

# COPPER MOUNTAIN TECHNOLOGIES UNIVERSITY KIT

## University Kit Includes:



- Vector Network Analyzer
- Mechanical Calibration Kit
- Filter/Diplexer
- Antenna
- Cables
- Adapters
- Torque Wrenches

- **Complete S-parameters measurement solution** that backs RF theory with a robust **hands-on VNA experience**.
- Exclusively offered to **educational institutions teaching RF**.
- Practical approach to a variety of measurements that will prepare students for a **wide range of industry engineering jobs**.
- CMT can assist with **creating labs** designed by applications engineers to walk students through common VNA measurements.
- **Software is free** to download on an unlimited number of PCs.
- Students can **perform measurement preparations and post-process results** on their own computers without the measurement module.

Like every CMT solution, the University Kit is backed with **comprehensive and responsive support from our expert engineers**.

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# The Whole Solution

## CMT304U



2-port  
1 MHz - 3.2 GHz

## CMT804U



2-port  
1 MHz - 8 GHz

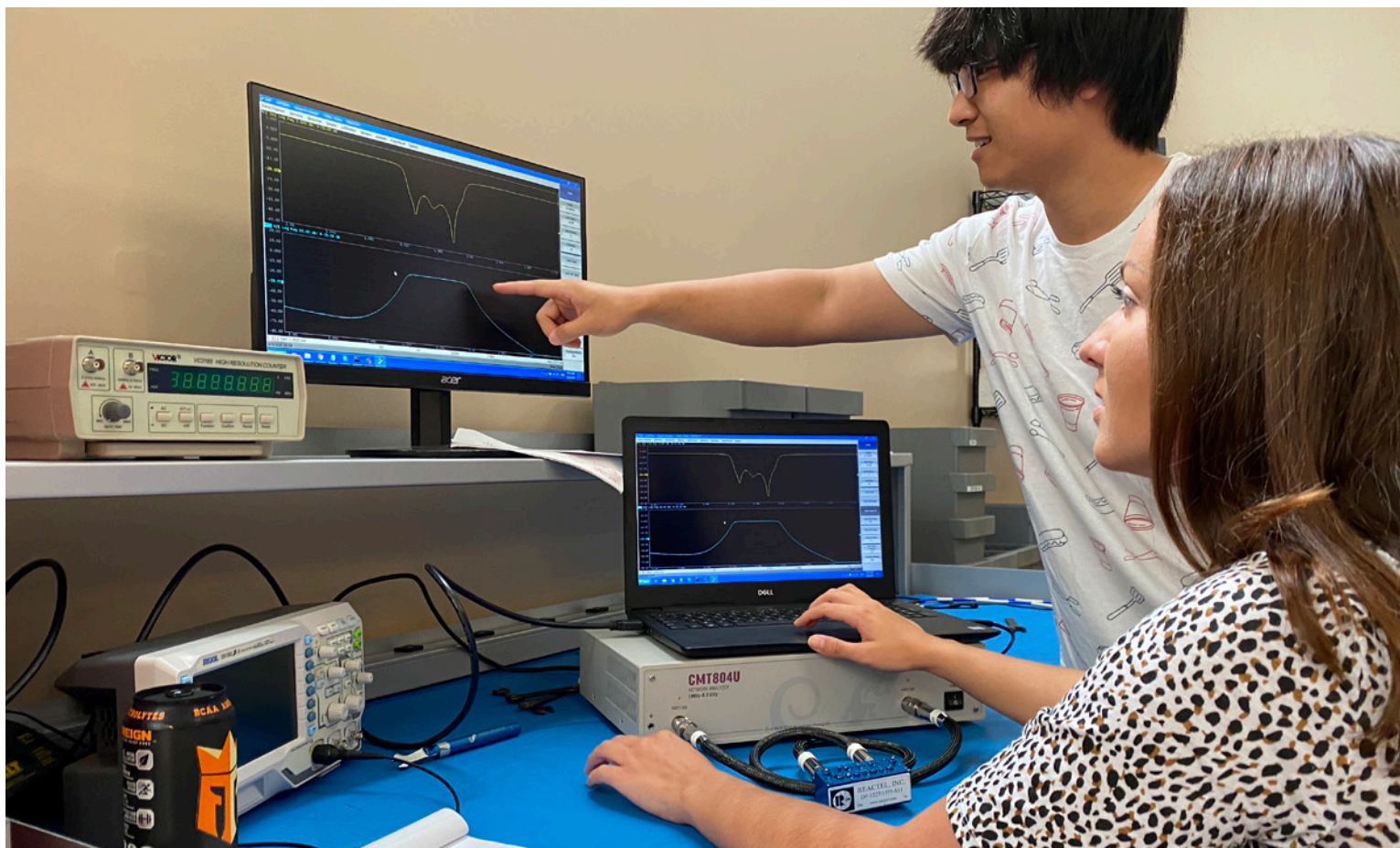
## CMT808U



4-port  
1 MHz - 8 GHz

Copper Mountain Technologies' University Kit is a complete solution designed to teach engineering students RF skills. It features three VNA options and includes the calibration equipment, device under test (DUT), and accessories necessary for an array of common VNA measurements. CMT's University Kit is an affordable way to outfit your lab with RF measurement equipment, providing a practical introduction to vector network analysis.

You can also work with CMT to create s-parameter measurement curriculum designed by RF engineers and materials to promote class interest. The University Kit is backed by comprehensive support from Copper Mountain Technologies' expert engineers. The hardware included in the University Kit will enable users to cover all major VNA measurements such as impedance, VSWR, return loss, and insertion loss.



# Kit Accessory Specifications

## Filters by Reactel

Since it was established in 1979, Reactel, Incorporated has become one of the industry leaders in the design and manufacture of RF and Microwave filters, diplexers, and sub-assemblies. Through a continuous process of research and development, they have established a full line of filters of all types. They offer the generally known tubular, LC, cavity, and waveguide designs, as well as state of the art high performance Suspended Substrate models. Reactel uses the latest in CAD/CAM methods and equipment in all of their design and manufacturing processes. **Reactel is a trusted RF manufacturer which is why CMT partnered with them for the University Kit to provide a quality filter or diplexer for testing with the University Kit.**

### Included with CMT304U Kit

Passband	1425 - 1575 MHz
Center Frequency	1500 MHz
VSWR (at Passband)	$\leq 1.5:1$
Insertion Loss (at Passband)	$\leq 0.6$ dB
Rejection at 1275 and 1680 MHz	$\geq 50$ dB
Connectors	SMA Female
Size	1 x 1.5 x 3.5" (nominal excluding connectors)

### Included with CMT804U Kit

Passband	3800-4200 MHz
Center Frequency	4000 MHz
VSWR (at Passband)	$\leq 1.5:1$
Insertion Loss (at Passband)	$\leq 0.6$ dB
Rejection at 3400 and 4500 MHz	$\geq 50$ dB
Connectors	SMA Female
Size	1 x 0.75 x 2.75" (nominal excluding connectors)

## Reactel Diplexer (Included with CMT808U)

### L-Band Channel

Passband	1900 - 2100 MHz
Center Frequency	2000 MHz
VSWR (at Passband)	$\leq 1.5:1$
Insertion Loss (at Passband)	$\leq 0.75$ dB
Rejection at 1600 and 2200 MHz	$\geq 50$ dB

### C-Band Channel

Passband	4750 - 5250 MHz
Center Frequency	5000 MHz
VSWR (at Passband)	$\leq 1.5:1$
Insertion Loss (at Passband)	$\leq 0.6$ dB
Rejection at 4250 and 5700 MHz	$\geq 50$ dB

# Kit Accessory Specifications

## Mechanical Calibration Kit

### Electrical Data

Impedance	50Ω
Frequency Range	DC to 8 GHz
Connector Type	SMA female

### Mechanical Data

Mating Cycles	> 500 times
Coupling torque	0.56 Nm
Open-end wrench size	8 mm

### Environmental Data

Operating temperature	15°C to 35°C
Storage temperature	-40°C to 75°C
Humidity	90% at 25°C (77°F)
Atmospheric Pressure	70.0 kPa to 106.7 kPa

### Effective System Data (typical)<sup>2,3</sup>

Directivity	30 dB
Source match	28 dB
Load match	30 dB
Reflection tracking	0.1 dB
Transmission tracking	0.1 dB

[1] All specifications subject to change without notice. [2] VNA maximum effective parameters after calibration. [3] All parameters are determined in the temperature range of 23±5 °C with the temperature variation after calibration of no more than ±1 °C.



### Coefficients

Open	$C_0 = -14.869 \times 10^{-15} \text{ F}$	
	$C_1 = 16054 \times 10^{-27} \text{ F/Hz}$	
	$C_2 = -3842 \times 10^{-36} \text{ F/Hz}^2$	
	$C_3 = 256.5 \times 10^{-45} \text{ F/Hz}^3$	
	Offset delay	60.435 ps
	Offset loss	3.9 GΩ/s
Short	$L_0 = 31.74 \times 10^{-12} \text{ F}$	
	$L_1 = 35652 \times 10^{-24} \text{ F/Hz}$	
	$L_2 = 8306 \times 10^{-33} \text{ F/Hz}^2$	
	$L_3 = -533 \times 10^{-42} \text{ F/Hz}^3$	
	Offset delay	59.954 ps
	Offset loss	3.5 GΩ/s
Thru	Electrical delay	161.12 ps
	Offset loss	4.07 GΩ/s
Load	Data Based	

## Dual Band WiFi Stick Antenna

### Electrical Specifications

Frequency range	2400-2500 MHz & 5150-6000 MHz
Nominal Impedance	50Ω
VSWR	2.0 Max
Peak Gain (2400-2500 MHz)	2.2 dBi
Peak Gain (5150-6000 MHz)	3.5 dBi
Average Efficiency (2400-2500 MHz)	65%
Average Efficiency (5150-6000 MHz)	70%
Polarization	Linear

### Mechanical Specifications

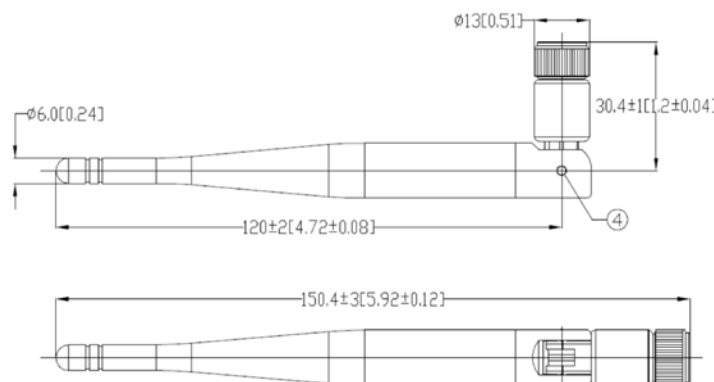
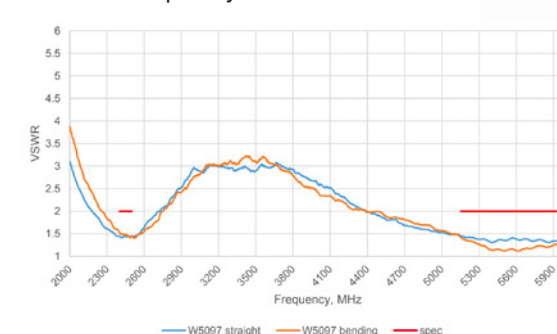
Antenna Body	TPEE
Color	Black
Ingress Protection	IP67
Weight	17.2 g
Overall Length	3.92 inches
Connector Type	SMA Male

### Environmental Specifications

Operating temperature <sup>3</sup>	-40°C to 85°C
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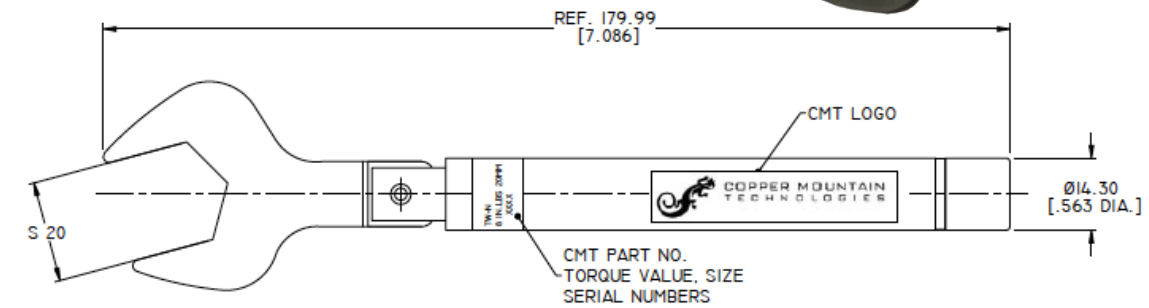


### VSWR vs Frequency



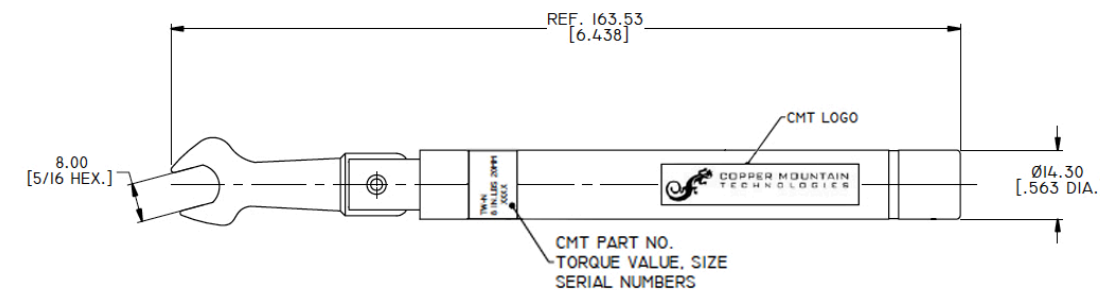
## TW-N N-Type Torque Wrench

The TW-N is an N-Type proof coupling torque wrench used to properly assemble or disassemble a wide range of coaxial connectors.



## TW-S SMA-Type Torque Wrench

The TW-S is an SMA proof coupling torque wrench used to properly assemble or disassemble a wide range of coaxial connectors.



# CMT304U Specifications<sup>1</sup>

## Primary Specifications

Impedance	50 Ohm
Test port connector	type N, female
Number of test ports	2
Frequency range	1 MHz to 3.2 GHz
Full frequency accuracy	±510 <sup>-6</sup>
Frequency resolution	1 Hz
Number of measurement points	2 to 200,001
Measurement bandwidths (with 1/1.5/2/3/5/7 steps)	1 Hz to 30 kHz
Dynamic range <sup>2</sup>	130 dB (135 dB typ.)

## Measurement Accuracy<sup>3</sup>

Accuracy of transmission measurements <sup>4</sup>	Magnitude / Phase
+5 dB to +15 dB	±0.2 dB / ±2°
-50 dB to +5 dB	±0.1 dB / ±1°
-70 dB to -50 dB	±0.2 dB / ±2°
-85 dB to -70 dB	±1.0 dB / ±6°
Accuracy of reflection measurements <sup>5</sup>	Magnitude / Phase
-15 dB to 0 dB	±0.4 dB / ±3°
-25 dB to -15 dB	±1.0 dB / ±6°
-35 dB to -25 dB	±3.0 dB / ±20°
Trace noise magnitude (IF bandwidth 3 kHz)	0.001 dB rms
Temperature dependence	0.02 dB/°C

## Measurement Speed

Time per Point	125 µs typ.		
Port switchover time	10 ms		
Typical cycle time vs number of measurement points			
Frequency range	Number of points	Uncorrected	2-port calibration
1 MHz to 3.2 GHz	51	7 ms	34 ms
(IF bandwidth 30 kHz)	201	27 ms	73 ms
	401	53 ms	125 ms
	1601	207 ms	434 ms

## Effective System Data

Directivity	46 dB
Source match	40 dB
Load match	46 dB
Reflection tracking	±0.10 dB
Transmission tracking	±0.08 dB

## Uncorrected System Performance

Directivity	25 dB
Source match	15 dB
Load match	25 dB

## Test Port Output

Power range	-55 dBm to +10 dBm
Power accuracy	±10 dB
Power resolution	0.05 dB
Harmonic distortion <sup>6</sup>	-30 dBc
Non-harmonic spurious <sup>6</sup>	-30 dBc

## Test Port Input

Noise floor	-130 dBm/Hz
Damage level	+26 dBm
Damage DC voltage	35 V

## Frequency Reference Input

Port	10 MHz Ref In
External reference frequency	10 MHz
Input level	0 dBm to 4 dBm
Input impedance	50 Ohm
Connector type	BNC, female

## Frequency Reference Output

Port	10 MHz Ref Out
Internal reference frequency	10 MHz
Output reference signal level at 50 Ohm impedance	1 dBm to 5 dBm
Connector type	BNC, female

## Trigger Input

Port	Ext Trig
Input level	
Low threshold voltage	0.5 V
High threshold voltage	2.7 V
Input level range	+3 V to +5 V
Pulse width	≥1 µs
Polarity	positive or negative
Input impedance	≥10 kOhm
Connector type	BNC, female

## System & Power

Operating system	Windows 7 and above
CPU frequency	10 GHz
RAM	512 MB
Interface	USB 2.0
Connector type	USB B
Power supply	110-240 V, 50/60 Hz
Power consumption	30 W

## Dimensions

Length	324 mm
Width	415 mm
Height	96 mm
Weight	7 kg (247 oz)

## Calibration

Recommended Factory Adjustment Interval	3 Years
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## Environmental Specifications

Operating temperature	+5 °C to +40 °C (41 °F to 104 °F)
Storage temperature	-50 °C to +70 °C (-58 °F to 158 °F)
Humidity	90 % at 25 °C (77 °F)
Atmospheric pressure	70.0 kPa to 106.7 kPa

[1] All specifications subject to change without notice. [2] The dynamic range is defined as the difference between the specified maximum power level and the specified noise floor. The specification applies at 10 Hz IF bandwidth. [3] Reflection and transmission measurement accuracy applies over the temperature range of (73 ± 9) °F or (23 ± 5) °C after 40 minutes of warming-up, with less than 1 °C deviation from the full two-port calibration temperature, at output power of -5 dBm. Frequency points have to be identical for measurement and calibration (no interpolation allowed). [4] Transmission specifications are based on a matched DUT, and IF bandwidth of 10 Hz. [5] Reflection specifications are based on an isolating DUT. [6] Specification applies at output power of 0 dBm. © Copper Mountain Technologies - www.coppermountaintech.com - Rev. 2020Q2

# CMT804U Specifications<sup>1</sup>

## Primary Specifications

Impedance	50 Ohm	
Test port connector	type N, female	
Number of test ports	2	
Frequency range	1 MHz to 8.0 GHz	
Full frequency accuracy	±5·10 <sup>-6</sup>	
Frequency resolution	1 Hz	
Number of measurement points	2 to 500,001	
Measurement bandwidths (with 1/1.5/2/3/5/7 steps)	1 Hz to 30 kHz	
Dynamic range <sup>2</sup>		
	1 MHz to 6 GHz	135 dB (140 dB typ.)
	6 GHz to 8 GHz	130 dB (140 dB typ.)

## Measurement Accuracy<sup>3</sup>

Accuracy of transmission measurements <sup>4</sup>	
	+5 dB to +15 dB
	-50 dB to +5 dB
	-70 dB to -50 dB
	-90 dB to -70 dB
Accuracy of reflection measurements <sup>5</sup>	
	-15 dB to 0 dB
	-25 dB to -15 dB
	-35 dB to -25 dB
Trace noise magnitude (IF bandwidth 3 kHz)	
Temperature dependence	

## Measurement Speed

Time per Point	100 µs typ.		
Port switchover time	10 ms		
Typical cycle time vs number of measurement points			
Frequency range	Number of points	Uncorrected	2-port calibration
1 MHz to 8 GHz	51	6.5 ms	32.4 ms
(IF bandwidth 30 kHz)	201	211 ms	617 ms
	401	40.5 ms	100.3 ms
	1601	157.7 ms	333.0 ms

## Effective System Data

Directivity	46 dB
Source match	40 dB
Load match	46 dB
Reflection tracking	±0.10 dB
Transmission tracking	±0.08 dB

## Uncorrected System Performance

Directivity	18 dB
Source match	18 dB
Load match	18 dB

## Test Port Output

Power range		
	1 MHz to 6 GHz	-60 dBm to +10 dBm
	6 GHz to 8 GHz	-60 dBm to +5 dBm
Power accuracy	±15 dB	
Power resolution	0.05 dB	
Harmonic distortion <sup>6</sup>	-25 dBc	
Non-harmonic spurious <sup>6</sup>	-30 dBc	

## Test Port Input

Noise floor	-135 dBm/Hz
Damage level	+26 dBm
Damage DC voltage	35 V

## Frequency Reference Input

Port	10 MHz Ref In
External reference frequency	10 MHz
Input level	0 dBm to 4 dBm
Input impedance	50 Ohm
Connector type	BNC, female

## Frequency Reference Output

Port	10 MHz Ref Out
Internal reference frequency	10 MHz
Output reference signal level at 50 Ohm impedance	1 dBm to 5 dBm
Connector type	BNC, female

## Trigger Input

Port	Ext Trig	
Input level		
	Low threshold voltage	0.5 V
	High threshold voltage	2.7 V
Input level range	+3 V to +5 V	
Pulse width	≥1 µs	
Polarity	positive or negative	
Input impedance	≥10 kOhm	
Connector type	BNC, female	

## System & Power

Operating system	Windows 7 and above
CPU frequency	10 GHz
RAM	512 MB
Interface	USB 2.0
Connector type	USB B
Power supply	110-240 V, 50/60 Hz
Power consumption	40 W

## Dimensions

Length	324 mm
Width	415 mm
Height	96 mm
Weight	7 kg (247 oz)

## Calibration

Recommended Factory Adjustment Interval	3 Years
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## Environmental Specifications

Operating temperature	+5 °C to +40 °C (41 °F to 104 °F)
Storage temperature	-50 °C to +70 °C (-58 °F to 158 °F)
Humidity	90 % at 25 °C (77 °F)
Atmospheric pressure	70.0 kPa to 106.7 kPa

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# CMT808U Specifications<sup>1</sup>

## Primary Specifications

Impedance	50 Ohm
Test port connector	type N, female
Number of test ports	4
Frequency range	1 MHz to 8.0 GHz
Full frequency accuracy	±510 <sup>-6</sup>
Frequency resolution	1 Hz
Number of measurement points	2 to 500,001
Measurement bandwidths (with 1/1.5/2/3/5/7 steps)	1 Hz to 30 kHz
Dynamic range <sup>2</sup>	
1 MHz to 6 GHz	135 dB (140 dB typ.)
6 GHz to 8.0 GHz	130 dB (140 dB typ.)

## Measurement Accuracy<sup>3</sup>

Accuracy of transmission measurements <sup>4</sup>	Magnitude / Phase
+5 dB to +15 dB	±0.2 dB / ±2°
-50 dB to +5 dB	±0.1 dB / ±1°
-70 dB to -50 dB	±0.2 dB / ±2°
-90 dB to -70 dB	±1.0 dB / ±6°
Accuracy of reflection measurements <sup>5</sup>	Magnitude / Phase
-15 dB to 0 dB	±0.4 dB / ±3°
-25 dB to -15 dB	±1.0 dB / ±6°
-35 dB to -25 dB	±3.0 dB / ±20°
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Temperature dependence	0.02 dB/°C

## Measurement Speed

Time per Point	100 µs typ.		
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## Effective System Data

Directivity	46 dB
Source match	40 dB
Load match	46 dB
Reflection tracking	±0.10 dB
Transmission tracking	±0.08 dB

## Uncorrected System Performance

Directivity	18 dB
Source match	18 dB
Load match	18 dB

## Test Port Output

Power range		
1 MHz to 6 GHz	-60 dBm to +10 dBm	
6 GHz to 8 GHz	-60 dBm to +5 dBm	
Power accuracy	±15 dB	
Power resolution	0.05 dB	
Harmonic distortion <sup>6</sup>	-25 dBc	
Non-harmonic spurious <sup>6</sup>	-30 dBc	

## Test Port Input

Noise floor	-135 dBm/Hz
Damage level	+26 dBm
Damage DC voltage	35 V

## Frequency Reference Input

Port	10 MHz Ref In
External reference frequency	10 MHz
Input level	0 dBm to 4 dBm
Input impedance	50 Ohm
Connector type	BNC, female

## Frequency Reference Output

Port	10 MHz Ref Out
Internal reference frequency	10 MHz
Output reference signal level at 50 Ohm impedance	1 dBm to 5 dBm
Connector type	BNC, female

## Trigger Input

Port	Ext Trig
Input level	
Low threshold voltage	0.5 V
High threshold voltage	2.7 V
Input level range	+3 V to +5 V
Pulse width	≥1 µs
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## Environmental Specifications

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Storage temperature	-50 °C to +70 °C (-58 °F to 158 °F)
Humidity	90 % at 25 °C (77 °F)
Atmospheric pressure	70.0 kPa to 106.7 kPa

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Technology is supposed to move. It's supposed to change and update and progress. It's not meant to sit stagnant year after year simply because that's how things have always been done.

The engineers at Copper Mountain Technologies are creative problem solvers. They know the people using VNAs don't just need one giant machine in a lab. They know that VNAs are needed in the field, requiring portability and flexibility. Data needs to be quickly transferred, and a test setup needs to be easily automated and recalled for various applications. The engineers at Copper Mountain Technologies are rethinking the way VNAs are developed and used.

Copper Mountain Technologies' VNAs are designed to work with the Windows or Linux PC you already use via USB interface. After installing the test software, you have a top-quality VNA at a fraction of the cost of a traditional analyzer. The result is a faster, more effective test process that fits into the modern workspace. This is the creativity that makes Copper Mountain Technologies stand out above the crowd.

We're creative. We're problem solvers.



Copper Mountain Technologies has more educational tools to utilize for teaching RF. Go to [www.coppermountaintech.com](http://www.coppermountaintech.com) to see the IoT Kit for teaching proper antenna design. Looking for educational resources to support your teaching? Go to [usb-vna.com](http://usb-vna.com) to view application notes and videos for RF and microwave beginners.

	CMT304U	CMT804U	CMT808U
Frequency Range	1 MHz to 3.2 GHz	1 MHz to 8 GHz	1 MHz to 8 GHz
Number of Ports	2	2	4
Dynamic Range	135 dB, typ.	140 dB, typ.	140 dB, typ.

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