User Guide

Automated Tuner

Model MT982AL Series
To protect this unit during transit, the tuner carriage has been locked into position via a locking screw inserted from the underside of the unit. Before applying power, it is necessary to remove this screw from its locking position "A" and place it in its storage position "B". Refer to Appendix, Figure A 1, at the rear of this manual which shows the two positions. Retain this notice along with all packing materials in the event unit requires future shipment. Before shipping the unit, refer to Appendix for packaging instructions.
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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MT982AL Series Automated Tuners

The MT982AL Series Automated Tuners are precision electromechanical slide screw tuners. These tuners serve as a matching network for reducing reflections caused by mismatches present in a transmission line or to introduce a controlled mismatch into an otherwise matched transmission line.

The tuners are slide screw tuners in which the probe and carriage motions are automated by stepper motors. The tuners have two probes to cover the operational frequency range. The low frequency probe is designed to induce a mismatch in the frequency range below the specified cross over frequency. The high frequency probe is designed to induce a mismatch in the frequency range above the specified cross over frequency. Each probe should be used in its designated range.

Each probe is individually operated by a stepper motor. The probe motors are operated in half-stepping.

The (non-contacting) probes are 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 probes at the tuners lowest rated frequency. The carriage motor is operated in half-stepping mode.

![Typical VSWR Response](image)

**Figure 1.** Typical VSWR Response

**Operation**

The MT982AL 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

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency Range (GHz)</th>
<th>Cross Over Frequency (GHz)</th>
<th>Matching Range (min)</th>
<th>VSWR (1) (max)</th>
<th>Insertion Loss (1) (max)</th>
<th>Vector Repeatability</th>
<th>Power Capability (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT982AL01</td>
<td>1.8 – 18.0</td>
<td>5.5</td>
<td>10:1</td>
<td>1.05:1</td>
<td>0.4 dB</td>
<td>&gt;50 dB typical</td>
<td>50 W CW</td>
</tr>
<tr>
<td>MT982AL02</td>
<td>15:1 (1.8 – 8.0 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>500 W PEP</td>
</tr>
<tr>
<td>MT982AL06</td>
<td>20:1 (8.0 – 16.0 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:1 (16.0 – 18.0 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) With probes fully retracted.
(2) Power rated at maximum VSWR.

Motion Control Specifications

- Probe Motor Step Size (1) ......................... 62.5 µin [1.59 µm]
- Carriage Motor Step Size (1) ..................... 355 µin [9.02 µm]
  (approx. 0.39° per step @ 18.0 GHz)

- Positioning Accuracy ........................... ±1 step

(1) Based on half stepping the motors.
Installation

Safety Precautions

The MT982AL 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.
- 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.
- 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.
Performance Verification

Performance Tests
The tests described in this section enable the operator to verify the minimum performance levels of the MT982AL 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. 7mm Fixed Termination - MMC 2610D or equivalent

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, click “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.
8. Select “Test” and TunLXI.exe will be executed.
**Figure 2.** Single Port Test Configuration

**Figure 3.** 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 7mm fixed termination, connect the equipment as shown in Figure 2.
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.
7. Input the following destinations for each of the motors: Carriage=100, Probe 1=0, Probe 2=5000. 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 per Table 1, is as specified in Table 1. The VNA display should be similar to the sample shown in Figure 4.

![Figure 4. Low Band VSWR Range Display](image-url)
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 7mm fixed termination, connect the equipment as shown in Figure 2.

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.


7. Input the following destinations for each of the motors: Carriage=100, Probe 1=5000, 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 crossover frequency of the tuner per Table 1, is as specified in Table 1. The VNA display should be similar to the sample shown in Figure 5.

![Figure 5. High Band VSWR Range Display](image)
**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 7mm fixed termination, connect the equipment as shown in Figure 2.

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.


7. Input the following destinations for each of the motors: Carriage=100, Probe 1=5000, Probe 2=5000. This will move both probes to fully retracted position.

8. Set VNA controls for a convenient display and verify that the VSWR is 1.05:1 maximum over the full frequency range of the tuner per Table 1. The VNA display should be similar to the sample shown in Figure 6.

![VSWR Display (Probes Retracted)](image)

**Figure 6. 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 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.


7. Input the following destinations for each of the motors: Carriage=100, Probe 1=5000, Probe 2=5000. 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 7.

![Figure 7. Insertion Loss Display (Probes Retracted)](image-url)
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 5000 for the probes. Carriage travel is 9400.

   **Note 2:** For frequencies below the crossover frequency, keep probe 2 (the high frequency probe) at 5000. For frequencies above the crossover frequency, keep probe 1 (the low frequency probe) at position 5000.

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 8 for the low frequency probe and Figure 9 for the high frequency probe.
Figure 8. Low Band Repeatability Display

Figure 9. 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. This measurement is taken with the collet removed from the center conductor. Special care should be taken when removing the collet to insure the center conductor is not damaged or loosened from the connector. 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 2. Connector Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Gage Kit</th>
<th>Pin Depth Specification (recessed with collet removed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT982AL Series</td>
<td>MMC A028D</td>
<td>0 to 0.0015&quot;</td>
</tr>
</tbody>
</table>

Lubrication

Periodic application of a lubricant to certain moving parts is required to reduce wear and extend the operational life of the Automated Tuner. The lubrication schedule is dependent upon the amount of use the tuner receives. In a laboratory environment, lubrication at six (6) month intervals should be sufficient. In continuous use applications, lubrication should be performed on a monthly basis.

Suggested lubricant: Tufoil Lubit-8™
Flouramics Inc.
Mahwah, NJ 07430

Lubrication Process

1. Remove tuner cover by removing the eight (8) screws on the sides of the cover holding it to the end plates.
2. Through the access hole in the carriage (see Figure 10), apply a small amount of lubricant to the point where the probe motor lead screws enter the probe drive blocks. The amount of lubricant to be applied should be a single drop of lubricant, approximately one millimeter (0.04 inches) in diameter.
3. Exercise the probes up and down from limit to limit to evenly distribute the lubricant.
4. Apply a small amount of lubricant to the rack gear and carriage motor worm gear and cycle the carriage from end to end to evenly distribute the lubricant.
5. Wipe up any excess lubricant and replace the cover onto the tuner.
Figure 10. Lubrication Points
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 carriage must be secured in its locking position and the tuner 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 Locking Tuner Carriage 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 lock position

Method 1:

- Look for the instructional label on the side of the tuner cover to determine the locking position of the carriage (different tuner models may have different locking positions).
- From the Tuner Properties dialog box, select “Park”. Input the carriage position in the “Input Carriage Park Position” dialog box. Select “OK”.
- The park position is displayed (i.e. Tuner moved to park position 0 2500 2500).

Method 2:

- Look for the instructional label on the side of the tuner cover to determine the locking position of the carriage (different tuner models may have different locking positions).
- Select “Move Tuner” from “Test” menu “. “Destination Positions” dialog box appears.
- Enter the carriage position found on the instructional label of the tuner. For Probe 1 and Probe 2, change the position to half of its initialized position.
  - For example, if the initialized position is 5000, then change it to 2500.
- After the positions are set, click “OK” and the tuner should move to the locking position.

Step 3. Insert the locking screw into the locking position

- Locate the screw and put it in the hole labeled “A” on the underside of the tuner base plate. (See Figure A 1)
• The screw should go all the way in without any resistance or pressure. If there is resistance half way while inserting the screw, stop immediately and check the carriage position again.

• If the screw will still not thread all the way in, open the cover and check if the screw and the locking hole under the carriage are lined up. If not, manually move the carriage a few positions at a time until one can visually see the hole under the carriage and the screw are lined up; then insert the screw. Securely replace the tuner cover once completed.

![Diagram of Locking Screw Position]

**Figure A 1.** Locking Screw Position
Figure A 2. Crating Unit
Data Sheet Resources

LXI-Certified Automated Tuners
4T-072A - LXI™ Certified 7mm Automated Tuners
http://www.maurymw.com/MW_RF/7mm_Tuners.php

2Z-022H – 7mm VNA Calibration Kits
http://maurymw.com/datasheets/2Z-022H.pdf

2Y-005A – "Metrology Grade" 7mm Connector Gage Kit
http://maurymw.com/datasheets/2Y-005A.pdf
2Y-006 – Connector Gage Kit – Precision 14mm and 7mm
2Y-001 – Connector Gages and Connector Gage Kits
http://maurymw.com/datasheets/2Y-001.pdf

2Y-050A – Torque Wrenches
http://maurymw.com/datasheets/2Y-050A.pdf
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