USER GUIDE

MILLIMETER-WAVE AUTOMATED TUNERS

Models MT977AL, MT978AL & MT979AL

Maury Microwave

MT977-315 (C) 3/24

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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

MT97xAL Series Automated Tuner

The MT97xAL Series Automated Tuner is a precision electromechanical slide screw tuner. 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 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 VSWR response 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.

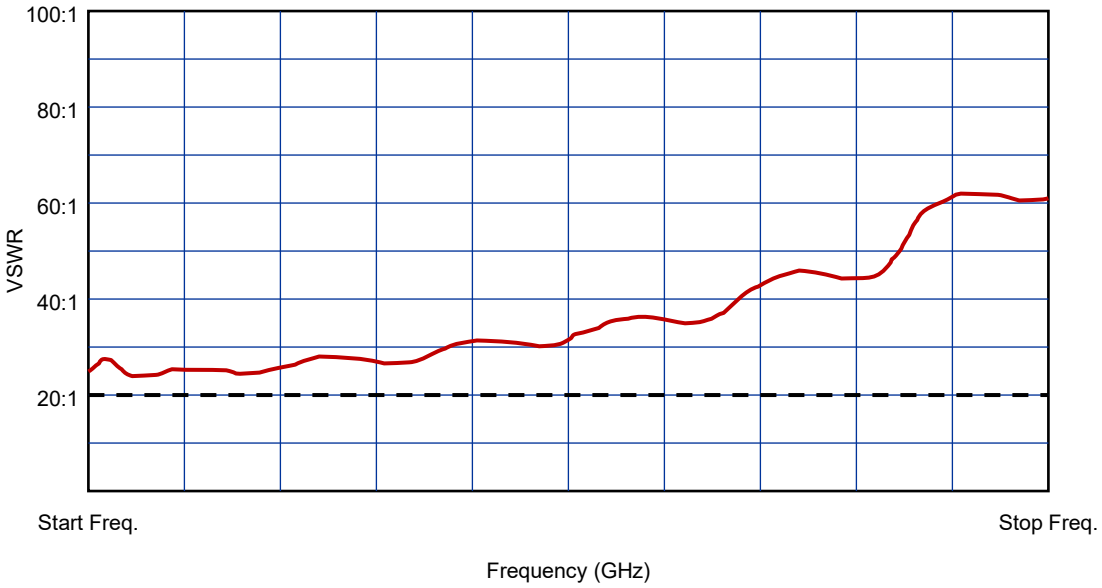

Figure 1. Typical VSWR Response

Operation

The MT97xAL Series Automated Tuner supports 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 (TunXtIP.exe), version 5.20.00 or higher
- MT993V05 tuner control DLL

Please consult XT981-557 Tuner User Manual for information on configuring your computer for operation of the tuner using Ethernet or USB port.

Specifications

Electrical Specifications

Table 1. Tuner Electrical Specifications

Model	Frequency Range (GHz)	Matching Range (min)	Insertion Loss[1] (max)	Vector Repeatability (min)	Power Capability[2]	Dissipative Loss[3] (max)
MT977AL	50.0 – 75.0	20:1	0.65 dB	-50 dB	20 W CW 200 W PEP	7.0 dB
MT978AL	60.0 – 90.0					
MT979AL	75.0 – 110.0					

(1) Probe Retracted
(2) Power rated at maximum VSWR
(3) At maximum VSWR

Motion Control Specifications

Probe Motor Step Size (1) ..... 19.7 µin [0.5 µm]
Carriage Motor Step Size (1) ..... 19.7 µin [0.5 µm]
(approx. 0.028° per step @ 75 GHz)
(approx. 0.091° per step @ 90 GHz)
(approx. 0.112° per step @ 110 GHz)
Positioning Accuracy ..... ±2 steps

(1) Based on half stepping the motors.

INSTALLATION

Safety Precautions

The MT97xAL Series Automated Tuner is 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 or TCS 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 of the mating connectors and the tuner connectors to ensure that all are clean and undamaged before connecting.
- Align the mating connectors with the tuner connectors and connect the DUT 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 (Tuner_USB.inf)
- When using TCPIP connection, the computer Ethernet connector has to be configured to match the tuner network settings. See XT981-557 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 or result in incorrect measurements.*

PERFORMANCE VERIFICATION

Performance Tests

The tests described in this section enable the operator to verify the minimum performance levels of the MT97xAL Series Automated Tuner. The tests are:

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

Equipment Required

1. MT1020F Power Supply (included with tuner).
2. USB cable (MT1020S7) or TCP/IP network cable (MT1020S8) (included with tuner).
3. DB15 cable (MT977C12) – DO NOT use a different cable (included with tuner).
4. Vector Network Analyzer (VNA)
5. VNA test cable
6. Fixed Termination

Running TunXtIp.exe (if using TCP/IP connection) or TunXtUsb.exe (if using USB connection)

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 the corresponding driver.
6. In “Tuner Properties” dialog box, input the IP address displayed on the tuner or the COM port associated with the tuner.
7. Select the tuner model from the drop down menu and the serial number.
8. Select “Find On-Line”.
9. Select “Test” and tuner driver will be executed.

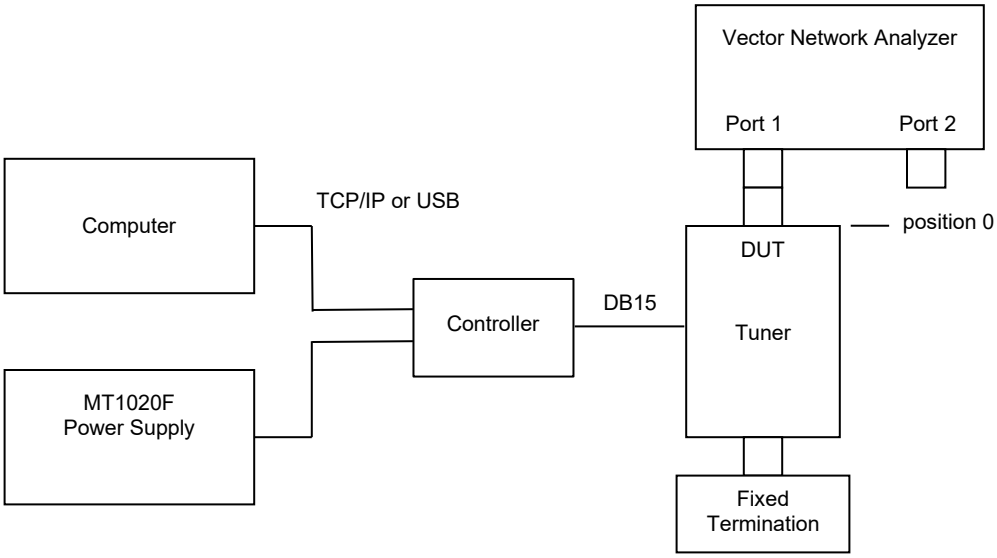

Figure 2. Single Port Test Configuration

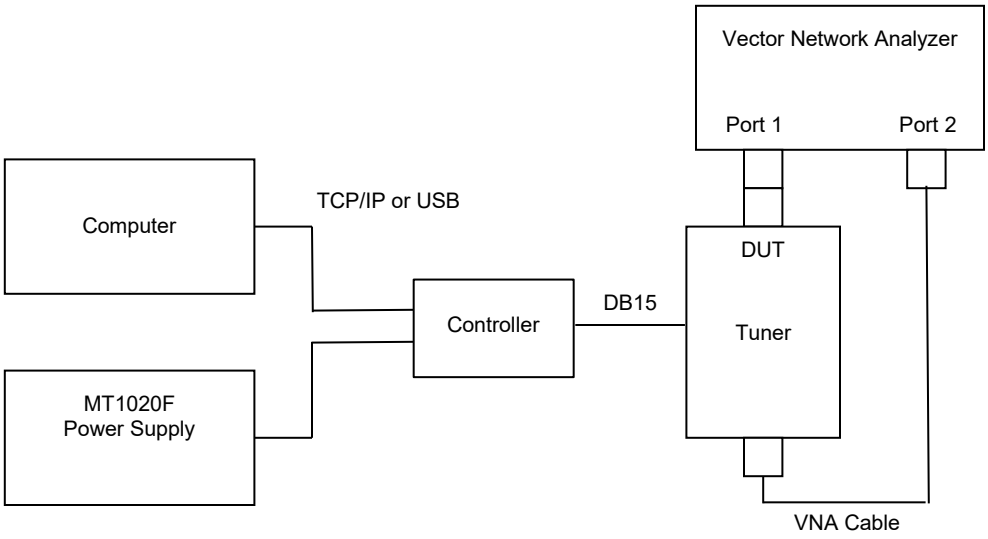

Figure 3. Two Port Test Configuration

VSWR 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 the tuner driver program based on the connection type.
4. Select “Find Tuner” from the “Test” menu. Verify tuner model, serial number and IP address (or COM port). 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 =0. This will move the probe to position zero.
8. Set the VNA controls for a convenient display and verify that the VSWR is as specified in Table 1. The VNA display should be similar to the sample shown in Figure 4.

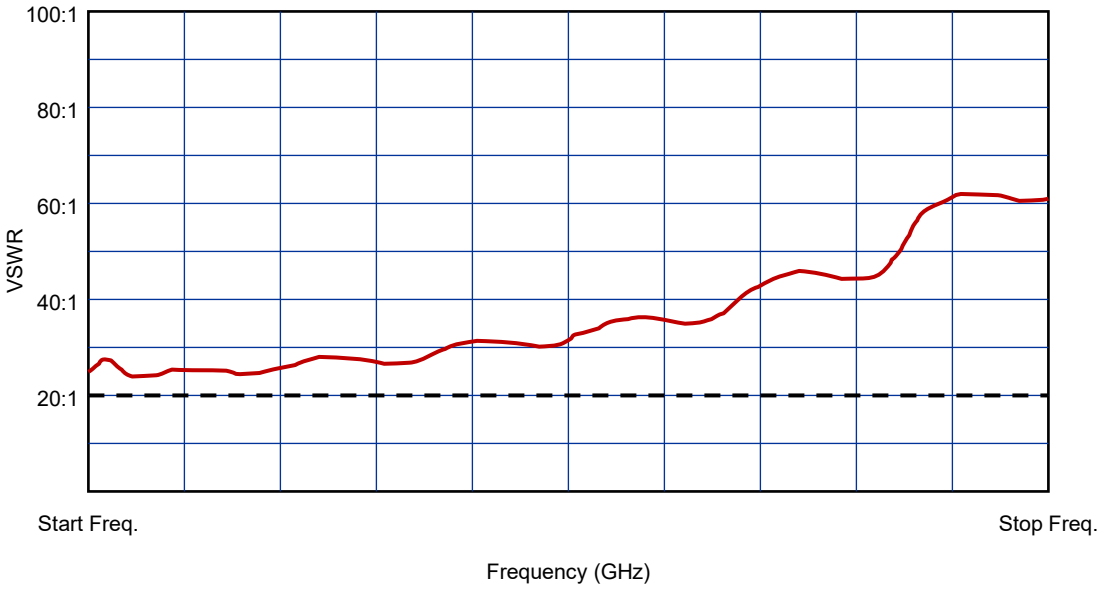

Figure 4. VSWR Range Display

VSWR Test (Probe 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 the tuner driver program based on the connection type.
4. Select “Find Tuner” from the “Test” menu. Verify tuner model, serial number and IP address (or COM port). 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 carriage destination = 100, and the probe per Table 2 below. This will move the probe to fully retracted position.
8. Set VNA controls for a convenient display and verify that the VSWR 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 5.

Model	Probe Travel – Minimum (steps)	Carriage Travel – Minimum (steps)
MT977AL	4,000	12,000
MT978AL	2,800	9,750
MT979AL		7,500

Table 2. Minimum Probe and Carriage Travel

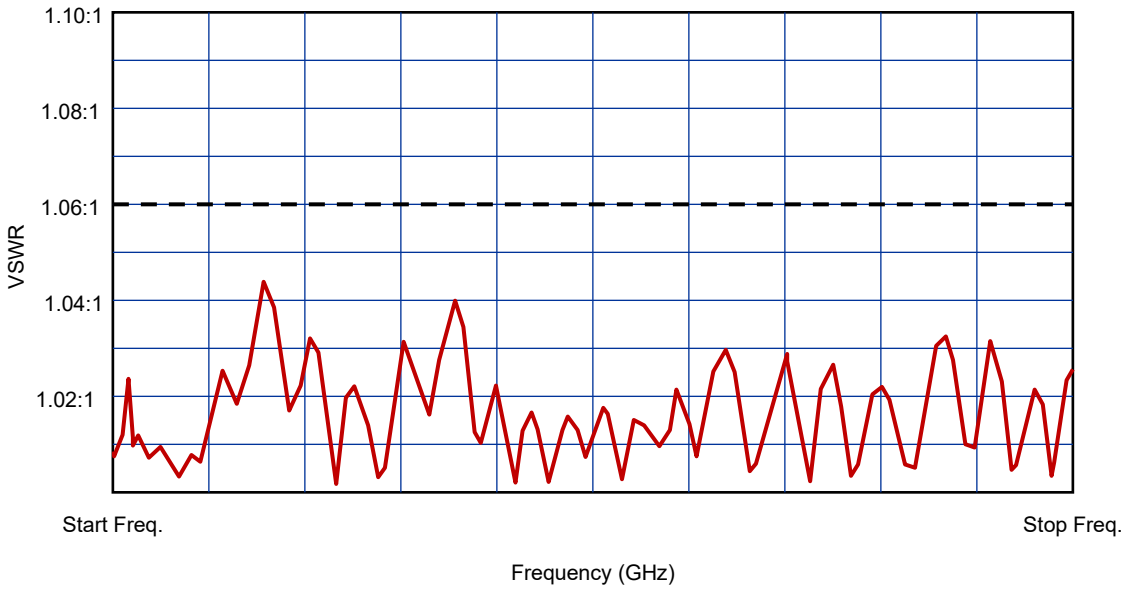

Figure 5. VSWR Display (Probe Retracted)

Loss Test (Probe 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 the tuner driver program based on the connection type.
4. Select “Find Tuner” from the “Test” menu. Verify tuner model, serial number and IP address (or COM port). 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 carriage destination = 100, and the probe per Table 2 above. This will move the probe 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 6.

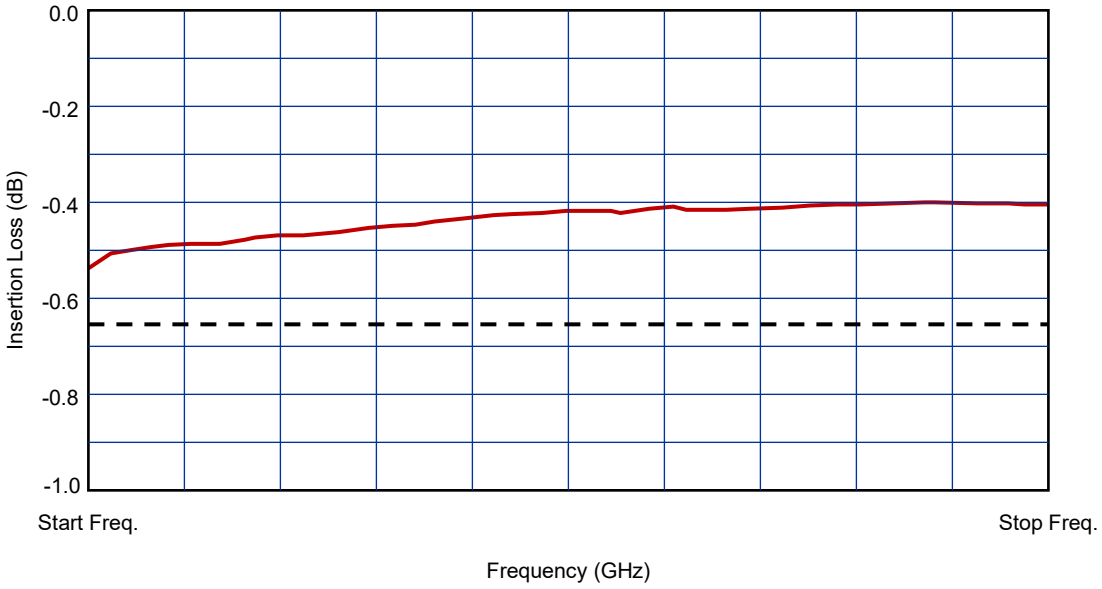

Figure 6. Insertion Loss Display (Probe Retracted)

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.

We suggest performing this test first without the tuner to validate the repeatability of the setup. Waveguide setups are very sensitive and this test can help to detect potential setup issues.

1. Initiate the tuner driver program based on the connection type.
2. Select “Find Tuner” from the “Test” menu. Verify tuner model, serial number and IP address (or COM port). 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. See Table 2 above for the minimum probe and carriage travel requirements. Use start position = 100 for the carriage, and 0 for probe.

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 -50 dB verifying repeatability specification of > 50 dB.
9. Repeat S11 repeatability test at all positions of interest.
10. Repeat the above procedure for S21 repeatability test.

    Note 2: 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 7.

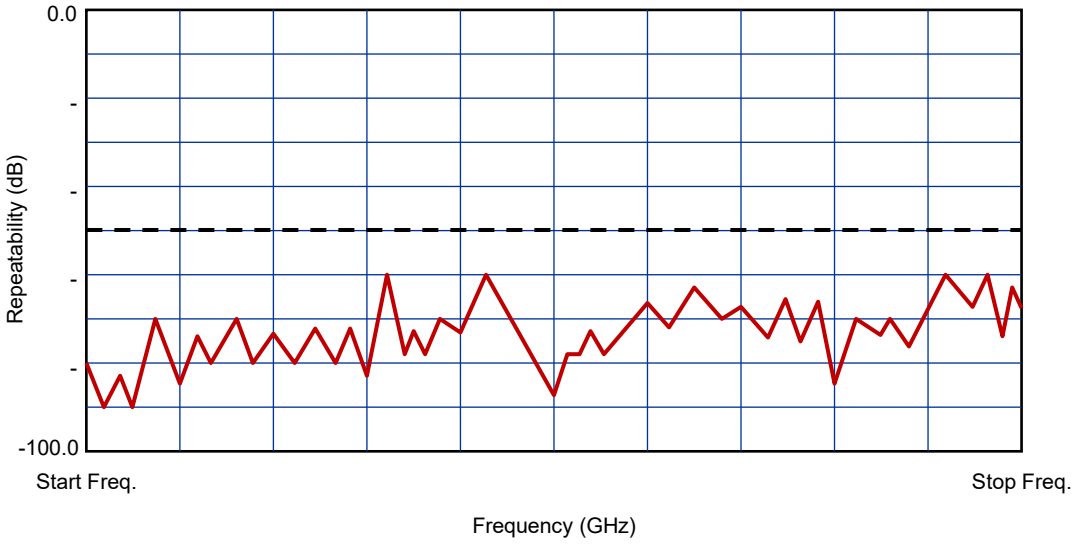

Figure 7. Repeatability Display

MAINTENANCE

Flange Maintenance

To maintain optimum performance of the tuner, periodically visually and mechanically inspect the precision WR15 flanges. Inspect for burrs, scratches, damages threads, contamination, corrosion or damage. If cleaning is required, the only solvent to be used is isopropyl alcohol (99% pure). The solvent should be applied with clean cotton swabs. After solvent application, use clean, dry compressed air to dry the waveguide flange. Visually inspect to ensure there are no cotton fibers attached.

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 two (2) year intervals should be sufficient. In continuous use applications, lubrication should be performed on a yearly basis.

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

Lubrication Process

1. Remove the screws from the tuner cover and remove the cover.
2. Through the access hole in the carriage (see Figure 8), apply a small amount of lubricant to the point where the probe motor lead screw enters the probe drive block. The amount of lubricant to be applied should be a single drop of lubricant, approximately one millimeter (0.04 inches) in diameter. More oil than this could migrate into the waveguide portion of the tuner and degrade electrical performance.
3. Exercise the probe up and down from limit to limit to evenly distribute the lubricant.
4. Apply a small amount of lubricant to the carriage drive screw 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.

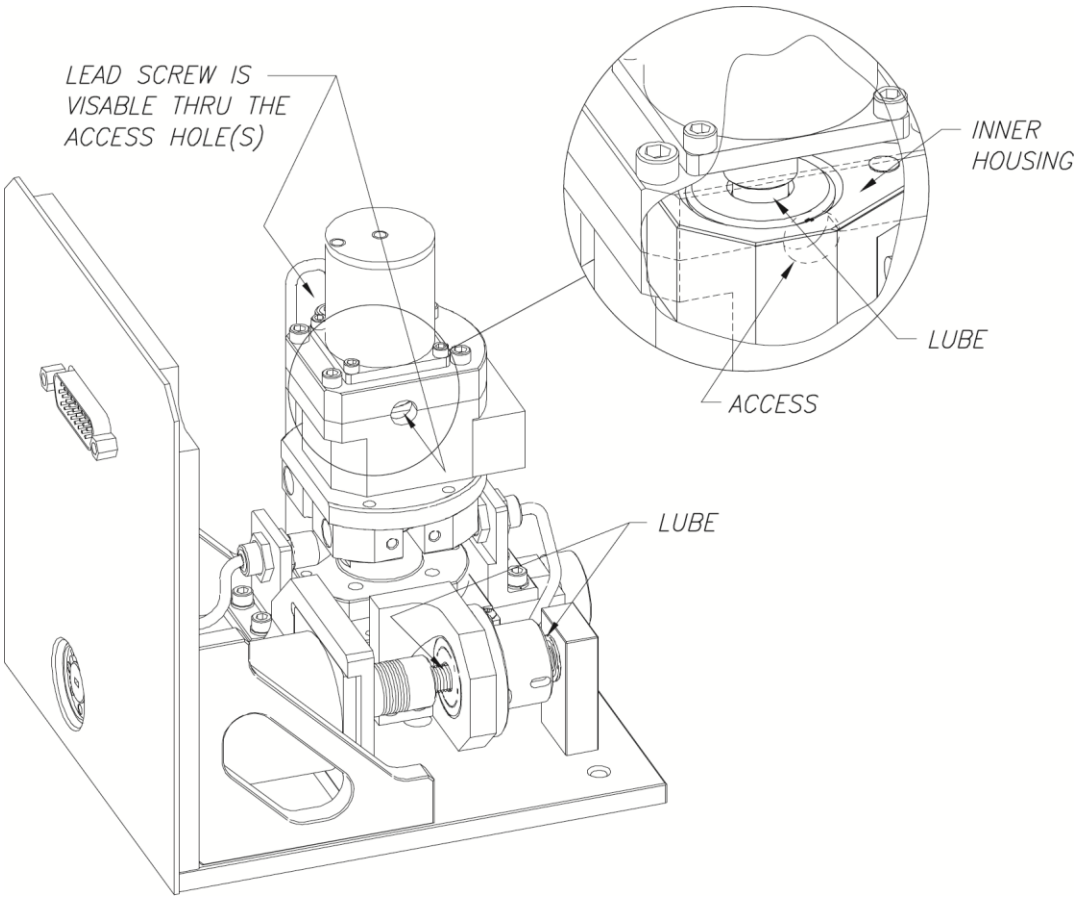

Figure 8. Lubrication Points

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 the tuner driver program based on the connection type.
- Select “Find Tuner” from the “Test” menu. Verify tuner model, serial number and IP address (or COM port). 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 initializations 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 the Probe to 2000 (approx. mid travel position).
- After the positions are set, click “OK” and the tuner should move to the shipping position.

Locking the carriage is no longer necessary

Figure A 1. Crating Unit

Data Sheet Resources

4T-050G05 – Millimeter-Wave Automated Tuners
https://www.maurymw.com/pdf/datasheets/4T-050G05.pdf

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