MAURY

RF Device Characterization Systems

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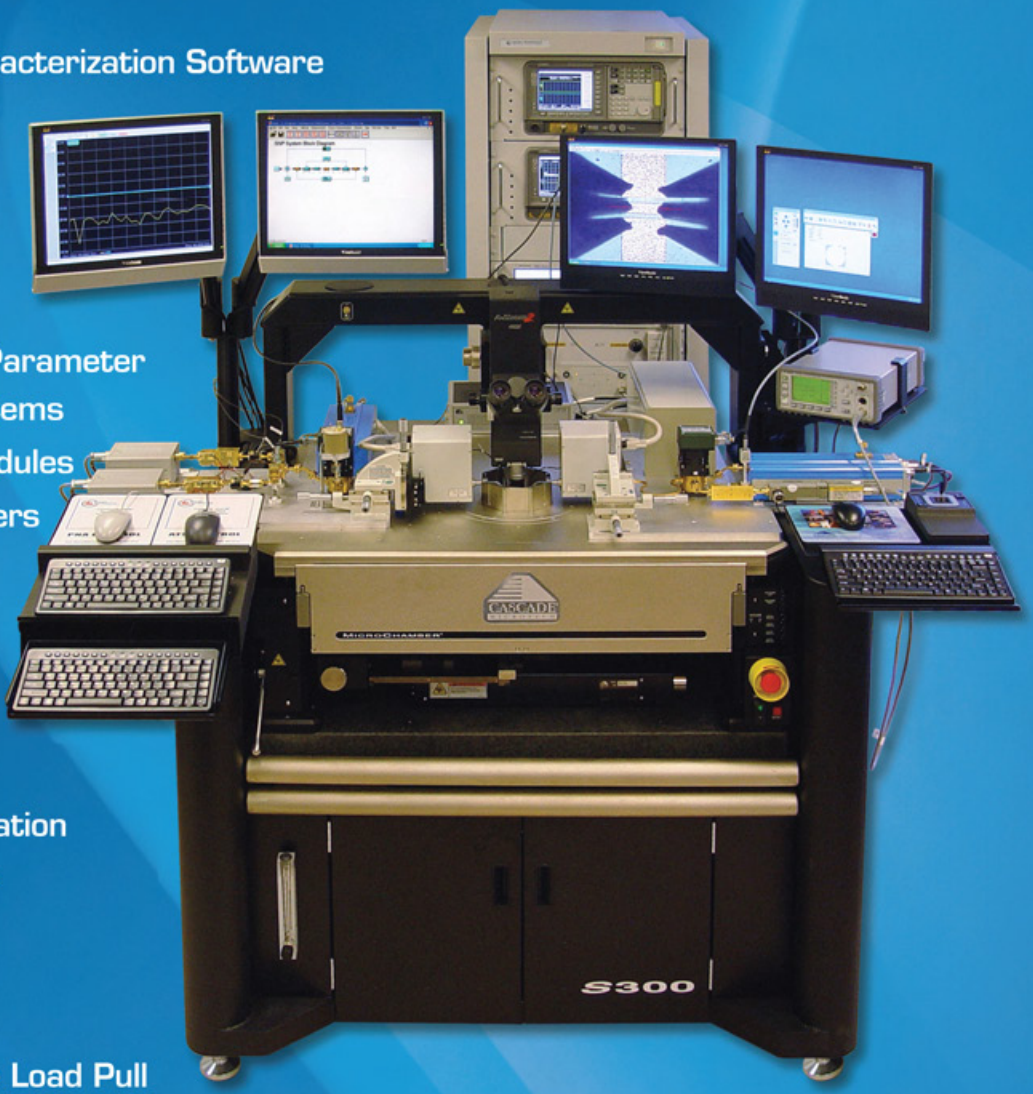

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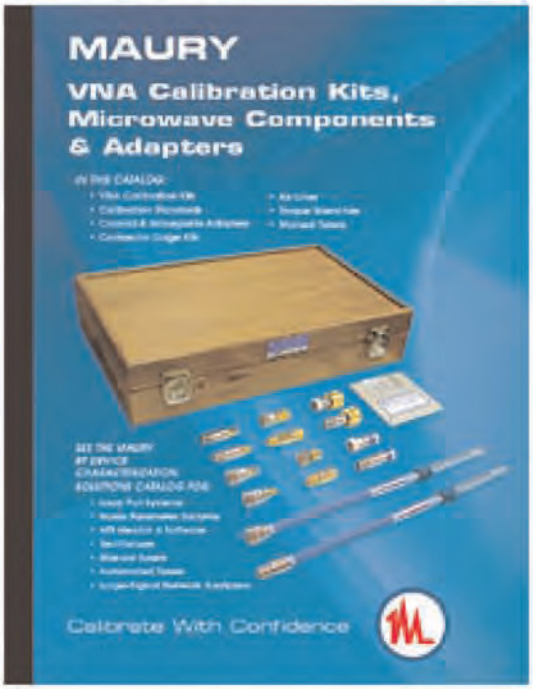

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Maury Device Characterization Systems

Maury Microwave Has the Most Complete Selection of Load Pull Solutions! We Are Your Complete Measurement & Modeling Solutions Partner!

In This Volume:

RF Device Characterization Methods

Accurate de-embedded performance evaluation of the power, intermodulation distortion, adjacent channel power, noise and network (S-parameter) characteristics of packaged or on-wafer devices under various conditions of impedance matching is the foundation of successful design, manufacture, and use of RF and microwave devices. Maury device characterization systems support the best industry-recognized test and measurement methods.

Pitfalls To Avoid When Purchasing A Device Characterization System

An automated device characterization system can greatly simplify test and measurement operations and quickly provide reliable empirically-based data for design and modeling of new products. But finding the right system is not simple. There are mistakes to be avoided if you are to maximize return on investment, achieve your test and measurement goals, and get your products to market. Here is some valuable advice from the experts at Maury.

Device Characterization Software (IVCAD, ATSv5 and AMTSv2)

Maury IVCAD software is the newest and most advanced measurement and modeling software in the market. It supports multiple load pull techniques, performs noise parameter, DC-IV and pulsed-IV measurements, and incorporates sophisticated device modeling tools. Maury's ATS software (ATSv5) includes a comprehensive set of upgrades, improvements, and additions to the classic ATS test and measurement tools.
Maury's Automated Mobile Test System software (AMTSv2) is designed specifically to automate the testing of mobile phones in transmit and receive modes, for output power and sensitivity. It now includes support for GSM, WCDMA and CDMA2000.

Load Pull and Noise Parameter Systems

Maury offers fully integrated, automated tuner-based systems configured to operate from 0.25 to110 GHz. These complete turnkey systems can be customized to support Basic (power, gain and PAE) and Advanced Load Pull characterization (modulation, optimal ACPR, CDP, and Harmonic LP). Maury Noise Parameter systems are available in electromechanical and solid state versions that can be customized to perform on-wafer or in-fixture noise parameter characterization at frequencies from 0.25 to 110 GHz.

Automated Tuners, Controllers And Hubs

Maury USB-controlled automated tuners and hubs are described in detail, with their respective specifications and applications.

Accessories

Maury offers a number of accessories to support your test bench needs, including automated tuner controllers, noise receiver modules, diplexers and triplexers, pre-matching probe mounts, manual tuners, and automated sliding shorts.

Advanced Device Characterization Systems

Maury now offers Mixed-Signal Active Load Pull systems, and the AMCAD Engineering PIV/PLP family of Pulsed IV systems.

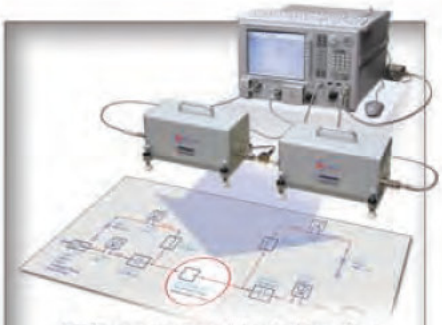
You Have Load Pull Needs – We Have You Covered!

Maury Microwave Has the Most Complete Selection of Load Pull Solutions

MAURY's Mixed-Signal Active Load Pull Allows Wideband Modulated Impedance Control for Base Station PAs

Active and Hybrid Load Pull Using PNA-X Simplifies Harmonic Tuning with Gamma = 1

Pulsed-Bias Pulsed-RF Harmonic Load Pull for GaN and Wide Band-Gap Devices



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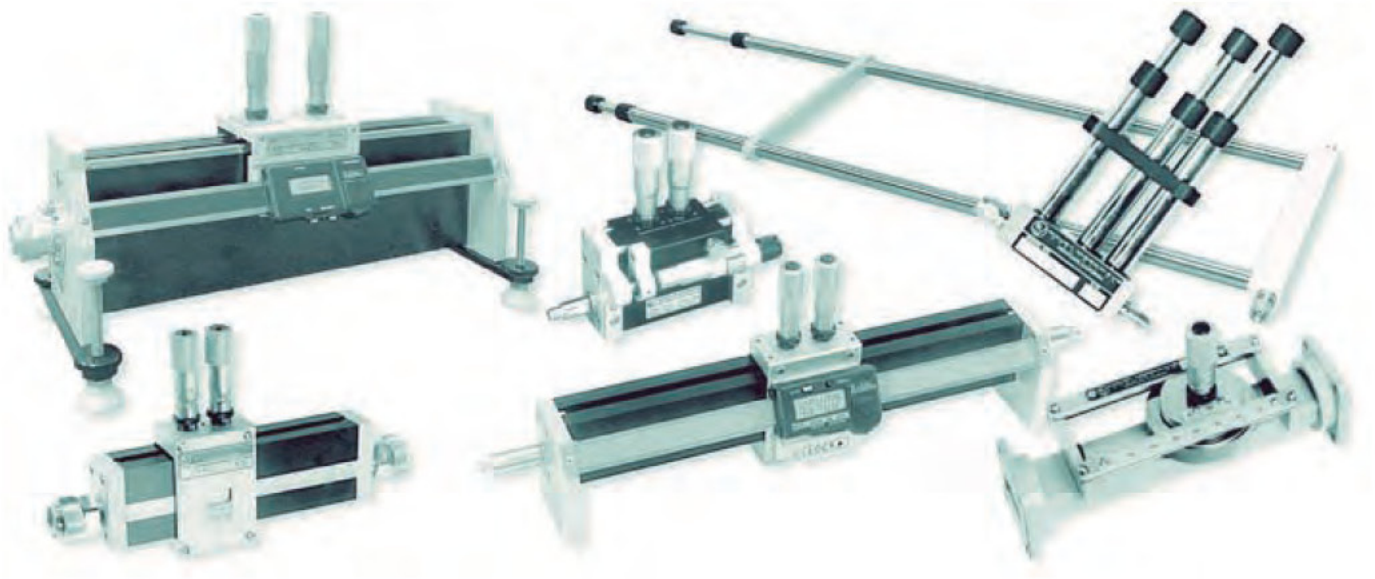
SOLID-STATE ELECTRONIC TUNER SYSTEMS

AMCAD ENGINEERING PULSED IV SYSTEMS

Manual Tuners



General Information

Manual tuners are used both in the laboratory and as system components to either establish or transform impedances for a number of applications. They can be used to establish optimum source or load terminations for device characterization, normalize a source or load for precision laboratory measurements or calibrations (noise, power, etc.), and can act as a matching transformer between a mismatched source and a mismatched load. Maury produces several types of coaxial manual tuners in two categories; slide screw tuners and stub tuners. Waveguide slide screw tuners are available in standard matching ranges only.

Coaxial Stub Tuners – Maury stub tuners are basic laboratory tools used for matching load impedances to provide for maximum power transfer between a generator and a load, and for introducing a mismatch into an otherwise matched system. Typical applications include power and attenuation measurements, tuned reflectometer systems and providing a DC return for single-ended mixers and detectors. Maury stub tuners are available in double- and triple-stub configurations with frequency ranges extending from 0.2 to 18.0 GHz.

Coaxial Slide Screw Tuners – Maury coaxial slide screw tuners are particularly well suited for use in establishing impedances for device characterization, or for any other application requiring a precisely repeatable mismatch condition. Calibrated position indicators on these tuners make it possible to repeat a specific matching condition with a high degree of accuracy. Their design allows the reflection magnitude and phase to be set independently. Slide screw tuners are also easy to use due to the almost independent electrical results of the mechanical motions.

These tuners employ a slab-line transmission structure which defines their frequency range, with dual probes for enhanced matching characteristics. The probes are micrometer driven and work with a vernier readout of carriage position (except for the 3.5mm and 2.4mm units which have micrometer driven carriages). Position locks are provided on both the probe micrometers and the carriage mechanism. Units with sexed connectors have a female connector on one end and a male on the other.

The inter-stub spacing determines the range of impedances that can be matched and the ease of tuning. Triple-stub tuners are more convenient to use since tuning sensitivity is relatively independent of stub spacing.

Waveguide Slide Screw Tuners – Maury also offers manual tuners designed with slotted waveguide sections and movable carriages supporting micrometer driven probes that extend down into the waveguide. They are valuable tools for optimizing a mismatched load and/or source for maximum power transfer, or for establishing a specific source or load termination condition for device characterization.

They differ from coaxial slide screw tuners in that reflection phase is set by the position of a single probe along the waveguide, instead of the dual probes and slab line/center conductor assembly of coaxial models. Magnitude is still set by the probe penetration depth, which can be controlled to 0.001-inch resolution and can be locked down to prevent movement after adjustment. The carriage is held in constant tension to provide smooth movement and to eliminate the need for a position lock.

Key Literature: Maury data sheet 2G-008, 2G-030, 2G-035, 2G-035A, 2G-035B, 2G-035C and 3A-353.

Coaxial Stub Tuners

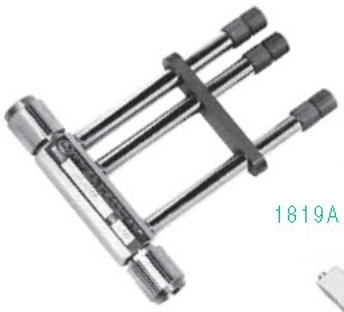
Description

Maury stub tuners are basic laboratory tools used for matching load impedances to provide for maximum power transfer between a generator and a load, and for introducing a mismatch into an otherwise matched system. Typical applications include power and attenuation measurements, tuned reflectometer systems and providing a DC return for single-ended mixers and detectors. Maury stub tuners are available in double- and triple-stub configurations with frequency ranges extending from 0.2 to 18.0 GHz.

Stub tuners work as impedance transformers to introduce a variable shunt susceptance into a coaxial transmission line. They consist of one or more short-circuited, variable length lines (stubs) connected at right angles to the primary transmission line. To provide all possible shunt susceptances, each stub must be movable over 1/2 wavelength at the lowest frequency of operation; therefore, the lower frequency limit of a tuner is determined by the frequency at which the maximum stub travel equals 1/2 wavelength. The upper frequency limit for a stub tuner is established by its connectors.

The inter-stub spacing of multiple-stub tuners determines the range of impedances that can be matched and the ease of tuning. Triple-stub tuners are more convenient to use since tuning sensitivity is relatively independent of stub spacing.

2612C2



1819A

1719A

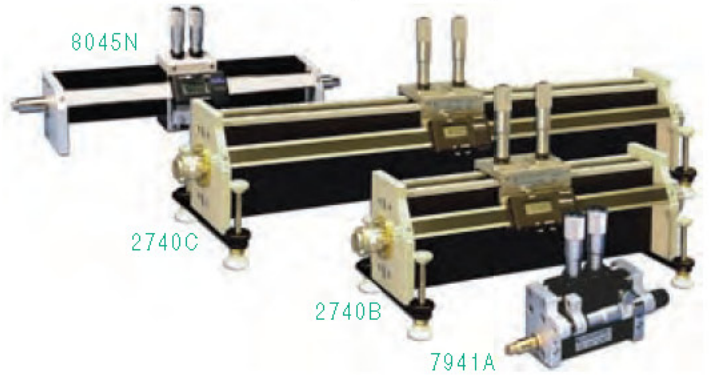
Available Models

Stub Configuration	Frequency Range (GHz)	Model (By Connector Type)			Stub Travel		Stub Spacing	
		Type N	7mm	SMA	Inches	(CM)	Inches	(CM)
Double-Stub	0.2 — 0.5	1778G	2612B7	—	30.00	(76.2)	4.60	(11.7)
	0.4 — 1.0	1778A	2612B1	1719A	15.00	(38.1)	4.60	(11.7)
	0.8 — 4.0	1778B	2612B2	1719B	7.50	(19.1)	2.00	(5.1)
	2.0 — 12.0	1778C	2612B3	1719C	3.00	(7.6)	0.75	(1.9)
	2.0 — 18.0	1778E	—	—	3.00	(7.6)	0.50	(1.3)
	4.0 — 18.0	1778D	2612B4	1719D	1.75	(4.4)	0.50	(1.3)
Triple-Stub	0.2 — 0.5	1878G	2612C7	—	30.00	(76.2)	4.60 (11.7) / 2.00	(5.1)
	0.4 — 1.0	1878A	2612C1	1819A	15.00	(38.1)	4.60 (11.7) / 2.00	(5.1)
	0.8 — 4.0	1878B	2612C2	1819B	7.50	(19.1)	1.00 (2.5) / 0.75	(1.9)
	2.0 — 18.0	1878C	2612C3	1819C	3.00	(7.6)	0.75 (1.9) / 0.50	(1.3)
	4.0 — 18.0	1878D	2612C4	1819D	1.75	(4.4)	0.75 (1.9) / 0.50	(1.3)

Coaxial Slide Screw Tuners – Wide Matching Range

Features

- *Slab-line Transmission Structure*
- *Dual Probes for Improved Matching*
- *LCD Readout for Carriage Position*



Description

Maury wide matching range slide screw tuners feature a slab-line transmission structure with dual micrometer-driven probes that provide precise control of the mismatch magnitude. Models operating up to 18 GHz are equipped with a digital LCD readout to indicate carriage position (phase). Higher frequency models are equipped with a micrometer driven carriage mechanism which is also employed in the standard matching range models (see page 52).

The positional repeatability and high matching range of these tuners make them ideally suited for use in device characterization applications where there is a critical need to establish impedances near the outer edge of the Smith chart and to reproduce electrical characteristics as a function of mechanical position. They are designed to 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 models listed below are optimized for operation over wider matching ranges than the standard matching range models.

Available Models

Model	Frequency Range (GHz)	Connector Type	VSWR Matching Range	Maximum Loss (Probes Retracted)	Probe Crossover Frequency	Power Handling [1] (Ave/Peak Watts)	Dimension "A"		Dimension "B"	
							Inches	(CM)	Inches	(CM)
7941A	12.0 — 50.0	2.4mm [2]	10:1	1.0 dB	21.5 GHz	15/150	0.417	(1.059)	4.62	(11.735)
8041C	12.0 — 34.0	3.5mm [3]	10:1	0.7 dB	16.0 GHz	15/150	0.417	(1.059)	4.95	(12.573)
8045D1	1.8 — 18.0	3.5mm [3]	12:1	0.4 dB	5.5 GHz	25/250	3.4	(8.636)	8.94	(22.708)
2640D1		7mm [4]				50/500	3.4	(8.636)	8.88	(22.555)
1643D1		Type N [5]				50/500	3.4	(8.636)	8.92	(22.657)
8045P	0.8 — 18.0	3.5mm [3]	10:1	0.6 dB	4.6 GHz	25/250	7.8	(19.812)	13.34	(33.884)
2640P		7mm [4]				50/500	7.8	(19.812)	13.28	(33.731)
1643P		Type N [5]				50/500	7.8	(19.812)	13.32	(33.833)
1643N	0.8 — 2.5 2.5 — 8.0	Type N [5]	25:1 18:1	0.5 dB	2.8 GHz	50/500	7.8	(19.812)	13.32	(33.833)
2640N	0.8 — 2.5 2.5 — 8.0	7mm [4]	25:1 18:1	0.5 dB	2.8 GHz	50/500	7.8	(19.812)	13.28	(33.731)
8045N	0.8 — 2.5 2.5 — 8.0	3.5mm [3]	25:1 18:1	0.5 dB	2.8 GHz	25/250	7.8	(19.812)	13.28	(33.731)
2740B	0.8 — 8.0	7-16 [6]	35:1	0.1 dB	2.8 GHz	200/2000	7.88	(20.015)	14.48	(36.779)
2440B		14mm [7]					7.88	(20.015)	13.07	(33.198)
2740C	0.4 — 4.0	7-16 [6]	25:1	0.1 dB	1.4 GHz	200/2000	14.95	(37.973)	22.76	(57.810)
2440C		14mm [7]					14.95	(37.973)	21.35	(54.229)

[1] Within rated matching range.

[2] Precision 2.4mm per Maury data sheet 5E-064.

[3] Precision 3.5mm per Maury data sheet 5E-062.

[4] Precision 7mm per Maury data sheet 5E-060.

[5] Precision type N per Maury data sheet 5E-049.

[6] Precision 7-16 per Maury data sheet 5E-066.

[7] Precision 14mm (GR900) per Maury data sheet 5E-068.

Coaxial Slide Screw Tuners – Wide Matching Range

Functional Description

The dual probe structure in Maury coaxial slide screw tuners is designed so that one probe (the low frequency probe) covers the range from the lowest frequency to the crossover frequency listed in the Available Models table on page 50. The second probe (the high frequency probe) covers the range from the crossover frequency to the tuner's maximum rated frequency. The optimum crossover frequency varies from tuner to tuner.

As each micrometer-driven probe is introduced into the slabline transmission structure it induces a mismatch in its frequency range. The magnitude of this impedance mismatch is determined by the probe position (depth); the closer the probe approaches the center conductor, the greater the magnitude. The phase of the impedance mismatch is determined by the carriage position. The probes operate independently of each other with little or no interaction. Each probe will meet its specifications over its rated frequency range, and typically has considerably higher matching capability in the middle of its band. Figure 1 shows responses that are typical of those seen in a low frequency /high frequency pair of probes.

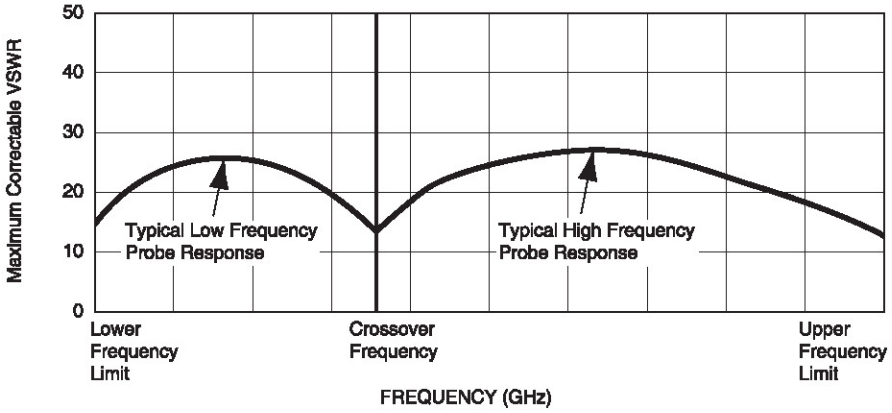
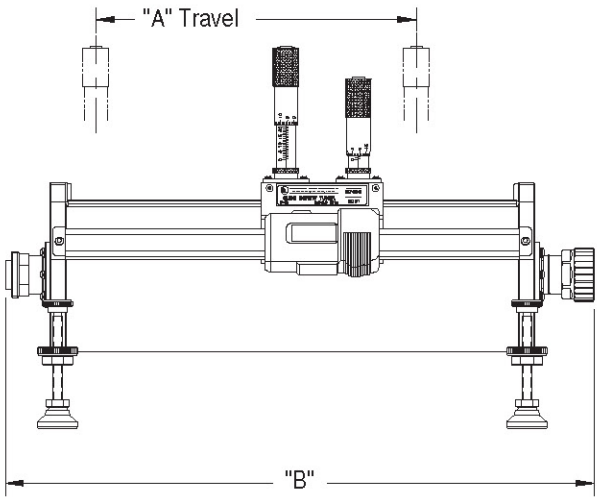
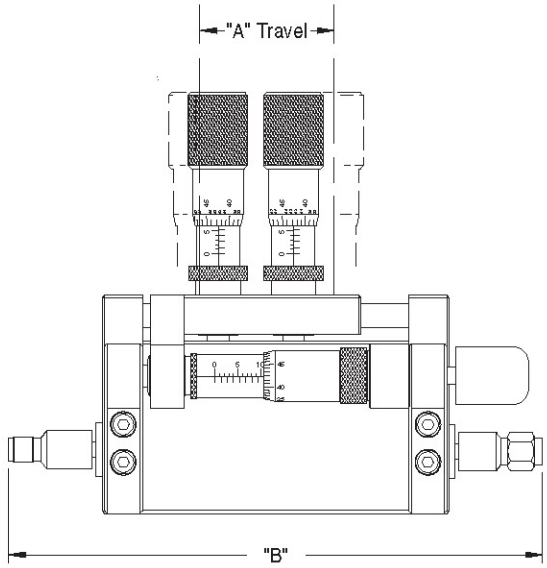


Figure 1. Typical responses seen in low frequency and high frequency probes as they are used in Maury coaxial slide screw tuners.

Typical Dimensions



Models with LCD readouts for carriage position



Models with micrometer-driven carriage blocks

Figure 2. Typical dimensions for Maury coaxial slide screw tuners. See the Available Models table on page 138 for model-specific dimensions at the "A" and "B" references.

Coaxial Slide Screw Tuners – Standard Matching Range

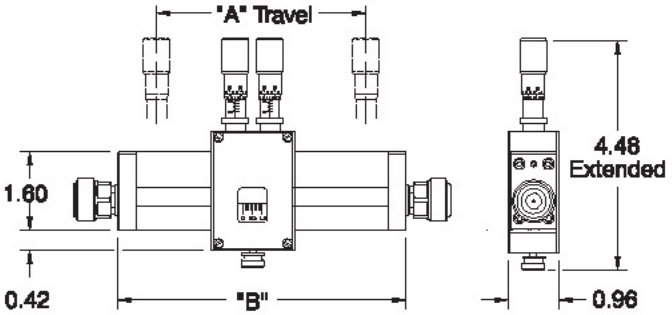
Description

Maury slide screw tuners are particularly well suited for use in establishing impedances for device characterization, or for any other application requiring a precisely repeatable mismatch condition The calibrated position indicators on these tuners make it possible to repeat a specific matching condition with a high degree of accuracy. These tuners are also designed to allow the reflection magnitude and phase to be set independently. Slide screw tuners are also easy to use due to the almost independent electrical results of the mechanical motions.

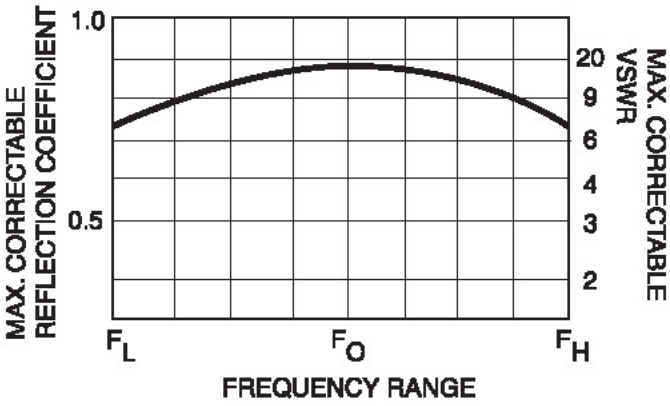
Maury produces two categories of coaxial slide screw tuners; standard matching range (minimum 6:1 equivalent VSWR) and wide matching range (up to 25:1 nominal VSWR). Both types employ a slab-line transmission structure which defines their frequency range, with probes designed to be very close to 1/4λ in the linear dimension at the mid-band of each range. Each tuner has two probes for enhanced matching characteristics. Units with sexed connectors have a female connector on one end and a male on the other.

Maury standard matching range tuners are provided with micrometer driven probes and vernier readout of carriage position (except for the 3.5mm units which have micrometer driven carriages). Position locks are provided on both the probe micrometers and the carriage mechanism.

Typical Dimensions



Typical Performance



Available Models

Model	Frequency Range (GHz)	Connector Type	VSWR Matching Range	Maximum Loss (Probes Retracted)	Probe Crossover Frequency	Power Handling [1] (Ave/Peak Watts)	Dimension "A"		Dimension "B"	
							Inches	(CM)	Inches	(CM)
8041B	12.0 — 26.5	3.5mm [2]	≥ 10:1	0.7 dB	16.0 GHz	25/250	0.52	(1.321)	2.90	(7.400)
8045D	1.8 — 18.0	3.5mm [2]	≥ 6:1	0.4 dB	5.5 GHz	25/250	3.40	(8.636)	7.50	(19.100)
2640D		7mm [3]				50/500				
1643D		Type N [4]				50/500				
8045C	0.9 — 12.4	3.5mm [2]	≥ 6:1	0.6 dB	4.6 GHz	25/250	7.80	(19.812)	10.50	(26.700)
2640C		7mm [3]				50/500				
1643C		Type N 4				50/500				

[1] Within rated matching range.

[2] Precision 3.5mm per Maury data sheet 5E-062.

[3] Precision 7mm per Maury data sheet 5E-060.

[4] Precision type N per Maury data sheet 5E-049.

Waveguide Slide Screw Tuners – Standard Matching Range

Features

- *Slotted Waveguide Transmission Structure*
- *Single Micrometer-Driven Probe*
- *Can Be Locked Down To Prevent Movement After Adjustment*

J353A

Description

Maury offers manual tuners that feature slotted waveguide sections and movable carriages supporting micrometer driven probes that extend down into the waveguide. They are valuable tools for optimizing a mismatched load and/or source for maximum power transfer, or for establishing a specific source or lad termination condition for device characterization.

They differ from coaxial slide screw tuners in that the reflection phase is set by the position of a single probe along the waveguide, instead of dual probes and slabline/center conductor assembly of coaxial models.

As is the case with the coaxial slide screw tuners, in these waveguide models magnitude is set by the probe penetration depth, which is controllable to 0.001-inch resolution and can be locked down to prevent movement after adjustment. The carriage is held in constant tension to provide smooth movement and to eliminate the need for a position lock.

Available Models

Frequency Range (GHz)	Matching Range (Correctable to <1,02)	Model	EIA WR Number	Equivalent Flange	Overall Body Length Inches	(CM)
8.2 — 12.4	VSWR ≤ 20:1	X353	90	UG39/U	6.00	(15.2)
12.5 — 18.0	VSWR ≤ 20:1	P353	62	UG419/U	6.00	(15.2)
18.0 — 26.5	VSWR ≤ 20:1	K353	42	UG595/U	4.38	(11.1)
26.5 — 40.0	VSWR ≤ 20:1	U353	28	UG599/U	4.38	(11.1)
33.0 — 50.0	VSWR ≤ 20:1	J353A	22	UG383/U	4.75	(12.1)

Key Literature: Maury data sheet and 3A-353.