

Noise Calibration Systems and Accessories

DATA SHEET / 4N-062



Noise Calibration Systems and Components



MT7095J99
WR42 18–26.5 GHz
Noise Calibration System

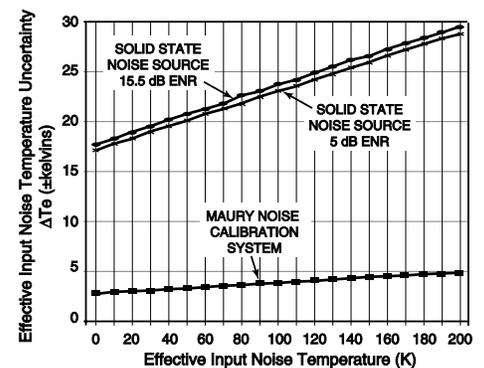
Introduction

The Maury Noise Calibration Systems (NCS) are self-contained, highly accurate sources of RF and microwave noise power. These systems are used wherever noise source accuracy is critical. Examples are: receiver noise measurements such as noise figure and effective input noise temperature; calibration of solid state noise sources; evaluation and verification of earth station receivers; and as radiometer reference sources.

Each NCS consists of one (hot or cold), two (hot and cold) or three (hot/ambient/cold) thermal noise sources whose outputs can be conveniently switched into a single calibrated output port. This capability makes for a unique combination of accuracy and convenience. The incorporation of the output switch makes the operation of the NCS in a noise performance measurement as convenient as a solid state noise generator – without the accuracy penalty associated with the latter. The plot shown at right illustrates the improvement in accuracy that can be gained by the use of an NCS in a typical measurement application (effective input noise temperature).

The cold noise source is a liquid nitrogen (LN2) cooled termination. A liquid nitrogen level sensor and an automatic fill system maintains the proper nitrogen level. The user must provide a suitable liquid nitrogen reservoir. The cold termination is also pressurized with helium at 2 psi. Pressure is maintained by a regulator that requires 20 psi maximum from an external user-supplied source. Since most helium bottles are pressurized to about 1,000 psi or more, the MT152C pressurizing system is included.

The hot noise source is a heated termination whose temperature is maintained by proportional control to better than $\pm 0.2\text{K}$ by the MT155J controller. Actual temperature is indicated by a digital readout on the controller front panel.



Noise Calibration Systems and Components

(CONTINUED)

Typical NCS Models

The table below shows a some of the more popular NCS available from Maury. Each model is a complete system made up of the appropriate terminations assembled on a mounting plate, the MT155J controller and the interconnecting cable. All dual-load systems shown consist of cold (LN2) and heated terminations. The tri-load system (MT7208J99) includes an ambient termination as well. Please consult our Sales Department if you do not see a noise calibration system in this table suitable for your application or if you would like more detailed information on any of these systems.

Frequency Range	Transmission Line	Connector or Flange	Cryogenic	Thermal	Dual-Load	Tri-Load
DC — 18.0	Coaxial	7mm	MT7118J99	MT7108J99	MT7098J99	MT7208J99
3.3 — 4.9	WR229	MPF229B	N/A	MT7005J99	N/A	N/A
7.05 — 10.0	WR112	UG51/U	MT7040J99	N/A	N/A	N/A
8.2 — 12.4	WR90	MPF90	MT7041J99	MT7081J99	MT7091J99	N/A
10.0 — 15.0	WR75	MPF75B	MT7042J99	MT7082J99	MT7093J99	N/A
12.4 — 18.0	WR62	UG419/U	MT7043J99	N/A	N/A	N/A
15.0 — 22.0	WR51	MPF51B	MT7044J99	MT7009J99	MT7094J99	N/A
18.0 — 26.5	WR42	UG595/U	MT7021J99	MT7084J99	MT7095J99	N/A
26.5 — 40.0	WR28	UG599/U	MT7022J99	MT7085J99	MT7096J99	N/A
33.0 — 50.0	WR22	UG383/U	MT7023J99	MT7086J99	MT7097J99	N/A
50.0 — 75.0	WR15	UG385/U	MT7025J99	MT7088J99	MT7100J99	N/A
60.0 — 90.0	WR12	UG385/U	MT7026J99	MT7089J99	MT7101J99	N/A
75.0 — 110.0	WR10	UG385/U	MT7027J99	MT7090J99	MT7149J99	N/A

Cryogenic Noise Terminations (Cold Loads)



MT7025J99 with Power Supply and Foam-lined Wood Carrying Case.

Introduction

Maury cryogenic terminations are liquid nitrogen cooled loads which provide accurately known noise power at a well matched output port. Used with ambient and/or thermal terminations and a noise figure meter, these terminations provide cold reference temperatures needed for highly accurate noise figure or effective input noise temperature measurements. Because of the accuracy of their noise output, cryogenic terminations are often used as a noise standard for calibration of solid state noise generators.

The accuracy achieved by these terminations is possible because they utilize the known temperature of

boiling liquid nitrogen as a constant for calculating noise temperature. Because of this, measurements made with these terminations are traceable to the fundamental quantity, temperature and NIST via temperature and network calibration standards. Each unit is provided with a swept data calibration report which includes VSWR and available output noise temperature data at standard frequencies. See Maury data sheet 4E-020, which provides specifics for the MT7250 series Noise Calibration Swept Data Module, a software tool that allows users to work with non-standard data points in addition to, or in place of the factory standards.

The cryogenic terminations require user-provided liquid nitrogen and dry helium gas at 2 psi. Maury's MT152C pressurization system is available as an optional accessory to regulate the helium pressure (see page 2). The terminations include a heater circuit to prevent frosting on the output connector and to prevent the heat load of the device under test from affecting the output noise temperature.

MT7118J99 7mm Coaxial Cryogenic Terminations

DC TO 18.0 GHZ

Features

- > Accurate Noise Temperature at Specified Calibration Frequencies
- > Low VSWR Across the Full Frequency Range
- > Liquid Nitrogen Cooled
- > Metrology Grade Calibration for Solid State Noise Generators
- > Low Noise Figure/Temperature Measurements



Description

The MT7118J99 cryogenic termination is a liquid nitrogen cooled noise source that provides accurately known noise temperatures at specified calibration frequencies and low VSWR over the full frequency range. It is used for performing accurate noise temperature measurements in 7mm applications such as certification of the noise performance of low noise earth stations. It is also used for general purpose, low noise figure/temperature measurements and calibration of solid state noise generators.

The MT7118J99 comes with a linear power supply that operates on line voltages of 120 VAC/60 Hz or 240 VAC/50 Hz, while supplying 48 VDC to the device power input.

The MT7118J99 can be packaged with an extensive complement of options and accessories, including calibrated adapters to other coaxial connector series and waveguide, and user specified calibration frequencies. Our sales staff will be happy to assist in tailoring the best package for your application.

The MT7118J99 can be optimized for VSWR and input noise temperature over other bandwidths. For calibration frequencies see Maury data sheet 4E-020, which covers the maury MT7250 series Noise Calibration Swept Data Module; a software tool that works with Microsoft® Excel® 2003 (or later) to provide an Effective Noise Temperature Interpolator. Please contact our Sales Department for additional information.

Maury also produces an extensive line of precision hot, cold and ambient terminations in both coaxial and waveguide configurations. Our sales staff is ready to assist you in ordering the right noise calibration solution for your applications.

Pressurizing System

Maury cryogenic terminations require helium gas pressurization at 2 psi. The optional MT152C pressurizing system (see page 6) provides the valves, gages, and hardware necessary to connect an external helium gas supply to Maury cryogenic terminations (helium gas supply is not provided).

Specifications

Frequency Range // DC to 18.0 GHz
Maximum VSWR: //
1.06, DC to 4.0 GHz
1.10, 4.0 to 12.0 GHz
1.15, 12.0 to 18.0 GHz
Operating Temperature (Load) //
77.36°K (liquid N cooled)

Calibration Frequencies & Noise Temperature

Uncertainty // ± 1.5 K
Connector // 7mm
Operating Orientation // Horizontal
Operating Life // 1 hour minimum (one fill)
Dewar Capacity // 1 liter
Weight // 7 lbs approximate (empty)
Pressurization //
2 psi helium gas (external supply)
AC Power //
100 to 240 VAC, 47 to 63 Hz
6.0 amps maximum
Accessories (provided) //
One (1) two meter power cord and a wooden instrument case

Note: For calibration frequencies, see the information on Maury's MT7250 series Noise Calibration Swept Data Module software (page 11), or consult our Sales Department.

Waveguide Cryogenic Terminations

MT70XX SERIES

Features

- > Accurate Noise Temperature at Specified Calibration Frequencies
- > Low VSWR Across the Full Frequency Range
- > Liquid Nitrogen Cooled
- > Metrology Grade Calibration for Solid State Noise Generators
- > Low Noise Figure/Temperature Measurements



Description

Maury offers waveguide cryogenic terminations in several styles and a wide range of waveguide sizes from WR430 through WR15. The table below represents a typical sample of the available terminations.

Waveguide terminations are calibrated within the waveguide band (using Maury MT7250 Noise Calibration Swept Data Module (see page 11)). Additional user-specified calibration frequencies are also available as an option.

In addition to liquid nitrogen, these terminations require pressurization with helium gas (not provided) at 2 psi. The MT152C pressurizing system (see page 11) is available to provide proper regulation of the helium supply.

The MT70xx series units come with a universal input power supply that operates on line voltages of 100–240 VAC and 47–63 Hz, while supplying 48 VDC to the device power input.

Available Model Series

Model	Frequency Range (GHz)	EIA Waveguide Size
MT7040J99	7.05 – 10.0	WR112 ¹
MT7041J99	8.2 – 12.4	WR90 ¹
MT7042J99	10.0 – 15.0	WR75
MT7043J99	12.4 – 18.0	WR62 ¹
MT7044J99	15.0 – 22.0	WR51 ¹
MT7021J99	18.0 – 26.5	WR42 ¹
MT7022J99	26.5 – 40.0	WR28 ¹
MT7023J99	33.0 – 50.0	WR22 ¹
MT7025J99	50.0 – 75.0	WR15 ¹
MT7026J99	60.0 – 90.0	WR12 ¹
MT7027J99	75.0 – 110.0	WR10 ¹

Calibration Uncertainty

Frequency Range (GHz)	Calibration Uncertainty
< 18.0	±1.5 K
18.0 – 40.0	±1.5 K
40.0 – 50.0	±1.8 K
50.0 – 110.0	±2.6 K

¹ Flange mates with the applicable military (UG) flange.

Cryogenic Termination Accessories

MT152A/C Helium Pressurizing Systems

Maury cryogenic terminations must be supplied with helium gas at about 2 psi to purge contaminants (air, carbon dioxide, etc.) from the coaxial or waveguide transmission line (connecting the cooled termination to the output connector) before the dewar is filled with liquid nitrogen. For stand-alone cryogenic terminations, the MT152A regulates the helium supply by use of a two-stage pressure regulator preset to provide 2 to 3 psi output pressure and a safety pressure relief valve set to 4 psi.

These are included with an 8 foot hose and CGA-580 fittings for connecting your helium supply to the termination.

Maury dual-load and tri-load noise calibration systems are provided with the MT152C helium pressurizing system, a modified version of the MT152A, which serves the same purpose.



Thermal Noise Terminations (Hot Loads)



MT151C



MT7090J99

Introduction

Maury thermal terminations are low-mismatch, heated loads in a precisely controlled thermal environment which provide an accurately known noise power. Used with ambient and/or cryogenic terminations and a noise figure meter, these terminations provide the hot termination temperature needed for highly accurate noise figure or effective input noise temperature measurements. Because of the accuracy of the noise output, thermal terminations are often used as a noise standard for calibration of solid state noise generators.

The accuracy achieved by these terminations is possible because they utilize the proven concept of thermal

(Johnson) noise operating in a precision thermal environment provided by the MT151C temperature controller. (The MT151C is a highly stable, proportional temperature controller that is accurately calibrated against NIST-traceable temperature measuring equipment.) This is the same concept used in several national standards laboratories and NIST at the higher microwave frequencies.

The termination and the controller are matched during calibration; therefore, the two instruments must be purchased as a unit. In addition, a line voltage option must be specified. Each unit is provided with a calibration report which includes VSWR and available output noise temperature at specific frequencies.

Maury offers the MT7250 series Noise Calibration Swept Data Module as a tool that allows users to work with non-standard data points in addition to, or in place of the factory standards¹. Other accessories such as special instrument cases and calibrated adapters to other coaxial series or waveguide are also available.

¹ See Maury Data Sheet 4E-020. See also page 11.

Coaxial Thermal Termination

MT7108J99



MT151C

MT7108J99

Description

Maury offers a single thermal noise termination model (the MT7108J99), which is equipped with a precision 7mm coaxial output connector, and operates from DC to 18 GHz. This compact, reliable instrument is equally suited for both field measurements and laboratory use. It is generally used to make accurate low noise figure/temperature measurements and for calibration of solid state noise generators. The flexibility and versatility of the MT7108J99 are enhanced by an extensive selection of options and accessories. These include calibrated adapters to other coaxial connector series and waveguide flanges, and factory calibration specified frequencies. (Maury's MT7250 series Noise Calibration Swept Data Module is included as a tool that allows users to work with non-standard data points in addition to, or in place of the factory standards¹.)

¹ See Maury data sheet 4E-020 for details, and page 11 in this volume.

² Precision 7mm per Maury data sheet 5E-060.

The MT7108J99 comes with a MT151C controller, with which it is precisely matched during the initial factory calibration. For accurate performance, these units must be used together. The MT151C's internal proportional controller responds to sensors in physical proximity to the termination and directs the MT7108J99's heater circuit to maintain the physical temperature of the termination at 373.1 kelvins (100°C). Heavy insulation of the entire termination assembly minimizes the effects of the external environment. The MT151C's line voltage must be specified at the time of order. This ensures that the MT151C will be properly fused and shipped with the appropriate power cable (AC power option 22 for 100/120 VAC, 50/60 Hz, or option 32 for 220/240 VAC, 50/60 Hz).

A certified calibration report with traceability to NIST is provided with each unit.

Specifications

Frequency Range // DC to 18 GHz
Nominal Physical Load Temperature // 373.1 K
Load Temperature Stability // ± 0.2 K

VSWR (maximum):

DC to 4 GHz // 1.06
4 to 12 GHz // 1.10
12 to 18 GHz // 1.15

AC Power (User specifies one of two options):

Option 22 // 100/120 VAC, 50/60 Hz
Option 32 // 220/240 VAC, 50/60 Hz
Noise Temperature Uncertainty // ± 0.7 K
Connector // Precision 7mm²

Accessories Provided

- > One (1) MT151C controller
- > One (1) MT151P controller cable
- > One (1) Instrument case

Waveguide Thermal Terminations

MT70XX SERIES



MT151C

MT7090J99

Description

Maury offers waveguide thermal terminations in several styles and a wide range of waveguide sizes, from WR430 through WR10. The chart below represents a typical sample of the available terminations.

Waveguide terminations are calibrated at frequencies within the applicable frequency range. Maury's MT7250 series Noise Calibration Swept Data Module is included as a tool that allows users to work with non-standard data points in addition to, or in place of the factory standards¹. Please contact our Sales Department for more information.

The physical temperature of the waveguide terminations is 350 kelvins with a stability of ± 0.2 kelvins. These terminations are calibrated with a specific temperature controller, and the two instruments are provided as a unit. A line voltage option must be specified at the time of order.

Available Models

Model	Frequency Range (GHz)	EIA Waveguide Size
MT7005J99	3.3 – 4.9	WR229 ²
MT7081J99	8.2 – 12.4	WR90 ³
MT7082J99	10.0 – 15.0	WR75
MT7009J99	15.0 – 22.0	WR51 ³
MT7084J99	18.0 – 26.5	WR42 ³
MT7085J99	26.5 – 40.0	WR28 ³
MT7086J99	33.0 – 50.0	WR22 ³
MT7088J99	50.0 – 75.0	WR15 ³
MT7089J99	60.0 – 90.0	WR12 ³
MT7090J99	75.0 – 110.0	WR10 ³

¹ See Maury data sheet 4E-020 and page 11 in this volume.

² Flange mates with applicable CPR and CMR flanges.

³ Flange mates with the applicable military (UG) flange.

Calibration Uncertainty

Frequency Band (GHz)	Uncertainty (Kelvins)
< 18.0	± 0.70 K
18.0 – 40.0	± 0.60 K
40.0 – 50.0	± 0.65 K
50.0 – 110.0	± 1.00 K

Accessories Provided

- > One (1) MT151C controller
- > One (1) MT151P controller cable
- > One (1) Instrument case

Thermal Terminations – Options and Accessories



MT151C

Temperature Controller, MT151C

A temperature controller is provided with each thermal termination. The controller and the termination are calibrated together and are sold as a unit. A line voltage must be specified at the time of order:

- > Option 22 // 100/120 VAC
- > Option 32 // 220.240 VAC



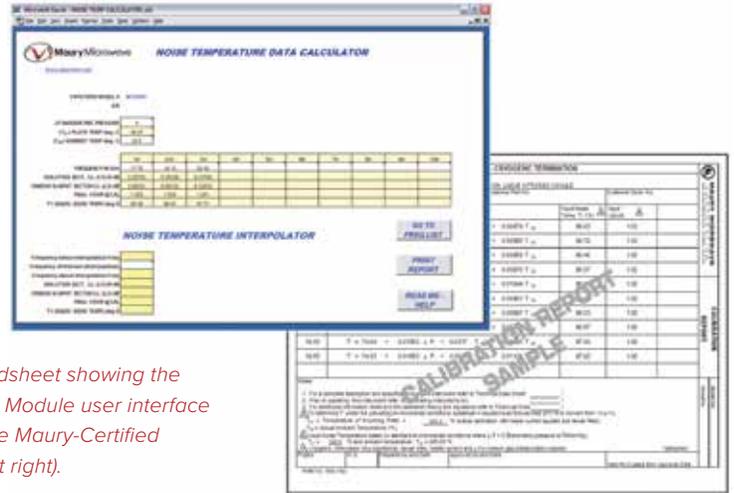
Instrument Case

Most Maury heated terminations are supplied in a foam-lined instrument case (like the one shown at below) for convenient handling and storage. Please contact our Sales Department for details.

A typical foam-lined Instrument case with one (1) model MT7090J99, one (1) calibrated MT151C Controller and one (1) Operating Manual.

Noise Calibration Swept Data Module

MT7250 SERIES



Typical Excel® spreadsheet showing the MT7250 Swept Data Module user interface (above) and a sample Maury-Certified Calibration Report (at right).

Features

- > Multiple Data Points
- > Effective Noise Temperature Calculator
- > Effective Noise Temperature Interpolator
- > Certified Calibration Report Generator
- > Standard and User-Defined Frequencies

Description

Maury cryogenic and thermal terminations, whether stand-alone models or components of Maury noise calibration systems, are calibrated for hot/cold noise temperatures at their output connectors for a number of frequencies. Waveguide units are typically calibrated at specific

standard frequencies or data points at the band edges and the arithmetic center frequency of the waveguide. Coaxial units are calibrated within the frequency range the connector type is rated for. Maury offers the MT7250 series Noise Calibration Swept Data Module as a tool that allows users to work with other, non-standard, data points in addition to, or in place of, the factory standards.

The MT7250 series Swept Data Module Software works with Microsoft® Excel® 2003¹ (or later) to give users the ability to generate standardized, or customized, Maury-certified calibration reports for any Maury cryogenic termination, thermal termination or noise calibration system. The data module can be supplied with a new unit at time of purchase, or with a re-certified unit.

¹ Not provided.

The Effective Noise Temperature Calculator

The Effective Noise Temperature Calculator uses measured loss and actual temperature data to produce Maury-certified calibration reports. These reports are based on a) pre-measured data points (as shown in the table on the page 11), or b) a user-defined or customized set of measured data points, or c) a combination of both.

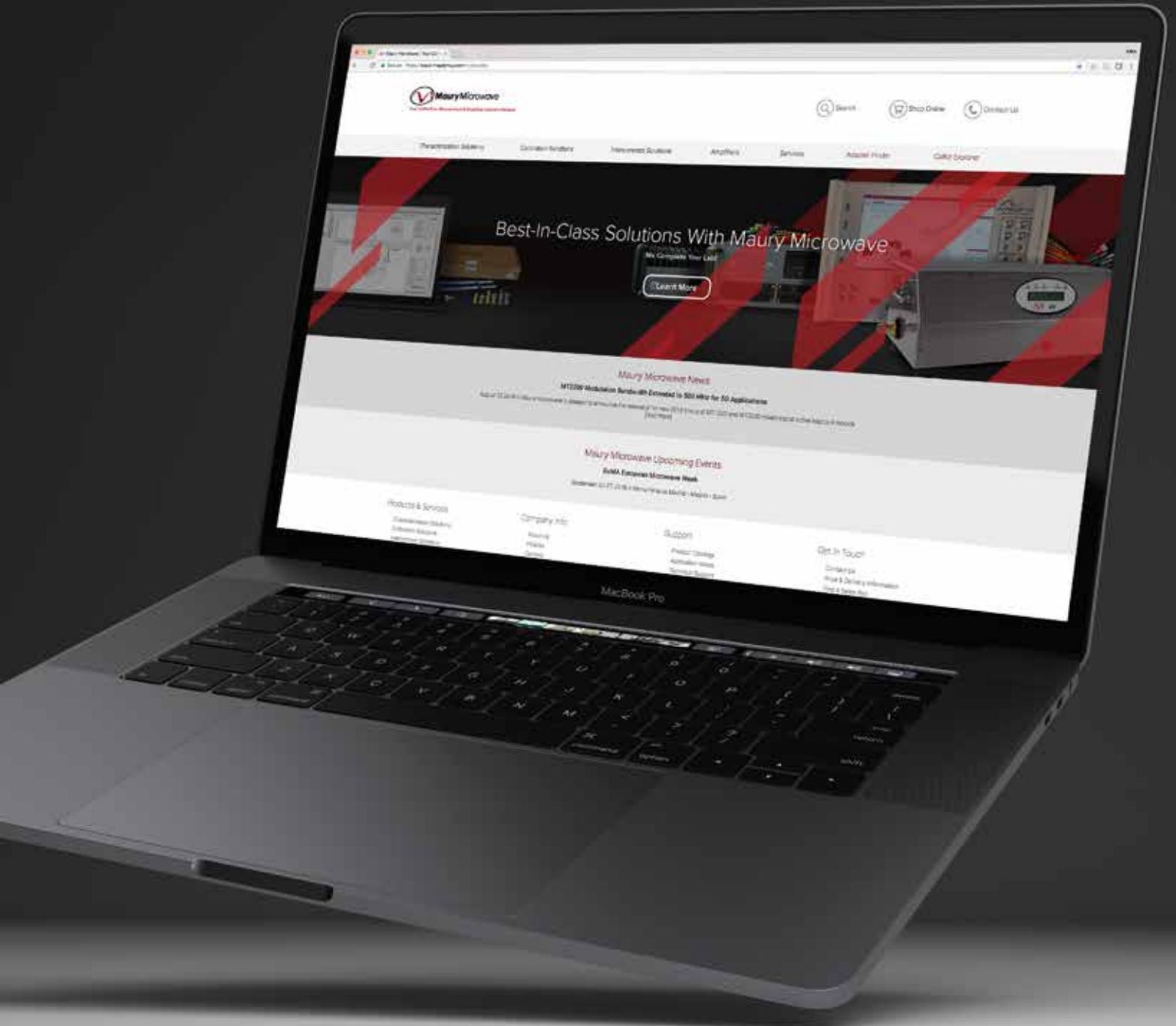
The Effective Noise Temperature Interpolator

For use as a reference tool, the built-in Effective Noise Temperature Interpolator can be used to generate noise temperatures for non-measured data points within the data band of interest.

Standard Pre-Measured Data Points

Waveguide or Line	Frequency Band (GHz)	Step Size
7mm	0.2 – 18.0	0.20
WR229	3.3 – 4.9	0.01
WR112	7.05 – 10.0	0.05
WR90	8.2 – 12.4	0.05
WR75	10.0 – 15.0	0.10
WR62	12.4 – 18.0	0.10
WR51	15.0 – 22.0	0.10
WR42	18.0 – 26.5	0.10
WR28	26.5 – 40.0	0.25
WR22	33.0 – 50.0	0.25
WR15	50.0 – 75.0	0.50
WR12	60.0 – 90.0	0.50
WR10	75.0 – 110.0	0.50

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