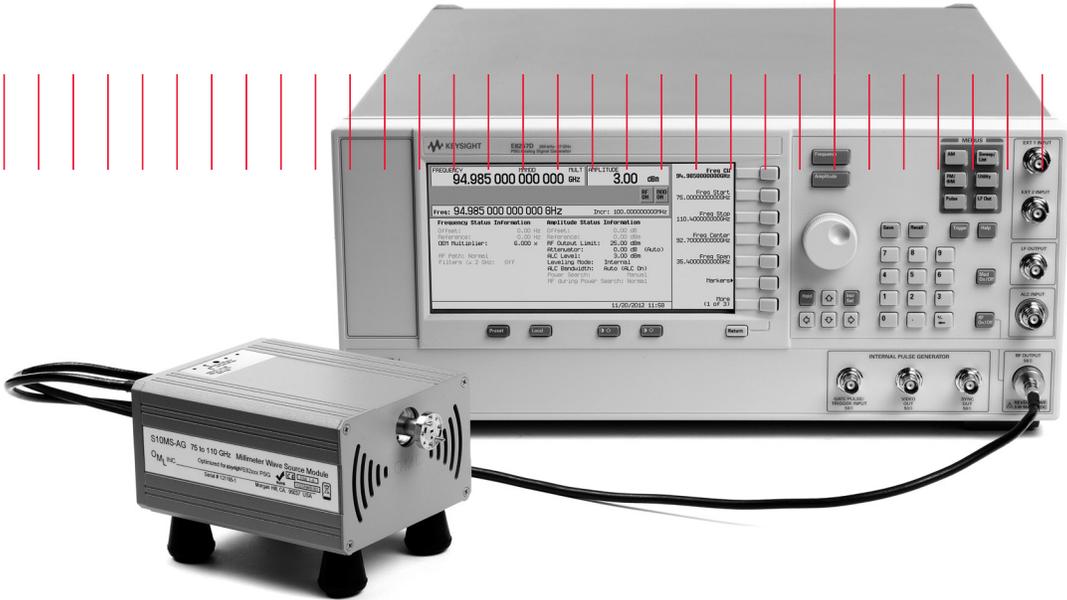


# Keysight Technologies mm-wave Source Modules from OML, Inc. for PSG Signal Generators

## Technical Overview



50 to 75 GHz    75 to 110 GHz    110 to 170 GHz

60 to 90 GHz    90 to 140 GHz    140 to 220 GHz    220 to 325 GHz    325 to 500 GHz

High performance mm-wave source modules extend the frequency coverage of the PSG to 500 GHz. The Keysight Technologies, Inc. PSG signal generators (PSG) provide excellent signal power, resolution, stability, and analog modulation performance for coaxial applications to 67 GHz. Now, when paired with new, high power mm-wave source modules from OML, Inc., much of the PSG's capability can be extended up to 500 GHz to meet the requirements of emerging mm-wave applications.

### Characteristics of the Millimeter Wave Spectrum

While it is generally recognized that mm-wave frequencies are between 30 GHz and 300 GHz, factors such as broadband solid state microwave electronics, relatively low atmospheric absorption of signals < 50 GHz, the need for high communication bandwidths, and advances in coax transmission capabilities have allowed the microwave band to virtually encompass the 30 GHz to 50 GHz frequency applications.

The mm-wave spectrum beyond 70 GHz offers many advantages to certain applications. Millimeter-wave wavelengths are small (< 10 mm) which means mm components are smaller than microwave components. This in turn results in smaller, more focused transmit and receive antennas – with apertures that have narrower beam widths and transmissions that suffer less losses in the presence of rain, smoke, fog, and dust.

Atmospheric constituents and gases attenuate millimeter signals at different rates for different frequencies. Overall, there are narrow regions (bands) of high

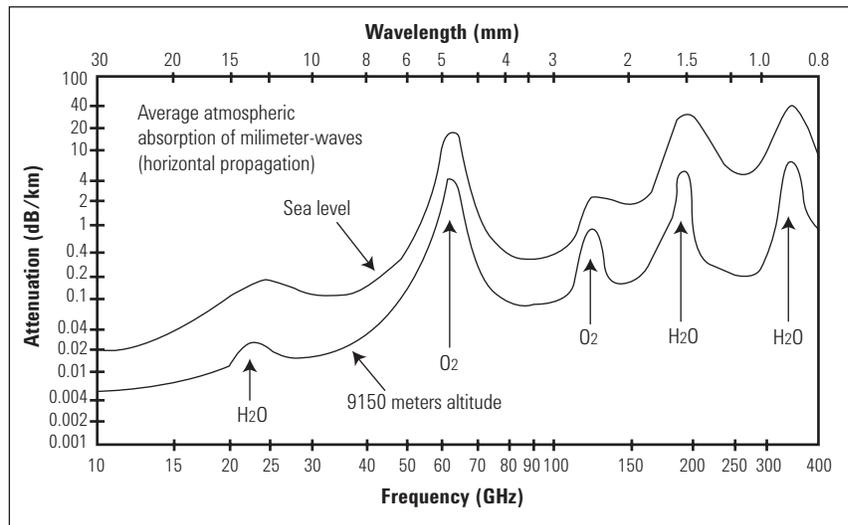


Figure 1. Atmospheric absorption of millimeter waves.

signal absorption and wide regions of low signal absorption that occur over the entire millimeter frequency range. The low absorption bands provide sufficient bandwidth for localized applications such as automotive collision radar or autonomous cruise control (77, 94 GHz), broadband gigabit wireless communications (70 to 86 GHz), non-ionic imaging (110 to 300 GHz), material characterization and chemical sensing (225 to 310 GHz).

### Solving your mm-wave signal source needs

Millimeter wave sources are essential instruments for developing almost all millimeter wave systems and for extending the range of microwave systems. The SxxMS-AG series of high power, frequency banded mm-wave source modules from OML, Inc., when driven by Keysight's high performance PSG, provide synthesized mm-wave test signals for waveguide bands from 50 to 500 GHz. The SxxMS-AG series have RF input power protection allowing all PSG's with high output power (Option 1EU or 1EA) to drive mm-wave source modules without the need for external RF power amplifiers. In addition, the SxxMS-AG series were designed to derive DC power directly from the PSG

(through the source-module-interface connector), and eliminates the need for an external DC power supply.

### High accuracy and resolution

Because the SxxMS-AG series modules employ frequency multiplication to generate mm-wave frequencies, the output frequency specifications are directly proportional to the characteristics of the PSG driving the module. The PSG's frequency resolution is typically in the milli-Hz range, which allows a mm-wave carrier frequency of 500 GHz to have a frequency resolution of < 1 Hz.

## Spectral Purity

The SxxMS-AG series mm-wave source modules offer harmonic, sub-harmonic, and spurious suppression of > 20 dBc, in any band. The high stability and low phase noise performance of the PSG is raised by a factor of  $20 \log N$ , where  $N$  is the multiplier factor of the specific module. For the eight SxxMS-AG series modules,  $N$  varies from 4 (50 to 75 GHz model) to 30 (325 to 500 GHz model) and  $20 \log N$  varies from 12 dB (50 to 75 GHz) to 18 dB (90 to 140 GHz) to 30 dB (325 to 500 GHz).

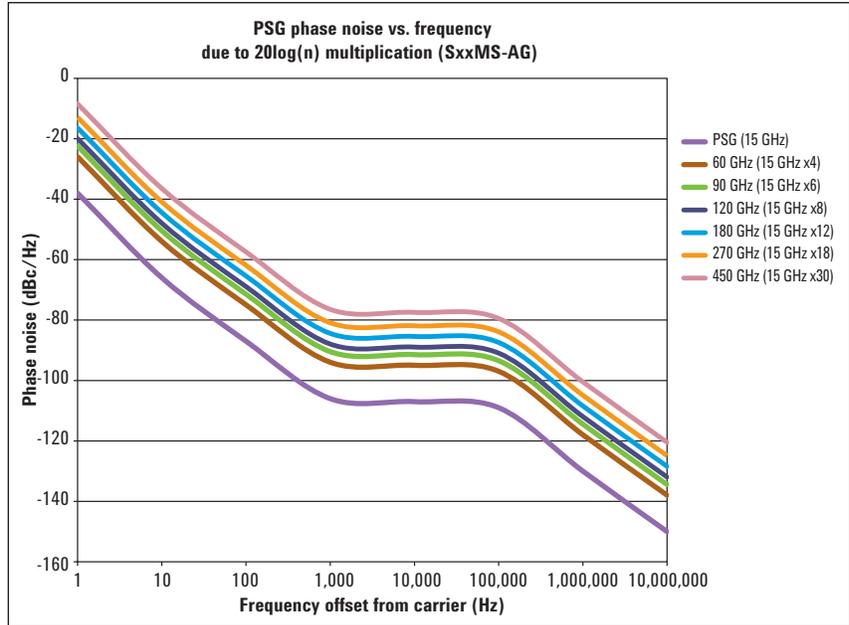


Figure 2. Typical phase noise performance of PSG with OML S10MS-AG module at different carrier frequencies.

## Output Power

The SxxMS-AG series modules offer substantial fixed output power, allowing them to be used as LO's in mixer measurements and provides additional dynamic range for insertion loss/gain measurements. For example, the W-band performance shown in Figure 3 demonstrates a measured output power of +7 dBm with typical output power flatness of  $\pm 1$  dB.

The output signal power is fixed and can only be varied through the use of an external fixed attenuator, an external mechanical variable attenuator, or an external electronic variable attenuator.

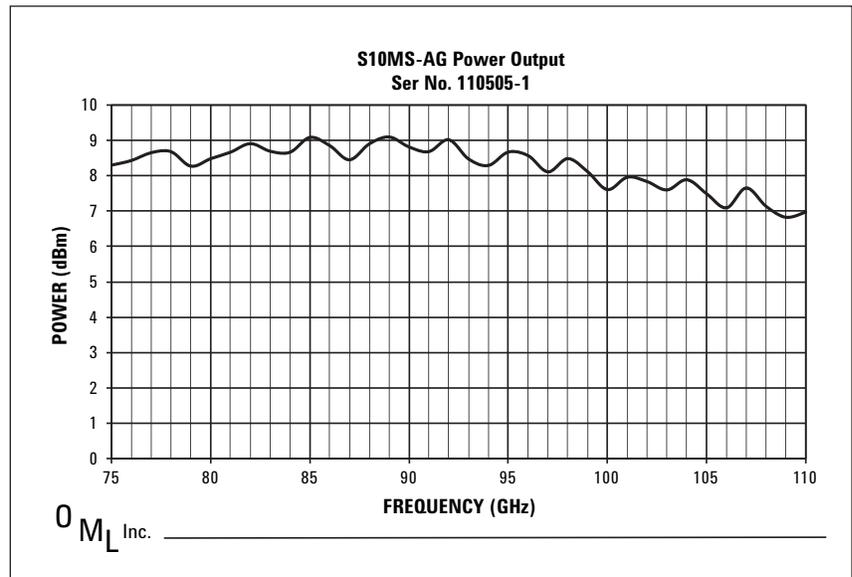


Figure 3. Typical output power vs. mm-wave frequency for OML S10MS-AG.

## Excellent FM, PM and Pulse Modulation

FM and/or PM may be applied to the SxxMS-AG series module input signal with the corresponding mm-wave output signal being modulated with an FM/PM deviation that is N times the input deviation (no change in the FM/PM rate) where N is the multiplier factor of the SxxMS-AG module.

The pulse modulation characteristics of the input signal are reproduced faithfully, with the exception of pulse rise and fall times. The non-linear characteristics of the source module will typically produce an output signal pulse with faster rise and fall times. Faster rise and fall times will also yield a small increase in the width of the pulse.

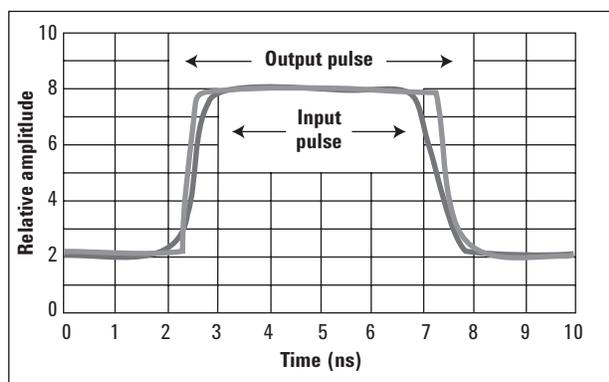


Figure 4. Typical rise and fall time of the module output signal vs. the pulsed, input driving signal.

## AM and Vector Modulation

The non-linear multiplication characteristics of the SxxMS-AG series do not allow replication of linear AM (sinusoidal amplitude modulation) or vector modulated signals.

### Easy connection and operation

The SxxMS-AG has been designed to work directly with the PSG source-module interface (SMI) power supply specifications. Once the SxxMS-AG module is connected to the PSG via the SMI cable and an RF cable (Figure 5), the PSG user interface can be configured to directly display the mm-wave output frequency.

Connect the SxxMS-AG module per Figure 5. Then follow the PSG key steps shown in Figure 6 to select the appropriate mm-wave frequency band for the connected module. Once the OEM source module "ON" selection has been made, the frequency shown on the PSG will be the output frequency of the mm-wave source module. To change the output frequency of the source module, simply enter the desired mm-wave output frequency into the PSG, and the PSG will do the rest. The amplitude value shown on the PSG is the output power of the PSG, and it must be set to +16 dBm for optimum performance of the source module.

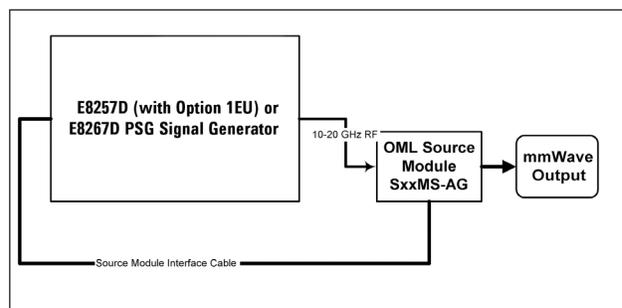
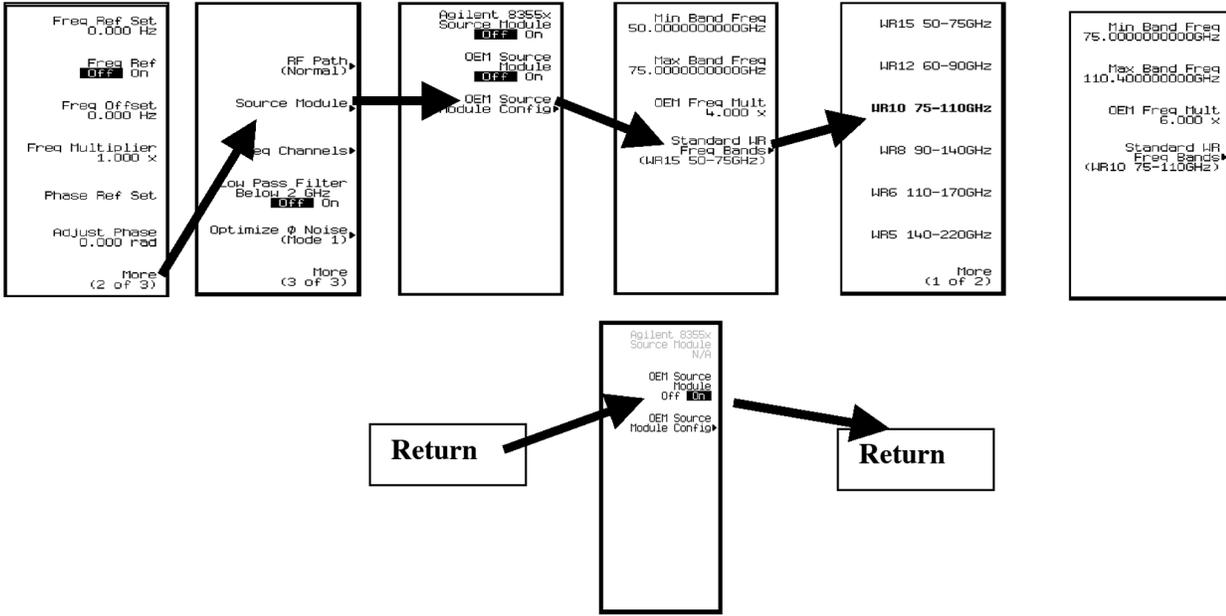


Figure 5. Source module to PSG hardware connections.

FREQUENCY <b>50.000 000 000 000 GHz</b>	AMPLITUDE <b>16.00 dBm</b>	Freq CH 50.0000000000GHz
<input type="checkbox"/> RF ON <input checked="" type="checkbox"/> HOD ON		Freq Start 67.0000000000GHz
Freq: <b>50.000 000 000 000 GHz</b> Incr: 99.000000000000GHz		Freq Stop 67.0000000000GHz
<b>Frequency Status Information</b>	<b>Amplitude Status Information</b>	Freq Center 67.0000000000GHz
Offset: 0.00 Hz	Offset: 0.00 dB	Freq Span 0.00 Hz
Reference: 0.00 Hz	Reference: 0.00 dBm	Markers▶
Multiplier: 1.000 x	RF Output Limit: 25.00 dBm	More (1 of 3) ▶
RF Path: Normal	Attenuator: 0.00 dB (Auto)	
Filters (<= 2 GHz): Off	ALC Level: 16.00 dBm	
	Leveling Mode: Internal	
	ALC Bandwidth: Auto (ALC On)	
	Power Search: Manual	
	RF during Power Search: Normal	
02/03/2012 11:47		



FREQUENCY <b>105.000 000 000 000 GHz</b>	MULT MULT	AMPLITUDE <b>-110.00 dBm</b>
<input type="checkbox"/> RF ON <input checked="" type="checkbox"/> HOD ON		RF Path (Normal)
Source Module		Freq Channels
<b>Frequency Status Information</b> Offset: 0.00 Hz Reference: 0.00 Hz OEM Multiplier: 6.000 x RF Path: Normal Filters (<= 2 GHz): Off		Low Pass Filter Below 2 GHz Optimize Noise (Mode 1) More (3 of 3)
<b>Amplitude Status Information</b> Offset: 0.00 dB Reference: 0.00 dBm RF Output Limit: 25.00 dBm Attenuator: 90.00 dB (Auto) ALC Level: -20.00 dBm Leveling Mode: Internal ALC Bandwidth: Auto (ALC On) Power Search: Manual RF during Power Search: Normal		
02/03/2012 11:58		

Figure 6. PSG keystroke sequence that enables the PSG source - mm module interface.

## Specifications

Oml Inc. source modules for use with Keysight PSG (E82x7C/D) signal generators

Model/ specifications <sup>1</sup>	S15MS-AG	S12MS-AG	S10MS-AG	S08MS-AG	S06MS-AG	S05MS-AG	S03MS-AG	S02.2MS-AG
Frequency in (GHz)	12.5 to 18.7	10.0 to 15.0	12.5 to 18.4	11.2 to 17.5	9.1 to 14.1	11.6 to 18.4	12.2 to 18.1	10.8 to 16.7
Frequency out (GHz)	50.0 to 75.0	60.0 to 90.0	75.0 to 110.0	90.0 to 140.0	110.0 to 170.0	140.0 to 220.0	220.0 to 325.0	325.0 to 500.0
Multiplier (x N)	x4	x6	x6	x8	x12	x12	x18	x30
RF in (dBm)	+16 dBm, supplied by E82x7C/D PSG with Option 1EU or 1EA (high power)							
RF in, damage level (dBm)	+36	+36	+36	+36	+36	+36	+36	+36
RF out (dBm) typical <sup>2</sup>	+8	+6	+5	-5	-13	-15	-25	-27
Harmonics and sub-harmonics (dBc) typical <sup>3</sup>	≤ -20	≤ -20	≤ -20	≤ -20	≤ -20	≤ -20	≤ -20	≤ -20
In-band spurious (dBc) typical <sup>4</sup>	≤ -20	≤ -20	≤ -20	≤ -20	≤ -20	≤ -20	≤ -20	≤ -20
RF in VSWR	≤ 2.0	≤ 2.0	≤ 2.0	≤ 2.0	≤ 2.0	≤ 2.0	≤ 2.0	≤ 2.0
RF out VSWR	≤ 1.7	≤ 1.7	≤ 1.7	≤ 1.7	≤ 1.7	≤ 1.7	≤ 3.0	≤ 3.0
RF in port	SMA female							
RF out port <sup>5</sup>	WR-15	WR-12	WR-10	WR-08	WR-06	WR-05	WR-03	WR-02.2
Power	Supplied by E82x7C/D PSG (+8 VDC @ 1.2 A max, +15 VDC @ 150 mA max)							
Temperature	+20 to +30 °C							
Weight	2.5 lbs typical							
Size <sup>6</sup>	2.8" (H) x 4.3" (W) x 5.7" (D)							

## Order information<sup>7</sup>

Keysight model number	OML model model number	Description	Frequency range
E8257DS15	S15MS-AG	WR-15 Source Module	50 to 75 GHz
E8257DS12	S12MS-AG	WR-12 Source Module	60 to 90 GHz
E8257DS10	S10MS-AG	WR-10 Source Module	75 to 110 GHz
E8257DS08	S08MS-AG	WR-08 Source Module	90 to 140 GHz
E8257DS06	S06MS-AG	WR-06 Source Module	110 to 170 GHz
E8257DS05	S05MS-AG	WR-05 Source Module	140 to 220 GHz
E8257DS03	S03MS-AG	WR-03 Source Module	220 to 325 GHz
E8257DS02	S02.2MS-AG	WR-02.2 Source Module	325 to 500 GHz

### OML standard accessories

V00CDC2	2 m DC power cable
V00LOIF	1 m RF cable SMA(m) to SMA(m)

1. Specifications subject to change without notice.
2. As there are no internationally recognized power standards above 110 GHz, any power data supplied above 110 GHz is traceable only to OML's calorimeter.
3. As relates to the desired output frequencies.
4. In-band mixing products. Typically ≤ -15 dBc in the lower 10% of the WR-15, WR-12 or WR10 bands.
5. RF output port flange configuration per MIL-DTL-3922/67D (UG387/U-M).
6. Height excludes the adjustable rubber feet length and depth dimension excludes the output waveguide length.
7. Each source module ordered includes one each of the Standard Accessories listed below (2 m DC power cable and 1 m RF cable).

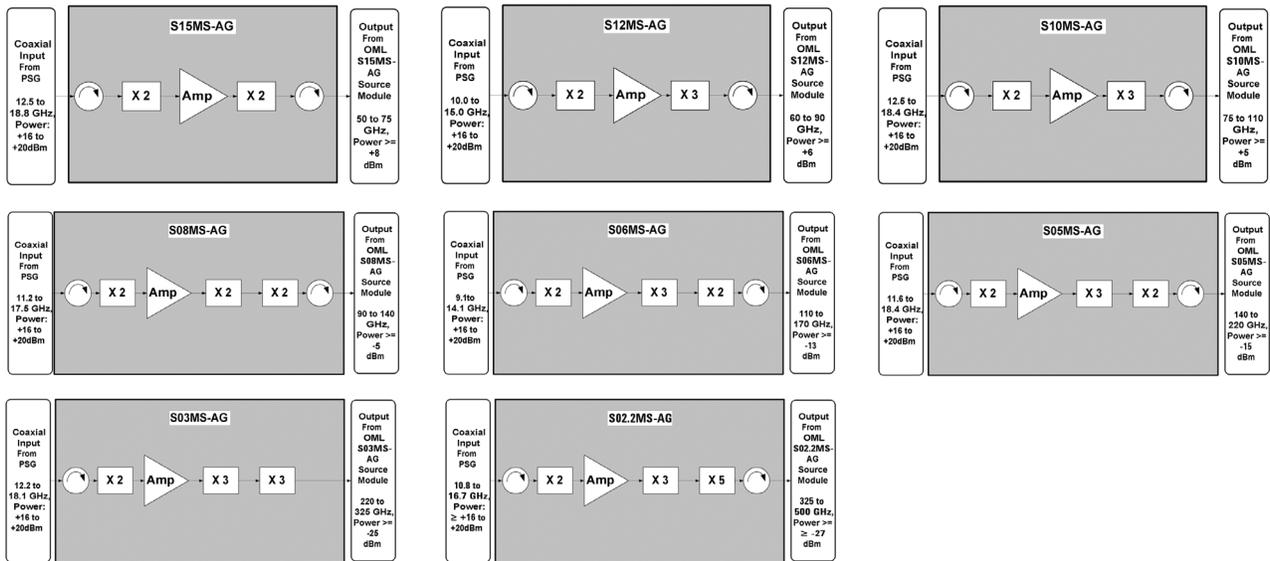


Figure 7. SxxMS-AG internal multiplier configurations.

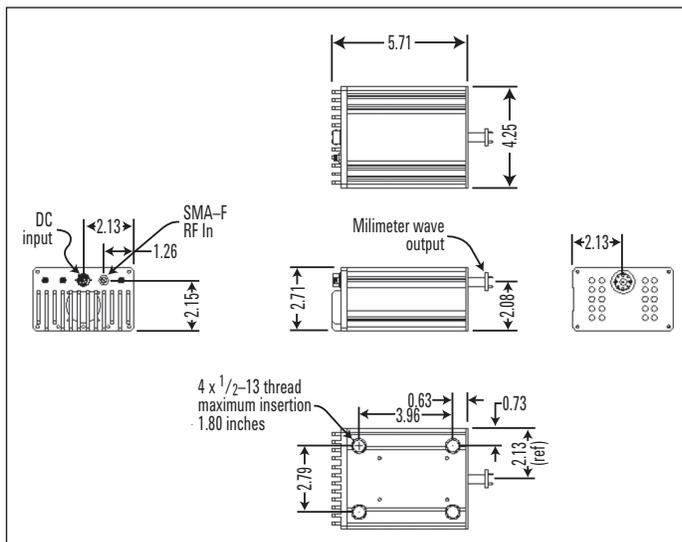


Figure 8. Overall dimensions of the millimeter wave source modules.



Figure 9. The E8257DS10 source module provides 75 to 110 GHz coverage.



Figure 10. Millimeter wave source module works with the Keysight M1970 Smart Mixer to create a stimulus-response test system.

## Related Literature

Keysight E8267D PSG Vector Signal Generator,  
Data Sheet,  
Literature number 5989-0697EN

Keysight E8267D PSG Vector Signal Generator,  
Configuration Guide, Literature number  
5989-1326EN

Keysight PSG Signal Generators, Brochure,  
Literature number 5989-1324EN

Keysight E8257D PSG Analog  
Signal Generator, Data Sheet,  
Literature number 5989-0698EN

Keysight E8257D PSG Analog  
Signal Generator,  
Configuration Guide,  
Literature number 5989-1325EN

## Related Web Resources

For more information on Keysight PSG signal  
generators, visit:  
**[www.keysight.com/find/PSG](http://www.keysight.com/find/PSG)**

For more information on OML Inc.'s source  
modules, visit: **[www.omlinc.com](http://www.omlinc.com)**

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