USER GUIDE

# AUTOMATED TUNER

Models MT984AL & MT985AL Series


Maury Microwave

MT984-471 (Rev C) 10/17

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## Models MT984AL & MT985AL Series

Maury Microwave

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MT984-471 (Rev C) 10/17

## *Warranty*

Maury Microwave hardware products are warranted against defects in materials and workmanship for a period of one year from date of shipment. During the warranty period, Maury Microwave will, at its option, either repair or replace products which prove to be defective.

Maury Microwave software products are warranted against defects in material and workmanship of the media on which the product is supplied for a period of ninety (90) days from date of shipment. Maury also warrants that the product shall operate substantially in accordance with published specifications during the same warranty period. During the warranty period, Maury Microwave will, at its option, either repair or replace products which prove to be defective. Maury does not warrant that the operation of the product shall be uninterrupted or error-free.

For warranty service or repair, all products must be returned to Maury Microwave and must be issued a return authorization number by Maury prior to shipment. Buyer shall prepay shipping charges to Maury. Obligation is limited to the original Buyer.

## *Limitation of Warranty*

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Buyer, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or wear resulting from normal use. No other warranty is expressed or implied. Maury Microwave specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

The remedies provided herein are the Buyer's sole and exclusive remedies. Maury Microwave shall not be liable for any direct, indirect, special, incidental, or consequential damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or any other financial loss) arising out of the Buyer's use of or inability to use the product, even if Maury or an authorized Maury dealer has been advised of the possibility of such damages.

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# GENERAL INFORMATION

## *MT984AL & MT985AL Automated Tuners*

The MT984AL & MT985AL Automated Tuners are precision electromechanical slide screw tuners. These tuners serve as matching networks for reducing reflections caused by mismatches present in a transmission line or to introduce a controlled mismatch into an otherwise matched transmission line.

The tuner is a slide screw tuner in which the probe and carriage motions are automated by stepper motors. The tuner has one probe to cover the operational frequency range. The typical maximum correctable VSWR of the probe is shown in Figure 1.

The probe is operated by a stepper motor. One revolution of the motor will change the probe's location by approximately 0.0079 inches. In full stepping mode, the probe will move in increments of 39.4 micro inches per step. In half stepping mode, the increment is 19.7 micro inches per step. The probe is moved along the transmission line by the carriage. The stepper motor and anti-backlash gear train will provide a minimum of one-half wavelength lateral movement of the probe at the tuners lowest rated frequency. Half-stepping the carriage motor will move the carriage 19.7 micro inches per step (approximately 0.028 degrees per step at 75GHz). Full steps are 39.4 micro inches per step (approximately 0.056 degrees per step at 75GHz).

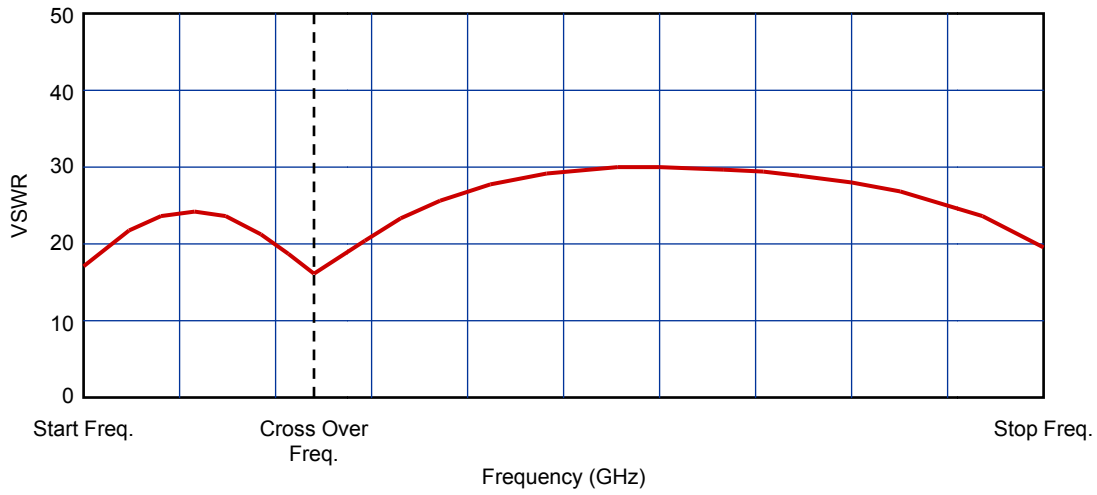


**Figure 1.** Typical VSWR Response

## *Operation*

The MT984AL & MT985AL Series of LXI tuners support multiple mode of remote control operation:

- Web based control using Ethernet connection
- Telnet based control using Ethernet connection (port 5024)
- COM port serial communication using USB connection (virtual COM port)
- ATS compatible driver (TunLXI.exe), version 5.20.00 or higher
- MT993V05 tuner control DLL

Please consult MT981-659 LXI Tuner User Manual for information on configuring your computer for operation of the LXI tuner using Ethernet or USB port.

## *Specifications*

### Electrical Specifications

**Table 1.** Tuner Electrical Specifications

| Model | Connector Type | Frequency Range (GHz) | Cross Over Freq. (GHz) | Matching Range (min) | VSWR [1] | Insertion Loss [1] | Vector Repeatability | Power Capability [2] |
|---|---|---|---|---|---|---|---|---|
| MT984AL01 | 2.4mm (male - High Matching Port) | 8.0 – 50.0 | 20 | 10:1 | 1.15:1 max | 0.6 dB max @ DC-48 GHz<br>0.65 dB max @ 48–50 GHz | 40 dB min | 10 W CW<br>100 W PEP |
| MT985AL01 | 1.85mm (male - High Matching Port) | 8.0 – 65.0 | 26.5 | | 1.25:1 max | 1.15 dB | | |

[1] With probes fully retracted.

[2] Power rated at maximum VSWR.

### Motion Control Specifications

Probe Motor Step Size [1] ..... 31 µin [0.787 µm]

Carriage Motor Step Size [1] ..... 50 µin [1.27 µm] (approx. 0.15° per step @ 50 GHz)

Positioning Accuracy..... ±1 step

[1] Based on half stepping the motors.

# INSTALLATION

## *Safety Precautions*

The MT984AL & MT985AL Series Automated Tuners are not electrically, chemically, nor mechanically hazardous to the operator. The following precautions are necessary to protect the instrument:

- Use extreme care in moving, handling, and storing this instrument, and avoid physical contact with other instruments.
- The tuner power source must be OFF before connecting power to the tuner to avoid potential damage to the tuner.
- Adjust the instrument supports to provide proper alignment with mating devices. Never allow the instrument to be supported by the connectors. Refer to Figure 2 for effect of improper support.
- Do not move the instrument by pulling an attached cable.
- Visually and mechanically inspect the connectors regularly to maintain performance characteristics and minimize damage to the instrument or any mating devices.
- To keep the precision components inside the tuner clean, the cover should be kept on the tuner at all times, except when the tuner is being serviced.

## *Software Installation*

If this is the first time a Maury Automated Tuner is being installed on the host computer, ATS software, version 5.20.00 or later, must first be installed before connecting the tuner to the computer.

## *Tuner Installation*

- Before installing the tuner, inspect each end of the cable connectors and the tuner connectors to ensure that all are clean and undamaged before connecting.
- Align the mating connectors with the tuner connector and connect the male tuner connector to the device under test.
- The tuner power source must be OFF before connecting power to the tuner to avoid potential damage to the tuner.
- Connect the DC power and either RJ45 network or USB cables.
- When using USB connection, the host computer will detect the tuner as a new device and automatically install the tuner drivers (LXITuner_USB.inf)
- When using TCPIP connection, the computer Ethernet connector has to be configured to match the tuner network settings. See MT981-659 LXI Tuner User Manual for more information.

***NOTE:*** *Verify that the tuner connectors are correctly aligned before any measurements are attempted. Improper connector alignment may damage the tuner. Refer to Figure 2 for effect of improper alignment.*

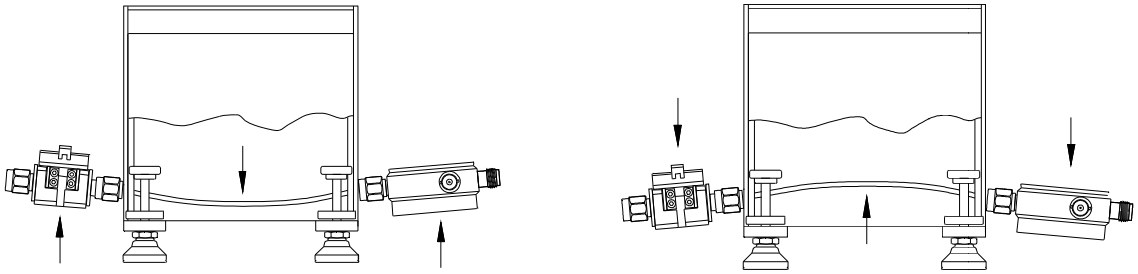

**Figure 2.** Effects of Improper Connector Support

# PERFORMANCE VERIFICATION

## *Performance Tests*

The tests described in this section enable the operator to verify the minimum performance levels of the MT984AL & MT985AL Series Automated Tuners. The tests are:

- VSWR Range
- VSWR (Probes Retracted)
- Loss (Probes Retracted)
- Repeatability

## *Equipment Required*

1. MT1020F Power Supply
2. USB cable (MT1020S7) or TCP/IP network cable (MT1020S8).
3. Vector Network Analyzer (VNA)
4. VNA test cable
5. Fixed Termination

## *Running TunLXI.exe*

1. Install MT993 ATS software, version 5.20.00 or later, and start software.
2. Select “Instruments” from the “Setup” menu.
3. From the Instrument Setup dialog box, click “Tuners” button.
4. In “Tuners” dialog box, select “Details”.
5. Select “Browse” from the “Tuner Properties” dialog box, and select “TunLXI.exe”.
6. In “Tuner Properties” dialog box, input the IP address displayed on the tuner.
7. Under tuner model, select LXI Tuner.
8. Select “Test” and TunLXI.exe will be executed.

**Table 2.** Recommended Fixed Terminations

| Model | Connector Type | Termination Type (Performance Verification) |
|---|---|---|
| MT984AL01 | 2.4mm | 2.4mm - MMC 7931A1 (female) & 7931B1 (male) |
| MT985AL01 | 1.85mm | 1.85mm – MMC 7832A (female) & 7832B (male) |

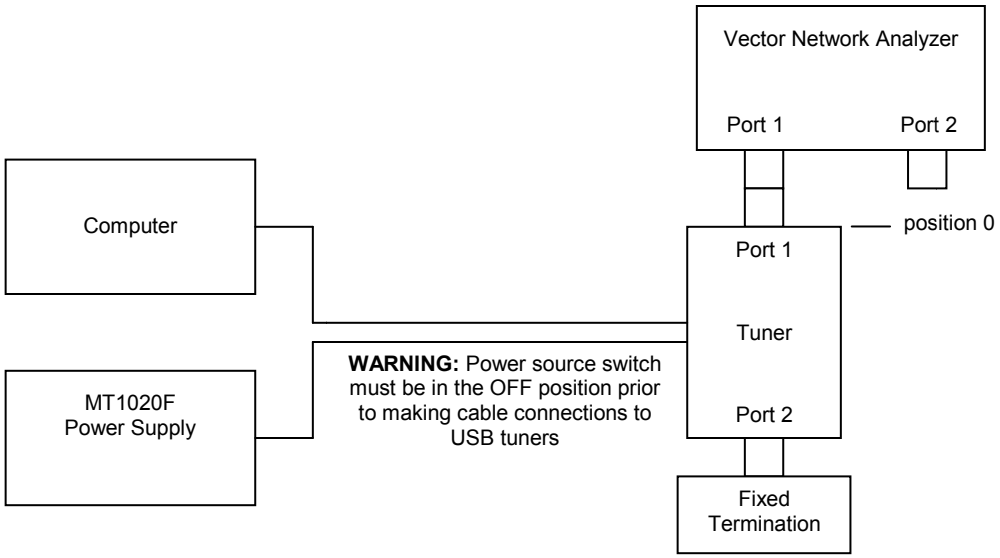


**Figure 3.** Single Port Test Configuration

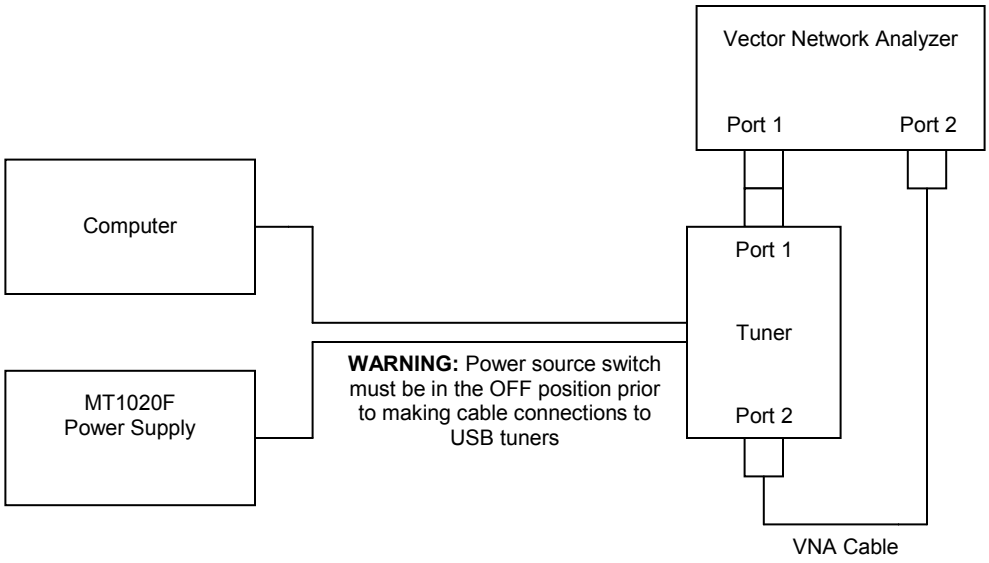


**Figure 4.** Two Port Test Configuration

## *VSWR Range Test*

### Low Frequency Range Test

1. Calibrate the VNA to perform a single port measurement over the full frequency range of the tuner per Table 1. VNA resolution is critical; 401 points is recommended with narrow IF bandwidth.
2. Using a fixed termination per Table 2, connect the equipment as shown in Figure 3.
3. Initiate TunLXI.exe program.
4. Select “Find Tuner” from the “Test” menu. Verify Tuner model (LXITuner) and IP address. Select “OK”. Click “OK” when tuner found.
5. Select “Init Tuner” from the “Test” menu. Initializing Tuner dialog box appears on the screen and closes once the tuner has finished the initializations process.
6. Select “Move Tuner” from “Test” menu. “Destination Positions” dialog box appears.
7. Input the following destinations for each of the motors: Carriage=100, Probe 1=0, Probe 2=4500. This will move the Low Frequency probe to zero and keep the High Frequency probe to fully retracted position.
8. Set VNA controls for a convenient display and verify that the VSWR in the low band, from the start frequency to the cross over frequency of the tuner is as specified in Table 1. The VNA display should be similar to the sample shown in Figure 5.

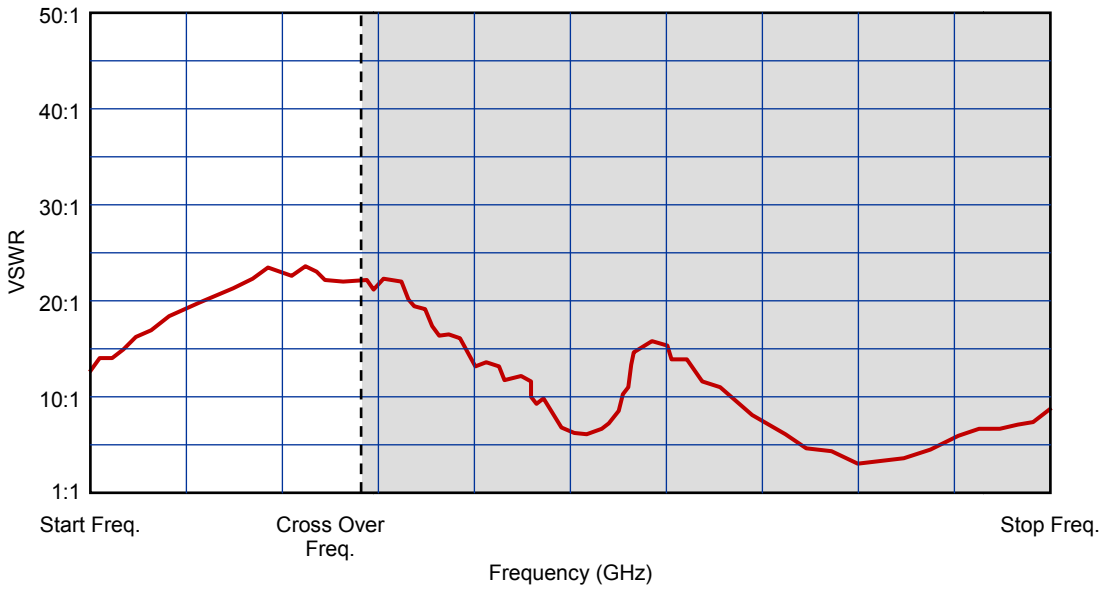


**Figure 5.** Low Band VSWR Range Display

## High Frequency Range Test

1. Calibrate the VNA to perform a single port measurement over the full frequency range of the tuner per Table 1. VNA resolution is critical; 401 points is recommended with narrow IF bandwidth.
2. Using a fixed termination per Table 2, connect the equipment as shown in Figure 3.
3. Initiate TunLXI.exe program.
4. Select “Find Tuner” from the “Test” menu. Verify Tuner model (LXITuner) and IP address. Select “OK”. Click “OK” when tuner found.
5. Select “Init Tuner” from the “Test” menu. Initializing Tuner dialog box appears on the screen and closes once the tuner has finished the initializations process.
6. Select “Move Tuner” from “Test” menu. “Destination Positions” dialog box appears.
7. Input the following destinations for each of the motors: Carriage=100, Probe 1=4500, Probe 2=0. This will move the High Frequency probe to zero and keep the Low Frequency probe to fully retracted position.
8. Set VNA controls for a convenient display and verify that the VSWR in the low band, from the start frequency to the cross over frequency of the tuner is as specified in Table 1. The VNA display should be similar to the sample shown in Figure 6.

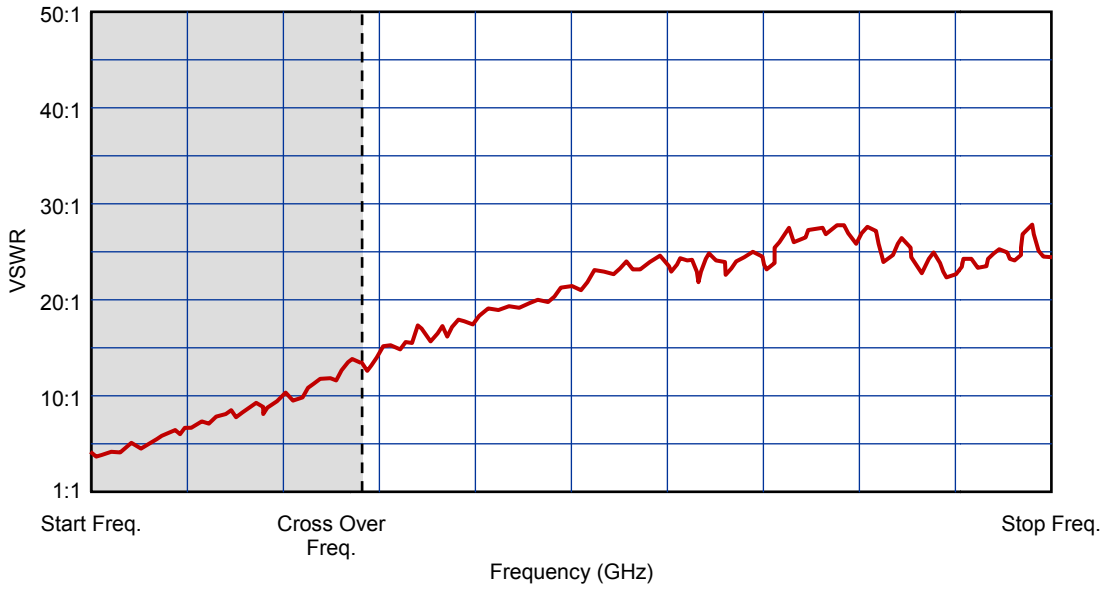


**Figure 6.** High Band VSWR Range Display

## *VSWR Test (Probes Retracted)*

1. Calibrate the VNA to perform a single port measurement over the full frequency range of the tuner per Table 1. VNA resolution is critical; 401 points is recommended with narrow IF bandwidth.
2. Using a fixed termination per Table 2, connect the equipment as shown in Figure 3.
3. Initiate TunLXI.exe program.
4. Select “Find Tuner” from the “Test” menu. Verify Tuner model (LXITuner) and IP address. Select “OK”. Click “OK” when tuner found.
5. Select “Init Tuner” from the “Test” menu. Initializing Tuner dialog box appears on the screen and closes once the tuner has finished the initializations process.
6. Select “Move Tuner” from “Test” menu. “Destination Positions” dialog box appears.
7. Input the following destinations for each of the motors: Carriage=100, Probe 1=4500, Probe 2=4500. This will move both probes to fully retracted position.
8. Set VNA controls for a convenient display and verify the VSWR maximum over the full frequency range of the tuner per Table 1. The VNA display should be similar to the sample shown in Figure 7.

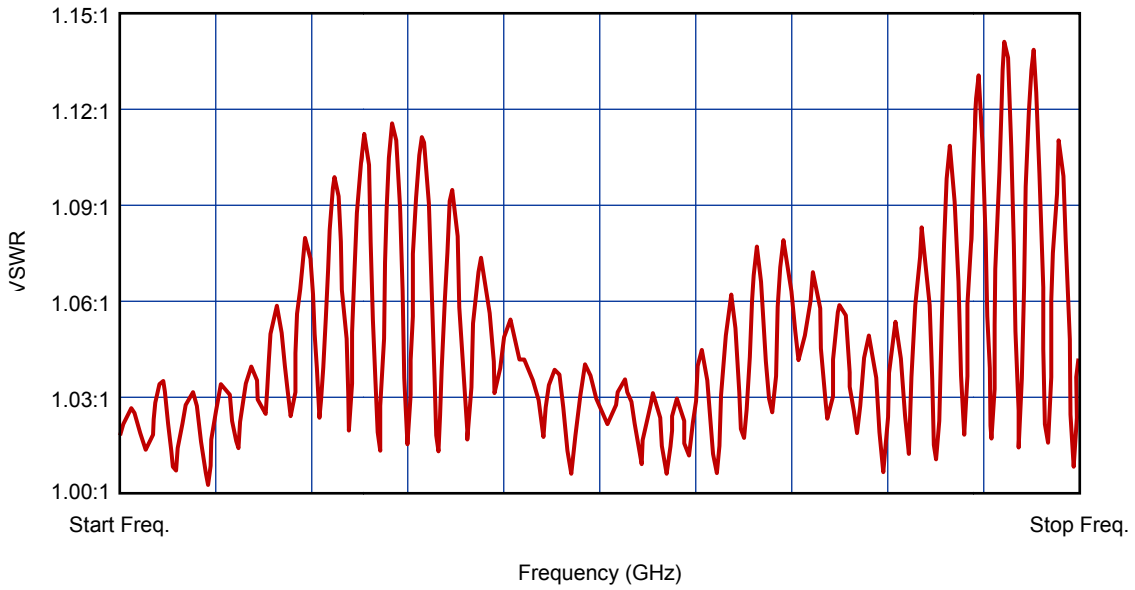


**Figure 7.** VSWR Display (Probes Retracted)

## *Loss Test (Probes Retracted)*

1. Calibrate the VNA to perform a two port measurement over the full frequency range of the tuner per Table 1. VNA resolution is critical; 401 points is recommended with narrow IF bandwidth.
2. Connect the equipment as shown in Figure 4.
3. Initiate TunLXI.exe program.
4. Select “Find Tuner” from the “Test” menu. Verify Tuner model (LXITuner) and IP address. Select “OK”. Click “OK” when tuner found.
5. Select “Init Tuner” from the “Test” menu. Initializing Tuner dialog box appears on the screen and closes once the tuner has finished the initializations process.
6. Select “Move Tuner” from “Test” menu. “Destination Positions” dialog box appears.
7. Input the following destinations for each of the motors: Carriage=100, Probe 1=4500, Probe 2=4500. This will move both probes to fully retracted position.
8. Set VNA controls for a convenient display and verify that the insertion loss is as specified in Table 1 over the full frequency range of the tuner per Table 1. The VNA display should be similar to the sample shown in Figure 8.

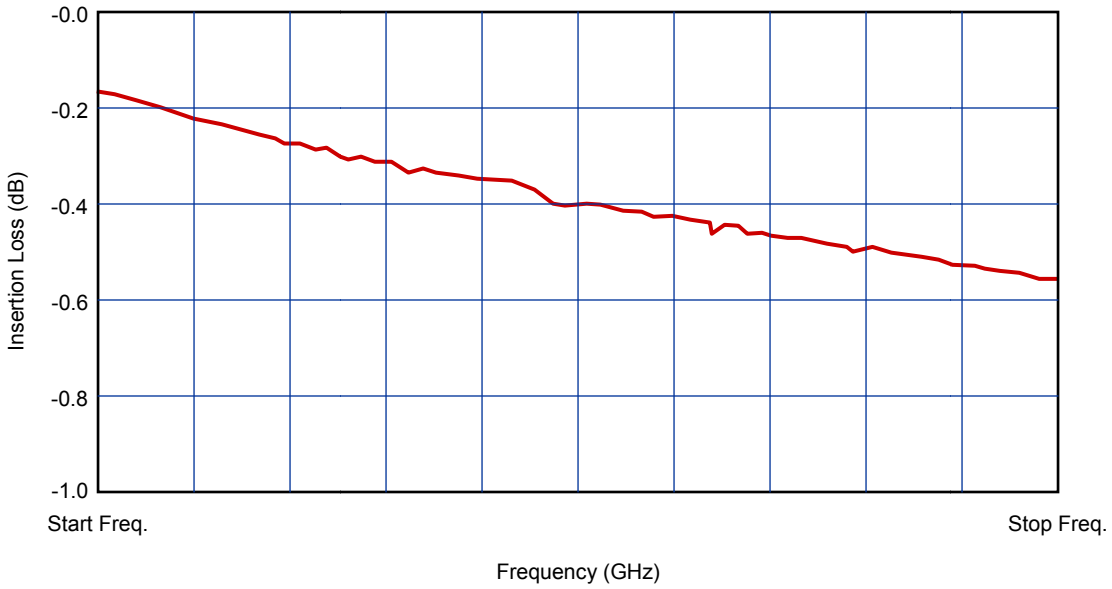


**Figure 8.** Insertion Loss Display (Probes Retracted)

## *Repeatability Test*

*Note: Some drivers may not support the REPEATABILITY test function. Please contact Maury Microwave to obtain the latest version of the driver that supports the test.*

1. Initiate TunLXI.exe program.
2. Select “Find Tuner” from the “Test” menu. Verify Tuner model (LXITuner) and IP address. Select “OK”. Click “OK” when tuner found.
3. Select “Init Tuner” from the “Test” menu. Initializing Tuner dialog box appears on the screen and closes once the tuner has finished the initializations process.
4. Under "Test" menu, select "Repeatability Test".
5. Set parameters per Notes 1 and 2 and click "OK".

   ***Note 1:*** Make sure the selected test position is in the available travel range of the tuner. This is 0 to 4500 for the probes. Carriage travel is 15300.

   ***Note 2:*** For frequencies below the crossover frequency, keep probe 2 (the high frequency probe) at 4500. For frequencies above the crossover frequency, keep probe 1 (the low frequency probe) at position 4500.

6. After saving S11 data to memory, click "OK". This is done manually via the front panel of VNA.
7. Current S11 response is saved to VNA memory. Record Tune - position select "Data - Memory" trace on VNA. Move tuner to a new position greater than 100 steps away from the parameters set for the carriage position and probe position.
8. Move tuner back to reference position. Verify VNA trace "Data-Memory" is less than -40 dB verifying repeatability specification of > 40 dB.
9. Repeat S11 repeatability test at all positions of interest.
10. Repeat the above procedure for S21 repeatability test.

    ***Note 3:*** Display Data-Memory in Log Magnitude format. This will display the repeatability vs. frequency for the selected position. The VNA display should be similar to the samples in Figure 9 for the low frequency probe and Figure 10 for the high frequency probe.

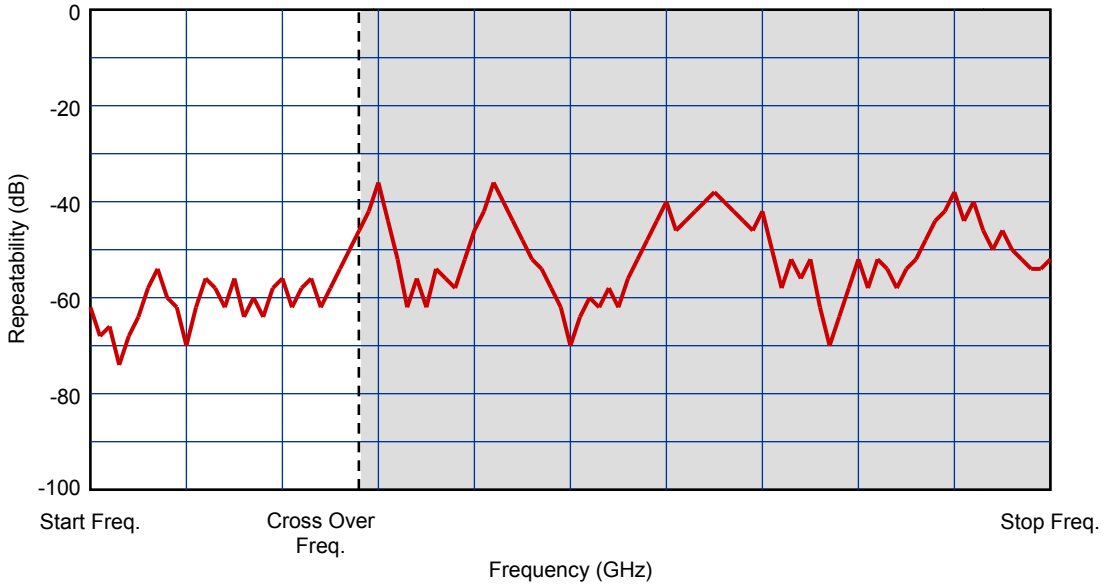


**Figure 9.** Low Band Repeatability Display

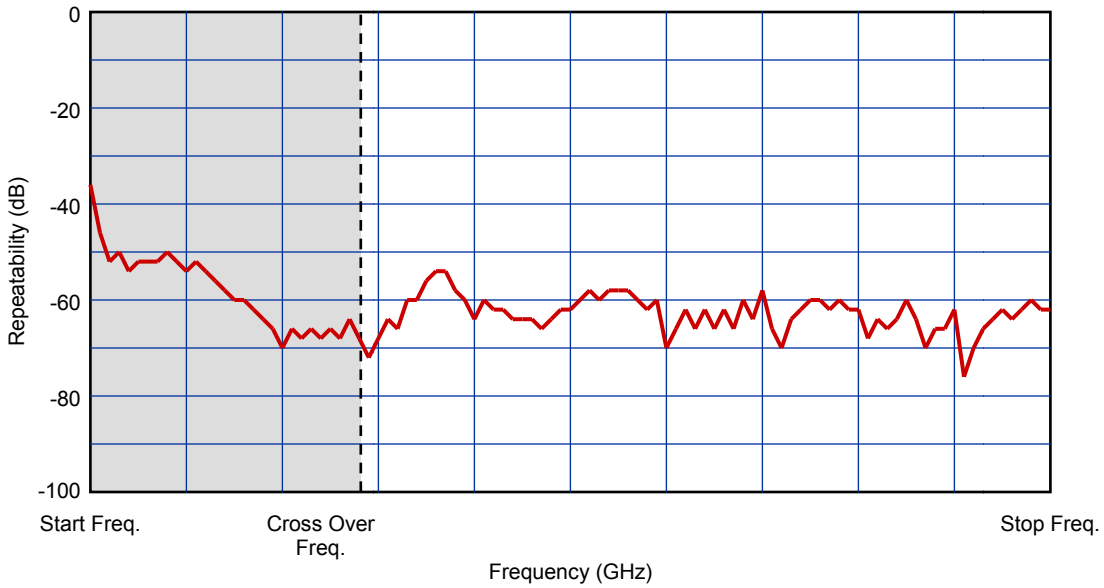


**Figure 10.** High Band Repeatability Display

# MAINTENANCE

## *Connector Maintenance*

Periodically inspect the connectors for signs of damage. Tuners with damaged connectors should be returned to the factory for repair. Connectors should be cleaned using dry compressed air of a very low velocity first; then cleaned with a solvent such as isopropyl alcohol. Clean the contacting surfaces, alignment parts and threads using a lint free swab. Reapply dry compressed air to evaporate any residual solvent. After cleaning, re-inspect the connector to make sure that no fibers have been left around the contact or mating surfaces.

Mechanical inspection of the connector requires the use of a connector gage (refer to Table 3 for recommended gage kits). The connector gage will measure the location of the mating surface on the center conductor with respect to the mating surface on the outer conductor. The center conductor surface should not protrude beyond the outer conductor surface or be recessed more than specified in Table 3. If this condition is not satisfied, do not connect any other device to the connector (connector repair is required).

**Table 3.** Connector Specifications

| Model | Connector | Gage Kit | Pin Depth Specification (recessed) |
|---|---|---|---|
| MT984AL01 | 2.4mm | MMC A035C, A035E or A048A | 0 to 0.0015” |
| MT985AL01 | 1.85mm | MMC A048A | 0 to 0.001” |

## *Lubrication*

The tuner is lubricated at the factory.  No additional lubrication is required.

# APPENDIX

## *Packaging of the Automated Tuner*

All shipping containers and packing materials for the Automated Tuner should be retained in the event it becomes necessary to return the instrument to the factory. If the instrument fails to meet specifications or the contents are incomplete, notify the carrier and Maury Microwave Corporation immediately and wait for instructions before returning any products. In the event that you have to return the tuner for any reason, please refer to the following packaging instructions.

### Packing Instructions

To protect the tuner during transit, the tuner must be packaged in its original shipping container and packing materials. If you do not have the original shipping container and/or packing materials, contact your Maury Microwave representative or the factory and a packaging kit will be provided. The instructions provided herein will properly prepare the tuner for return to the factory.

**Instruction for Preparing Tuner Before Shipping**

Step 1. Initialize the tuner

- Initiate TunLXI.exe program.
- Select “Find Tuner” from the “Test” menu. Verify Tuner model (LXITuner) and IP address. Select “OK”. Click “OK” when tuner found.
- Select “Init Tuner” from the “Test” menu. Initializing Tuner dialog box appears on the screen and closes once the tuner has finished the initialization process.

Step 2. Move tuner to shipping position

- Select “Move Tuner (Prec.)” from “Test” menu. “Destination Positions” dialog box appears. Set the Carriage to position 100, and both Probe to 2000 (mid travel position).
- After the positions are set, click “OK” and the tuner should move to the shipping position.

*Locking the carriage is not necessary*

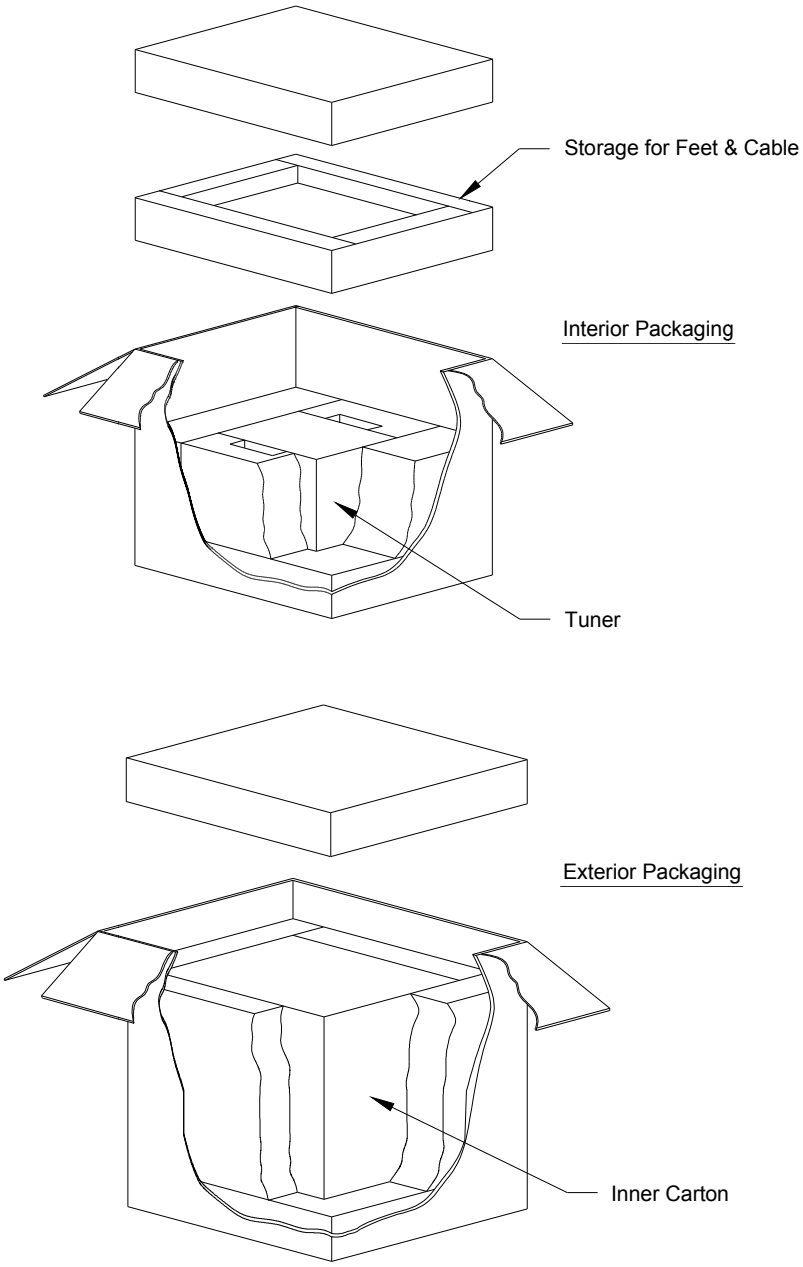


**Figure A1.** Tuner Packaging

## *Data Sheet Resources*

LXI-Certified Automated Tuners

www.maurymw.com/MW_RF/LXI_Tuners.php

4T-050G04 - LXI™ Certified 3.5mm, 2.4mm & 1.85mm Automated Tuners

www.maurymw.com/pdf/datasheets/4T-050G04.pdf

2Z-057 – Precision Calibration Kits – 2.4mm

http://www.maurymw.com/pdf/datasheets/2Z-057.pdf

2Z-056 – Precision Calibration Kits – 1.85mm

http://www.maurymw.com/pdf/datasheets/2Z-056.pdf

2Y-022A – "Metrology Grade" 2.4mm Connector Gage Kit

http://www.maurymw.com/pdf/datasheets/2Y-022A.pdf

2Y-048 – "Metrology Grade" 1.85/2.4mm Digital Connector Gage Kit

http://www.maurymw.com/pdf/datasheets/2Y-048.pdf

2Y-001 – Connector Gages and Connector Gage Kits

http://www.maurymw.com/pdf/datasheets/2Y-001.pdf

2Y-050A – Torque Wrenches

http://www.maurymw.com/pdf/datasheets/2Y-050A.pdf

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## Web Site

http://maurymw.com

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