixture	Resistance: 78 Ohm Power: 20 Watts	Anritsu Model T3536
Calibration Tee	N male	Anritsu Model OSLN50-1
GPS Antenna	Magnet Mount (active 3 V to 5 V) with SMA connector	Anritsu p/n 2000-1528-R
Adapter	Connector: SMA(m) to BNC(f)	Pomona p/n 4290
Adapter	Frequency: DC to 18 GHz Connector: N(m) to N(m)	Anritsu Model 34NN50A
RF Coaxial Cable	Frequency: DC to 18 GHz Connector: N(m) to N(f), 50 Ohm	Anritsu p/n 15NN50-1.5C
Coaxial Cable	Connector: BNC(m) to BNC(m)	Anritsu p/n 2000-1627-R (Quantity 3)
Terminator	Impedance: 93 Ohm Connector: BNC(m)	Amphenol p/n B1004A-ND3G-93R-0.05-1W
Vector Signal Generator	Frequency: 100 kHz to 3 GHz	Anritsu Model MG3700A with options MG3700A-002 and MG3700A-021. Also requires LTE waveform license MX370108A (for Option 541 or 542)
Power Meter	Power Range: -70 dBm to +20 dBm	Anritsu Model ML2438A
Power Sensor	Frequency: 10 MHz to 18 GHz Power Range: -60 dBm to +20 dBm	Anritsu Model MA2482D
Power Splitter	Frequency: DC to 18 GHz	Aeroflex/Weinschel Model 1870A
Fixed Attenuator	Frequency: DC to 18 GHz Attenuation: 10 dB	Aeroflex/Weinschel Model 44-10 (Qty 2)
Frequency Reference	10 MHz	Symmetricon Model, RubiSource T&M

1-7 Replaceable Parts and Assemblies

To ensure that the correct options are provided on the replacement assembly when ordering either a Main PCB Assembly or Main/SPA PCB Assembly, all installed instrument options must be declared on the order.

The installed options are listed on a label on the top of the S412E. They can also be viewed in the System/Status display.

The table below summarizes the available replaceable parts and assemblies.

Table 1-5. List of Replaceable Parts and Assemblies (1 of 2)

Part Number	Description
ND72107	Main/VNA PCB Assembly ^a (For unit serial numbers less than 1545041, does not include GPS Receiver Module)
ND82054	Main/VNA PCB Assembly ^a (For unit serial numbers greater than 1545040 and less than 1606078: does not include GPS Receiver Module, does include Ethernet hardware)
ND82188	Main/VNA PCB Assembly ^a (For unit serial numbers greater than 1606077: does not include GPS Receiver Module, does include Ethernet hardware)
ND72121	SPA PCB Assembly
ND72122	Signal Generator PCB for Rev 1 units, unit s/n < 1243137
ND75326	Signal Generator PCB for Rev 2 units, 1243137 < unit s/n < 1501000
ND81073	Signal Generator PCB for Rev 2 units, unit s/n > 1501000
ND70320	GPS Receiver Module, Option 31
3-71585	Model S412E ID Label
3-15-147	LCD Display, Units with serial numbers less than 1329107
3-15-165	LCD Display, Units with serial numbers greater than 1329107 and less than 1606078
3-15-174	LCD Display, Units with serial numbers greater than 1606077
3-68567-3	Inverter PCB Assembly for LCD Backlight, Units with serial numbers below 1329107
2000-1654-R	Soft Carrying Case
ND73191	Front Case with Gasket (excludes Model ID label, LCD, touchscreen, encoder and keypad assemblies.)
ND74508	Front Case Kit (includes Keypad PCB, Rubber Keypad, Keypad Washers, Keypad Screws, Encoder, Encoder Knob, Speaker Assembly with gaskets)
ND73199	Back Case (Excludes Tilt Bale)
ND73201	Battery Door
633-75	7500 mAh Li-ion Battery Pack
3-513-100	RF Connector used on SPA and Signal Generator PCB
3-513-105	RF Connector used on VNA ports 1 and 2
40-187-R	AC to DC Power Adapter
3-410-103	Encoder (excluding knob)
3-61360-2	Knob (excluding encoder)
ND73200	Tilt Bail Assembly
ND81940	Fan Assembly
ND75294	Main Numeric Keypad
3-72773	Rubber Keypad
3-72767	Keypad Washer
3-905-2744	Keypad Screw
ND73192	Speaker

Table 1-5. List of Replaceable Parts and Assemblies (2 of 2)

Part Number	Description
ND80480	Touchscreen with Protection
2000-1797-R	Protective Film (Touchscreen not included)
806-141-R	Automotive 12 Volt DC Adapter
3-2000-1498	USB Type 2 A to Mini B Cable, 3 meters (10 feet)
3-806-215	Signal Generator to Main PCB co-axial cable
783-1399	Signal Generator Cable Removal Tool
3-72758	Vent 1 (Fan Vent, above battery door)
3-72759	Vent 2 (Intake Vent, top vent on keypad side)
3-72760	Vent 3 (Battery Vent, bottom vent on keypad side)
3-72781	LCD Bracket, Units with serial numbers less than 1606078
3-76302	LCD Bracket, Units with serial numbers greater than 1606077
3-71625-1	Cable, LCD to Keypad, Units with serial numbers greater than 1329107 and less than 1606078
3-70675-1	Cable, LCD to Keypad, Units with serial numbers greater than 1606077
3-72771	Cable, Keypad to Main PCB, 15 cm
3-72770	Cable, Keypad to Inverter PCB, 6 cm, Units with serial numbers less than 1329107
3-72621-4	Cable, LCD to Main PCB, 7cm, Units with serial numbers less than 1606078
3-70674-4	Cable, LCD to Main PCB, 7cm, Units with serial numbers greater than 1606077
3-803-110	Cable, Ribbon, 2x20, Main to SPA PCB
3-806-197	Cable, MMCX-MMCX, DSP to SPA PCB

a. When ordering the Main/VNA PCB Assembly, in order to ensure installation of correct options, all options that are installed on the instrument must be declared on the order. The options are listed and shown in the System (Shift - 8) / Status display.

1-8 Performance Verification Procedures

Performance verification procedures are in the following Chapters:

- [Chapter 2, “Vector Network Analyzer Verification”](#)
- [Chapter 3, “Spectrum Analyzer Verification”](#)
- [Chapter 4, “CW Signal Generator Verification”](#)
- [Chapter 5, “Option Verification”](#)

Refer to [Table 1-6](#) for the list of performance verification procedures required for the S412E. Perform all the procedures with a “x” in the Std column. Also perform the procedures with an “x” in Option column when those options are installed in the S412E. Options with a “N/A” in the Procedure Section are valid options for the S412E, but do not require additional verification testing.

Table 1-6. Required Performance Verification Procedures for the S412E

Performance Verification Procedure	Standard	Options	Procedure Section
VNA Frequency Accuracy	x		Section 2-2
VNA Transmission Dynamic Range	x		Section 2-3
VNA Return Loss Measurements Accuracy	x		Section 2-4
Spectrum Analyzer Frequency Accuracy	x		Section 3-2
Spectrum Analyzer Residual Spurious Response	x		Section 3-3
Spectrum Analyzer Displayed Average Noise Level (DANL)	x		Section 3-4
Spectrum Analyzer Single Side Band (SSB) Phase Noise	x		Section 3-5
Spectrum Analyzer Spurious Response (2nd Harmonic Distortion)	x		Section 3-6
Spectrum Analyzer Resolution Bandwidth Accuracy	x		Section 3-7
Spectrum Analyzer Amplitude Accuracy	x		Section 3-8
Spectrum Analyzer Third Order Intercept (TOI)	x		Section 3-9
Signal Generator Frequency Accuracy Verification	x		Section 4-2
VNA Mode Bias Tee Operational Check (Option 10)		x	Section 5-2
GPS Operational Check (Option 31)		x	Section 5-3
Fixed WiMAX Signal Analyzer (Option 46/47)		x	Section 5-4
Mobile WiMAX Signal Analyzer (Option 66/67)		x	Section 5-5
Modulation Fidelity Verification for P25/P25p2 (Option 521/522)		x	Section 5-6
Modulation Fidelity Verification for NXDN (Option 531/532)		x	Section 5-7
LTE Signal Analyzer Verification (Option 541/542)		x	Section 5-8
TETRA Analyzer and Coverage (Option 581/582)		x	Section 5-9
Modulation Fidelity Verification for DMR2 (Option 591/592)		x	Section 5-10
Signal Integrity Verification for PTC (Option 721/722)		x	Section 5-11
Vector Voltmeter (Option 15)		x	N/A
Interference Analysis (Option 25)		x	N/A
Channel Scanner (Option 27)		x	N/A
Mobile WiMax OTA Measurements (Option 37)		x	N/A
Coverage Mapping (Option 431)		x	N/A
EMF Measurements (Option 444)		x	N/A
AM/FM/PM Analyzer (Option 509)		x	N/A
LTE OTA Measurements (Option 546)		x	N/A

Chapter 2 — Vector Network Analyzer Verification

2-1 Introduction

This chapter provides the performance verification procedure for the vector network analyzer section of S412E. The vector network analyzer performance verification tests consist of the following:

- [“Frequency Accuracy” on page 2-1](#)
- [“Transmission Dynamic Range” on page 2-2](#)
- [“Return Loss Measurement Accuracy Verification” on page 2-3](#)

2-2 Frequency Accuracy

The following test can be used to verify the CW frequency accuracy of the vector network analyzer of the S412E. Measurement calibration is not required for this test.

Equipment Required

- Frequency Counter, Anritsu Model MF2412C
- 10 MHz Time Base Reference
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C
- BNC male to BNC male Cable, Anritsu Model 2000-1627-R

Procedure

1. Connect a BNC cable between the output connector of the external Time Base Reference to the Reference Input connector of the Frequency Counter.
2. Power on the Frequency Counter.
3. Power on the S412E and put it into Vector Network Analyzer mode using the **Menu** button.
4. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, and then the **Preset** button.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

5. Press the **Freq/Dist** main menu and set the Start Freq to 1.0 GHz and the Stop Freq to 1.0 GHz.
6. Connect the RF cable between the VNA Port 1 connector of the S412E and the RF Input 1 connector of the Frequency Counter.
7. On the Frequency Counter, press the **Preset** key.
8. Record the measured value to [Table A-1, “VNA Frequency Accuracy” on page A-2](#).

2-3 Transmission Dynamic Range

The following test is used to verify the transmission dynamic range of the vector network analyzer. The procedures are automated by using the LMR Master Instrument Test software, CDROM part number 2300-535, in conjunction with the equipment listed in the Equipment Required section below.

The software guides the user to perform multiple full 12 Term calibrations on the LMR Master for specific frequency bands using the appropriate calibration tees, measure the noise floor, and calculate the Transmission Dynamic Range.

Equipment Required

- Calibration Tee, N male, Anritsu Model OSLN50-1
- Calibration Tee, N female, Anritsu Model OSLNF50-1
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C
- USB Mini-B male to USB Type A male Cable, Anritsu part number 3-2000-1498
- Personal Computer with Microsoft Windows XP or Windows 7 Operating System, USB port and National Instrument VISA software 4.4.1 or later
- Test Software CD, Anritsu part number 2300-535.

Procedure

1. Install the software from Test Software CD 2300-535.
2. Open the VNA Instrument Test Verification software.
3. Choose Verify System.
4. Choose Begin VNA Verification.
5. Follow the directions under the USB Interface Protocol.
6. After choosing Check VNA Connection, choose Next.
7. Enter the Operator's name.
8. Choose Transmission_Reflection_Measurement.
9. Choose S412E_Series_N-CalKit_Verification.
10. Choose Manual Calibration and enter the serial numbers of the Male and Female OSL calibration tees.
11. Choose Next > (Begin Measurements).
12. Allow the software to create the file path for the test results if not already created.
13. In the Tests section two tests should be selected: VNA Calibration and Transmission Dynamic Range (RMS).
14. Choose Start VNA Measurements.
15. Follow the directions on the screen until both the VNA Calibration and the Transmission Dynamic Range (RMS) tests are complete.
16. Go to the directory on the PC where the test data was saved. The default path is:
C:\Anritsu VNA Verification\VNA_Reports\S412E_unit_serial_number.
17. Print the test results reported by the software and attach it to the test record in [Appendix A](#).

2-4 Return Loss Measurement Accuracy Verification

The following test can be used to verify the accuracy of return loss measurements. Measurement calibration of the S412E is required for this test.

Equipment Required

- Calibration Tee, N male, Anritsu Model OSLN50-1
- 20 dB Offset Termination, N male, Anritsu Model SC7423
- 6 dB Offset Termination, N male, Anritsu Model SC7424

Procedure

1. Power on the S412E and put it into Vector Network Analyzer mode using the **Menu** button.
2. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the **Preset** button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

3. Press the **Shift** key and then the **Calibrate (2)** key.
4. Touch the **Cal Type** submenu button and choose 1-port.
5. Touch the **Start Cal** submenu button to begin the Open/Short/Load calibration.
6. Connect the Open, Short and Load to VNA Port 1 when prompted from the on screen instructions.
7. When the calibration finishes, choose “Calculate and Finish Cal”.
8. Touch the **Measure** main menu button and set **Measurement Type** to Return Loss.
9. Touch the **Scale** main menu button and set the **Top** to 0 dB and the **Bottom** to –12 dB.
10. Connect the 6 dB Offset Termination to the VNA Port 1 connector of the S412E.
11. Touch the **Marker** main menu button and turn **Marker Table On**.
12. Touch the **Peak Search** and record the Marker TR1 value in [Table A-2, “VNA Return Loss Measurement Accuracy” on page A-2](#).
13. Touch the **Valley Search** and record the Marker TR1 value in [Table A-2](#).
14. Verify that both the Peak and Valley readings are within specification.
15. Disconnect the 6 dB Offset and connect the 20 dB Offset Termination to the VNA Port 1.
16. Touch the **Scale** main menu button and set the **Top** to –15 dB and the **Bottom** to –25 dB.
17. Touch the **Peak Search** and record the Marker TR1 value in [Table A-2, “VNA Return Loss Measurement Accuracy” on page A-2](#).
18. Touch the **Valley Search** and record the Marker TR1 value in [Table A-2](#).
19. Verify that both the Peak and Valley readings are within specification.

Chapter 3 — Spectrum Analyzer Verification

3-1 Introduction

This chapter provides the performance verification procedure for the spectrum analyzer section of S412E. The spectrum analyzer performance verification tests consist of the following:

- “Frequency Accuracy Verification and Adjustment” on page 3-2
- “Residual Spurious Response” on page 3-4
- “Displayed Average Noise Level (DANL)” on page 3-6
- “Single Side Band (SSB) Phase Noise” on page 3-8
- “Spurious Response (Second Harmonic Distortion)” on page 3-9
- “Resolution Bandwidth Accuracy” on page 3-11
- “Amplitude Accuracy” on page 3-12
- “Third Order Intercept (TOI)” on page 3-17

3-2 Frequency Accuracy Verification and Adjustment

The following procedure is used to verify and adjust the frequency accuracy of the spectrum analyzer in the S412E. Adjustment of the frequency can be performed on instruments using application package version 1.12 or greater.

Equipment Required

- Synthesized Signal Generator, Anritsu Model MG3692x series
- K(m) to N(f) Adapter, Anritsu Model 34RKNF50
- 10 MHz Reference Standard
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C
- BNC(m) to BNC(m) Coaxial Cable, Anritsu part number 2000-1627-R

Procedure

1. Connect a BNC Coaxial Cable between the 10 MHz Reference Standard output and the 10 MHz Ref In connector of the Anritsu MG3692x Synthesized Signal Generator.

Note Do not connect the external 10 MHz Reference to the LMR Master.

2. Turn On both the 10 MHz Reference Standard and the Synthesized Signal Generator.
3. Set the MG3692x output to 1 GHz CW, with an RF output level of -30 dBm.
4. Install the 34RKNF 50 Adapter to the output of the MG3692x Generator, and connect the 15NN50-1.5C RF Coaxial Cable between the Adapter and the RF In connector of the S412E.
5. Press the **On/Off** key to turn on the S412E.
6. Press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight Spectrum Analyzer and then press the **Enter** key to switch to Spectrum Analyzer mode.
7. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, and then the Preset button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

8. Press the **Shift** key, then the **Sweep (3)** key, then the Sweep Mode key, and then select the Performance submenu key.
9. Press the **Amplitude** main menu button and set the Reference Level to -10 dBm.
10. Press the **Span** main menu button and set the Span to 10 kHz.
11. Press the **BW** main menu button and set the RBW to 100 Hz.
12. Press the VBW submenu button and set it to 30 Hz.
13. Press the **Freq** main menu button and set the Center Freq to 1 GHz.
14. Press the **Marker** main menu button and then the More submenu button.
15. Set Counter Marker to On, press the Back submenu button and then press the Peak Search submenu button.

Note Without the Counter Marker On, the frequency resolution will be lowered.

16. Verify that the marker frequency reading is within specification listed within [Table A-7, “Spectrum Analyzer Frequency Accuracy”](#) on page A-5. If the marker frequency is within the specification, record

the measured value in [Table A-7](#). Skip [Step 17](#) through [Step 19](#) and proceed to [Step 20](#). If the marker frequency is outside the specification, proceed to the next step for adjustment.

Note	The following steps to adjust the frequency accuracy can be performed on instruments with application package version 1.12 or greater. The application package version can be found in the System > Status menu as “Package Version”.
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17. Perform [Step 17](#) through [Step 19](#) only if the previous step is out of specification. Press and hold the **Shift** key while simultaneously pressing the **9-5-3** keys all at once. Three quick beeps sound and the Frequency Calibration soft key is then displayed.
18. Press the Frequency Calibration soft key. The 10 MHz Ref DAC number will be shown and can be adjusted to bring the marker frequency within specification. Larger DAC numbers decrease the measured frequency and smaller DAC numbers increase the measured frequency.
19. Adjust the DAC number by entering a new DAC value and pressing the Decimal soft key. The instrument will take a few seconds to update and then the peak can be remeasured using **Marker**, **Peak Search**. The **System** menu returns the Frequency Calibration soft key if readjustment is necessary. Continue adjusting the DAC value until the peak search marker value is within specification. After the instrument is adjusted, turn the instrument power off and back on to remove the Frequency Calibration soft key. Record the marker frequency in [Table A-7](#), “[Spectrum Analyzer Frequency Accuracy](#)” on [page A-5](#).
20. If Option 6 is installed, adjust the center frequency of the S412E and the frequency on the MG3692x to the frequencies in [Table A-7](#), and record the measured results for the other frequencies in [Table A-7](#).

Note	If the instrument fails this test, contact your local Anritsu Service Center (http://www.anritsu.com/Contact.asp)
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3-3 Residual Spurious Response

The following test is used to verify the residual spurious response of the spectrum analyzer of the S412E.

Equipment Required

- 50 Ohm Termination, Anritsu Model 28N50-2

Procedure

1. Connect the 50 Ohm Termination to the RF In connector of the S412E.
2. Power on the S412E and put the instrument into Spectrum Analyzer mode with the **Menu** button.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the Preset button on the touchscreen.

Note	Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.
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4. Press the Amplitude submenu button.
5. Touch the Detection submenu button and then the Peak submenu button.

Residual Spurious Test with Preamp Off

6. Set the Reference Level to -40 dBm using the **Amplitude** menu on the touchscreen.
7. Set the Attenuation Level to 0 dB using the Atten Lvl submenu.
8. Make sure that the Pre Amp On/Off submenu button is in the Off position. If the preamp is on, then touch the Pre Amp On/Off submenu button to turn it off.
9. Set the Start Freq to 10 MHz using **Freq** menu on the touchscreen.
10. Set the Stop Freq to 50 MHz.
11. Set the RBW to 1 kHz using the **BW** menu.
12. Set the VBW to 300 Hz.
13. Wait until one sweep is completed.
14. Touch the **Marker** main menu button and then the Peak Search submenu button.
15. Verify that Marker 1 amplitude is ≤ -90 dBm.

Note	If a spur larger than -90 dBm appears, wait another full sweep and observe whether the spur re-appears at the same point on the second sweep. If the spur does not appear at the same point on the second sweep, then the spur on the first sweep was not real.
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16. Record the Marker 1 amplitude reading in [Table A-3](#), “Spectrum Analyzer Residual Spurious Response with Preamp Off” on page A-3.
17. Repeat [Step 9](#) through [Step 16](#) for the other frequency band settings in [Table A-3](#). Change RBW and VBW setting as applicable.

Residual Spurious Test with Preamp On

18. Set the Reference Level to -50 dBm using the **Amplitude** menu.
19. Set the Attenuation Level to 0 dB using the **Atten Lvl** submenu.
20. Touch the **Pre Amp On/Off** submenu button to turn it on.
21. Touch the **Freq** main menu button and set the **Start Freq** to 10 MHz.
22. Set the **Stop Freq** to 1.6 GHz.
23. Touch the **BW** main menu button and set the **RBW** to 10 kHz.
24. Touch the **VBW** submenu button and set the **VBW** to 1 kHz.
25. Wait until one sweep is completed.
26. Touch the **Marker** main menu button and then the **Peak Search** submenu button.
27. Verify that **Marker 1** amplitude is ≤ -90 dBm.

Note

If a spur larger than -90 dBm appears, wait another full sweep and observe whether the spur re-appears at the same point on the second sweep. If the spur does not appear at the same point on the second sweep, then the spur on the first sweep was not real.

28. Record the **Marker 1** amplitude reading in [Table A-4, “Spectrum Analyzer Residual Spurious Response with Preamp On”](#) on page A-3.
29. Repeat [Step 21](#) through [Step 28](#) for the 1.6 GHz to 6 GHz frequency band if Option 6 is installed, and record results in [Table A-4](#).

3-4 Displayed Average Noise Level (DANL)

The following test is used to verify the Displayed Average Noise Level (DANL) of the spectrum analyzer in the S412E. This test is performed using the RMS detection mode.

Equipment Required

- 50 Ohm Termination, Anritsu Model 28N50-2

Procedure

1. Connect the 50 Ohm Termination to the RF In connector of the S412E.
2. Press the **On/Off** key to turn on the S412E.
3. Press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight Spectrum Analyzer and then press the **Enter** key to switch to Spectrum Analyzer mode.
4. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the Preset button on the touchscreen.

Note Before continuing, allow a 30 minute warm up period for the internal circuitry to stabilize.

5. Press the Amplitude submenu button.
6. Touch the Detection submenu button and then the RMS/AVG submenu button.

DANL Test with Preamp Off

7. Touch the **Amplitude** button on the touchscreen main menu and set the Reference Level to -20 dBm.
8. Touch the **Atten Lvl** submenu button and set to 0 dB.
9. Make sure that the Pre Amp On/Off submenu button is in the Off position. If the preamp is on, then touch the Pre Amp On/Off submenu button to turn it off.
10. Touch the **Freq** main menu button and set the Start Freq to 10 MHz.
11. Set the Stop Freq to 1.6 GHz.
12. Touch the **BW** main menu button and set the RBW to 100 kHz.
13. Touch the **VBW** submenu button and set to 1 kHz.
14. Wait until one sweep is completed.
15. Touch the **Marker** main menu button and then the Peak Search submenu button.
16. Record the Marker 1 amplitude reading into the **100 kHz RBW Measured Value** column in [Table A-5](#), “Spectrum Analyzer DANL with Preamp Off” on page A-4.

Note The noise floor consists of totally random signals whereas a spur is a fixed spike of varying amplitude that is always visible.

17. Repeat [Step 10](#) through [Step 16](#) for other frequency settings in [Table A-5](#), if Option 6 is installed.
18. For each measured 100 kHz RBW value in [Table A-5](#), normalize it to 10 Hz RBW value by subtracting 40 dB from the 100 kHz RBW measured value.
For example, if the marker shows a value of -100 dBm at 100 kHz RBW, the calculated value at 10 Hz RBW is -140 dBm (-100 dBm $-$ 40 dB = -140 dBm).
19. Enter the calculated values into the **10 Hz RBW Calculated Value** column in [Table A-5](#).
20. Verify that the calculated value is less than or equal to the value in the **Specification** column in [Table A-5](#).

DANL Test with Preamp On

21. Touch the **Amplitude** button on the touchscreen main menu and set the Reference Level to -50 dBm.
22. Touch the Pre Amp On/Off submenu button to turn the preamp On.
23. Touch the **Freq** main menu button and set the Start Freq to 10 MHz.
24. Touch the Stop Freq submenu button and set it to 1.6 GHz.
25. Wait until one sweep is completed.
26. Touch the **Marker** main menu button and then the Peak Search submenu button.
27. Record the Marker 1 amplitude reading into the **100 kHz RBW Measured Value** column in [Table A-6](#), “Spectrum Analyzer DANL with Preamp On” on page A-4.

Note

The noise floor consists of totally random signals where a spur is a fixed spike of varying amplitude that is always visible.

28. Repeat [Step 23](#) through [Step 27](#) for other frequency settings in [Table A-6](#) if Option 6 is installed.
29. For each measured 100 kHz RBW value in [Table A-6](#), normalize it to 10 Hz RBW value by subtracting 40 dB from the 100 kHz RBW measured value.
For example, if the marker shows a value of -100 dBm at 100 kHz RBW, the calculated value at 10 Hz RBW is -140 dBm (-100 dBm $-$ 40 dB = -140 dBm).
30. Enter the calculated values into the **10 Hz RBW Calculated Value** column in [Table A-6](#).
31. Verify that the calculated value is less than or equal to the value in the **Specification** column in [Table A-6](#).

3-5 Single Side Band (SSB) Phase Noise

This test is used to verify the single side band (SSB) phase noise of the spectrum analyzer in the S412E.

Equipment Required

- Synthesized Signal Generator, Anritsu Model MG3692x
- K(m) to N(f) Adapter, Anritsu Model 34RKNF50
- 10 MHz Reference Standard
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C
- BNC(m) to BNC(m) Coaxial Cable, Anritsu part number 2000-1627-R

Procedure

1. Connect the BNC Coaxial Cable between the 10 MHz Reference Standard output and the 10 MHz Ref In connector of the Anritsu MG3692x Synthesized Signal Generator.
2. Turn both the 10 MHz Reference Standard and the Synthesized Signal Generator on.
3. Set the MG3692x output to 1 GHz CW, with an RF output level of +0 dBm.
4. Install the 34RKNF50 Adapter to the output of the MG3692x and then connect the 15NN50-1.5C RF Coaxial Cable between the Adapter and the RF In connector of the S412E.
5. Press the **On/Off** key to turn on the S412E.
6. Press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight Spectrum Analyzer and then press the **Enter** key to switch to Spectrum Analyzer mode.
7. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the Preset button on the touchscreen.

Note	Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.
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8. Touch the **Amplitude** button on the touchscreen main menu and set the Reference Level to 0 dBm.
9. Touch the Atten Lvl submenu button and set to 15 dB.
10. Touch the **Freq** main menu button and set the Center Freq to 1 GHz.
11. Touch the Span submenu button and set to 110 kHz.
12. Touch the **BW** main menu button and set the RBW to 1 kHz.
13. Set the VBW to 3 Hz.
14. Press the **Shift** key, press the **Trace (5)** key and then touch the Trace A Operations submenu button.
15. Set the # of Average to 7.
16. Wait until the Trace Count displays “7/7”.
17. Touch the **Marker** main menu button and then Peak Search submenu button.
18. Touch the Delta On/Off submenu button to turn Delta On.
19. Use the numeric keypad to enter 10 kHz.
20. Record the measured value in [Table A-8, “Spectrum Analyzer SSB Phase Noise” on page A-5](#).
21. Subtract 30 dB from the measured value and verify that the result is better than -100 dBc/Hz (for 10 kHz offset) or -105 dBc/Hz (for 100 kHz offset) or -115 dBc/Hz (for 1 MHz offset) and record the calculated values in [Table A-8](#).
For example: -70 dBc (measured) $- 30$ dB = -100 dBc/Hz
22. Repeat [Step 11](#) through [Step 21](#) for 100 kHz offset (set Span to 220 kHz) and 1 MHz offset (set Span to 2.04 MHz). Record the measured values and calculated values in [Table A-8](#).

3-6 Spurious Response (Second Harmonic Distortion)

The following test is used to verify the input related spurious response of the spectrum analyzer in the S412E.

Equipment Required

- Synthesized Signal Generator, Anritsu Model MG3692X
- K(m) to N(f) Adapter, Anritsu Model 34RKNF50
- 10 MHz Reference Standard
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C
- 50 MHz Low Pass Filter, Anritsu part number 1030-96
- BNC(m) to BNC(m) Coaxial Cable, Anritsu part number 2000-1627-R

Procedure

1. Connect the BNC Coaxial Cable between the 10 MHz Reference Standard output and the 10 MHz Ref In connector of the Anritsu MG3692x Synthesized Signal Generator.
2. Turn On both the 10 MHz Reference Standard and the Synthesized Signal Generator.
3. Set the MG3692x output to 50.1 MHz CW, with an RF output level of -30 dBm.
4. Install the 34RKNF50 Adapter to the output of the MG3692x Generator and then connect the male end of the 50 MHz Low Pass Filter to the Adapter.
5. Connect the 15NN50-1.5C RF Coaxial Cable between the 50 MHz Low Pass Filter and the RF In connector of the S412E.
6. Press the **On/Off** key to turn on the S412E.
7. Press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight Spectrum Analyzer and then press the **Enter** key to switch to Spectrum Analyzer mode.
8. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the **Preset** button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

9. Touch the **Amplitude** button on the touchscreen main menu and set the Reference Level to -27 dBm.
10. Touch the **Atten Lvl** submenu button and set to 0 dB.
11. Touch the **Freq** main menu button and set the Center Freq to 50.1 MHz.
12. Touch the **Span** submenu button and set to 100 kHz.
13. Touch the **BW** main menu button and set the RBW to 1 kHz.
14. Touch the **VBW** submenu button and set to 10 Hz.
15. Press the **Amplitude** submenu button.
16. Touch the **Detection** submenu button and then the **Peak** submenu button.
17. Press the **Shift** key, press the **Trace (5)** key and then touch the **Trace A Operations** submenu button.
18. Set the # of Average to 5.
19. Wait until the Trace Count displays "5/5".
20. Touch the **Marker** main menu button and then **Peak Search** submenu button.
21. Record the amplitude of 50.1 MHz in [Table A-9, "Spectrum Analyzer Spurious Response \(Second Harmonic Distortion\)" on page A-5](#).
22. Touch the **Freq** main menu button and set the Center Freq to 100.2 MHz.
23. Press the **Shift** key, press the **Trace (5)** key and then touch the **Trace A Operations** submenu button.

24. Set the # of Average to 5.
25. Wait until the Trace Count displays “5/5”.
26. Touch the **Marker** main menu button and then **Peak Search** submenu button.
27. Record the amplitude of 100.2 MHz in [Table A-9](#).
28. Calculate the second Harmonic level in dBc by subtracting the 50.1 MHz amplitude from the 100.2 MHz amplitude using the following formula:
Second Harmonic level dBc = 100.2 MHz amplitude – 50.1 MHz amplitude
29. Record the calculated Second Harmonic Level in [Table A-9](#) and verify that it is ≤ -56 dBc.

3-7 Resolution Bandwidth Accuracy

The following test is used to verify the resolution bandwidth accuracy of the spectrum analyzer in the S412E.

Equipment Required

- Synthesized Signal Generator, Anritsu Model MS3692X
- K(m) to N(f) Adapter, Anritsu Model 34RKNF50
- 10 MHz Reference Standard
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C
- BNC(m) to BNC(m) Coaxial Cable (Qty 2), Anritsu part number 2000-1627-R
- BNC Tee Adapter, BNC(m) to BNC(f)/BNC(f), Anritsu part number 3-2600-2

Procedure

1. Connect the BNC Tee Adapter to the output of the 10 MHz Reference Standard.
2. Connect a BNC Coaxial Cable between the BNC Tee Adapter and the 10 MHz Ref In connector of the Anritsu MG3692x Synthesized Signal Generator.
3. Connect a BNC Cable between the BNC Tee Adapter and the External Ref In connector of the S412E.
4. Turn On both the 10 MHz Reference Standard and the Synthesized Signal Generator.
5. Set the MG3692x RF output frequency to 1 GHz CW and level to -30 dBm.
6. Install the 34RKNF50 Adapter to the output of the MG3692x Generator and then connect the 15NN50-1.5C RF Coaxial Cable between the Adapter and the RF In connector of the S412E.
7. Press the **On/Off** key to turn on the S412E.
8. Press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight Spectrum Analyzer and then press the **Enter** key to switch to Spectrum Analyzer mode.
9. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the Preset button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

10. Touch the **Amplitude** main menu button and set the Reference Level to -10 dBm.
11. Touch the Atten Lvl submenu button and set to 0 dB.
12. Set the Scale to 10 dB/div.
13. Touch the **Freq** main menu button and set the Center Freq to 1 GHz.
14. Touch the Span submenu button and set to the first **Span** value listed in [Table A-10, “Spectrum Analyzer Resolution Bandwidth Accuracy”](#) on page A-6.
15. Touch the **BW** main menu button and set the RBW to the first **RBW** value listed in [Table A-10](#).
16. Set the VBW to the first **VBW** value listed in [Table A-10](#).
17. Press the **Shift** key and then the **Measure (4)** key.
18. Touch the OCC BW submenu button and then dBc submenu button.
19. Use the numeric keypad to enter 3 and then press the **Enter** key.
20. Touch the OCC BW On/Off submenu button to turn occupied bandwidth measurement on.
21. Record the OCC BW reading into the **Measured Value** column in [Table A-10](#).
22. Verify that the OCC BW reading frequency is within $\pm 10\%$ of the RBW.
23. Repeat [Step 14](#) through [Step 22](#) for other settings and record the results into [Table A-10](#).

3-8 Amplitude Accuracy

The following tests are used to verify the amplitude accuracy of the spectrum analyzer in the S412E. The tests consist of:

- “50 MHz Amplitude Accuracy Verification” on page 3-13
- “Amplitude Accuracy Across Frequency Verification” on page 3-15

Equipment Required

- Synthesized Signal Generator, Anritsu Model MG3692x
- K(m) to N(f) Adapter, Anritsu Model 34RKNF50
- 10 MHz Reference Standard
- BNC(m) to BNC(m) Coaxial Cable, Anritsu part number 2000-1627-R
- Dual Channel Power Meter, Anritsu Model ML2438A
- High Accuracy Power Sensors (Qty 2), Anritsu Model SC7400
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C
- Power Splitter, Aeroflex/Weinschel Model 1870A
- 10 dB Fixed Attenuator, Aeroflex/Weinschel Model 44-10
- N(m) to N(m) Adapter, Anritsu Model 34NN50A

Setup

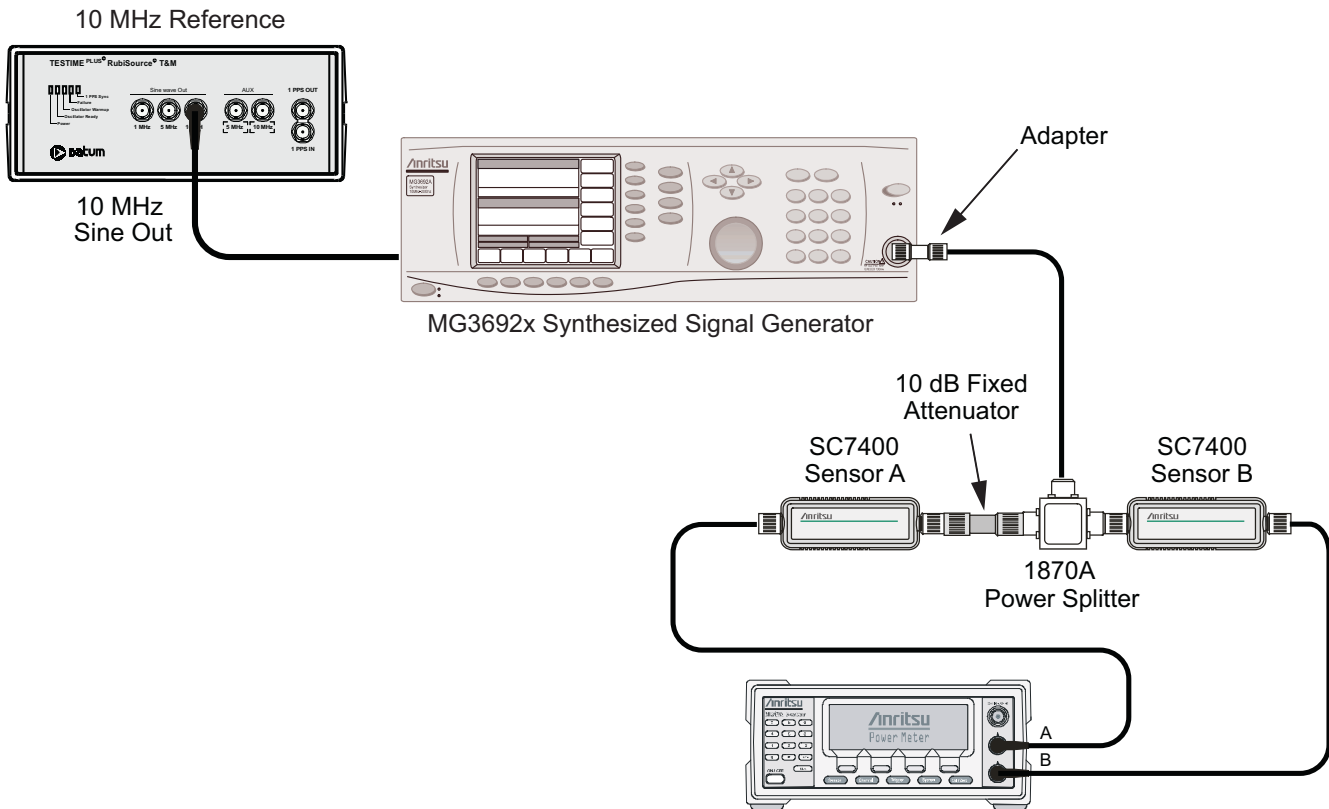


Figure 3-1. Amplitude Accuracy Pretest Setup

50 MHz Amplitude Accuracy Verification

Test Setup Characterization

1. Turn on the 10 MHz Reference Standard, the ML2438A Power Meter, the MG3692x Signal Generator, and the S412E.

Note Before continuing, allow a 30-minute warm up period for the internal circuitry to stabilize.

2. Install the 34RKNF50 Adapter to the MG3692x Signal Generator output, and then connect the 15NN50-1.5C Cable to the 34RKNF50 Adapter.
3. Connect the Power Splitter to the open end of the 15NN50-1.5C Cable.
4. On the power meter, press the **Channel** front panel key, the **Setup** soft key, and then the **Channel** soft key to display Channel 2 Setup menu.
 - a. Press the **Input** key twice to set the Input Configuration to B.
 - b. Press the **Sensor** key to display both Sensor A and Sensor B readings.
 - c. Connect the power sensors to the **Calibrator** port of the power meter and calibrate the sensors.
 - d. Press the **Sensor** key, the **Cal Factor** soft key, and then the **Freq** soft key.
 - e. Use the numeric keypad to enter 50 MHz as the input signal frequency. Do this for both Sensor A and Sensor B. This sets the power meter to use the proper power sensor cal factor.
5. Connect Sensor B to one of the Power Splitter outputs.
6. Install the 10 dB Fixed Attenuator to the other Power Splitter output and then connect Sensor A to the end of the attenuator as shown in [Figure 3-1](#).
7. Set the MG3692x to a frequency of 50 MHz.
8. Starting with 0 dBm, adjust the power level of the MG3692x to get a reading on Sensor A that matches the power level into the **Test Power Level @ 50 MHz** column in [Table A-11](#), “[Spectrum Analyzer 50 MHz Amplitude Accuracy Setup Table](#)” on page A-7.
9. Record the Sensor B reading into the **Required Sensor B Reading** column in [Table A-11](#).
10. Repeat [Step 8](#) and [Step 9](#) for the other input levels from -4 dBm to -50 dBm.

50 MHz Amplitude Accuracy Measurements

1. Disconnect Sensor A from the 10 dB Fixed Attenuator and then install the 34NN50A Adapter to the end of the attenuator.

Note To maintain test setup integrity, do not disconnect Sensor B, the Power Splitter or the Fixed Attenuator.

2. Connect the open end of the 34NN50A Adapter to the RF In connector of the S412E as shown in Figure 3-2.

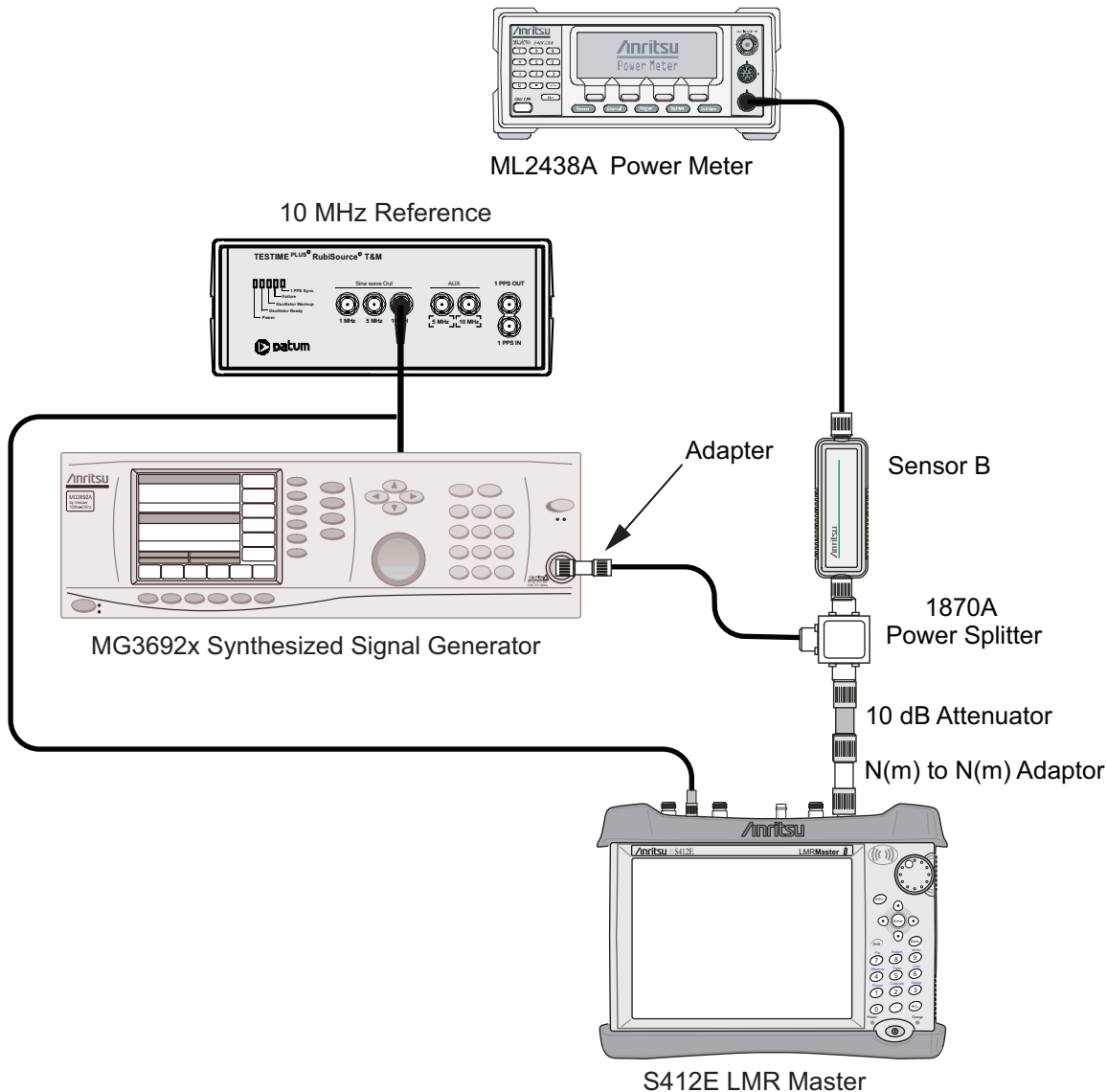


Figure 3-2. Amplitude Accuracy Verification Test Setup

3. On the S412E, press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight Spectrum Analyzer and then press the **Enter** key to switch to Spectrum Analyzer.

4. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the **Preset** button on the touchscreen. Using the Sweep menu, change the Sweep Mode to Performance.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

5. Touch the **Freq** main menu button and set the Center Freq to 50 MHz.
6. Touch the **BW** main menu button and set the RBW to 1 kHz.
7. Set the VBW to 10 Hz.
8. Set the Span to 10 kHz.
9. Touch the **Amplitude** main menu button and set the Reference Level to 10 dBm.
10. Set the Atten Lvl to 30 dB.
11. Adjust the power level on the MG3692x so that the power meter displays the corresponding desired Sensor B reading as recorded for 0 dBm in the **Required Sensor B Reading** column in [Table A-11](#), “[Spectrum Analyzer 50 MHz Amplitude Accuracy Setup Table](#)” on page A-7.
12. Touch the **Marker** main menu button and then the **Peak Search** submenu button.
13. Record the Marker 1 amplitude reading in the 0 dBm row of [Table A-12](#), “[Spectrum Analyzer 50 MHz Amplitude Accuracy](#)” on page A-8.
14. Repeat [Step 11](#) through [Step 13](#) for the other power level settings. The last two settings are with the pre-amp turned on, to ensure pre-amp functionality. Change Reference Level and Atten Lvl setting as required. Refer to [Table A-11](#) for Required Sensor B Readings. Use [Table A-12](#) to record test results.
15. Calculate deviation values of all input levels by subtracting the value in the **Test Power** column from the value in **Measured Value Reading** column. Enter the results into the **Deviation** column in [Table A-12](#).
16. Verify that all deviation values are within the specification.

Amplitude Accuracy Across Frequency Verification

Test Setup Characterization

1. Turn on the 10 MHz Reference Standard, the ML2438A Power Meter, the MG3692x Signal Generator, and the S412E.

Note Before continuing, allow a 30-minute warm up period for the internal circuitry to stabilize.

2. On the power meter, press the **Channel** front panel key, the **Setup** soft key and then the **Channel** soft key to display Channel 2 Setup menu.
 - a. Press the **Input** key twice to set the Input Configuration to B.
 - b. Press the **Sensor** key to display both Sensor A and Sensor B readings.
 - c. Connect the power sensors to the **Calibrator** port of the power meter and calibrate the sensors.
3. Install the 34RKNF50 Adapter to the MG3692x Signal Generator output and then connect the 15NN50-1.5C Cable to the 34RKNF50 Adapter.
4. Connect the Power Splitter to the open end of the 15NN50-1.5C Cable.
5. Connect Sensor B to one of the Power Splitter outputs
6. Install the 10 dB Fixed Attenuator to the other Power Splitter output and then connect Sensor A to the end of the attenuator as shown in [Figure 3-1](#) on page 3-12.
7. Set the MG3692x frequency to 100 kHz
8. On the power meter, press the **Sensor** key, the **Cal Factor** soft key, and then the **Freq** soft key. Use the numeric keypad to enter the value matching the frequency of MG3692X as the input signal frequency.

Do this for both Sensor A and Sensor B. This sets the power meter to use the proper power sensor cal factor. Press the **System** key to display the power reading.

9. Adjust the MG3692x output level so that Sensor A reading is $-2 \text{ dBm} \pm 0.1 \text{ dB}$.
10. Record the Sensor B reading into the **-2 dBm** column in [Table A-13, “Spectrum Analyzer Amplitude Accuracy Across Frequency Setup Table”](#) on page A-9.
11. Adjust the MG3692x output level so that Sensor A reading is $-30 \text{ dBm} \pm 0.1 \text{ dB}$.
12. Record the Sensor B reading into the **-30 dBm** column in [Table A-13](#).
13. Adjust the MG3692x output level so that Sensor A reading is $-50 \text{ dBm} \pm 0.1 \text{ dB}$.
14. Record the Sensor B reading into the **-50 dBm** column in [Table A-13](#).
15. Repeat [Step 7](#) through [Step 14](#) for all the frequencies listed in [Table A-13](#).

Amplitude Across Frequency Measurements

1. Disconnect Sensor A from the 10 dB Fixed Attenuator and then install the 34NN50A Adapter to the end of the attenuator.

Note	To maintain test setup integrity, do not disconnect Sensor B, the Power Splitter or the Fixed Attenuator.
-------------	-----------------------------------------------------------------------------------------------------------

2. Connect the open end of the 34NN50A Adapter to the RF In connector of the S412E as shown in [Figure 3-2 on page 3-14](#).
3. On the S412E, press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight Spectrum Analyzer and then press the **Enter** key to switch to Spectrum Analyzer mode.
4. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the **Preset** button on the touchscreen. Using the Sweep menu, change the Sweep Mode to Performance.

Note	Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.
-------------	---------------------------------------------------------------------------------------

5. Touch the **BW** main menu button and set the RBW to 1 kHz and VBW to 10 Hz.
6. Set the Span to 10 kHz.
7. Press the Freq soft key and set the Center Frequency to 100 kHz.
8. Press the Amplitude soft key and set the Reference Level to -40 dBm and turn the Pre-Amp On.
9. Set the Attenuation Level to 15 dB.
10. Set the power meter to display Channel B. Press the **Sensor** key, the **Cal Factor** soft key, and then the **Freq** soft key. Use the numeric keypad to enter the value matching the frequency of MG3692x as the input signal frequency. This sets the power meter to use the proper power sensor cal factor. Press the **System** key to display the power reading.
11. Set the MG3692x frequency to 100 kHz CW and adjust the level so that the power meter displays a reading which matches the Sensor B reading for **-50 dBm** in [Table A-13](#).
12. On the S412E press the **Marker** main menu button and then the **Peak Search** submenu button.
13. Record the Marker 1 amplitude reading in [Table A-14, “Spectrum Analyzer Amplitude Accuracy Across Frequency”](#) on page A-10.
14. Calculate the deviation by subtracting -50 dBm from the Marker 1 amplitude reading. Record the result in [Table A-14](#).
15. Verify the deviation value is within the specification.
16. Repeat [Step 7](#) through [Step 15](#) for other frequencies, input power, reference level, attenuation, and pre-amp settings in [Table A-14](#).

3-9 Third Order Intercept (TOI)

The following test verifies the Third Order Intercept point (also known as TOI or IP₃) of the spectrum analyzer in the S412E.

Equipment Required

- 10 MHz Reference Standard
- Synthesized Signal Generator, Anritsu Model MG3692x (Qty 2)
- Power Splitter, Aeroflex/Weinschel Model 1870A
- Power Meter, Anritsu Model ML2438A
- Power Sensor, Anritsu Model MA2442D
- Fixed Attenuator, Aeroflex/Weinschel Model 44-2 (Qty 2)
- Fixed Attenuator, Aeroflex/Weinschel Model 44-6 (Qty 2)
- Fixed Attenuator, Aeroflex/Weinschel Model 44-20 (Qty 2)
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C (Qty 2)
- Adapter, Anritsu Model 34NN50A
- BNC(m) to BNC(m) Coaxial Cable, Anritsu part number 2000-1627-R (Qty 3)
- Tee Adapter, BNC(m) to BNC(f)/BNC(f), Anritsu Part Number 3-2600-2 (Qty 2)

Setup

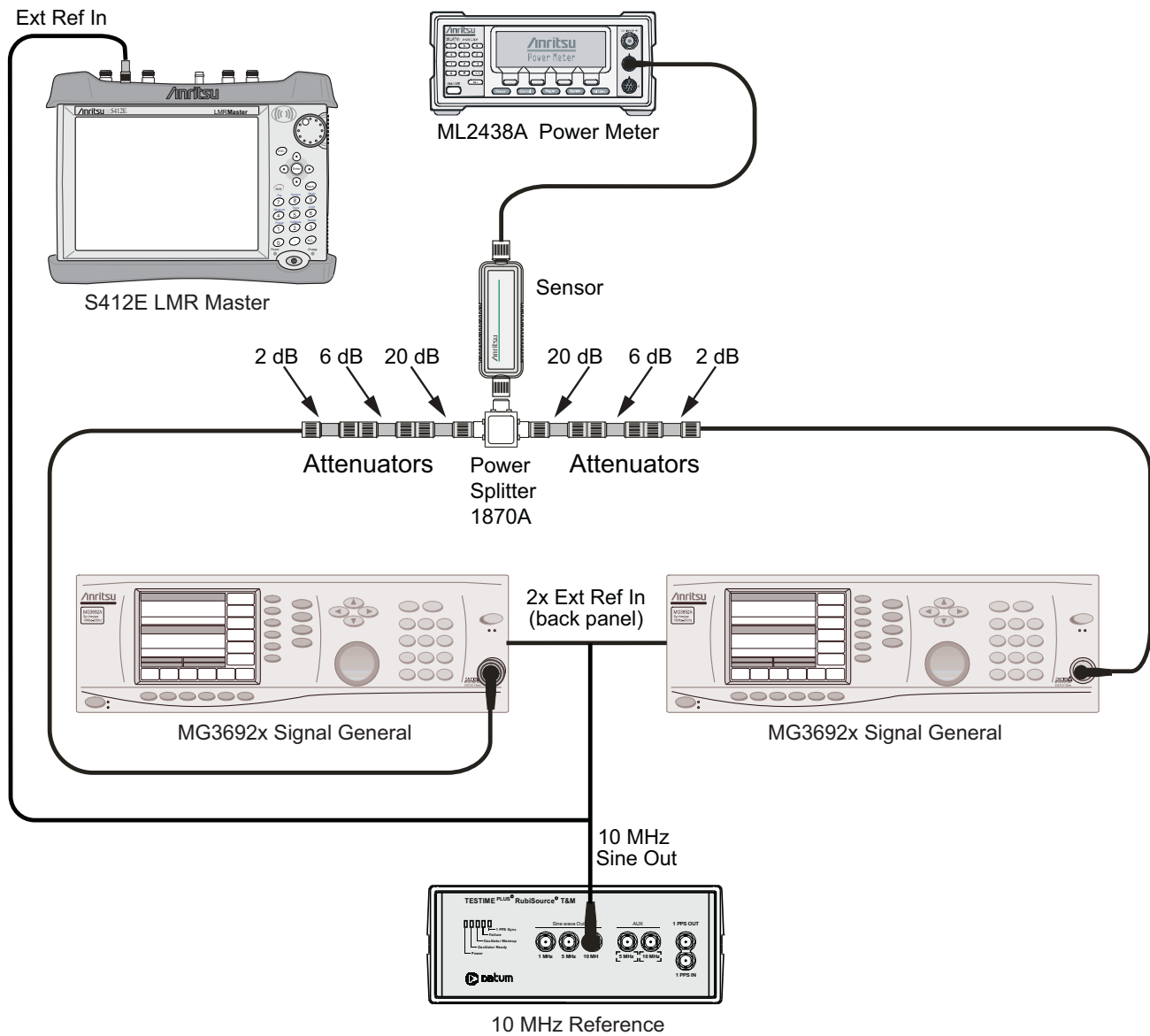


Figure 3-3. Third Order Intercept (TOI) Pre-test Setup

800 MHz TOI Test

1. Connect the equipment as shown in [Figure 3-3](#). The power splitter will be used as an RF combiner (the normal RF outputs will become inputs, and the normal input will become the RF output).

Note The 10 MHz External Reference is connected to the S412E.

2. Set the MG3692x Synthesized Signal Generator #1 to 799.951 MHz CW, and set the MG3692x Synthesized Signal Generator #2 to 800.051 MHz.
3. Turn Off the RF of the MG3692x Synthesized Signal Generator #1 and the MG3692x Synthesized Signal Generator #2.
4. On the ML2438A power meter, zero the sensor and set the calibration factor to 800 MHz.
5. Connect the power sensor to the power splitter output.
6. On the MG3692x Synthesized Signal Generator #1, turn the RF On, and adjust the RF amplitude so that -20 dBm appears at the splitter output (approximately +16 dBm).
7. Turn Off the RF of the MG3692x Synthesized Signal Generator #1.
8. On the MG3692x Synthesized Signal Generator #2, turn the RF On, and adjust the RF amplitude so that -20 dBm appears at the splitter output (approximately +16 dBm).
9. Turn Off the RF of the MG3692x Synthesized Signal Generator #2.
10. On the S412E, press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight **Spectrum Analyzer** and then press the **Enter** key to switch to Spectrum Analyzer mode.
11. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the **Preset** button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

12. Touch the **Amplitude** submenu button and select the **Detection** submenu button and then the **RMS/AVG** submenu button.
13. Set the S412E as follows:
 - Center Frequency: 800.151 MHz
 - Span: 100 Hz
 - RBW: 30 Hz
 - VBW: 1 Hz
 - Reference Level: -15 dBm
 - Atten Lvl: 0 dB
 - Preamp: Off
14. Disconnect the power sensor from the output of the power splitter and connect the power splitter output to the S412E RF In connector through the Anritsu Model 34NN50A adapter as shown in [Figure 3-4](#).

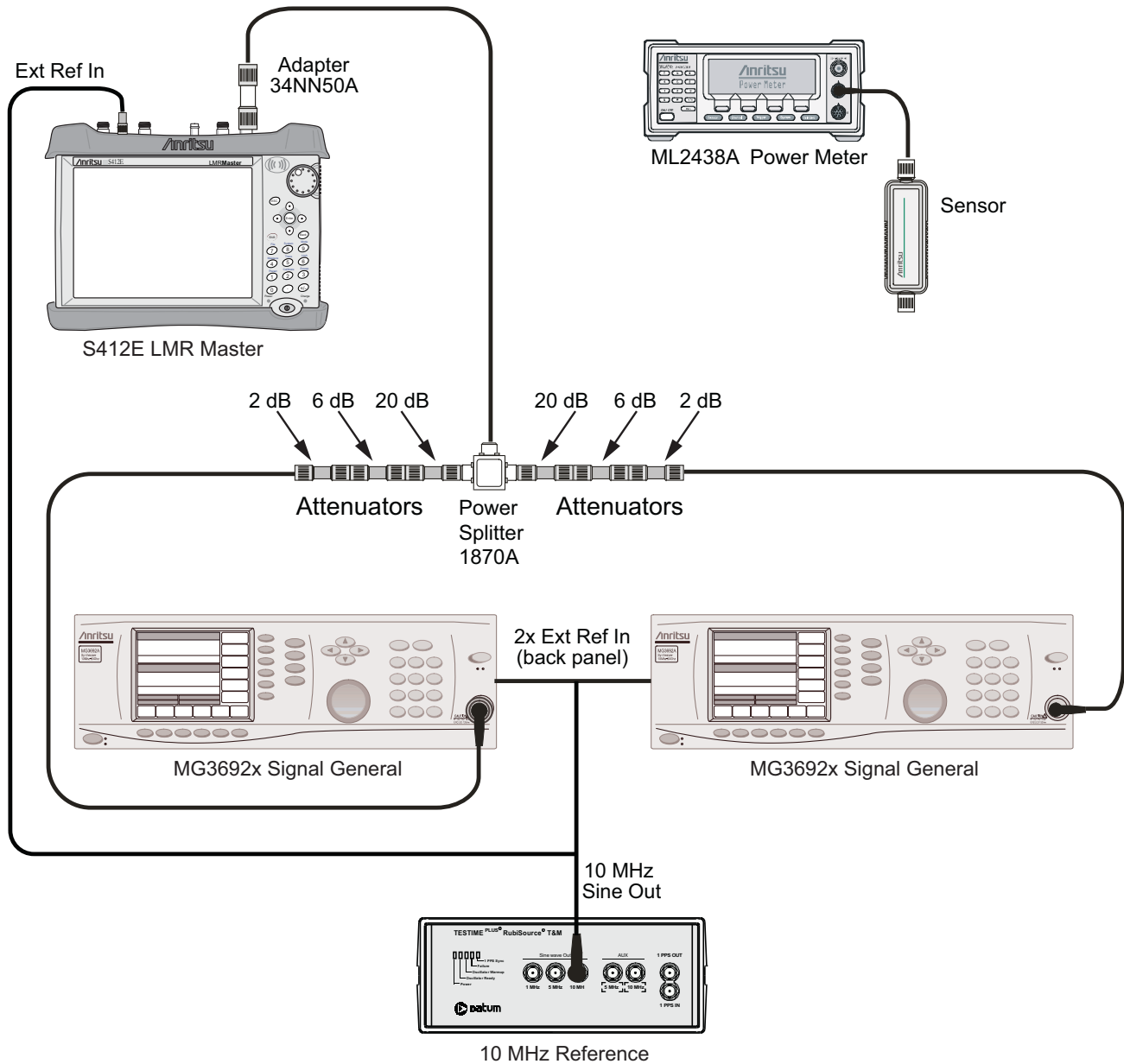


Figure 3-4. Third Order Intercept (TOI) Measurement Setup

15. Turn On the RF of both MG3692x #1 and MG3692x #2.
16. Press the **Shift** key and then the **Trace (5)** key. Press Trace A Operations, and set # of Averages to 2.
17. After two sweeps have occurred (Trace Count 2/2 appears on the left of the display), turn on a marker, and press Peak Search. Record the amplitude of the signal at 800.151 MHz in [Table A-15, "Spectrum Analyzer Third Order Intercept"](#) on page A-15.
18. Change the center frequency of the S412E to 799.851 MHz.
19. After two sweeps have occurred (Trace Count 2/2 appears on the left of the display), turn on a marker, and press Peak Search. Record the amplitude of this signal in [Table A-15](#).

20. Determine which signal is larger (the 799.851 MHz signal or the 800.151 MHz signal). Use the larger value for **max** in the following formula to calculate the TOI for 800 MHz (refer to the example calculation following the formula):

$$\text{TOI} = -20 + [(-20 - \text{max}) / 2] + 10 \text{ dBm}$$

Example: Assume $\text{max} = -72 \text{ dBm}$

$$\text{Then: TOI} = -20 + [(-20 - (-72))/2] + 10 = +16 \text{ dBm}$$

21. Record the calculated 800 MHz TOI measurement in [Table A-15](#).
22. Turn Off the RF of the MG3692x Synthesized Signal Generator #1 and the MG3692x Synthesized Signal Generator #2.

2400 MHz TOI Test (for units with Option 6 installed)

1. Disconnect the power splitter from the S412E.
2. Set the MG3692x Synthesized Signal Generator #1 to 2399.951 MHz CW, and set the MG3692x Synthesized Signal Generator #2 to 2400.051 MHz.
3. On the ML2438A power meter, set the calibration factor to 2.4 GHz.
4. Connect the power sensor to the power splitter output. Refer to [Figure 3-3 on page 3-18](#).
5. Set the MG3692x Synthesized Signal Generator #1 RF to On and adjust the RF amplitude so that -20 dBm appears at the power splitter output (approximately $+16 \text{ dBm}$).
6. Turn Off the RF of the MG3692x Synthesized Signal Generator #1.
7. On the MG3692x Synthesized Signal Generator #2, turn the RF On, and adjust the RF amplitude so that -20 dBm appears at the splitter output (approximately $+16 \text{ dBm}$).
8. Turn Off the RF of the MG3692x Synthesized Signal Generator #2.
9. Disconnect the power sensor from the output of the power splitter and connect the power splitter output to the S412E RF In connector through the Anritsu Model 34NN50A adapter. Refer to [Figure 3-4 on page 3-20](#).
10. Turn On the RF of both MG3692x #1 and MG3692x #2.
11. Set the S412E center frequency to 2400.151 MHz.
12. Press the **Shift** key and then the **Trace (5)** key. Press Trace A Operations, and set # of Averages to 2.
13. After two sweeps have occurred (Trace Count 2/2 appears on the left of the display), turn on a marker, and press **Peak Search**. Record the amplitude of the signal at 2400.151 MHz in [Table A-15](#).
14. Change the Center Frequency of the S412E to 2399.851 MHz.
15. After two sweeps have occurred (Trace Count 2/2 appears on the left of the display), turn on a marker, and press **Peak Search**. Record the amplitude of this signal in [Table A-15](#).
16. Determine which signal is larger (the 2399.851 MHz signal or the 2400.151 MHz signal). Use the larger value for **max** in the following formula to calculate the TOI for 2400 MHz (refer to the example calculation following the formula):

$$\text{TOI} = -20 + [(-20 - \text{max}) / 2] + 10 \text{ dBm}$$

Example: Assume $\text{max} = -80 \text{ dBm}$

$$\text{Then: TOI} = -20 + [(-20 - (-80))/2] + 10 = +20 \text{ dBm}$$
17. Record the calculated 2400 MHz TOI measurement in [Table A-15](#).
18. Turn Off the RF of both MG3692x #1 and MG3692x #2.

Chapter 4 — CW Signal Generator Verification

4-1 Introduction

This chapter provides the procedures for verifying the performance and the functionality of the CW Signal Generator in the S412E. The test procedures consist of the following:

- [“Frequency Accuracy Verification” on page 4-1](#)

4-2 Frequency Accuracy Verification

The following test is used to verify the frequency accuracy of the S412E in CW signal generator mode.

Equipment Required

- RF coaxial cable, Anritsu Model 15NN50-1.5C
- Frequency Counter, Anritsu Model MF2412C
- AC Power Adapter, Anritsu part number 40-187-R

Procedure

1. Connect the AC Power Adapter (Anritsu part number 40-187-R) to the S412E and then plug the power cord of the AC Power Adapter to an AC outlet.
2. Power on the S412E and put the instrument into CW Signal Generator mode.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the Preset button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

4. Connect the RF cable between the Signal Generator Out and RF In of the frequency counter.
5. Press the **Frequency** main menu button and set Tx Freq to 1 GHz.
6. In the lower right hand corner of the touchscreen ensure the button shows **Turn Sig-Gen OFF**, meaning the signal generator is turned on. If the button shows **Turn Sig-Gen ON**, then press it once to turn on the signal generator and have the button change to **Turn Sig-Gen OFF**. This will allow the signal generator to be turned off when the procedure is completed.
7. Record the frequency reading in [Table A-16, “Signal Generator Frequency Accuracy Verification” on page A-16](#), and verify the value is within specification.

Chapter 5 — Option Verification

5-1 Introduction

This chapter provides the procedures for verifying the performance and the functionality of various options in the S412E. The test procedures consist of the following:

- “VNA Mode Bias Tee Operational Check, Option 10” on page 5-1
- “GPS Verification, Option 31” on page 5-3
- “Fixed WiMAX Signal Analyzer Verification, Option 46 and 47” on page 5-6
- “Mobile WiMAX Signal Analyzer Verification, Option 66 and 67” on page 5-10
- “P25/P25p2 Modulation Fidelity Verification, Option 521 and 522” on page 5-16
- “NXDN Modulation Fidelity Verification, Option 531 and 532” on page 5-18
- “LTE Signal Analyzer Verification, Option 541 and 542” on page 5-19
- “TETRA EVM Verification, Option 581 and 582” on page 5-23
- “DMR2 Modulation Fidelity Verification, Option 591 and 592” on page 5-24
- “Positive Train Control (PTC) Verification, Option 721 and 722” on page 5-25

5-2 VNA Mode Bias Tee Operational Check, Option 10

If the Bias Tee (Option 10) is installed in the S412E, the following test can be used to verify the internal bias tee functionality.

Equipment Required

- Calibration Tee, N male, Anritsu Model OSLN50-1
- 78 Ohm, 1 Watt, Low Current Load, Anritsu part number T3536
- 105 Ohm, 1 Watt, Low Current Load, Anritsu part number T3377
- AC Power Adapter, Anritsu part number 40-187-R

Procedure

1. Connect the AC Power Adapter (Anritsu part number 40-187-R) to the S412E, and then plug the power cord of the AC Power Adapter to an AC outlet.

Note The S412E must be powered by external AC power for this test.

2. Power on the S412E and put the instrument into Vector Network Analyzer mode with the **Menu** button.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the **Preset** button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

4. Touch the **Freq/Dist** main menu button on the touchscreen main menu and set the Start Freq to 2 MHz.
5. Touch the **Shift** key, then the **System (8)** key, then the Application Options button, change the Meas Menu from Field to VNA.
6. Touch the **Sweep** main menu button.
7. Touch the Configure Ports submenu button and then select Bias Tee Setup.

Voltage and Current Test

8. Connect the 105 Ohm Load to VNA Port 2 connector of the S412E.
9. Ensure that the Int Voltage P2 setting is 12.0 V.
10. Touch the Bias Tee submenu button and then touch the On submenu button to turn the Bias Tee On.
11. Verify the voltage and current readings displayed on the upper left corner of the screen are within the range shown in [Table 5-1](#).

Table 5-1. VNA Bias Tee Verification

Current Reading	12.0 V	18.0 V	32.0 V
Expected Voltage	10.8 V to 13.2 V	16.2 V to 19.8 V	28.8 V to 35.2 V
Expected Current	85 mA to 145 mA	142 mA to 202 mA	370 mA to 450 mA

12. Touch the Off submenu button to turn the Bias Tee Off. Touch the Back submenu button to return to previous menu.
13. Touch the Int Voltage P2 submenu button. Use the numeric keypad to enter 18, and then touch the V submenu button to change the voltage to 18.0 V.
14. Repeat [Step 10](#) through [Step 12](#).
15. Remove the 105 Ohm Load from VNA Port 2 and connect the 78 Ohm Load to VNA Port 2.
16. Touch the Int Voltage P2 submenu button. Use the numeric keypad to enter 32, and then touch the V submenu button to change the voltage to 32.0 V.
17. Repeat [Step 10](#) through [Step 12](#).
18. Remove the 78 Ohm Load from the VNA Port 2 connector.

Fault Test

19. Connect the Short of the Calibration Tee to VNA Port 2.
20. Change Int Voltage P2 to 12.0 V.
21. Touch the Bias Tee submenu button and then touch the On submenu button to turn the Bias Tee On.
22. Verify that the instrument displays the Bias Tee voltage, and that the current reading in the upper-left corner of the screen is flashing 0.0 V and 0 mA.
23. Touch the Off submenu button to turn the Bias Tee off.

5-3 GPS Verification, Option 31

The following test is used to verify the operation of the GPS Option on the S412E.

Note Ensure that the Anritsu GPS Antenna is in a direct line-of-sight relationship to the GPS satellites or that the Antenna is placed outside without any obstructions.

- “Touch the GPS submenu button.” on page 5-3
- “Spectrum Analyzer Frequency Accuracy with GPS On” on page 5-4

GPS Antenna Bias Tee Operational Check

Equipment Required

- SMA(m) to BNC(f) Adapter, Pomona part number 4290
- BNC(m) 93 Ohm Terminator, Amphenol part number B1004A1-ND3G-93R-0.05-1W
- GPS Antenna, Anritsu part number 2000-1528-R
- AC Power Adapter, Anritsu part number 40-187-R

Procedure

1. Connect the SMA(m) to BNC(f) Adapter to the GPS connector of the S412E.
2. Connect the BNC(m) 93 Ohm terminator to the BNC(f) end of the adapter.
3. Connect the external AC Power Adapter (Anritsu part number 40-187-R) to the S412E and then plug the power cord of the AC Power Adapter to an AC outlet.

Note The S412E must be powered by external AC power for this test.

4. Press the **On/Off** key to turn on the S412E.
5. Press the **Shift** key and then the **Preset (1)** key. Touch the Preset button on the touchscreen submenu to set the instrument to the factory preset state.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize

6. Press the **Shift** key and then the **System (8)** key.
7. Touch the GPS submenu button.
8. Confirm that the 3.3 V setting on the GPS Voltage submenu button is selected (underlined).
9. Touch the GPS On/Off submenu button to turn the GPS feature On.
10. Touch the GPS Info submenu button and wait until the **GPS INFO** dialog box appears.
11. Verify that the GPS Antenna Current is within the expected current range for 3.3 V Bias per [Table 5-2](#).

Table 5-2. Option 31 GPS Antenna Bias Tee Operational Check

Voltage Setting	Expected Current Range
3.3 V	27 mA to 38 mA
5 V	42 mA to 64 mA

12. Press the **Esc** key to dismiss the **GPS INFO** dialog box.
13. Touch the GPS Voltage submenu button to select 5 V.
14. Touch the GPS Info submenu button and wait until the **GPS INFO** dialog box appears.
15. Verify that the GPS Antenna Current is within the expected current range for 5 V Bias per [Table 5-2](#).

16. Press the **Esc** key to dismiss the **GPS INFO** dialog box.
17. Touch the **GPS On/Off** submenu button to turn GPS feature off.
18. Remove the adapter and terminator from the GPS connector of the S412E.
19. Connect the 2000-1528-R GPS Antenna to the GPS connector of the S412E.
20. Touch the **GPS On/Off** submenu button to turn GPS feature on.

Note

When GPS is first turned on, a red GPS icon will appear at the top of the display. When the GPS receiver has tracked at least three satellites, the GPS icon will change to green. Latitude and Longitude information is displayed in the white bar on top of the display. Acquiring satellites may take as long as three minutes.

21. Verify that GPS icon does turn green, which indicates that the GPS receiver of the S412E can acquire satellite signals.

Spectrum Analyzer Frequency Accuracy with GPS On

The following test is used to verify the frequency accuracy of the spectrum analyzer with GPS On for the S412E.

Note

Ensure that the Anritsu GPS Antenna is in a direct line-of-sight relationship to the GPS satellites or that the Antenna is placed outside without any obstructions.

Equipment Required

- GPS Antenna, Anritsu part number 2000-1528-R
- Vector Signal Generator, Anritsu Model MG3700A
- 10 MHz Reference Standard
- RF Coaxial Cable, Anritsu Model 15NN50-1.5C
- BNC(m) to BNC(m) Coaxial Cable, Anritsu part number 2000-1627-R

Procedure

1. Connect the BNC Coaxial Cable between the 10 MHz Reference Standard output and the 10 MHz Ref In connector of the Anritsu MG3700A Signal Generator.

Note

Do not connect the external 10 MHz Reference to the S412E.

2. Turn on both the 10 MHz Reference Standard and the Signal Generator.
3. Set the MG3700A output to 1.5 GHz CW with an RF output level of -30 dBm.
4. Connect the 15NN50-1.5C RF Coaxial Cable between the MG3700A and the RF In connector of the S412E.
5. Press the **On/Off** key to turn on the S412E.
6. Press the **Shift** key and then the **Mode (9)** key. Use the rotary knob to highlight **Spectrum Analyzer** and then press the **Enter** key to switch to Spectrum Analyzer mode.
7. Press the **Shift** key and then the **Preset (1)** key. Touch the **Preset** button on the touchscreen submenu to set the instrument to the factory preset state.

Note

Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize

8. Connect the GPS antenna and turn on the GPS. Wait until the Reference Source has changed to "GPS Hi Accy" at the lower left hand corner of the S412E screen.

9. Touch the **Amplitude** button on the touchscreen main menu and set the Reference Level to -10 dBm.
10. Touch the **Span** submenu button and set to 10 kHz.
11. Touch the **BW** main menu button and set the RBW to 100 Hz.
12. Set the VBW to 30 Hz.
13. Touch the **Freq** main menu button and set the Center Freq to 1.5 GHz.
14. Touch the **Marker** main menu button and then the **More** submenu button.
15. Set Counter Marker to On, touch the **Back** submenu button, and then touch the **Peak Search** submenu button.

Note Without the Counter Marker On, the frequency resolution will not allow looking at the kHz accuracy.

16. Verify that the marker frequency reading is within specification and record the measured value in [Table A-17, “Option 31, Spectrum Analyzer Frequency Accuracy with GPS On”](#) on page A-17.

Note If the instrument fails this test, contact your local Anritsu Service Center (http://www.anritsu.com/Contact.asp)

5-4 Fixed WiMAX Signal Analyzer Verification, Option 46 and 47

The tests in this section verify the performance of the optional Fixed WiMAX Signal Analyzer of the S412E LMR Master. There are tests for the following:

- “Fixed WiMAX Signal Analyzer Option Verification (Options 46)”
- “Fixed WiMAX Signal Analyzer Option Verification (Option 47)” on page 5-8

Fixed WiMAX Signal Analyzer Option Verification (Options 46)

The tests in this section verify the Channel Power Accuracy of the optional Fixed WiMAX Signal Analyzer in Model S412E LMR Master.

Equipment Required

- Anritsu MG3700A Vector Signal Generator
- Anritsu ML2438A Power Meter
- Anritsu MA2482D Power Sensor
- Anritsu 34NN50A Adapter
- Anritsu 15NN50-1.5C RF Coaxial Cable
- Aeroflex/Weinschel 1870A Power Splitter
- Aeroflex/Weinschel 44-10 10 dB Fixed Attenuator (2)
- Anritsu PN 2000-1627-R BNC Coaxial Cables (3)
- 10 MHz Reference Standard

Setup

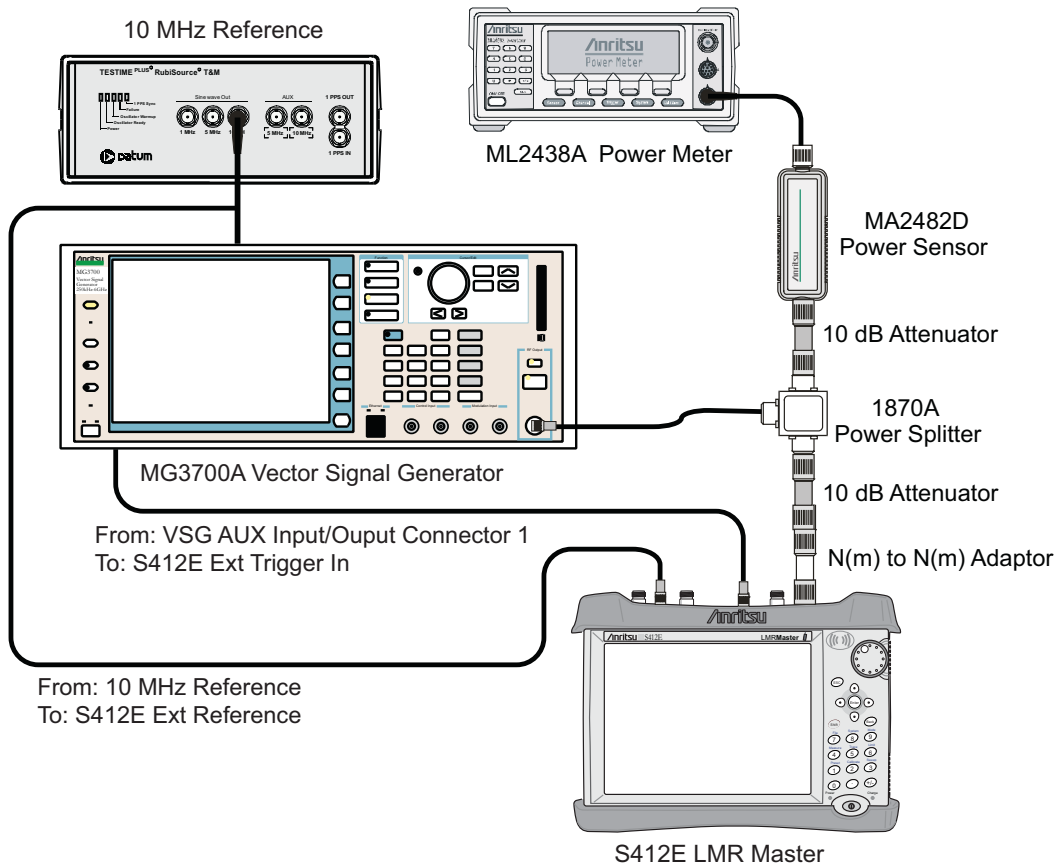


Figure 5-1. Fixed WiMAX Signal Analyzer Option Verification

Procedure

1. Connect the MA2482D Power Sensor to the power meter and zero the sensor.
2. Set the cal factor frequency of the power sensor to 2600.5 MHz.
3. Connect the equipment as shown in [Figure 5-1](#).
4. Set the MG3700A as follows:
 - a. Press the yellow **Preset** key (answer yes to the question).
 - b. Press the **Set** key.
 - c. Press the (F1) soft key to select Load File to Memory.
 - d. Press the (F1) soft key again to select Select Package.
 - e. Using the **Down Arrow** key step through the selection list until WiMax is highlighted.
 - f. Press the **Set** key.
 - g. Press the Return (F6) soft key.
 - h. Press the **Set** key. The Select Package list box will appear. Again select WiMax and the **Set** key.
 - i. Another file list will appear. Select (highlight) Mx10g32.
 - j. Press the **Set** key.
 - k. Press the **MOD On/Off** key and verify that the LED is on. Confirm that the “Playing” indicator is displaying the moving pattern.
 - l. Press the **Frequency** key, then enter 2600.5 MHz.
 - m. Press the **Level** key, then enter 2 dBm. Turn the output On.
5. Adjust the MG3700A level setting with the knob so that the power meter reads $-15.0 \text{ dBm} \pm 0.2 \text{ dB}$.
6. Set the S412E to Fixed WiMax Signal Analyzer mode and preset the unit.
7. Set the S412E as follows:
 - a. Press the **Freq** main menu key and set the center frequency to 2600.5 MHz.
 - b. Press the **Setup** submenu key and set the Bandwidth to 10 MHz.
 - c. Press the CP Ratio submenu key (under the Setup submenu key) and set the CP Ratio to 1/32.
 - d. Press the **Measurements** submenu key and select RF, then select Power vs. Time.
8. Record the S412E Channel Power (RSSI) reading in the **Measured Channel Power (RSSI)** column of [Table A-18](#), “[Option 46, Fixed WiMAX Channel Power Accuracy](#)”.
9. Calculate the Channel Power Error by subtracting the S412E Channel Power (RSSI) reading from the power meter reading in [Step 5](#). Record the result in the **Error** column of [Table A-18](#).
10. Verify that the error is within specification.
11. Adjust the MG3700A level setting to approximately -33 dBm so that the power meter reads -50.0 dBm .
12. Record the S412E Channel Power (RSSI) reading in the **Measured Channel Power (RSSI)** column of [Table A-18](#).
13. Calculate the Channel Power Error by subtracting the S412E Channel Power (RSSI) reading from the power meter reading in [Step 11](#). Record the result to the **Error** column of [Table A-18](#).
14. Verify that the error is within specification.
15. Set the cal factor frequency of the power sensor to 3600.5 MHz.
16. Set the MG3700A frequency to 3600.5 MHz.
17. Change the S412E center frequency to 3600.5 MHz.
18. Measure the Channel Power (RSSI) for both -15 and -50 dBm and then record the measured result and calculated error in [Table A-18](#).

19. Verify that the error is within specification.
20. Set the cal factor frequency of the power sensor to 5600.5 MHz.
21. Set the MG3700A frequency to 5600.5 MHz.
22. Change the S412E center frequency to 5600.5 MHz.
23. Repeat [Step 18](#) and [Step 19](#).

Fixed WiMAX Signal Analyzer Option Verification (Option 47)

The tests in this section verify the Residual EVM and Frequency Error of the optional Fixed WiMAX Signal Analyzer in Model S412E LMR Master.

Equipment Required

- Anritsu MG3700A Vector Signal Generator
- Anritsu ML2438A Power Meter
- Anritsu MA2482D Power Sensor
- Anritsu 34NN50A Adapter
- Anritsu 15NN50-1.5C RF Coaxial Cable
- Aeroflex/Weinschel 1870A Power Splitter
- Aeroflex/Weinschel 44-10 10 dB Fixed Attenuator (2)
- Anritsu PN 2000-1627-R BNC Coaxial Cables (3)
- 10 MHz Reference Standard

Procedure

1. Connect the MA2482D Power Sensor to the power meter and zero the sensor.
2. Set the cal factor frequency of the power sensor to 2600.5 MHz.
3. Connect the equipment as shown in [Figure 5-1](#).
4. Set the MG3700A as follows:
 - a. Press the yellow **Preset** key (answer yes to the question).
 - b. Press the **Set** key.
 - c. Press the (F1) soft key to select Load File to Memory.
 - d. Press the (F1) soft key again to select Select Package.
 - e. Using the **Down Arrow** key step through the selection list until WiMax is highlighted.
 - f. Press the **Set** key.
 - g. Press the Return (F6) soft key.
 - h. Press the **Set** key. The Select Package list box will appear. Again select WiMax and the **Set** key.
 - i. Another file list will appear. Select (highlight) Mx10g32.
 - j. Press the **Set** key.
 - k. Press the **MOD On/Off** key and verify that the LED is on. Confirm that the “Playing” indicator is displaying the moving pattern.
 - l. Press the **Frequency** key, then enter 2600.5 MHz.
 - m. Press the **Level** key, then enter 2 dBm. Turn the output On.
5. Adjust the MG3700A level setting with the knob so that the power meter reads $-15.0 \text{ dBm} \pm 0.2 \text{ dB}$.
6. Set the S412E to Fixed WiMax Signal Analyzer mode and preset the unit.

7. Set the S412E as follows:
 - a. Press the **Freq** main menu key and set the center frequency to 2600.5 MHz.
 - b. Press the **Setup** submenu key and set the Bandwidth to 10 MHz.
 - c. Press the **CP Ratio** submenu key (under the **Setup** submenu key) and set the CP Ratio to 1/32.
 - d. Press the **Measurements** submenu key and select **Demodulator**, then select **Modulation Summary**.
8. Record the S412E EVM(rms) reading in [Table A-19, “Option 47, Fixed WiMAX Residual EVM” on page A-17](#).
9. Verify that the measured EVM is within specification.
10. Adjust the MG3700A level setting to approximately -33 dBm so that the power meter reads -50.0 dBm \pm 0.2 dB.
11. Record the S412E EVM(rms) reading in [Table A-19](#).
12. Verify that the measured EVM is within specification.
13. Record the S412E Freq Error reading in [Table A-20, “Option 47, Fixed WiMAX Frequency Error” on page A-18](#).
14. Verify that the measured frequency error is within specification.
15. Set the cal factor frequency of the power sensor to 3600.5 MHz.
16. Set the MG3700A frequency to 3600.5 MHz.
17. Change the center frequency of the S412E to 3600.5 MHz.
18. Measure the EVM(rms) for both -15 dBm and -50 dBm, record the measured results in [Table A-19](#).
19. Verify that the measured EVM is within specification.
20. Set the cal factor frequency of the power sensor to 5600.5 MHz.
21. Set the MG3700A frequency to 5600.5 MHz.
22. Adjust the MG3700A level setting with the knob so that the power meter reads -15.0 dBm \pm 0.2 dBm.
23. Change the center frequency of the S412E to 5600.5 MHz.
24. Record the S412E EVM(rms) reading in [Table A-19](#).
25. Verify that the measured EVM is within specification.
26. Adjust the MG3700A level setting to approximately -33 dBm so that the power meter reads -50.0 dBm \pm 0.2 dB.
27. Record the S412E EVM(rms) reading in [Table A-19](#).
28. Verify that the measured EVM is within specification.
29. Record the S412E frequency error reading in [Table A-20](#).
30. Verify that the measured frequency error is within the specification.

5-5 Mobile WiMAX Signal Analyzer Verification, Option 66 and 67

The tests in this section verify the functionality of the Mobile WiMAX Signal Analyzer of the S412E. There are tests for the following:

- “[Mobile WiMAX Channel Power Accuracy Tests \(Option 66\)](#)”
- “[Mobile WiMAX Residual EVM and Frequency Error Tests \(Option 67\)](#)” on page 5-13

Mobile WiMAX Channel Power Accuracy Tests (Option 66)

The tests in this section verify the function of the optional Mobile WiMAX Signal Analyzer in Model S412E LMR Master.

Equipment Required

- Anritsu MG3700A Vector Signal Generator
- Anritsu ML2438A Power Meter
- Anritsu MA2482D Power Sensor
- Anritsu 34NN50A Adapter
- Anritsu 15NN50-1.5C RF Coaxial Cable
- Aeroflex/Weinschel 1870A Power Splitter
- Aeroflex/Weinschel 44-10 10 dB Fixed Attenuator (2)
- Anritsu PN 2000-1627-R BNC Coaxial Cables (2)
- 10 MHz Reference Standard

Setup

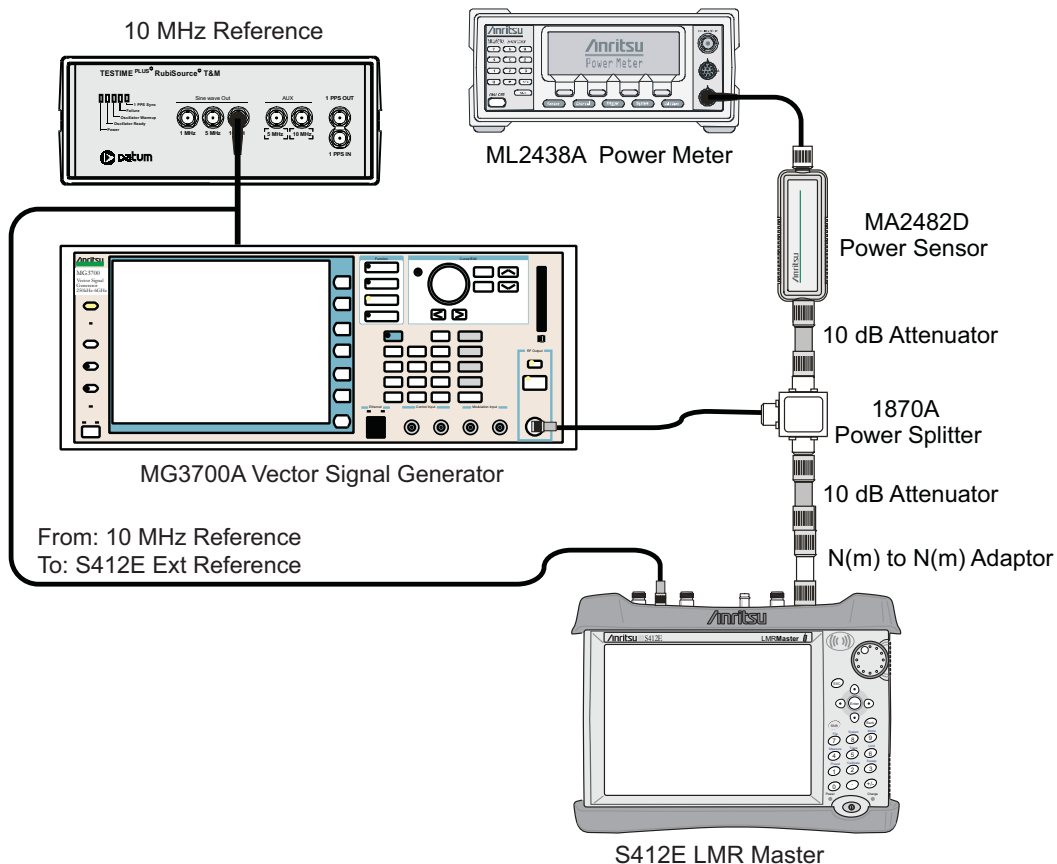


Figure 5-2. Mobile WiMAX Signal Analyzer Option Verification

Procedure

1. Connect the MA2482D Power Sensor to the power meter and zero the sensor.
2. Set the Power Meter Measurement MODE to True RMS, set Averaging MODE to Moving, and set Averaging NUMBER to 256.
3. Set the calibration factor frequency of the power sensor to 2600.5 MHz.
4. Connect the equipment as shown in [Figure 5-2](#).

Channel Power Accuracy (10 MHz Bandwidth and 10 ms Frame Length)

5. Set the MG3700A as follows:
 - a. Press the yellow button (answer yes to the question).
 - b. Press the **Set** key
 - c. Press the (F1) soft key to select Load File to Memory.
 - d. Press the (F1) soft key again to select Select Package.
 - e. Using the **Down Arrow** key step through the selection list until “mWiMax” is highlighted.
 - f. Press the **Set** key.
 - g. Press the (F6) soft key Return.
 - h. Press the **Set** key. The Select Package list box will appear. Again select mWiMax and **Set**.
 - i. Another file list will appear. Select (highlight) 10m1024g8_0_10_cap.
 - j. Press the **Set** key.
 - k. Press the **MOD On/Off** key and verify that the LED is On. Confirm that the “playing” indicator is displaying the moving pattern.
 - l. Press the **Frequency** key, then enter 2600.5 MHz.
 - m. Press the **Level** key, then enter 2 dBm. Turn the output On.
6. Adjust the MG3700A level setting with the knob so that the power meter reads $-15.0 \text{ dBm} \pm 0.2 \text{ dB}$.
7. Set the S412E to Mobile WiMax Signal Analyzer mode and preset the unit.
8. Set the S412E as follows:
 - a. Press the **Freq** main menu key and set the Center Freq to 2600.5 MHz.
 - b. Press the **Setup** submenu key and set the Bandwidth to 10 MHz.
 - c. Press the **Frame Length** submenu key and set the Frame Length to 10 ms.
 - d. Press the **Measurements** submenu key and select RF, then select Power vs. Time.
9. Record the S412E Channel Power (RSSI) reading in the **Measured Channel Power (RSSI)** column, **2600.5 MHz, -15 dBm** row of [Table A-21, “Option 66, Mobile WiMAX Channel Power Accuracy \(10 MHz Bandwidth and 10 ms Frame Length\)”](#).
10. Calculate the Channel Power Error by subtracting the S412E “Channel Power (RSSI)” reading from the power meter reading in [Step 6](#). Record the result into the test record in the **Error** column, **2600.5 MHz, -15 dBm** row of [Table A-21](#).
11. Verify that the error is within specification.
12. Adjust the MG3700A level setting to approximately -33 dBm so that the power meter reads $-50.0 \text{ dBm} \pm 0.2 \text{ dB}$.
13. Record the S412E Channel Power (RSSI) reading in the **2600.5 MHz, -50 dBm** row of [Table A-21](#).
14. Calculate the Channel Power Error by subtracting the S412E “Channel Power (RSSI)” reading from the power meter reading that was recorded in [Step 13](#). Record the result in [Table A-21](#).
15. Verify that the error is within specification.

16. Set the calibration factor frequency of the power sensor to 3600.5 MHz.
17. Set the MG3700A frequency to 3600.5 MHz.
18. Change the S412E center frequency to 3600.5 MHz.
19. Measure the Channel Power (RSSI) for both -15 dBm and -50 dBm, and then record the measured result and calculated error in [Table A-21](#).
20. Verify that the error is within specification.

Channel Power Accuracy (5 MHz Bandwidth and 5 ms Frame Length)

21. Set the MG3700A as follows:
 - a. Press the yellow **Preset** button (answer yes to the question).
 - b. Press the **Set** key
 - c. Press the (F1) soft key to select Load File to Memory.
 - d. Press the (F1) soft key again to select Select Package.
 - e. Using the **Down Arrow** key step through the selection list until mWiMax is highlighted.
 - f. Press the **Set** key.
 - g. Press the (F6) soft key Return.
 - h. Press the **Set** key. The Select Package list box will appear. Again select mWiMax and **Set**.
 - i. Another file list will appear. Select (highlight) 5m512g8_2_5_cap.
 - j. Press the **Set** key.
 - k. Press the **MOD On/Off** key and verify that the LED is on. Confirm that the “playing” indicator is displaying the moving pattern.
 - l. Press the **Frequency** key, then enter 2600.5 MHz.
 - m. Press the **Level** key, then enter 2 dBm. Turn the output On.
22. Set the calibration factor frequency of the power sensor to 2600.5 MHz.
23. Adjust the MG3700A level setting with the knob so that the power meter reads -15.0 dBm \pm 0.2 dB.
24. Set the S412E to Mobile WiMax Signal Analyzer mode and preset the unit.
25. Set the S412E as follows:
 - a. Press the **Freq** main menu key and set the Center Freq to 2600.5 MHz.
 - b. Press the Setup submenu key and set the Bandwidth to 5 MHz.
 - c. Press the Frame Length submenu key and set the Frame Length to 5 ms.
 - d. Press the Measurements submenu key and select RF, then select Power vs. Time.
26. Repeat [Step 9](#) through [Step 20](#) recording the results into the test record in [Table A-22](#), “[Option 66, Mobile WiMAX Channel Power Accuracy \(5 MHz Bandwidth and 5 ms Frame Length\)](#)” on page A-18.

Mobile WiMAX Residual EVM and Frequency Error Tests (Option 67)

The tests in this section verify the function of the optional Mobile WiMAX Signal Analyzer in Model S412E LMR Master.

Equipment Required

- Anritsu MG3700A Vector Signal Generator
- Anritsu 15NN50-1.5C RF Coaxial Cable
- Anritsu PN 2000-1627-R BNC Coaxial Cable (2)
- 10 MHz Reference Standard

Setup

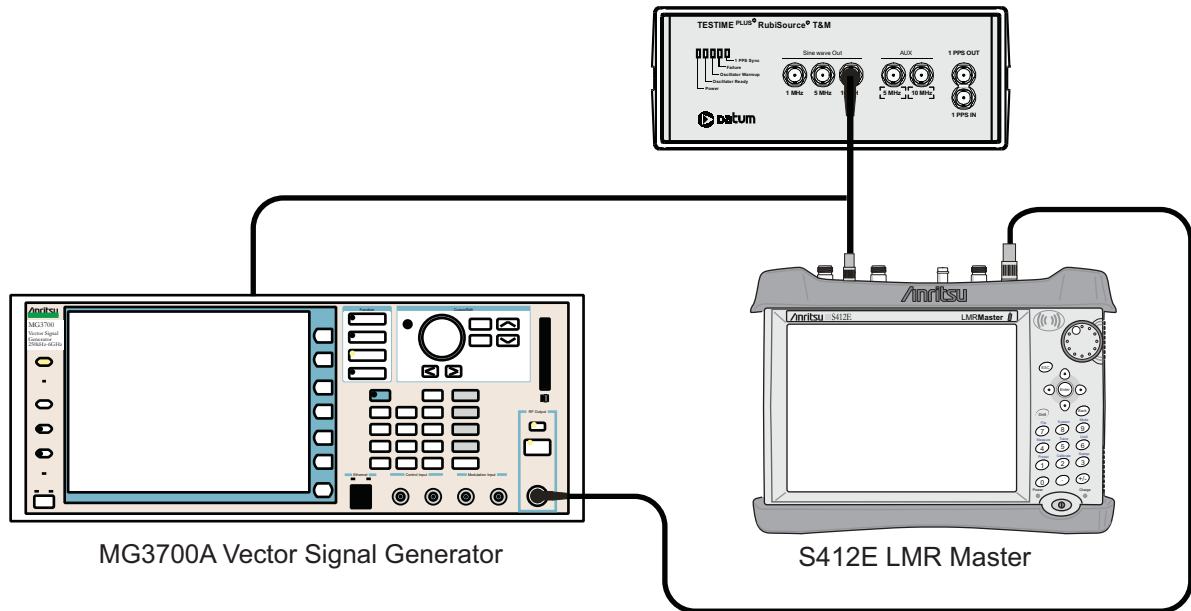


Figure 5-3. Mobile WiMAX Residual EVM and Frequency Error Test Setup

Procedure

1. Connect the equipment as shown in [Figure 5-3](#).

Residual EVM and Frequency Error (10 MHz Bandwidth and 10 ms Frame Length)

2. Set the MG3700A as follows:
 - a. Press the yellow **Preset** button (answer yes to the question).
 - b. Press the **Set** key
 - c. Press the (F1) soft key to select Load File to Memory.
 - d. Press the (F1) soft key again to select Select Package.
 - e. Using the **Down Arrow** key step through the selection list until mWiMax is highlighted.
 - f. Press the **Set** key.
 - g. Press the (F6) soft key Return.
 - h. Press the **Set** key. The Select Package list box will appear. Again select mWiMax and Set.
 - i. Another file list will appear. Select (highlight) 10m1024g8_0_10_cap.
 - j. Press the **Set** key.

Residual EVM and Frequency Error (5 MHz Bandwidth and 5 ms Frame Length)

19. Set the MG3700A as follows:

- a. Press the yellow **Preset** button (answer yes to the question).
- b. Press the **Set** key
- c. Press the (F1) soft key to select Load File to Memory.
- d. Press the (F1) soft key again to select Select Package.
- e. Using the **Down Arrow** key step through the selection list until “mWiMax” is highlighted.
- f. Press the **Set** key.
- g. Press the (F6) soft key Return.
- h. Press the **Set** key. The Select Package list box will appear. Again select mWiMax and **Set**.
- i. Another file list will appear. Select (highlight) 5m512g8_2_5_cap.
- j. Press the **Set** key.
- k. Press the **MOD On/Off** key and verify that the LED is On. Confirm that the “playing” indicator is displaying the moving pattern.
- l. Press the **Frequency** key, then enter 2600.5 MHz.

20. Press the **Level** key, then enter -15 dBm. Turn the output On.

Set the S412E as follows:

- a. Press the **Freq** main menu key and set the Center Freq to 2600.5 MHz
- b. Press the **Setup** submenu key and set the Bandwidth to 5 MHz.
- c. Press the CP Ratio submenu key (under the Setup submenu key) and set the CP Ratio to 1/8.
- d. Press the Frame Length submenu key and set the Frame Length to 5 ms.
- e. Press the Demod submenu key and set Demod to FCH.

21. Press the **Measurements** submenu key and select Demodulator, then select Modulation Summary.

22. Repeat [Step 6](#) through [Step 10](#), recording the S412E EVM (rms) in [Table A-25, “Option 67, Mobile WiMAX Residual EVM \(5 MHz Bandwidth and 5 ms Frame Length\)”](#) and the Frequency Error readings in [Table A-26, “Option 67, Mobile WiMAX Frequency Error \(5 MHz Bandwidth and 5 ms Frame Length\)”](#).

5-6 P25/P25p2 Modulation Fidelity Verification, Option 521 and 522

The following test is used to verify the modulation fidelity of the signal generator on the S412E. This test requires the P25 Option to be installed on revision 1 S412E's and P25/P25p2 Option to be installed on revision 2 or greater S412E's. If no revision is listed on the S412E serial number label, then the unit is revision 1.

Equipment Required

- RF coaxial cable, Anritsu Model 15NN50-1.5C
- AC Power Adapter, Anritsu part number 40-187-R

Procedure

1. Connect the AC Power Adapter (Anritsu part number 40-187-R) to the S412E and then plug the power cord of the AC Power Adapter to an AC outlet.
2. Power on the S412E and put the instrument into P25 Analyzer mode with the **Menu** button.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the Preset button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

4. Connect the RF cable between the Signal Generator Out and RF In connectors of the LMR Master.
5. Press the **Setup** main menu button and set Rx Pattern to 1011 Hz.
6. Set the Tx Pattern to p25_1011.
7. Press the **Amplitude** main menu button and set Tx Output Lvl to 0 dBm.
8. Press the **Frequency** main menu button and set Rx/Tx Coupling to On.
9. In the lower right hand corner of the touchscreen press the **Turn Sig-Gen ON** button to turn the signal generator on. The button will now appear as **Turn Sig-Gen OFF** to allow the signal generator to be turned off when the procedure is completed.
10. Press the **Frequency** main menu button and set Rx Frequency to 5.5 MHz.
11. Record the **Mod Fid** value in [Table A-27, "Options 521 and 522, Signal Generator Modulation Fidelity Verification for P25"](#) on page A-19, and verify the value is within specification.
12. Repeat [Step 10](#) through [Step 11](#) for the other Frequencies listed in [Table A-27](#).
13. Press the **Setup** main menu button and set Rx Pattern to O.153 (V.52) and Tx Pattern to p25_511(O.153).
14. Repeat [Step 10](#) through [Step 11](#) for the other Frequencies listed in [Table A-27](#).

For S412E that are Revision 2, proceed to the following steps. If the unit is Revision 1, then P25 verification is complete. (If the unit's serial number label does not have a revision, then the unit is Revision 1.)

15. Put the unit into P25p2 mode and Preset the unit.
16. Press the **Setup** main menu button and set Rx Pattern to 1031 Hz.
17. Set the Tx Pattern to p252_bs_1031.
18. Press the **Amplitude** main menu button and set Tx Output Lvl to 0 dBm.
19. Press the **Frequency** main menu button and set Rx/Tx Coupling to On.
20. In the lower right hand corner of the touchscreen press the **Turn Sig-Gen ON** button to turn the signal generator on. The button will now appear as **Turn Sig-Gen OFF** to allow the signal generator to be turned off when the procedure is completed.
21. Press the **Frequency** main menu button and set Rx Frequency to 5.5 MHz.
22. Record the **Mod Fid** value in [Table A-28, "Options 521 and 522, Signal Generator Modulation Fidelity Verification for P25p2 \(Rev 2 Units Only\)"](#) on page A-20, and verify the value is within specification.

23. Repeat [Step 21](#) through [Step 22](#) for the other Frequencies listed in [Table A-28](#).
24. Press the **Setup** main menu button and set Rx Pattern to **Silence** and Tx Pattern to **p252_bs_silence**.
25. Repeat [Step 21](#) through [Step 22](#) for the other Frequencies listed in [Table A-28](#).
26. When finished, press the **Turn Sig-Gen OFF** button to turn off the signal generator.

5-7 NXDN Modulation Fidelity Verification, Option 531 and 532

The following test is used to verify the modulation fidelity of the signal generator on the S412E. This test requires NXDN to be installed:

Equipment Required

- RF coaxial cable, Anritsu Model 15NN50-1.5C
- AC Power Adapter, Anritsu part number 40-187-R

Procedure

1. Connect the AC Power Adapter (Anritsu part number 40-187-R) to the S412E and then plug the power cord of the AC Power Adapter to an AC outlet.
2. Power on the S412E and put the instrument into NXDN Analyzer mode with the **Menu** button.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the Preset button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

4. Connect the RF cable between the Signal Generator Out and RF In connectors of the LMR Master.
5. Press the **Setup** main menu button and set Rx Pattern to 1031 Hz:
6. Set the Tx Pattern to nxdn_1031_9600.
7. Press the **Amplitude** main menu button and set Tx Output Lvl to 0 dBm.
8. Press the **Frequency** main menu button and set Rx/Tx Coupling to On.
9. In the lower-right hand corner of the touchscreen, press the **Turn Sig-Gen ON** button to turn the signal generator on. The button will now appear as **Turn Sig-Gen OFF** to allow the signal generator to be turned off when the procedure is completed.
10. Press the **Frequency** main menu button and set Rx Frequency to 5.5 MHz.
11. Record the **Mod Fid** value in [Table A-29, “Options 531 and 532, Signal Generator Modulation Fidelity Verification for NXDN”](#) on [page A-20](#), and verify the value is within specification.
12. Repeat [Step 10](#) through [Step 11](#) for the other Frequencies listed in [Table A-29](#).
13. Press the **Setup** main menu button and set Rx Pattern to O.153 (V.52) and Tx Pattern to nxdn_511(O.153)_9600.
14. Repeat [Step 10](#) through [Step 11](#) for the other Frequencies listed in [Table A-29](#).
15. When finished, press the **Turn Sig-Gen OFF** button to turn off the signal generator.

5-8 LTE Signal Analyzer Verification, Option 541 and 542

The tests in this section verify the functionality of the LTE Signal Analyzer of the S412E LMR Master. The following tests are included in this section:

- “LTE Channel Power Accuracy Verification (Option 541)” on page 5-20
- “LTE Frequency Error Verification (Option 542)” on page 5-21

Equipment Required

- Anritsu MG3700A Vector Signal Generator
- Anritsu ML2438A Power Meter
- Anritsu MA2482D Power Sensor
- Anritsu 34NN50A Adapter
- Anritsu 15NNF50-1.5C RF Coaxial Cable
- Aeroflex/Weinschel 1870A Power Splitter
- Aeroflex/Weinschel 44-10 10 dB Fixed Attenuator (2)
- Anritsu PN 2000-1627-R BNC Coaxial Cable (2)
- 10 MHz Reference Standard

Procedure

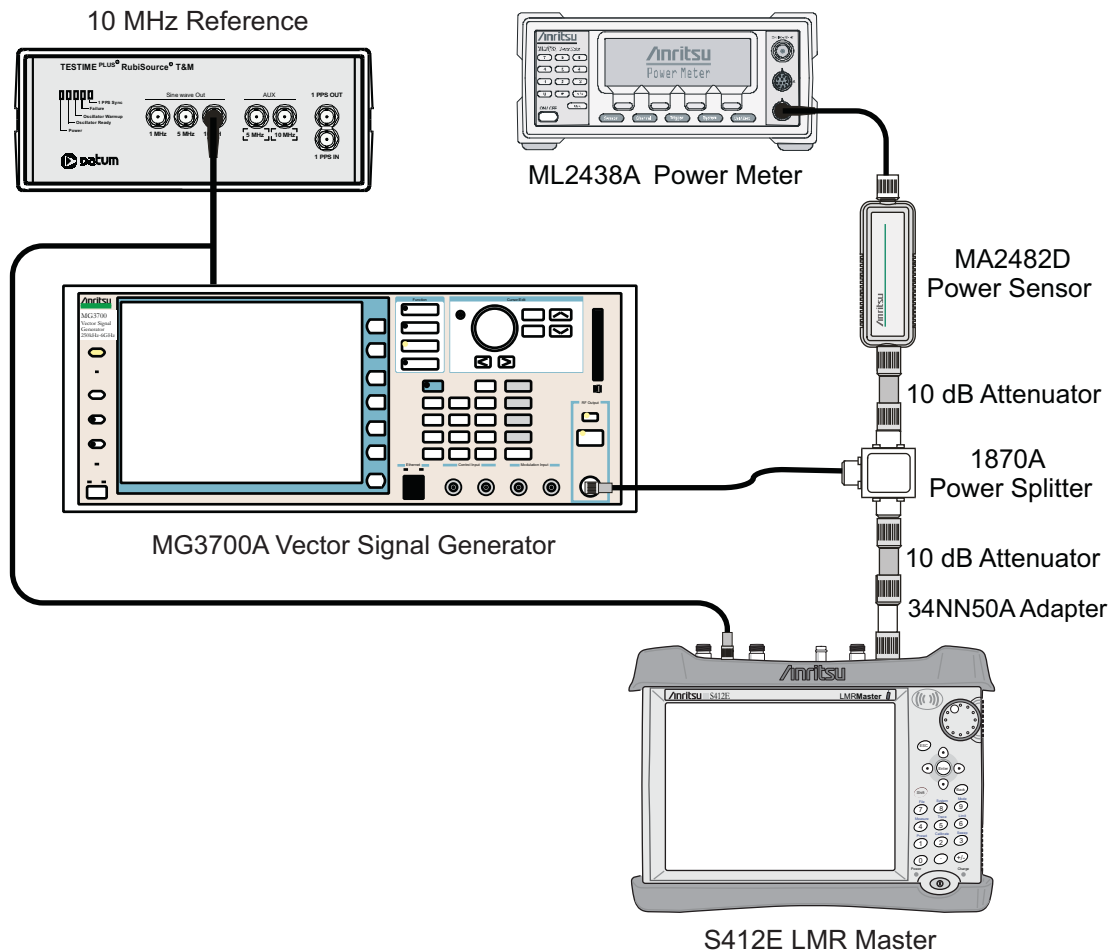


Figure 5-4. LTE Signal Analyzer Option Verification

LTE Channel Power Accuracy Verification (Option 541)

The tests in this section verify the function of the optional LTE Signal Analyzer in Model S412E LMR Master.

Procedure

1. Connect the MA2482D Power Sensor to the power meter and zero the sensor.
2. Set the Power Meter Measurement MODE to True RMS, set Averaging MODE to Moving, and set Averaging NUMBER to 256.
3. Set the calibration factor frequency of the power sensor to 797 MHz.
4. Connect the equipment as shown in [Figure 5-4](#).

Note

The LTE pattern requires a Waveform Data license MX370108A that must be purchased. Both **Set** keys on the MG3700A perform the same function.

5. Set the MG3700A as follows:
 - a. Press the yellow **Preset** button (answer yes to the question).
 - b. Press the **Set** key
 - c. Press the (F1) soft key to select Load File to Memory.
 - d. Press the (F1) soft key again to select Select Package.
 - e. Using the **Down Arrow** key step through the selection list until “LTE_DL_E-TM” is highlighted.
 - f. Press the **Set** key.
 - g. Press the (F6) soft key Return.
 - h. Press the **Set** key. The Select Package list box will appear. Again select LTE_DL_E-TM and then the **Set** key.
 - i. Another file list will appear. Select (highlight) E-TM_1-1_10M.
 - j. Press the **Set** key.
 - k. Press the **MOD On/Off** key and verify that the LED is On. Confirm that the “playing” indicator is displaying the moving pattern.
 - l. Press the **Frequency** key, then enter 797 MHz.
 - m. Press the **Level** key, then enter 2 dBm.
 - n. Turn the output on.
6. Adjust the MG3700A level setting with the knob so that the power meter reads $-10.0 \text{ dBm} \pm 0.5 \text{ dB}$.
7. Set the S412E to LTE Signal Analyzer mode and preset the unit.
8. Set the S412E as follows:
 - a. Press the **Freq** main menu key and set the Center Freq to 797 MHz.
 - b. Press the Measurements submenu key and select RF, then select Channel Spectrum.
9. Record the S412E Channel Power reading in the **797 MHz, -10 dBm** row, **Measured Channel Power** column of [Table A-30, “Option 541, LTE Channel Power Accuracy](#).
10. Calculate the Channel Power Error by subtracting the S412E “Channel Power” reading from the power meter reading in [Step 6](#). Record the result in the **797 MHz, -10 dBm** row, **Error** column of [Table A-30](#).
11. Verify that the error is within specification.
12. Adjust the MG3700A level setting to approximately -33 dBm so that the power meter reads $-50.0 \text{ dBm} \pm 0.5 \text{ dB}$.

13. Record the S412E Channel Power reading in the **797 MHz, -50 dBm** row, **Measured Channel Power** column of [Table A-30](#).
14. Calculate the Channel Power Error by subtracting the S412E “Channel Power” reading from the power meter reading that was recorded in [Step 13](#). Record the result in the **797 MHz, -50 dBm** row, **Error** column of [Table A-30](#).
15. Verify that the error is within specification.

[Step 16](#) through [Step 20](#) should be performed only for units with Option 6.

16. Set the calibration factor frequency of the power sensor to 2150 MHz.
17. Set the MG3700A frequency to 2150 MHz. Press the **Set** key.
18. Change the S412E center frequency to 2150 MHz.
19. Measure the Channel Power for -10 dBm and -50 dBm and then record the measured result in the **Measured Channel Power** column and the calculated error in the **Error** column of [Table A-30](#).
20. Verify that the error is within specification.

LTE Frequency Error Verification (Option 542)

The tests in this section verify the function of the optional LTE Signal Analyzer in Model S412E LMR Master.

Procedure

1. Connect the MA2482D Power Sensor to the power meter and zero the sensor.
2. Set the Power Meter Measurement MODE to True RMS, set Averaging MODE to Moving, and set Averaging NUMBER to 256.
3. Set the calibration factor frequency of the power sensor to 797 MHz.
4. Connect the equipment as shown in [Figure 5-4](#).

Note

The LTE pattern requires a Waveform Data license MX370108A that must be purchased.
Both **Set** keys on the MG3700A perform the same function.

5. Set the MG3700A as follows:
 - a. Press the yellow **Presets** button (answer yes to the question).
 - b. Press the **Set** key
 - c. Press the (F1) soft key to select Load File to Memory.
 - d. Press the (F1) soft key again to select Select Package.
 - e. Using the **Down Arrow** key step through the selection list until LTE_DL_E-TM is highlighted.
 - f. Press the **Set** key.
 - g. Press the (F6) soft key Return.
 - h. Press the **Set** key. The Select Package list box will appear. Again select LTE_DL_E-TM and press **Set**.
 - i. Another file list will appear. Select (highlight) E-TM_3-1_10M.
 - j. Press the **Set** key.
 - k. Press the **MOD On/Off** key and verify that the LED is On. Confirm that the “playing” indicator is displaying the moving pattern.
 - l. Press the **Frequency** key, then enter 797 MHz.
 - m. Press the **Level** key, then enter 2 dBm.
 - n. Turn the output On.

6. Adjust the MG3700A level setting with the knob so that the power meter reads $-10.0 \text{ dBm} \pm 0.5 \text{ dB}$.
 7. Set the S412E to LTE Signal Analyzer mode and preset the unit.
 8. Set the S412E as follows:
 - a. Press the **Freq** main menu key and set the Center Freq to 797 MHz.
 - b. Press the **Measurements** submenu key and select **Modulation Measurements**.
 - c. Press the **Constellation** submenu key.
 9. Record the S412E Frequency Error reading in the **797 MHz, -10 dBm** section of [Table A-31](#), “[Option 542, LTE Frequency Accuracy](#)”.
 10. Verify the value is within specification.
 11. Adjust the MG3700A level setting to approximately -33 dBm so that the power meter reads $-50.0 \text{ dBm} \pm 0.5 \text{ dB}$.
 12. Record the S412E Frequency Error reading into the **797 MHz, -50 dBm** section of [Table A-31](#).
 13. Verify the value is within specification.
- [Step 14](#) through [Step 22](#) should be performed only for units with Option 6.
14. Set the calibration factor frequency of the power sensor to 2150 MHz.
 15. Set the MG3700A frequency to 2150 MHz. Press the **Set** key.
 16. Adjust the MG3700A level setting with the knob so that the power meter reads $-10.0 \text{ dBm} \pm 0.5 \text{ dB}$.
 17. Change the S412E center frequency to 2150 MHz.
 18. Record the S412E Frequency Error reading into the **2150 MHz, -10 dBm** section of [Table A-31](#).
 19. Verify the value is within specification.
 20. Adjust the MG3700A level setting to approximately -33 dBm so that the power meter reads $-50.0 \text{ dBm} \pm 0.5 \text{ dB}$.
 21. Record the S412E Frequency Error reading in the **2150 MHz, -50 dBm** section of [Table A-31](#).
 22. Verify the value is within specification.

5-9 TETRA EVM Verification, Option 581 and 582

The following test is used to verify EVM of the signal generator on the S412E. This test requires the TETRA options to be installed:

Equipment Required

- RF coaxial cable, Anritsu Model 15NN50-1.5C
- AC Power Adapter, Anritsu part number 40-187-R

Procedure

1. Connect the AC Power Adapter (Anritsu part number 40-187-R) to the S412E and then plug the power cord of the AC Power Adapter into an AC outlet.
2. Power on the S412E and put the instrument into TETRA Analyzer mode with the **Menu** button.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, and then the Preset button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

4. Connect the RF cable between the Signal Generator Out and RF In connectors of the LMR Master.
5. Press the **Setup** main menu button and ensure the Tx Pattern is set to `tetra_bs_idle_unallocPCH`.
6. Press the **Amplitude** main menu button and set Tx Output Lvl to 0 dBm.
7. Press the **Frequency** main menu button and set Rx/Tx Coupling to On.
8. In the lower right-hand corner of the touchscreen press the **Turn Sig-Gen ON** button to turn the signal generator on. The button will now appear as **Turn Sig-Gen OFF** to allow the signal generator to be turned off when the procedure is completed.
9. Press the **Frequency** main menu button and set Rx Frequency to 5.5 MHz.
10. Record the **EVM** value in [Table A-32, “Options 581 and 582, Signal Generator EVM Verification for TETRA”](#) on [page A-22](#), and verify the value is within specification.
11. Repeat [Step 9](#) through [Step 10](#) for the other Frequencies listed in [Table A-32](#).
12. When finished press the **Turn Sig-Gen OFF** button to turn off the signal generator.

5-10 DMR2 Modulation Fidelity Verification, Option 591 and 592

The following test is used to verify the modulation fidelity of the signal generator on the S412E. This test requires DMR2 to be installed:

Equipment Required

- RF coaxial cable, Anritsu Model 15NN50-1.5C
- AC Power Adapter, Anritsu part number 40-187-R

Procedure

1. Connect the AC Power Adapter (Anritsu part number 40-187-R) to the S412E and then plug the power cord of the AC Power Adapter to an AC outlet.
2. Power on the S412E and put the instrument into DMR2 Analyzer mode with the **Menu** button.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the **Preset** button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

4. Connect the RF cable between the Signal Generator Out and RF In connectors of the LMR Master.
5. Press the **Setup** main menu button and set Rx Pattern to 1031 Hz.
6. Set the Tx Pattern to dmr2_bs_1031.
7. Press the **Amplitude** main menu button and set Tx Output Lvl to 0 dBm.
8. Press the **Frequency** main menu button and set Rx/Tx Coupling to On.
9. In the lower right hand corner of the touchscreen press the **Turn Sig-Gen ON** button to turn the signal generator on. The button will now appear as **Turn Sig-Gen OFF** to allow the signal generator to be turned off when the procedure is completed.
10. Press the **Frequency** main menu button and set Rx Frequency to 5.5 MHz.
11. Record the **Mod Fid** value in [Table A-33, “Options 591 and 592, Signal Generator Modulation Fidelity Verification for DMR2”](#) on [page A-22](#), and verify the value is within specification.
12. Repeat [Step 10](#) through [Step 11](#) for the other Frequencies listed in [Table A-33](#).
13. Press the **Setup** main menu button and set Rx Pattern to O.153 (V.52) and Tx Pattern to dmr2_bs_511(O.153).
14. Repeat [Step 10](#) through [Step 11](#) for the other Frequencies listed in [Table A-33](#).
15. When finished press the **Turn Sig-Gen OFF** button to turn off the signal generator.

5-11 Positive Train Control (PTC) Verification, Option 721 and 722

The following verification procedure is split into two procedures depending on the S412E's firmware version. One procedure is for units with firmware version 1.09 and below and the other is for units with firmware version 1.10 and above. Only one of the two procedures needs to be performed. Please note if upgrading a unit from firmware version 1.09 or lower, to version 1.10 or higher, the S412E will need to be sent to the local Service Center to have additional Signal Generator patterns installed.

Equipment Required

- RF coaxial cable, Anritsu Model 15NN50-1.5C
- AC Power Adapter, Anritsu part number 40-187-R

Procedure for Units with Firmware Version v1.09 and Lower

1. Connect the AC Power Adapter (Anritsu part number 40-187-R) to the S412E and then plug the power cord of the AC Power Adapter to an AC outlet.
2. Power on the S412E and put the instrument into PTC Analyzer mode with the **Menu** button.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the Preset button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

4. Connect the RF cable between the **Signal Generator Out** and **RF In** connectors of the LMR Master.
5. Press the **Setup** main menu button and set Tx Pattern to `ptc_4fsk_pattern0_6000`.
6. Press the **Amplitude** main menu button and set Tx Output Lvl to 0 dBm.
7. Press the **Frequency** main menu button and set Rx/Tx Coupling to On.
8. In the lower-right hand corner of the touchscreen press the **Turn Sig-Gen ON** button to turn the signal generator on. The button will now appear as **Turn Sig-Gen OFF** to allow the signal generator to be turned off when the procedure is completed.
9. Press the **Frequency** main menu button and set Rx Frequency to 5.5 MHz.
10. Record the **Mod Fid** value in [Table A-34, “Units with Firmware Version 1.09 and Lower, Options 721 and 722, PTC Verification”](#) on page A-22, and verify the value is within specification.
11. Repeat [Step 9](#) through [Step 10](#) for the other Frequencies listed in [Table A-34](#).
12. Press the **Setup** main menu button and set Symbol rate from 6000 to 18000.
13. Repeat [Step 9](#) through [Step 10](#) for all Frequencies listed in [Table A-34](#).
14. When finished press the **Turn Sig-Gen OFF** button to turn off the signal generator.

Procedure for Units with Firmware Version v1.10 and Higher

1. Connect the AC Power Adapter (Anritsu part number 40-187-R) to the S412E and then plug the power cord of the AC Power Adapter to an AC outlet.
2. Power on the S412E and put the instrument into PTC Analyzer mode with the **Menu** button.
3. Preset the S412E by pressing the **Shift** key, then the **Preset (1)** key, then the **Preset** button on the touchscreen.

Note Before continuing, allow a 30-minute warm up for the internal circuitry to stabilize.

4. Connect the RF cable between the **Signal Generator Out** and **RF In** connectors of the LMR Master.
5. Press the **Setup** main menu button and set Tx Pattern to pn9_cont_1_8000.
6. Ensure Symbol Rate is set to Half Rate
7. Press the **Amplitude** main menu button and set Tx Output Lvl to 0 dBm.
8. Press the **Frequency** main menu button and set Rx/Tx Coupling to On.
9. In the lower-right hand corner of the touchscreen press the **Turn Sig-Gen ON** button to turn the signal generator on. The button will now appear as **Turn Sig-Gen OFF** to allow the signal generator to be turned off when the procedure is completed.
10. Press the **Frequency** main menu button and set Rx Frequency to 5.5 MHz.
11. Record the **EVM** value in [Table A-35, “Units with Firmware Version 1.10 and Higher, Options 721 and 722 PTC Verification”](#) on page A-23, and verify the value is within specification.
12. Repeat [Step 10](#) through [Step 11](#) for the other Frequencies listed in [Table A-35](#).
13. Press the **Setup** main menu button and set Symbol rate Full Rate.
14. Repeat [Step 10](#) through [Step 11](#) for all Frequencies listed in [Table A-35](#).
15. When finished press the **Turn Sig-Gen OFF** button to turn off the signal generator.

Chapter 6 — Battery Information and Replacement

6-1 Introduction

This chapter describes the removal and replacement procedures for the instrument battery.

6-2 Replaceable Parts and Assemblies

The following replaceable parts are related to the battery pack and power adapters. To ensure that the correct parts are provided, be sure to list the model number, the instrument serial number, and the installed options with the order. The installed options are listed on a label on the back of the S412E and can also be viewed in the System/Status display.

Table 6-1. Replaceable Battery Parts and Assemblies

Part Number	Description
ND73201	Battery Door
40-187-R	AC to DC Power Adapter
633-75	Rechargeable Battery, Li-Ion
806-141-R	Automotive 12 Volt DC Adapter
2000-1374	External Dual Battery Charger

6-3 Battery Information

The following general information relates to the care and handling of the S412E Anritsu Rechargeable Lithium-Ion Battery.

Approved Batteries Only

- Always use the battery for its intended purpose only.
- Use only Anritsu-approved battery packs. Some non-approved battery packs may fit into the S412E but are electrically incompatible and will not charge correctly.
- The battery can be charged and discharged hundreds of times, but it will eventually wear out.
- The battery may need to be replaced when the operating time between charging becomes noticeably shorter than normal.
- Never use a damaged or worn out charger or battery.

Recharging

- The battery pack supplied with the S412E may need charging before use.
- Before using the S412E, the internal battery may be charged either in the unit using the 40-187-R AC-DC Adapter, or in an automobile using the 806-141-R Automotive 12 Volt DC Adapter.
- The battery can also be charged separately in the optional 2000-1374 Dual Battery Charger.
- Recharge the battery only in the S412E or in an Anritsu-approved charger.
- Do not charge batteries for longer than 24 hours; overcharging may shorten battery life.

Unit Not In Use

- When the S412E or the charger is not in use, disconnect it from the AC power source.
- If left unused, a fully charged battery will discharge itself over time.
- Temperature extremes affect the ability of the battery to charge. Allow the battery to cool down or warm up as necessary before use or charging.
- Discharge the battery from time to time to improve battery performance and battery life.
- Storing the battery in extreme hot or cold places will reduce the capacity and lifetime of the battery.

Physical Handling of Batteries

- Never short-circuit the battery terminals.
- Do not drop, mutilate or attempt to disassemble the battery.

Battery Disposal

- Do not dispose of batteries in a fire!
- Batteries must be recycled or disposed of properly. Do not place batteries in household garbage.

Warning

This equipment is supplied with a rechargeable battery that could potentially leak hazardous compounds into the environment. These hazardous compounds present a risk of injury or loss due to exposure. Anritsu Company recommends removing the battery for long-term storage of the instrument and storing the battery in a leak-proof, plastic container. Follow the environmental storage requirements specified in the product data sheet.

6-4 Battery Pack Removal and Replacement

This section provides instructions for the removal and replacing the S412E battery pack.

Note

Many of the procedures in this section are generic, and apply to many similar instruments. Photos and illustrations used are representative and may show instruments other than the S412E.

1. Locate the Battery Access Door, as shown in [Figure 6-1](#).



Figure 6-1. Battery Access Door Location

2. Place a finger in the battery access door notch and push the door down towards the bottom of the instrument.
3. Remove the Battery Access Door. The top will pop out a bit and then pull it up out of the access enclosure.

4. With the Battery Access Door completely removed, grasp the battery lanyard and pull the battery straight out of the unit, as illustrated in [Figure 6-2](#).



Figure 6-2. Removing the Battery

5. Replacement is the opposite of removal. Note the orientation of the battery contacts, and be sure to insert the new battery with the contacts facing the bottom of the unit, as shown in [Figure 6-3](#).

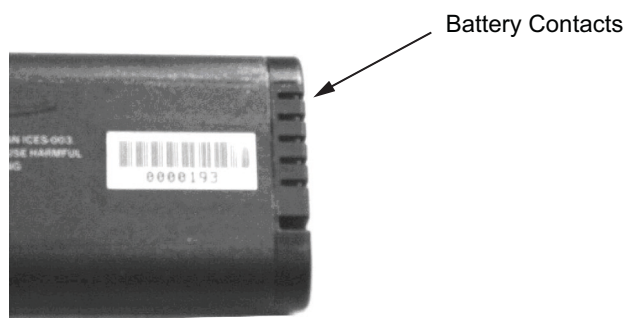


Figure 6-3. Orientation of Battery Contacts

Chapter 7 — Assembly Replacement

7-1 Replaceable Parts List

Refer to [Table 1-5, “List of Replaceable Parts and Assemblies”](#) for the list of replaceable parts. Refer to the following sections for basic replacement instructions.

Note

Many of the procedures in this section are generic, and apply to many similar instruments. Photos and illustrations used are representative and may not match your instrument.

Caution

Only qualified personnel should open the case and replace internal assemblies. Assemblies shown in [Table 1-5](#) are typically the only items that may be replaced. Because they are highly fragile, items that must be soldered may not be replaced without specialized training.

Removing RF shields from PC boards or adjustment of screws on or near the shields may detune sensitive RF circuits and will result in degraded instrument performance. All work should be performed in a static-safe work area.

7-2 Opening the S412E Case

Caution

Electrostatic Discharge (ESD) can damage the highly sensitive circuits in the instrument.

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

The LMR Master contains components that can be easily damaged by electrostatic discharge (ESD). An ESD safe work area and proper ESD handling procedures that conform to ANSI/ESD S20.20-1999 or ANSI/ESD S20.20-2007 is mandatory to avoid ESD damage when handling subassemblies or components found in the instrument.

This procedure provides instructions for opening the S412E case. With the case opened, the internal assemblies can be removed and replaced, as detailed in the following sections.

1. Remove the battery door and battery as shown in [Section 6-4 “Battery Pack Removal and Replacement” on page 6-3](#).

- Remove the top and bottom bumpers (Figure 7-1) to expose the screw holes on the back of the unit. Remove the nut and washer on the GPS Connector.



Figure 7-1. Top Bumper and Option 31

- Place the S412E face down on a stable work surface that will not scratch the display.
- Use a Phillips screwdriver to remove the six screws securing the two halves of the S412E case together (Figure 7-2).



Figure 7-2. Remove the Four Screws

- Carefully lift up on the side of the case indicated above and begin to separate the two halves.

6. Lay the S412E flat and remove the battery connector cable between the two halves (Figure 7-3).

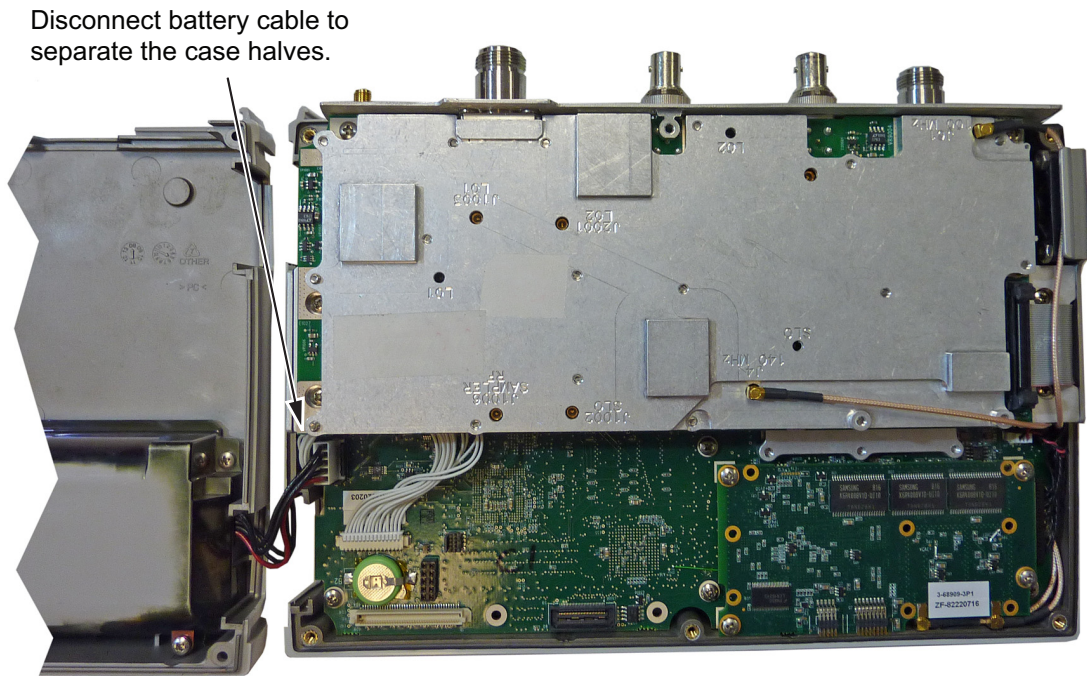


Figure 7-3. LMR Master Opened 180 Degrees

7. Closing the case is the reverse of opening. Ensure all cables are properly seated and none are pinched before closing the case.

7-3 PCB Assembly Replacement

Note Procedures in this section are generic, and apply to many similar instruments. Photos and illustrations used are representative and may not match your instrument.

This section describes the removal and replacement of the SPA and Main/VNA boards which are attached to each other and attached to the S412E Case.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Disconnect the Keypad PCB connector. For units with Ethernet hardware, unscrew and lift up the Ethernet PCB to gain access to the Keypad PCB connector.
3. Disconnect the Fan Assembly connector, and the LCD connector.
4. Use a Phillips screwdriver to remove the 8 screws securing the Assemblies to the Case ([Figure 7-4](#)).

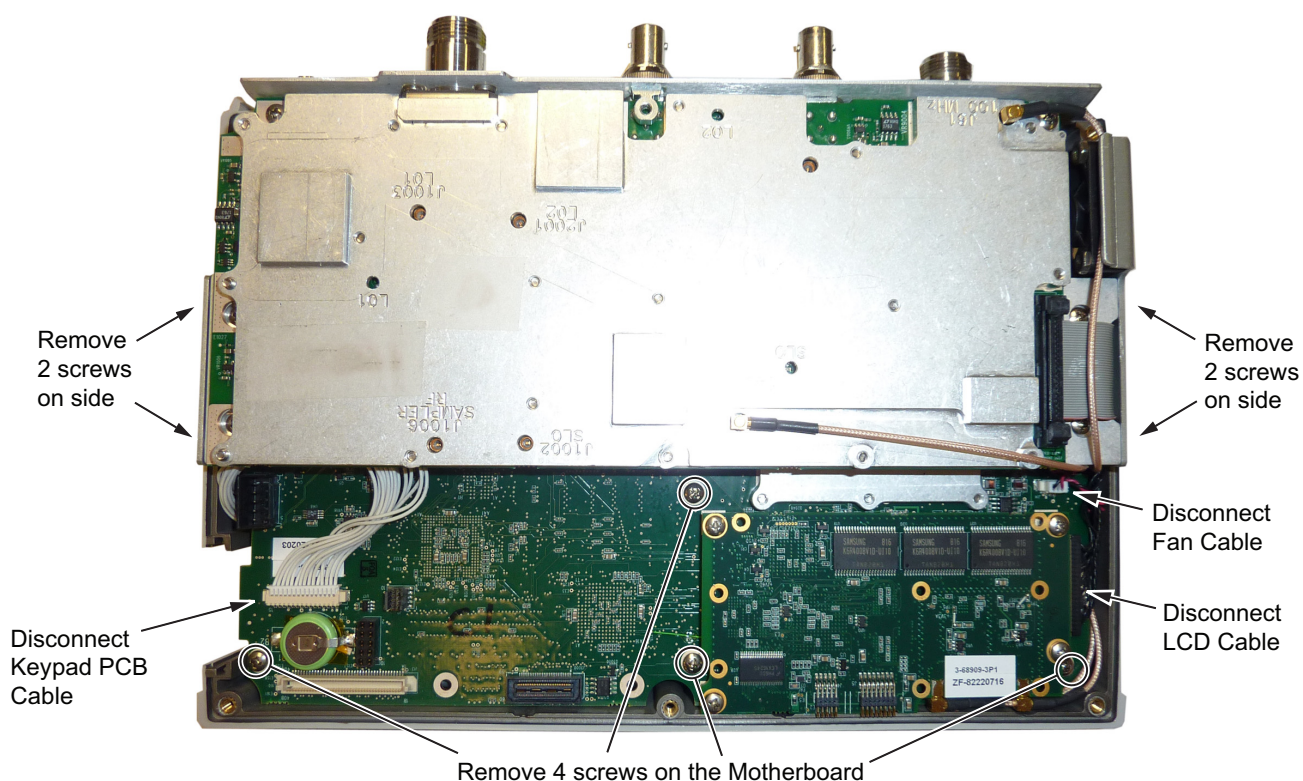


Figure 7-4. Removing the PCB Assemblies out of the Case

5. After the screws are removed the entire Assembly including the top connector panel will slide out of the case.
6. Installation is the reverse of removal. During installation ensure the Keypad PCB cable along with all other cables are properly seated at both ends. Also take care to properly fit the connector panel into the grooves in the top of the case and confirm that none of the cables will be pinched when the back case is replaced.

7-4 SPA Assembly Replacement

This section describes the removal of the SPA Assembly board.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the PCB Assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Remove the castle nuts from the External Reference connector and the External Trigger connector ([Figure 7-5](#)).
4. Remove the Main/VNA board ribbon connector.
5. Remove the 2 MCX connectors between the SPA board and the DSP board.
6. Remove the 6 screws retaining the SPA board.
7. Slide the SPA board out of the top panel.
8. Installation is the reverse of removal.

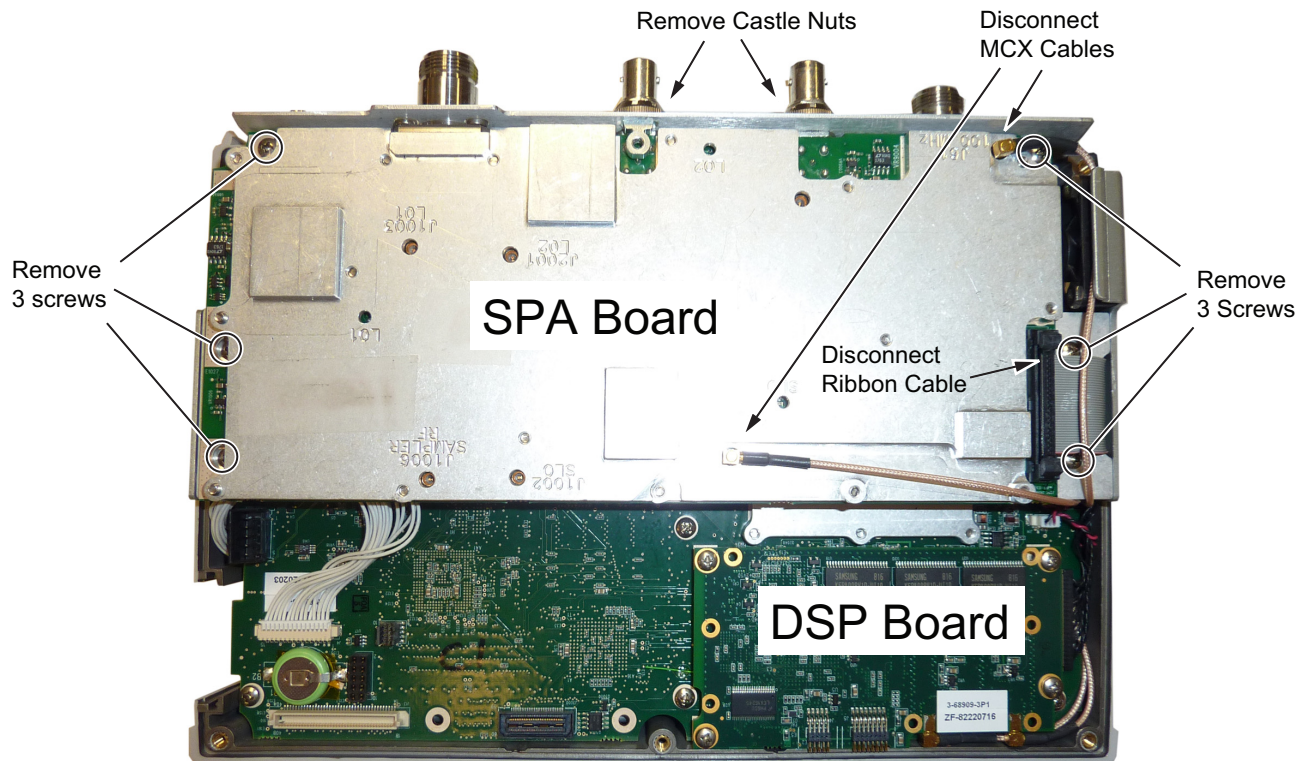


Figure 7-5. Removing the SPA Assembly

7-5 SPA and MB/VNA N Connector Replacement

This procedure provides instructions for replacing the N connector attached to the SPA assembly or MB/VNA assembly.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the PCB Assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Remove the SPA assembly as described in [Section 7-4 “SPA Assembly Replacement”](#).
4. If removing the MB/VNA N connector, remove the top plate from the MB/VNA.
5. Remove the four screws attaching the N connector to the shield ([Figure 7-6](#)).

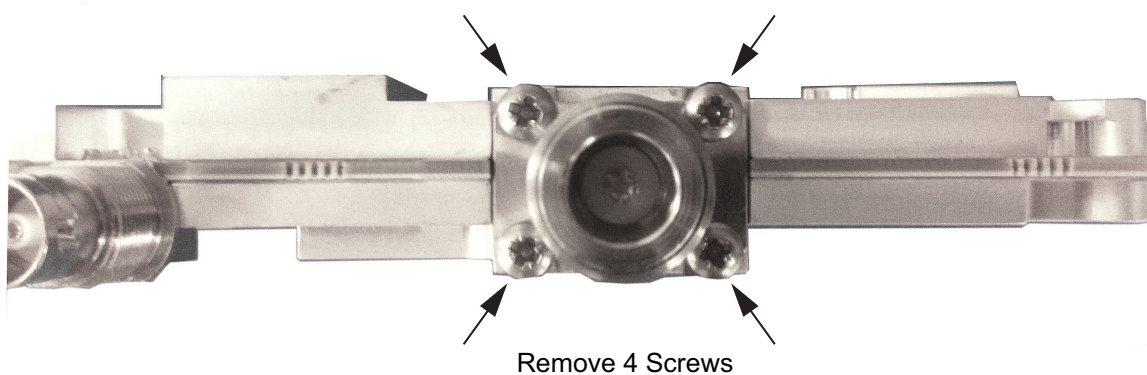


Figure 7-6. Remove 4 Screws

6. Disconnect the N connector from the SPA or MB/VNA by gently pulling the N connector away from the SPA or MB/VNA ([Figure 7-7](#)).

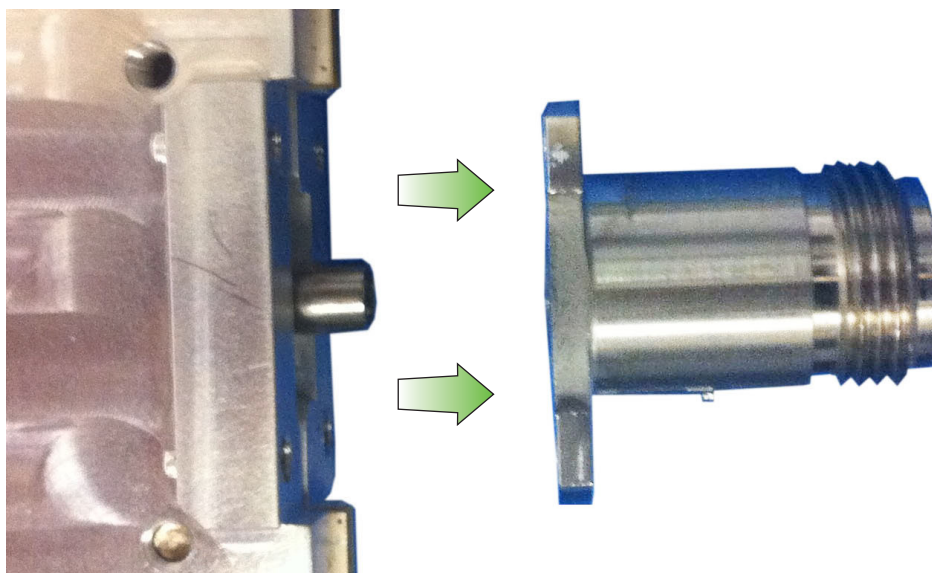


Figure 7-7. Remove N Connector from SPA or MB/VNA

7. Installation is the reverse of removal.

7-6 GPS (Option 31) Replacement

This procedure provides instructions for removing and replacing the GPS Module.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the PCB Assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Remove the SPA board as described in [Section 7-4 “SPA Assembly Replacement”](#).

Note The SPA board cables, connector and the DSP board do not need to be removed when replacing the GPS Module. Remove the screws and move the SPA board to the side.

4. If not already removed, use a 5/16 inch wrench to remove the nut and washer from the GPS SMA connector. Push the connector through the top panel.
5. Remove the 2 screws retaining the GPS module to the Main/VNA board.
6. Carefully lift straight up on the GPS module to remove. The back of the GPS module board is directly connected to the Main/VNA board.
7. Installation is the reverse of removal.

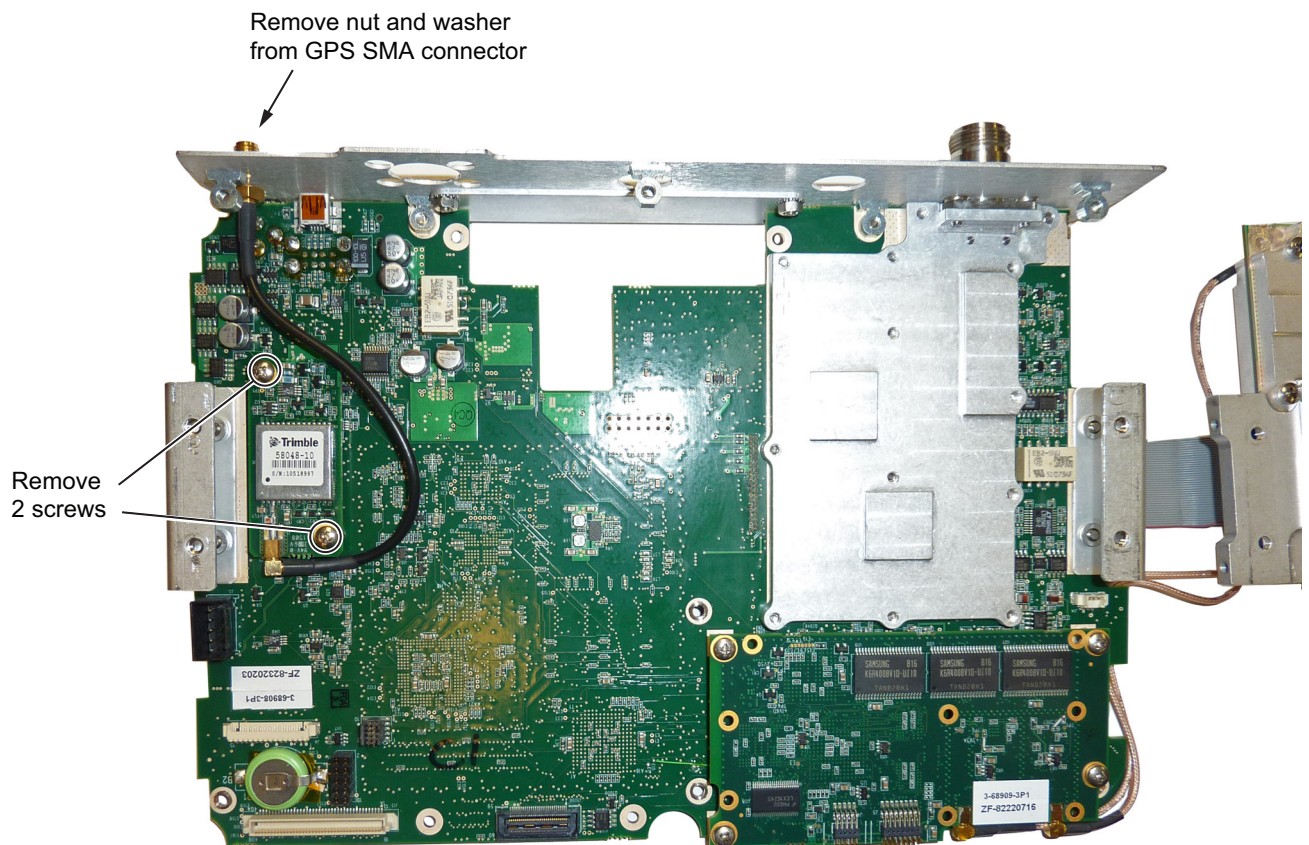


Figure 7-8. Removing the GPS Module from the Main/VNA board (SPA board set to the side)

7-7 Signal Generator Replacement

This procedure provides instructions for removing and replacing the Signal Generator PCB Assembly. This procedure requires a Cable Removal Tool, Anritsu part number 783-1399, to remove a co-axial cable connected between the Main PCB and Signal Generator PCB.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the PCB Assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Remove the SPA board as described in [Section 7-4 “SPA Assembly Replacement”](#).

Note The SPA board cables, connector and the DSP board do not need to be removed when replacing the Signal Generator PCB Assembly. Remove the screws and move the SPA board to the side.

4. Remove the castle nut on the Audio In connector on the top panel and the two screws shown in [Figure 4](#).

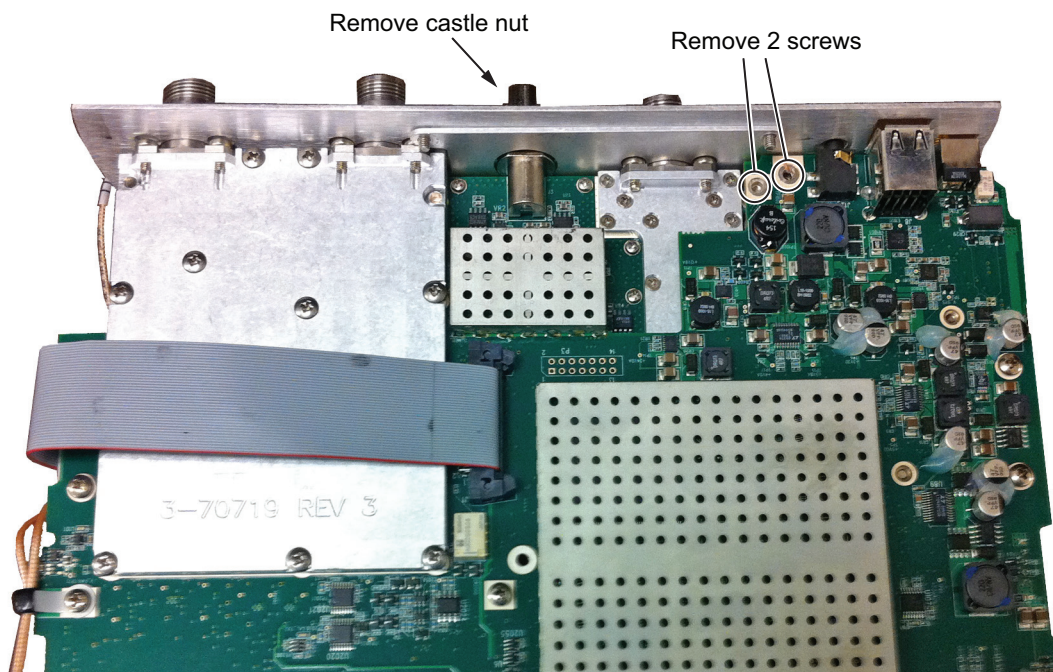


Figure 7-9. Remove Castle Nut and Two Screws

5. Turn over the PCB and remove the 4 screws shown in [Figure 7-10](#).

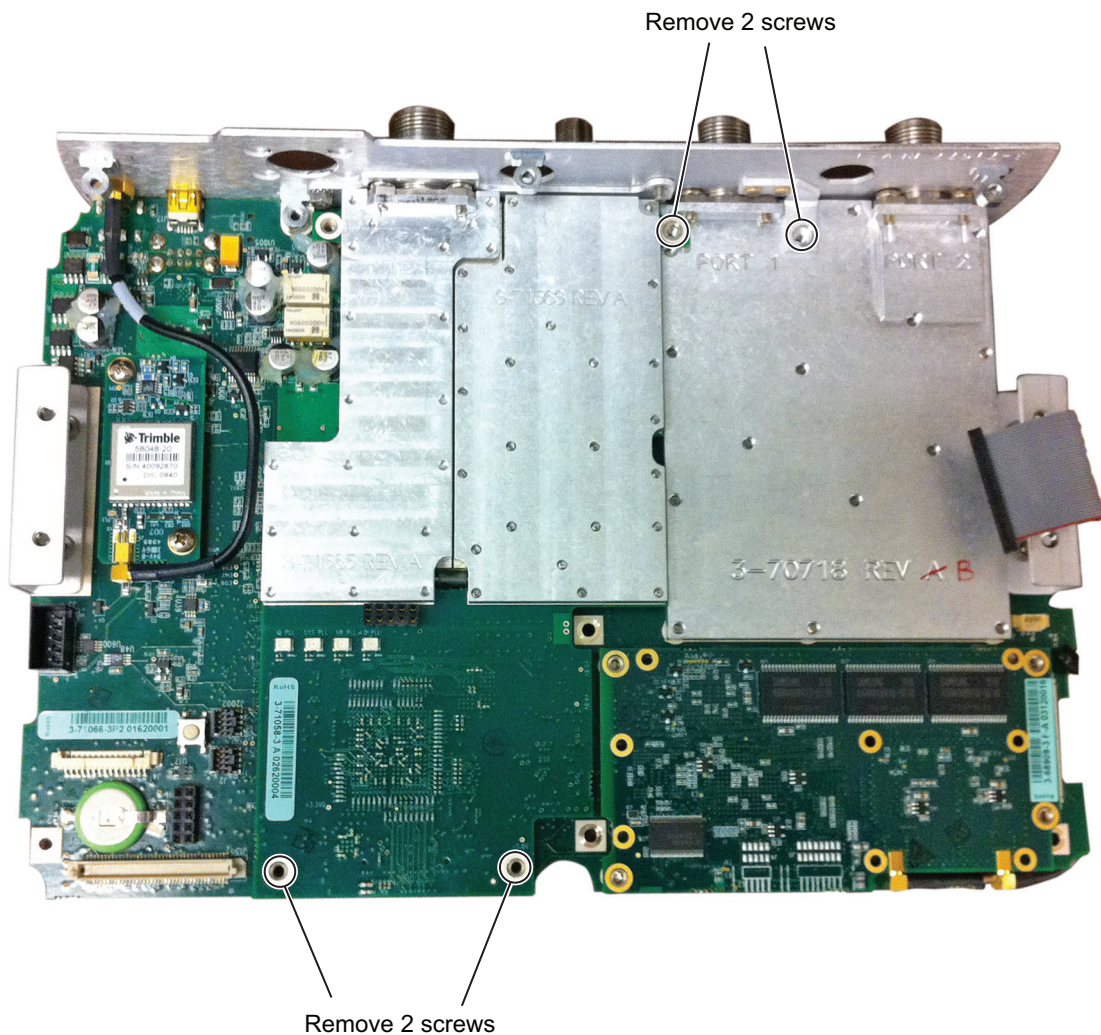


Figure 7-10. Remove 4 Screws

6. Carefully slide the top plate off of the connectors being careful not to damage the GPS cable (if connected).
7. Gently pull up on the Signal Generator board to separate it from the Main Board. Be careful not to separate it too far from the Main board. There is a cable between the Main board and Signal Generator which needs to be unplugged after separating the two boards.

8. Remove the cable shown in [Figure 7-11](#) using the cable removal tool, part number 783-1399. When inserting the cable onto the new Signal Generator make sure the cable connector is parallel to the PCB so the connector is plugged on correctly. The cable should not be removed or inserted at an angle.

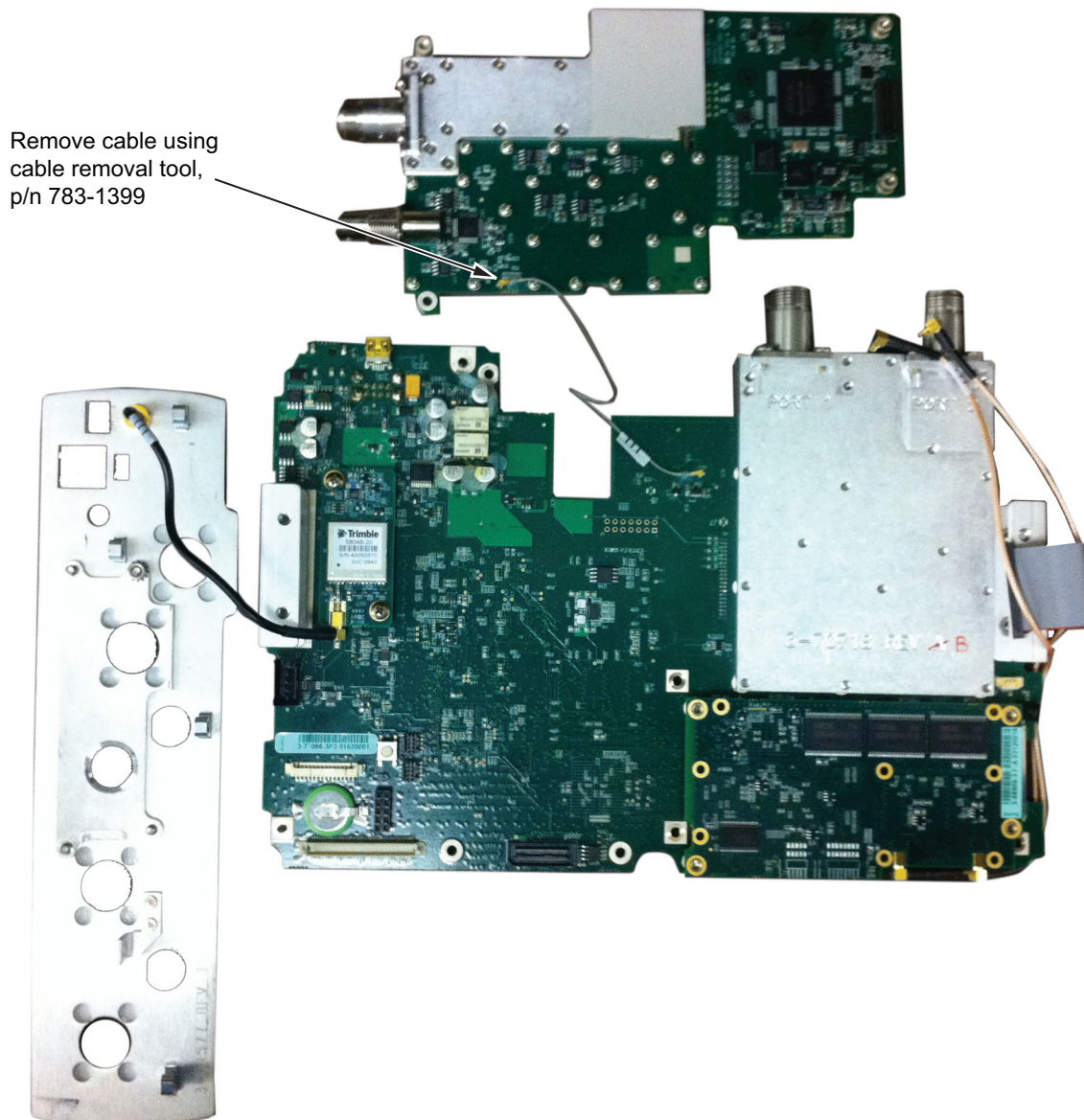


Figure 7-11. Remove Cable Using Cable Removal Tool

9. Reverse the above steps to install the Signal Generator PCB.

7-8 Main/VNA PCB Assembly Replacement

This procedure provides instructions for removing and replacing the Main/VNA PCB Assembly.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the PCB Assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Remove the SPA board as described in [Section 7-4 “SPA Assembly Replacement”](#).
4. Remove the GPS board as described in [Section 7-5 “SPA and MB/VNA N Connector Replacement”](#).

Note When ordering the Main/VNA PCB Assembly all options that are installed on the instrument must be stated on the order.

5. Remove the Signal Generator board as described in [Section 7-7 “Signal Generator Replacement”](#) on page 7-8
6. Installation is the reverse of removal.

7-9 Fan Assembly Replacement

This procedure provides instructions for removing and replacing the Fan Assembly.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the Main/VNA PCB assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Remove the 3 screws and nuts holding the Fan Assembly to the LCD Assembly housing. Refer to [\(Figure 7-12\)](#).

Note The fan connector cable is routed through the LCD Assembly housing

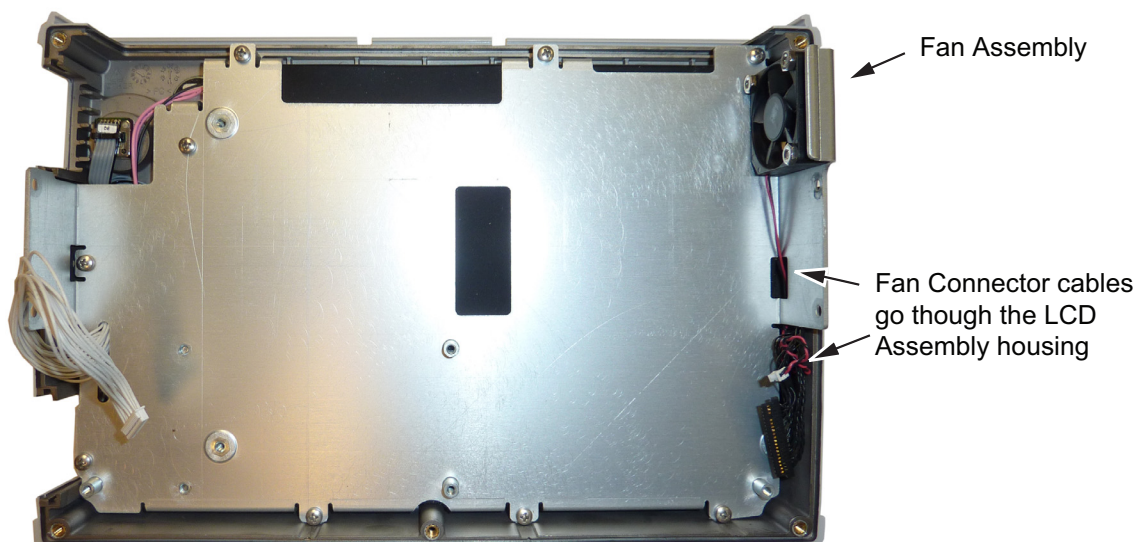


Figure 7-12. Front Panel Keypad Bezel

4. Reverse the above steps to install the replacement Fan Assembly.

7-10 LCD Assembly Replacement

This procedure provides instructions for removing and replacing the Liquid Crystal Display (LCD) once the Main/VNA PCB assembly has been separated from the S412E.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the Main/VNA PCB assembly as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Remove the 9 screws connecting the LCD Assembly to the front half of the case ([Figure 7-13](#)).

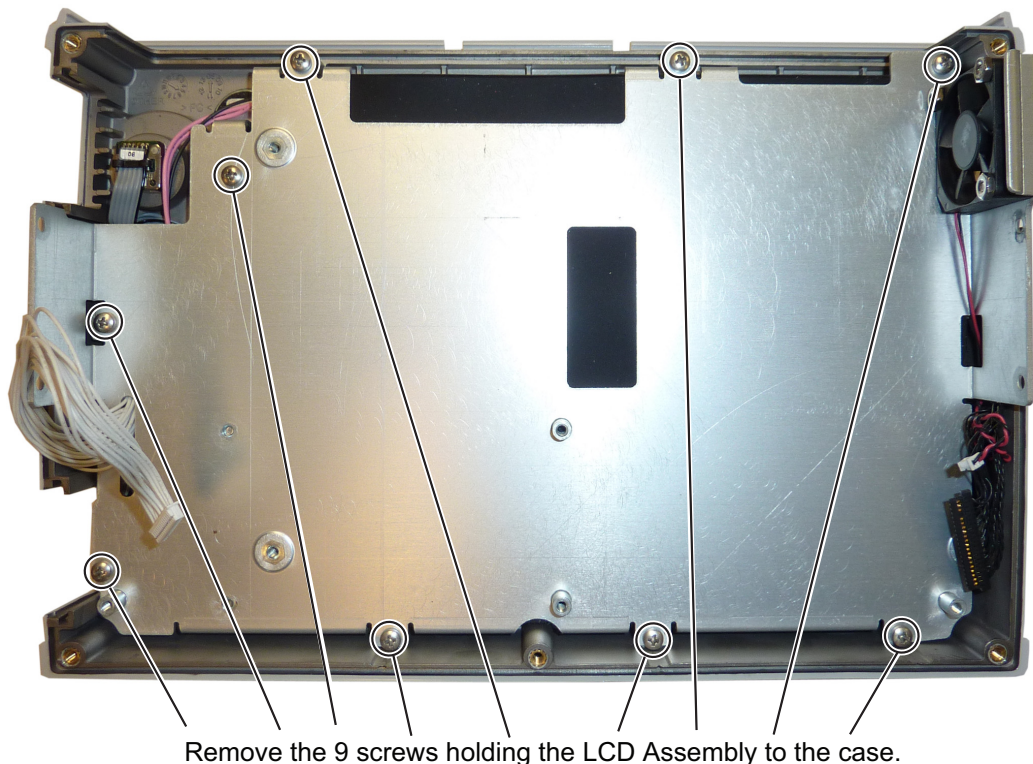


Figure 7-13. Removing the LCD Assembly

- Turn the LCD assembly over and disconnect the front half of the case from the LCD Assembly (Figure 7-14).

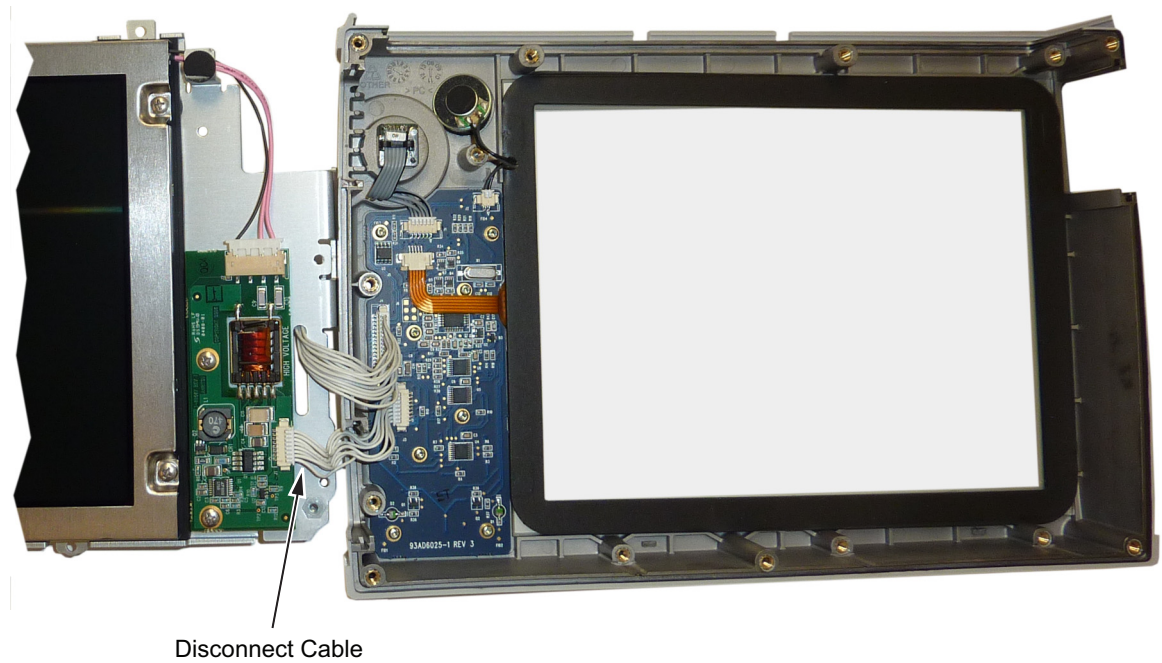


Figure 7-14. Replacing the LCD Assembly

- Use a Phillips screw driver to remove the four screws securing the LCD to the housing (Figure 7-15).

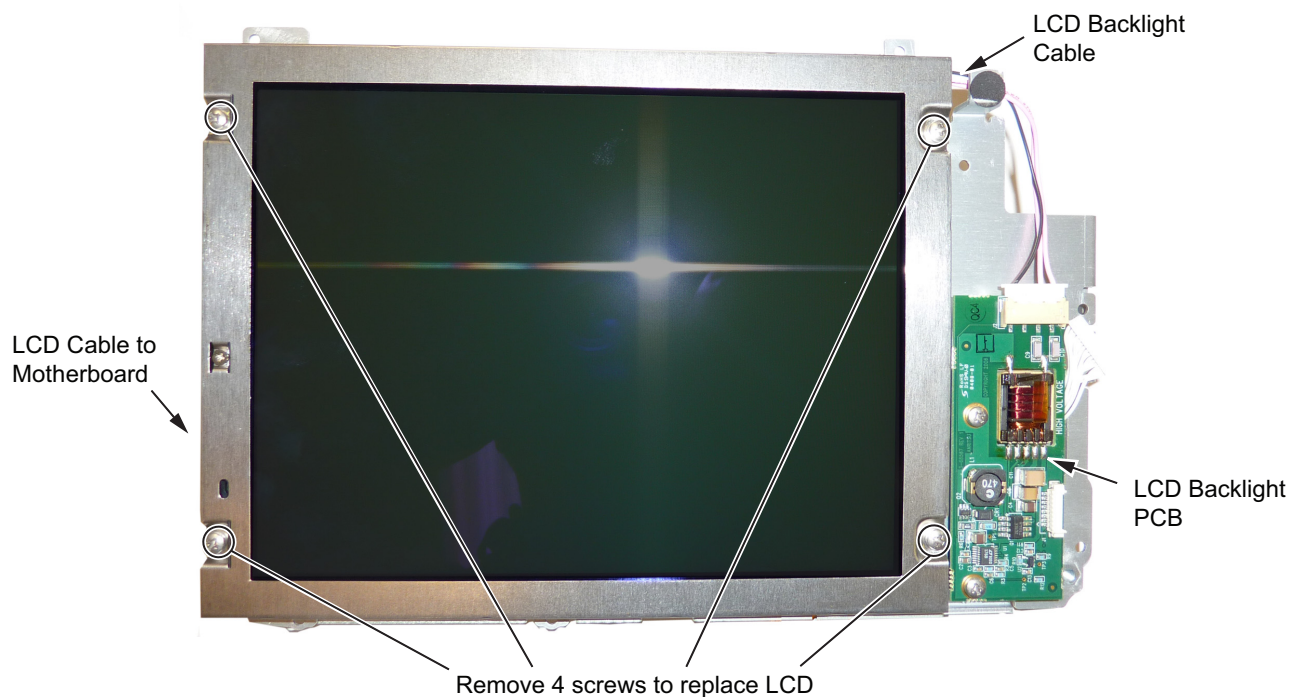


Figure 7-15. Replacing the LCD

6. Disconnect the LCD backlight cable from the LCD backlight PCB.
7. Disconnect the LCD cable from the side of the LCD.
8. Carefully remove the LCD.
9. Reverse the above steps to install the replacement LCD.

Note Pay attention to the routing of the LCD Backlight Cable. The cable must be positioned so it is not pinched when the unit is reassembled.

7-11 LCD Backlight PCB Removal and Replacement

This procedure provides instructions for removing and replacing the S412E LCD backlight PCB.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the Main/VNA PCB assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Perform Step 1 through Step 4 of [Section 7-10 “LCD Assembly Replacement”](#).
4. Disconnect the LCD backlight cable from the LCD backlight PCB.
5. Use a Phillips screw driver to remove the two screws securing the LCD backlight PCB to the Main PCB assembly ([Figure 7-16](#)).

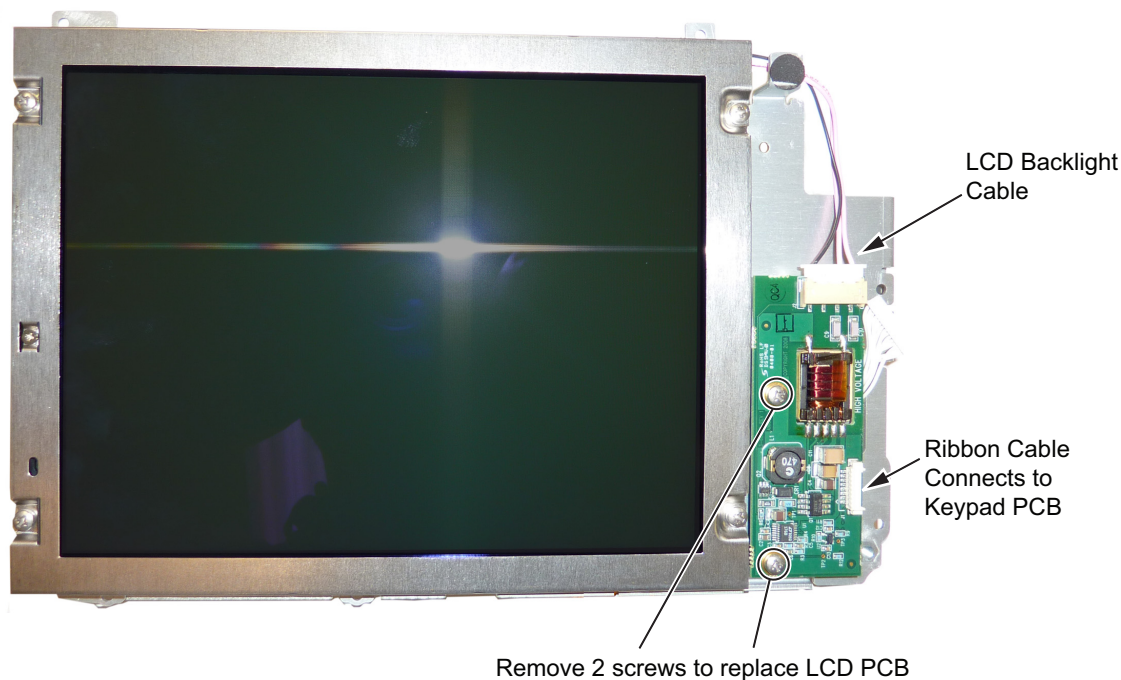


Figure 7-16. Replacing the LCD PCB

6. Carefully remove the LCD Backlight PCB.
7. Reverse the above steps to install the replacement LCD backlight PCB.

Note Pay attention to the routing of the LCD Backlight Cable. The cable must be positioned so it is not pinched when the unit is reassembled.

7-12 Keypad and Keypad PCB Replacement

This procedure provides instructions for removing and replacing the keypad and the keypad PCB.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the Main/VNA PCB assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Perform Step 1 through Step 4 of [Section 7-10 “LCD Assembly Replacement”](#).
4. Remove the 8 screws and the cable connectors to remove the Keypad PCB ([Figure 7-17](#)). The Rubber Keypad is located under the Keypad PCB.

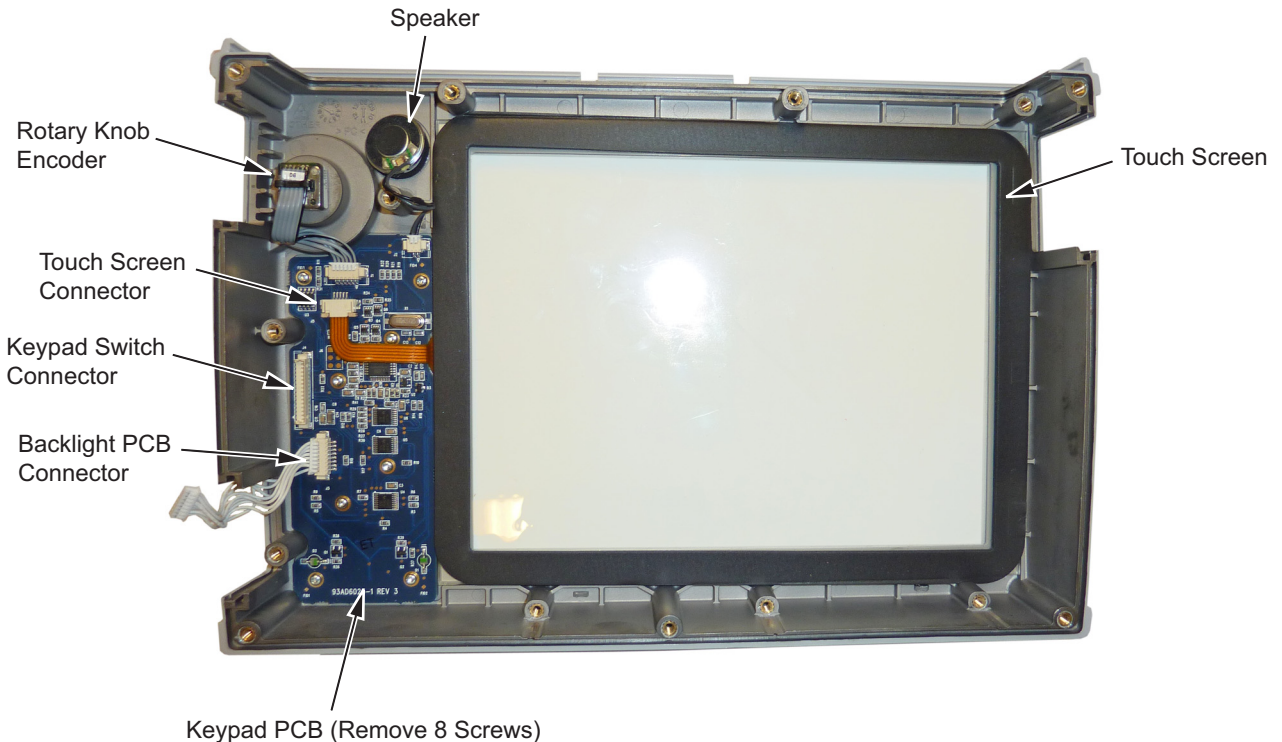


Figure 7-17. Front Panel Keypad Bezel

5. Reverse the above steps to install the replacement Keypad and/or Keypad PCB.
6. The Keypad PCB stores the touchscreen calibration data. If the Keypad PCB is replaced, then a touchscreen calibration must be performed. If no touchscreen calibration data is stored in the new Keypad PCB when powering on a unit, it will stay at the boot up screen with the Anritsu logo shown and a message at the bottom of the screen stating:

Failed to load touchscreen calibration data. Please reboot the instrument.

If this message is displayed, power off the unit and power the unit up in bootstrap mode by pressing and holding down the **Shift - 4 - 0** keys while pressing the power on button. Now the unit will boot up in bootstrap mode and prompt you to perform a touchscreen calibration. After following the on-screen calibration directions, power the unit off and it will boot up correctly on the next power cycle.

7. If the Keypad PCB was replaced with a PCB that has touchscreen calibration data, the unit will boot up properly, but the touchscreen calibration data will be invalid. Perform a touchscreen calibration by pressing the **Shift** key and then **0** key, and follow the touchscreen calibration directions on the screen.

7-13 Touchscreen Replacement

This procedure provides instructions for removing and replacing the touchscreen.

1. Open the case as described in [Section 7-2 “Opening the S412E Case”](#).
2. Remove the Main/VNA PCB assembly from the front panel as described in [Section 7-3 “PCB Assembly Replacement”](#).
3. Perform Step 1 through Step 4 of [Section 7-10 “LCD Assembly Replacement”](#).
4. Remove the touchscreen flex circuit connector from the Keypad PCB by pulling the tabs on each side of the connector away from the connector and in the direction of the flex circuit. Refer to [Figure 7-18](#).
5. Pull the touchscreen cable out of the connector housing.
6. Remove the touchscreen from the Bezel by pulling it straight up.

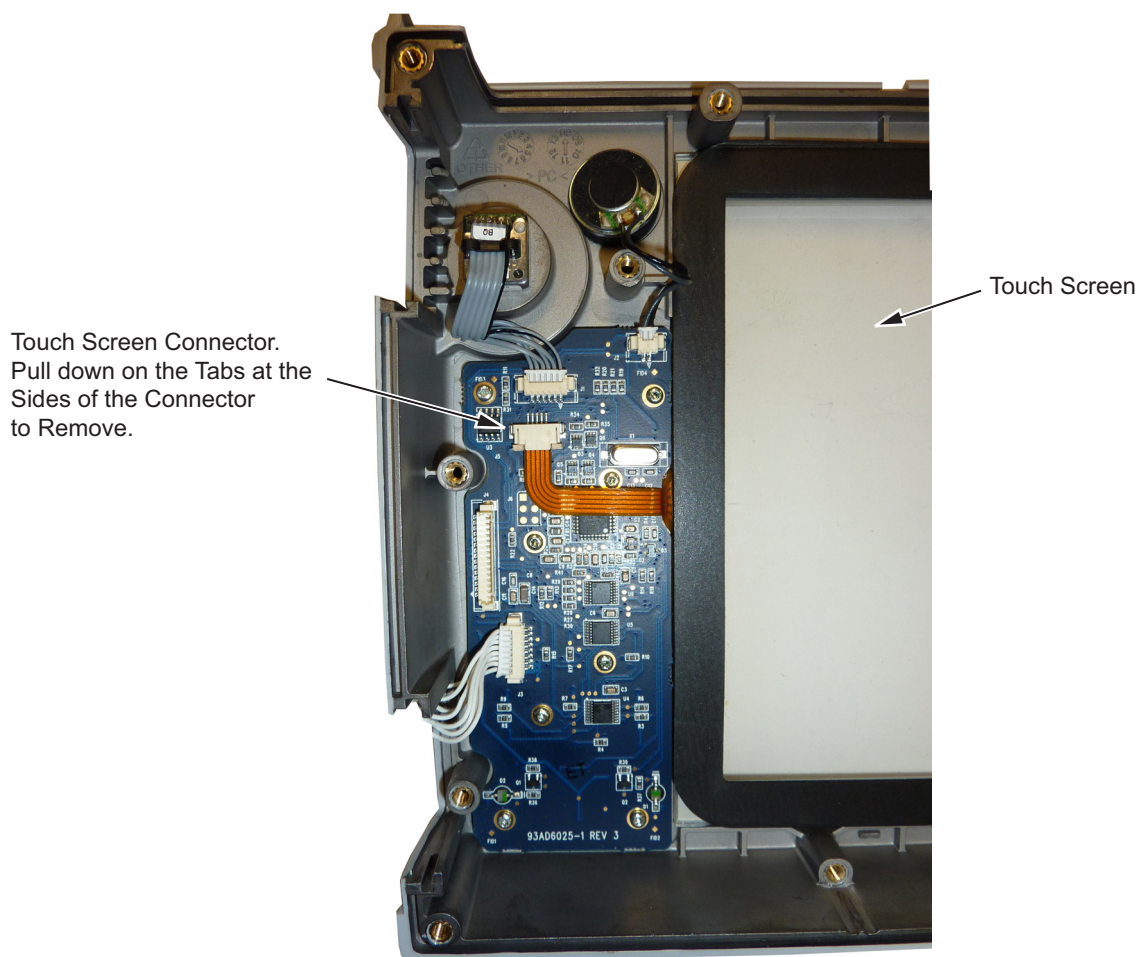


Figure 7-18. Replacing the Touchscreen

7. Reverse the above steps to install the replacement touchscreen.
8. Firmware version 1.04 and greater was modified to accept touchscreen calibration data needed for the newer touchscreen. When replacing a touchscreen, ensure firmware version 1.04 or greater is installed. If not, install the latest firmware.
9. Perform a touchscreen calibration by pressing the **Shift** key and then the **0** key, and follow the on-screen calibration directions.

Chapter 8 — Troubleshooting

8-1 Introduction

This chapter describes the primary troubleshooting operations that can be performed. Perform the troubleshooting suggestions in the order in which they are listed.

Only qualified service personnel should replace internal assemblies. Major sub-assemblies that are shown in the replaceable parts list are typically the items that may be replaced.

Because they are highly fragile, items that must be soldered may not be replaced without special training. Removal of RF shields from PC boards or adjustment of screws on or near the RF shields will detune sensitive RF circuits and will result in degraded instrument performance.

8-2 Turn-on Problems

Unit Cannot Boot Up

Unit cannot boot-up, no activity occurs when the **On/Off** key is pressed:

1. Battery may have been fully discharged. Use an external charger (Anritsu PN 2000-1374) to charge a completely discharged battery.
2. Battery may be the wrong type. Use only Anritsu approved battery packs. Some non-approved battery packs will fit into the S412E but they are electrically incompatible and will not charge correctly.
3. External AC to DC power adapter may have failed or be the wrong type. Replace the external power adapter.
4. **On/Off** switch may have damaged. Replace the rubber keypad membrane and keypad PCB.
5. Main PCB may have failed. Replace the Main PCB Assembly.

Unit Cannot Complete Boot-Up

Unit begins the boot process, but does not complete boot-up:

1. Firmware update may not have completed. Attempt reloading the firmware using bootstrap mode. Enter bootstrap mode by holding down the Shift - 4 - 0 keys while pressing the power on button. Plug a USB memory, with the latest firmware, into the S412E. Press the Load All soft key.
2. During the boot up process the unit stops with the message: "Failed to load touchscreen calibration data. Please reboot the instrument." Power the unit off and boot up in boot strap mode (hold down the Shift - 4 - 0 keys while pressing the power on button). In boot strap mode the unit will prompt you to perform a touchscreen calibration, follow the directions on the screen until the touchscreen calibration is complete and then power cycle the unit. Once the unit boots up, ensure the firmware version is 1.04 or greater. If not, load the latest firmware and perform a touchscreen calibration.
3. Main/VNA PCB may have failed. Replace the Main/VNA PCB Assembly for S412E.

Unit Boots with No Display

Unit produces a ding sound after a while, but with no display:

1. If the display is dim, check the Brightness setting under the System Menu | System Options.
2. LCD Backlight Inverter PCB may have failed. Replace LCD Backlight Inverter PCB.
3. LCD may have failed. Replace the LCD Display Assembly.
4. The Main/VNA PCB may have failed. Replace the Main/VNA PCB Assembly for the S412E.

Boot-up Self Test Fails

The unit boot-up self test fails with an error message:

1. Perform a Factory Defaults reset. This done by holding the **Esc** key down while pressing the **On/Off** key to power on the unit. During boot up a message will be seen in the lower left hand corner “Applying Factory Defaults”.
2. The Main/VNA PCB may have failed. Replace the Main/VNA PCB Assembly for the S412E.

8-3 Operating Problems

Battery Pack Charging Problems

1. Refer to [Chapter 6, “Battery Information and Replacement”](#).

Touchscreen Problems

Unit boots correctly, but the touchscreen is unresponsive.

1. The touchscreen may have lost its calibration data. Press **Shift** then **0** to enter the touchscreen calibration procedure. Follow the on-screen directions.
2. Check the version of firmware installed on the unit and ensure it's version 1.04 or greater. If not, install the latest version of firmware and redo the touchscreen calibration as described in step 1.
3. Replace the touchscreen.

Vector Network Analyzer Problems

Lock Error Message

1. VNA Port may have damaged or Main PCB Assembly may have failed.
2. Replace Main/VNA PCB Assembly.

Measurement Problems

1. Inspect VNA Port 1 and Port 2 connectors for damage.
2. Inspect the Open, Short, Load and cable(s) for damage. Verify their operation on a suitable test instrument.
3. Main/VNA PCB Assembly may have failed or damaged. Replace Main/VNA PCB Assembly for the S412E.

Spectrum Analyzer Problems

Lock Error Message

1. Spectrum Analyzer PCB Assembly may have failed or damaged. Replace SPA PCB Assembly for the S412E.

Measurement Problems

1. Inspect the Spectrum Analyzer RF In connector of damage.
2. Refer to the User Guide and Measurement Guide.
3. Spectrum Analyzer PCB Assembly may have failed or damaged. Replace SPA PCB Assembly.

Option 10, VNA Bias Tee Problems

1. Verify that the current load of the device attached does not exceed the current capability of the S412E.
2. Perform [VNA Mode Bias Tee Operational Check, Option 10](#).
3. Main/VNA PCB Assembly may have failed or damaged. Replace Main/VNA PCB Assembly for the S412E.

Option 31, GPS Problems

Unable to acquire GPS fix

1. Verify that the GPS Antenna is in direct line-of-sight relationship or is placed outside without any obstructions.
2. If the Anritsu 2000-1528-R GPS Antenna is used, attached the antenna to a large magnetic metal surface such as the roof on a passenger car.
3. Inspect GPS connector for damage.
4. GPS Receiver Module may have failed. Replace GPS Receiver Module.

Other Issues

1. Perform a Master Reset. This is performed by holding down the **System (8)** key while pressing the **On/Off** key to power on the unit. Note: A Master Reset will delete all user files.
2. Refer to the User Guide and Measurement Guide.
3. Update firmware.
4. Replace the failed parts or assemblies (e.g. LCD touchscreen, keypad, and etc.)

Appendix A — Test Records

A-1 Introduction

This appendix provides test records that can be used to record the performance of the S412E LMR Master. Make a copy of the following Test Record pages and document the measured values each time performance verification is performed. Continuing to document this process each performance verification session provides a detailed history of the instrument's performance.

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

A-2 Test Records for VNA Verification

Table A-1. VNA Frequency Accuracy

VNA Output Frequency	Specification	Frequency Counter Reading
1.0 GHz	± 2.5 kHz	kHz

VNA Transmission Dynamic Range

___ Refer to Attached Test Data Report

Table A-2. VNA Return Loss Measurement Accuracy

Return Loss	Specification	Measured Valley Value	Measured Peak Value
6 dB	$-5.05 \text{ dB} \geq x \geq -6.95 \text{ dB}$	dB	dB
20 dB	$-18.39 \text{ dB} \geq x \geq -21.61 \text{ dB}$	dB	dB

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

A-3 Test Records for Spectrum Analyzer Verification

Table A-3. Spectrum Analyzer Residual Spurious Response with Preamp Off

Start Freq	Stop Freq	RBW	VBW	Specification	Measured Values
10 MHz	50 MHz	1 kHz	300 Hz	≤ -90 dBm	dBm
50 MHz	1.6 GHz	3 kHz	10 kHz	≤ -90 dBm	dBm
(PERFORM THE FOLLOWING TESTS IF OPTION 6 IS INSTALLED)					
1.6 GHz	4.0 GHz	1 kHz	1 kHz	≤ -90 dBm	dBm
4.0 GHz	5.0 GHz	1 kHz	100 Hz	≤ -90 dBm	dBm
5.0 GHz	5.2 GHz	1 kHz	1 kHz	≤ -90 dBm	dBm
5.2 GHz	5.7 GHz	10 kHz	300 Hz	≤ -90 dBm	dBm
5.7 GHz	5.9 GHz	30 kHz	1 kHz	≤ -90 dBm	dBm
5.9 GHz	6.0 GHz	1 kHz	100 Hz	≤ -90 dBm	dBm

Table A-4. Spectrum Analyzer Residual Spurious Response with Preamp On

Start Freq	Stop Freq	Specification	Measured Values
10 MHz	1.6 GHz	≤ -90 dBm	dBm
(PERFORM THE FOLLOWING TESTS IF OPTION 6 IS INSTALLED)			
1.6 GHz	6 GHz	≤ -90 dBm	dBm

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-5. Spectrum Analyzer DANL with Preamp Off

Start Freq	Stop Freq	RBW	VBW	Specification	Measured Values at 100 kHz RBW	Calculated Values for 10 Hz RBW
10 MHz	1.6 GHz	100 kHz	1 kHz	≤ -131 dBm	dBm	dBm
(PERFORM THE FOLLOWING TESTS IF OPTION 6 IS INSTALLED)						
1.6 GHz	2.4 GHz	100 kHz	1 kHz	≤ -131 dBm	dBm	dBm
2.4 GHz	4.0 GHz	100 kHz	1 kHz	≤ -127 dBm	dBm	dBm
4.0 GHz	5.0 GHz	100 kHz	1 kHz	≤ -124 dBm	dBm	dBm
5.0 GHz	6.0 GHz	100 kHz	1 kHz	≤ -116 dBm	dBm	dBm

Table A-6. Spectrum Analyzer DANL with Preamp On

Start Freq	Stop Freq	RBW	VBW	Specification	Measured Values at 100 kHz RBW	Calculated Values for 10 Hz RBW
10 MHz	1.6 GHz	100 kHz	1 kHz	≤ -147 dBm	dBm	dBm
(PERFORM THE FOLLOWING TESTS IF OPTION 6 IS INSTALLED)						
1.6 GHz	2.4 GHz	100 kHz	1 kHz	≤ -147 dBm	dBm	dBm
2.4 GHz	4.0 GHz	100 kHz	1 kHz	≤ -144 dBm	dBm	dBm
4.0 GHz	5.0 GHz	100 kHz	1 kHz	≤ -140 dBm	dBm	dBm
5.0 GHz	6.0 GHz	100 kHz	1 kHz	≤ -133 dBm	dBm	dBm

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-7. Spectrum Analyzer Frequency Accuracy

Frequency	Specification	Measured Value	Deviation
1 GHz	± 120 Hz (± 120 ppb)	GHz	kHz
(PERFORM THE FOLLOWING TESTS IF OPTION 6 IS INSTALLED)			
3.9 GHz	± 468 Hz (± 120 ppb)	GHz	kHz
5.9 GHz	± 708 Hz (± 120 ppb)	GHz	kHz

Table A-8. Spectrum Analyzer SSB Phase Noise

Offset Frequency	Specification	Measured Value	Calculated Value
10 kHz	≤ -100 dBc/Hz	dBc/Hz	dBc/Hz
100 kHz	≤ -105 dBc/Hz	dBc/Hz	dBc/Hz
1 MHz	≤ -115 dBc/Hz	dBc/Hz	dBc/Hz

Table A-9. Spectrum Analyzer Spurious Response (Second Harmonic Distortion)

Frequency	Specification	Measured Value	2nd Harmonic Level
50.1 MHz	NA	dBm	
100.2 MHz	≤ -56 dBc	dBm	dBc

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-10. Spectrum Analyzer Resolution Bandwidth Accuracy

RBW	Span	VBW	Lower Limit	Measured Values	Upper Limit
3 MHz	6 MHz	300 kHz	2.7 MHz	MHz	3.3 MHz
1 MHz	2 MHz	100 kHz	0.9 MHz	MHz	1.1 MHz
300 kHz	600 kHz	30 kHz	270 kHz	kHz	330 kHz
100 kHz	200 kHz	10 kHz	90 kHz	kHz	110 kHz
30 kHz	60 kHz	3 kHz	27 kHz	kHz	33 kHz
10 kHz	20 kHz	1 kHz	9 kHz	kHz	11 kHz
3 kHz	6 kHz	300 Hz	2.7 kHz	kHz	3.3 kHz
1 kHz	2 kHz	100 Hz	0.9 kHz	kHz	1.1 kHz
300 Hz	600 Hz	30 Hz	270 Hz	Hz	330 Hz
100 Hz	200 Hz	10 Hz	90 Hz	Hz	110 Hz
30 Hz	60 Hz	3 Hz	27 Hz	Hz	33 Hz
10 Hz	20 Hz	3 Hz	9 Hz	Hz	11 Hz

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-11. Spectrum Analyzer 50 MHz Amplitude Accuracy Setup Table

Test Power Level @ 50 MHz	Required Sensor B Reading
0 dBm	dBm
-4 dBm	dBm
-10 dBm	dBm
-14 dBm	dBm
-20 dBm	dBm
-24 dBm	dBm
-30 dBm	dBm
-34 dBm	dBm
-40 dBm	dBm
-44 dBm	dBm
-50 dBm	dBm

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-12. Spectrum Analyzer 50 MHz Amplitude Accuracy

Test Power	Specification	Reference Level	Atten Lvl	Measured Value	Deviation
0 dBm	± 1.25 dB	10 dBm	30 dB	dBm	dB
-4 dBm	± 1.25 dB	10 dBm	30 dB	dBm	dB
-10 dBm	± 1.25 dB	0 dBm	20 dB	dBm	dB
-14 dBm	± 1.25 dB	0 dBm	20 dB	dBm	dB
-20 dBm	± 1.25 dB	-10 dBm	10 dB	dBm	dB
-24 dBm	± 1.25 dB	-10 dBm	10 dB	dBm	dB
-30 dBm	± 1.25 dB	-20 dBm	0 dB	dBm	dB
-34 dBm	± 1.25 dB	-20 dBm	0 dB	dBm	dB
-40 dBm	± 1.25 dB	-30 dBm	0 dB	dBm	dB
-44 dBm	± 1.25 dB	-30 dBm	0 dB	dBm	dB
-50 dBm	± 1.25 dB	-40 dBm	0 dB	dBm	dB
Turn Pre-Amp On (for the below measurement)					
-44 dBm	± 1.25 dB	-40 dBm	10 dB	dBm	dB
-50 dBm	± 1.25 dB	-45 dBm	5 dB	dBm	dB

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-13. Spectrum Analyzer Amplitude Accuracy Across Frequency Setup Table

Frequency	Required Sensor B reading for -2 dBm @ Attenuator Output	Required Sensor B reading for -30 dBm @ Attenuator Output	Required Sensor B reading for -50 dBm @ Attenuator Output
100 kHz	dBm	dBm	dBm
10.1 MHz	dBm	dBm	dBm
50 MHz	dBm	dBm	dBm
100 MHz	dBm	dBm	dBm
500 MHz	dBm	dBm	dBm
1000 MHz	dBm	dBm	dBm
1500 MHz	dBm	dBm	dBm
(PERFORM THE FOLLOWING TESTS IF OPTION 6 IS INSTALLED)			
2000 MHz	dBm	dBm	dBm
3000 MHz	dBm	dBm	dBm
4000 MHz	dBm	dBm	dBm
5000 MHz	dBm	dBm	dBm
5990 MHz	dBm	dBm	dBm

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-14. Spectrum Analyzer Amplitude Accuracy Across Frequency (1 of 5)

Freq (MHz)	Test Power (dBm)	Reference Level Setting (dBm)	Atten Level Setting (dB)	Pre-Amp Setting	Marker 1 Reading (dBm)	Dev (dB)	Spec (dB)
0.1	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
	-2	0	55	Off			±1.25
10.1	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
	-2	0	55	Off			±1.25

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-14. Spectrum Analyzer Amplitude Accuracy Across Frequency (2 of 5)

Freq (MHz)	Test Power (dBm)	Reference Level Setting (dBm)	Atten Level Setting (dB)	Pre-Amp Setting	Marker 1 Reading (dBm)	Dev (dB)	Spec (dB)
50	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
	-2	0	55	Off			±1.25
100	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
	-2	0	55	Off			±1.25
500	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
	-2	0	55	Off			±1.25

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-14. Spectrum Analyzer Amplitude Accuracy Across Frequency (3 of 5)

Freq (MHz)	Test Power (dBm)	Reference Level Setting (dBm)	Atten Level Setting (dB)	Pre-Amp Setting	Marker 1 Reading (dBm)	Dev (dB)	Spec (dB)
1000	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
1500	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
2000 (Units with Option 6)	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
-2	0	55	Off			±1.25	

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-14. Spectrum Analyzer Amplitude Accuracy Across Frequency (4 of 5)

Freq (MHz)	Test Power (dBm)	Reference Level Setting (dBm)	Atten Level Setting (dB)	Pre-Amp Setting	Marker 1 Reading (dBm)	Dev (dB)	Spec (dB)
3000 (Units with Option 6)	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
	-2	0	55	Off			±1.25
4000 (Units with Option 6)	-50	-40	15	On			±1.25
	-30	-20	0	Off			±1.25
	-30	-20	5	Off			±1.25
	-30	-20	10	Off			±1.25
	-30	-20	20	Off			±1.25
	-2	0	30	Off			±1.25
	-2	0	40	Off			±1.25
	-2	0	50	Off			±1.25
	-2	0	55	Off			±1.25
5000 (Units with Option 6)	-50	-40	15	On			±1.5
	-30	-20	0	Off			±1.5
	-30	-20	5	Off			±1.5
	-30	-20	10	Off			±1.5
	-30	-20	20	Off			±1.5
	-2	0	30	Off			±1.5
	-2	0	40	Off			±1.5
	-2	0	50	Off			±1.5
	-2	0	55	Off			±1.5

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-14. Spectrum Analyzer Amplitude Accuracy Across Frequency (5 of 5)

Freq (MHz)	Test Power (dBm)	Reference Level Setting (dBm)	Atten Level Setting (dB)	Pre-Amp Setting	Marker 1 Reading (dBm)	Dev (dB)	Spec (dB)
5990 (Units with Option 6)	-50	-40	15	On			±1.5
	-30	-20	0	Off			±1.5
	-30	-20	5	Off			±1.5
	-30	-20	10	Off			±1.5
	-30	-20	20	Off			±1.5
	-2	0	30	Off			±1.5
	-2	0	40	Off			±1.5
	-2	0	50	Off			±1.5
-2	0	55	Off			±1.5	

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-15. Spectrum Analyzer Third Order Intercept

Third Order Intercept at Center Frequency	Measured Value	Specification
800.151 MHz	dBm	
799.851 MHz	dBm	
Calculated TOI at 800 MHz	dBm	≥ +16 dBm
(PERFORM THE FOLLOWING TESTS IF OPTION 6 IS INSTALLED)		
2400.151 MHz	dBm	
2399.851 MHz	dBm	
Calculated TOI at 2400 MHz	dBm	≥ +20 dBm

S412E Firmware Rev: _____ Operator: _____ Date: _____
Serial Number: _____ Options: _____

A-4 Test Records for Signal Generator Verification

Table A-16. Signal Generator Frequency Accuracy Verification

Set Frequency	Tx Output Level	Received Frequency	Specification
1 GHz	0 dBm	Hz	1 GHz \pm 120 Hz

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

A-5 Test Records for Options Verification

GPS Verification, Option 31

Table A-17. Option 31, Spectrum Analyzer Frequency Accuracy with GPS On

Frequency	Specification	Measured Value	Deviation
1.5 GHz	± 75 Hz (± 50 ppb)	GHz	Hz

Fixed WiMAX Signal Analyzer Verification, Options 46, 47

Table A-18. Option 46, Fixed WiMAX Channel Power Accuracy

Frequency	Input Power	Measured Channel Power (RSSI)	Error	Specification
2600.5 MHz	-15 dBm	dBm	dB	± 1.5 dB
2600.5 MHz	-50 dBm	dBm	dB	± 1.5 dB
3600.5 MHz	-15 dBm	dBm	dB	± 1.5 dB
3600.5 MHz	-50 dBm	dBm	dB	± 1.5 dB
5600.5 MHz	-15 dBm	dBm	dB	± 1.5 dB
5600.5 MHz	-50 dBm	dBm	dB	± 1.5 dB

Table A-19. Option 47, Fixed WiMAX Residual EVM

Frequency	Power	BW	EVM (RMS)	Specification
2600.5 MHz	-15 dBm	10 MHz	%	$\leq 3.5\%$
2600.5 MHz	-50 dBm	10 MHz	%	$\leq 3.5\%$
3600.5 MHz	-15 dBm	10 MHz	%	$\leq 3.5\%$
3600.5 MHz	-50 dBm	10 MHz	%	$\leq 3.5\%$
5600.5 MHz	-15 dBm	10 MHz	%	$\leq 3.5\%$
5600.5 MHz	-50 dBm	10 MHz	%	$\leq 3.5\%$

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-20. Option 47, Fixed WiMAX Frequency Error

Frequency	Power	Frequency Error	Specification
2600.5 MHz	-50 dBm	Hz	± 182.03 Hz
5600.5 MHz	-50 dBm	Hz	± 392.03 Hz

Mobile WiMAX Signal Analyzer Verification, Options 66, 67**Table A-21.** Option 66, Mobile WiMAX Channel Power Accuracy (10 MHz Bandwidth and 10 ms Frame Length)

Frequency (MHz)	Input Power (dBm)	Measured Channel Power (RSSI)	Error	Specification
2600.5	-15	dBm	dB	± 1.5 dB
2600.5	-50	dBm	dB	± 1.5 dB
3600.5	-15	dBm	dB	± 1.5 dB
3600.5	-50	dBm	dB	± 1.5 dB

Table A-22. Option 66, Mobile WiMAX Channel Power Accuracy (5 MHz Bandwidth and 5 ms Frame Length)

Frequency (MHz)	Input Power (dBm)	Measured Channel Power (RSSI)	Error	Specification
2600.5	-15	dBm	dB	± 1.5 dB
2600.5	-50	dBm	dB	± 1.5 dB
3600.5	-15	dBm	dB	± 1.5 dB
3600.5	-50	dBm	dB	± 1.5 dB

Table A-23. Option 67, Mobile WiMAX Residual EVM (10 MHz Bandwidth and 10 ms Frame Length)

Frequency (MHz)	Power (dBm)	BW (MHz)	EVM (RMS)	Specification
2600.5	-15	10	%	≤ 3.0%
2600.5	-50	10	%	≤ 3.0%
3600.5	-15	10	%	≤ 3.0%
3600.5	-50	10	%	≤ 3.0%

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-24. Option 67, Mobile WiMAX Frequency Error (10 MHz Bandwidth and 10 ms Frame Length)

Frequency (MHz)	Power (dBm)	Freq Error	Specification
2600.5	-50	Hz	± 52.01 Hz
3600.5	-50	Hz	± 72.01 Hz

Table A-25. Option 67, Mobile WiMAX Residual EVM (5 MHz Bandwidth and 5 ms Frame Length)

Frequency (MHz)	Power (dBm)	BW (MHz)	EVM (RMS)	Specification
2600.5	-15	5	%	≤ 3.0%
2600.5	-50	5	%	≤ 3.0%
3600.5	-15	5	%	≤ 3.0%
3600.5	-50	5	%	≤ 3.0%

Table A-26. Option 67, Mobile WiMAX Frequency Error (5 MHz Bandwidth and 5 ms Frame Length)

Frequency (MHz)	Power (dBm)	Freq Error	Specification
2600.5	-50	Hz	± 52.01 Hz
3600.5	-50	Hz	± 72.01 Hz

P25/P25p2 Verification, Options 521, 522

Table A-27. Options 521 and 522, Signal Generator Modulation Fidelity Verification for P25

Frequency	Tx Pattern	Mod Fid	Specification
5.5 MHz	p25_1011	%	< 1.25%
	p25_511(O.153)	%	< 1.25%
845 MHz	p25_1011	%	< 1.25%
	p25_511(O.153)	%	< 1.25%
1545 MHz	p25_1011	%	< 1.25%
	p25_511(O.153)	%	< 1.25%

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-28. Options 521 and 522, Signal Generator Modulation Fidelity Verification for P25p2 (Rev 2 Units Only),

Frequency	Tx Pattern	Mod Fid	Specification
5.5 MHz	p252_bs_1031	%	< 2.00%
	p252_bs_silence	%	< 2.00%
845 MHz	p252_bs_1031	%	< 2.00%
	p252_bs_silence	%	< 2.00%
1545 MHz	p252_bs_1031	%	< 2.00%
	p252_bs_silence	%	< 2.00%

NXDN Verification, Options 531, 532

Table A-29. Options 531 and 532, Signal Generator Modulation Fidelity Verification for NXDN

Frequency	Tx Pattern	Mod Fid	Specification
5.5 MHz	nxdn_1031_9600	%	< 1.25%
	nxdn_511(O.153)_9600	%	< 1.25%
845 MHz	nxdn_1031_9600	%	< 1.25%
	nxdn_511(O.153)_9600	%	< 1.25%
1545 MHz	nxdn_1031_9600	%	< 1.25%
	nxdn_511(O.153)_9600	%	< 1.25%

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

LTE Signal Analyzer Verification, Options 541, 542

Table A-30. Option 541, LTE Channel Power Accuracy

Frequency (MHz)	Input Power (dBm)	Measured Channel Power	Error	Specification
797	-10	dBm	dB	± 1.5 dB
797	-50	dBm	dB	± 1.5 dB
2150 (Units with Opt. 6)	-10	dBm	dB	± 1.5 dB
2150 (Units with Opt. 6)	-50	dBm	dB	± 1.5 dB

Table A-31. Option 542, LTE Frequency Accuracy

Measurement	Measured Value	Specification
797 MHz @ -10 dBm		
Frequency Error	Hz	± 10 Hz
797 MHz @ -50 dBm		
Frequency Error	Hz	± 10 Hz
2150 MHz @ -10 dBm (Units with Opt. 6)		
Frequency Error	Hz	± 10 Hz
2150 MHz @ -50 dBm (Units with Opt. 6)		
Frequency Error	Hz	± 10 Hz

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

TETRA Verification, Options 581, 582

Table A-32. Options 581 and 582, Signal Generator EVM Verification for TETRA

Frequency	Tx Pattern	EVM	Specification
5.5 MHz	tetra_bs_idle_unallocPCH	%	< 3.5%
845 MHz	tetra_bs_idle_unallocPCH	%	< 3.5%
1545 MHz	tetra_bs_idle_unallocPCH	%	< 3.5%

DMR2 Verification, Options 591, 592

Table A-33. Options 591 and 592, Signal Generator Modulation Fidelity Verification for DMR2

Frequency	Tx Pattern	Mod Fid	Specification
5.5 MHz	dmr2_bs_1031	%	< 1.25%
	dmr2_bs_511(O.153)	%	< 1.25%
845 MHz	dmr2_bs_1031	%	< 1.25%
	dmr2_bs_511(O.153)	%	< 1.25%
1545 MHz	dmr2_bs_1031	%	< 1.25%
	dmr2_bs_511(O.153)	%	< 1.25%

PTC Verification, Options 721, 722

Table A-34. Units with Firmware Version 1.09 and Lower, Options 721 and 722, PTC Verification

Frequency	Symbol Rate	Mod Fid	Specification
5.5 MHz	6000	%	< 1.75%
	18000	%	< 1.85%
845 MHz	6000	%	< 1.75%
	18000	%	< 1.85%
1545 MHz	6000	%	< 1.75%
	18000	%	< 1.85%

S412E Firmware Rev: _____ Operator: _____ Date: _____
 Serial Number: _____ Options: _____

Table A-35. Units with Firmware Version 1.10 and Higher, Options 721 and 722 PTC Verification

Frequency	Symbol Rate	EVM	Specification
5.5 MHz	Half Rate	%	< 3.5%
	Full Rate	%	< 3.5%
845 MHz	Half Rate	%	< 3.5%
	Full Rate	%	< 3.5%
1545 MHz	Half Rate	%	< 3.5%
	Full Rate	%	< 3.5%

S412E Firmware Rev: _____ Operator: _____ Date: _____

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