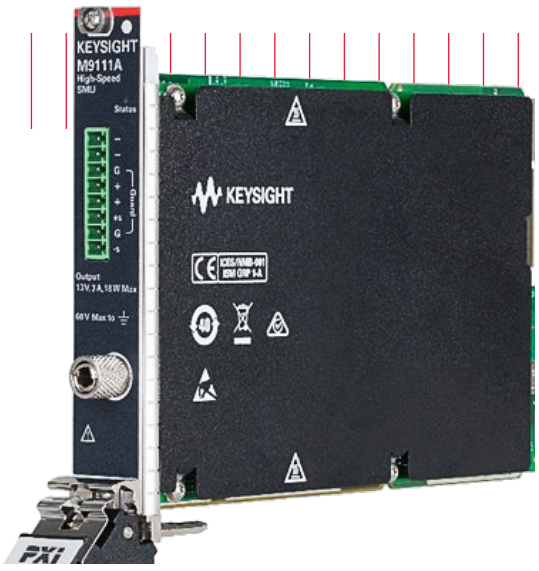
Keysight Technologies

M9111A PXIe High-Speed Source/Measure Unit

13 V, ± 1 A or 6 V, ± 3 A, 18 W

Data Sheet



KEYSIGHT TECHNOLOGIES

Source Faster, Measure Faster

Change voltage, stabilize, and make accurate measurements in less than 1 ms!

In automated test environments, the adage “time is money” is never more prevalent. Thus, speed of test is critical. The faster you are able to test a device, the more money you will save. Keysight’s M9111A PXIe High-Speed Source/Measure Unit (SMU) was specifically designed for this environment. It helps you achieve high-throughput, while maintaining measurement quality in design validation and production test of power amplifiers. The M9111A can change its output voltage, stabilize that voltage, and accurately measure current from Amps down to micro-Amps all in less than 1 ms so that you can move on to the next test as quickly as possible.

As part of Keysight’s RF PA/FEM Characterization and Test Reference Solution, this combination provides exceptional performance for the demanding requirements of testing modern power amplifiers (PAs) and front-end modules (FEMs).

Overview

The M9111A is a 1-slot, 2-quadrant PXIe module that delivers up to 13 V, ± 1 A or up to 6 V, ± 3 A, 18W. The M9111A SMU combines the capabilities of a voltage source, a current source, an ammeter and a voltmeter to provide stable, glitch-free sourcing and sinking, and high accuracy measurements. It offers:

- High-speed changes in voltage with fast settling times
- High-speed recovery and low-voltage droop when the DUT pulls fast slewing current pulses
- High-speed, accurate low level-current measurements, such as leakage current

Speed up test with high speed SMU output

When it comes to speed, the M9111A PXIe High-Speed Source/Measure Unit achieves performance unlike a typical DC power supply; it’s up to 20x faster than previous generation Keysight SMUs. The M9111A quickly changes voltage in 10-50 microseconds depending capacitance of the device under test (DUT), and that voltage quickly settles to its programmed value to quickly provide a stable output. Decrease test time by minimizing the wait time for a power supply voltage to settle with the M9111A, so the rest of the test system can continue to do its job.

Stable Voltage even with Dynamic or High Capacitive Loads

Power amplifiers and other components present a unique testing challenge: they draw rapid pulses of current. By offering superior transient performance, the M9111A SMU dramatically reduces the transient voltage drop due to pulsed loading and recovers quickly to its program voltage (even with capacitances of up to 150 µF).

The M9111A provides industry-leading output stability under extreme, dynamic load conditions so that you never have to worry about your power source interfering with your measurements. The M9111A SMU's glitch-free operation ensures that during programmed output or measurement ranges changes, the M9111A's output voltage and current remain steady and the DUT remains unaffected. Further, to provide this output stability, the M9111A SMU has user-selectable compensation modes that improves usability and productivity by instantly configuring the SMU's feedback loop to match the impedance of the system (DUT and wiring paths).

Accurately Measure Leakage and Dynamic Currents

Measuring static current accurately can be a challenge. Measuring dynamic currents from µA level to A is an even greater challenge. Depending on the level of current, a different precision measurement resistor must be used, representing a measurement range in the SMU. The three current measurement ranges (3 A, 1 mA, and 100 µA) of the M9111A makes it tuned to quickly and accurately measure the different operating states and power consumption of a device. The built-in measurement system enables fast measurement of low currents down to µA, even if the DUT has a large capacitor (up to 150 µF) and the built-in high-speed digitizer measures voltage and current every 5.12 µs (~200 ksamples/s).

Triggering

The M9111A PXIe SMU utilizes the PXI chassis backplane trigger-in to receive triggers to start a measurement.

Drivers and Soft Front Panel

To simplify system development, the M9111A comes with IVI.COM and IVI.C drivers for 32-bit and 64-bit Windows OS.

The soft front panel interface provides an easy way to monitor, configure, and control the M9111A SMU.

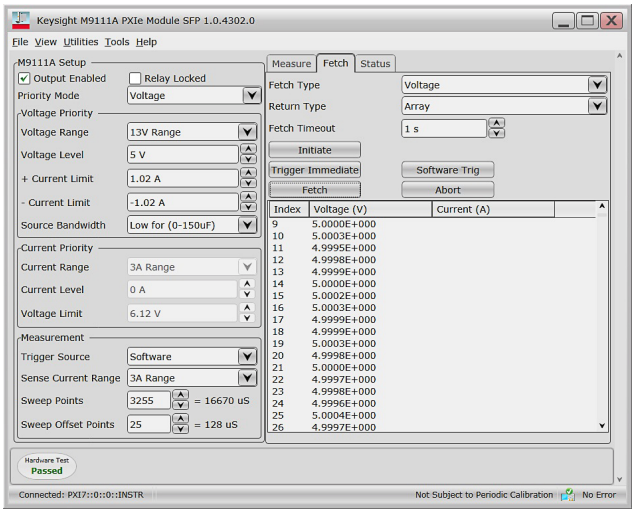


Figure 1. Soft front panel

Address RF PA/FEM Test Challenges with a Reference Solution

The M9111A PXIe High-Speed SMU is a part of the Keysight RF Power Amplifier/Front End Modules (PA/FEM) Characterization and Test Reference Solution. This reference solution enables rapid, full characterization of next-generation power amplifier modules such as PAD devices, including S-parameter, demodulation, power, adjacent channel power and harmonic distortion measurements.

Use the reference solution to rapidly evaluate new test configurations or augment your existing test system with open source shortcuts. Get a running start the RF PA/FEM reference system, to learn more, please see: **www.keysight.com/find/solution-padvt**

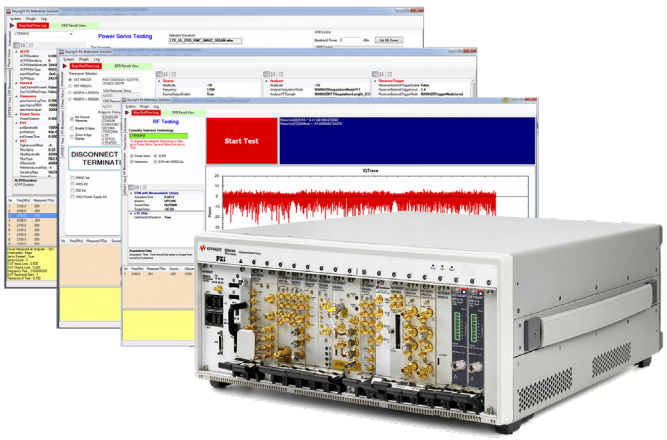


Figure 2. RF PA/FEM Characterization & Test Reference Solution

Performance Specifications

Unless otherwise noted, specifications warranted over the ambient temperature range of 0 to 45 °C after a 30-minute warm-up period.

M9111A	
DC ratings:	
Voltage	13 V/6 V
Current	± 1 A/± 3 A
Power	13 W/18 W
Output voltage ripple and noise (PARD) from 20 Hz – 20 MHz:	
Measured at the output terminals, under all load conditions, in voltage priority mode with output bandwidth setting = low	
CV peak-to-peak	15 mV
CV rms	1.5 mV
Load effect (load regulation):	
For any load change, with a lead drop of up to 1.0 V. The load lead drop reduces the maximum available voltage at the load.	
Voltage	500 µV
Current, 3 A range	200 µA
Current, 1 mA range	250 nA
Programming accuracy @ 23 °C ± 5 °C:	
Applies from minimum to maximum programming range at any load.	
Voltage, 13 V and 6 V ranges	0.025% + 1 mV
Current, 3 A range	0.05% + 1 mA
Current, 1 mA range	0.05% + 500 nA
Measurement accuracy @ 23 °C ± 5 °C:	
Applies when measuring the default value of 3255 data points with a 5.12 µs time interval.	
Voltage, 13 V and 6 V ranges	0.05% + 1 mV
Current, 3 A range	0.05% + 300 µA
Current, 1 mA range	0.05% + 100 nA
Current, 100 µA range	0.05% + 10 nA
Load transient response time in voltage priority mode:	
Time to recover to within the settling band. With 150 µF cap (ESR = 50 mΩ) at load, remote sensing at cap, 4.25' twisted pair load leads.	
Rise time (10% to 90%)	≥ 10 µs
Settling band 6 V range with a 1.4 A load step	± 20 mV
Recovery time	≤ 35 µs

Supplemental Characteristics

M9111A				
Minimum current and voltage compliance limits:				
13 V and 6 V ranges current priority mode	20 mV			
3 A range voltage priority mode	± 20 mA			
1 A range voltage priority mode	± 10 mA			
Programming range and resolution:				
Voltage, 13 V range	0 to 13.26 V; 260 µV			
Voltage, 6 V range	0 to 6.12 V; 260 µV			
Current	–3.06 A to 3.06 A; 100 µA			
Programming accuracy temperature coefficient per °C:				
Voltage, 13 V and 6 V ranges	0.0025% +200 µV			
Current	0.0025% +60 µA			
Measurement resolution:				
Voltage	120 µV			
Current, 3 A range	25 µA			
Current, 1 mA range	13 nA			
Current, 100 µA range	1.4 nA			
Measurement accuracy temperature coefficient per °C:				
Voltage	0.003 % + 75 µV			
Current, 3 A range	0.002% + 110µA			
Current, 1 mA range	0.002% + 5 nA			
Current, 100 uA range	0.002% + 500 pA			
Voltage programming speed and settling time: (at the specified bandwidth)				
With slew rate set to maximum; with high 2 output capacitor = 1 µF; with high 3 output capacitor = 7 µF				
Compensation setting	Low	High 1	High 2	High 3
Rise time from 10% to 90% of step 13 V and 6 V ranges with a 0-4 V step	300 µs	12 µs	15 µs	40 µs
Settling time to 0.1% of step 13 V and 6 V ranges with a 0-4 V step	1.2 ms	40 µs	50 µs	120 µs
High frequency output voltage noise: (at the specified bandwidth)				
With high 2 setting, output capacitor = 1 µF; with high 3 setting, output capacitor = 7 µF				
Compensation setting	Low	High 1	High 2	High 3
CV peak-to-peak from 20Hz - 20MHz 13 V and 6V ranges with any load	15 mV	15 mV	3 mV	3 mV
CV rms from 20Hz – 20MHz 13 V and 6 V ranges with any load	1.5 mV	1.5 mV	0.4 mV	0.3 mV
Voltage measurement noise: (peak value)				
13 V range	2.9 mV			
Voltage measurement settling time: (settling band of 0.1% of step - 10mV)				
Settling time	35 µs			
Voltage measurement small signal bandwidth:				
–3 db	DC to 30 kHz			
–1 db	DC to 17 kHz			

Supplemental Characteristics (continued)

M9111A

Voltage priority transient characteristic: (time to recover to within the settling band)

At the specified bandwidth, 6 V range only, with remote sensing at load cap, 4.25' twisted pair load leads.

Compensation setting	Low	High 1	High 2	High 3
Settling band.	40 mV	50 mV	30 mV	20 mV
CC load step	0.2 A	0.2 A	0.5 A	1.4 A
Rise time from 10% to 90% of step	10 µs	5 µs	5 µs	10 µs
Recovery time				
with no load cap	40 µs	12 µs	–	–
with 1µF load cap (ESR = 50 mΩ)	–	20 µs	12 µs	–
with 6.8µF load cap (ESR = 50 mΩ)	–	–	14 µs	15 µs
with 150µF load cap (ESR = 50 mΩ)	150 µs	–	–	35 µs
Maximum peak voltage				
deviation with no load cap	250 mV	260 mV	–	–
with 1µF load cap (ESR = 50 mΩ)	–	290 mV	140 mV	–
with 6.8µF load cap (ESR = 50 mΩ)	–	–	140 mV	60 mV
with 150µF load cap (ESR = 50 mΩ)	65 mV	–	–	45 mV

Over-voltage protection:	
Range	0 to 15 V
Accuracy	0.05% + 5 mV
Response time[1]	< 40 µs
Current programming speed and settling time:	
Rise time from 10% to 90% of step	
3 A range with a 0-1.5 A step	3 µs
1 mA range with a 0- 0.5mA step	1 ms
Settling time to 0.1% of step	
3 A range with a 0-1.5 A step	20 µs
1 mA range with a 0-0.5 mA step	7 ms
High frequency output current noise: (CC rms from 20 Hz – 20 MHz)	
3 A range	1 mA
1 mA range	1 µA
Current programming small signal bandwidth:	
-3 dB	
3 A range	DC to 100 kHz
1 mA range	DC to 1 kHz
Current measurement noise: (peak value)	
3 A range	305.2 µA
1 mA range	1.1 µA
100 µA range	25 nA
Current measurement settling time: (to 1% of the specified step with no range change)	
3 A range with a 0.5-1 A step	35 µs
1 mA range with a 0.5-1 mA step	120 µs
100 µA range with a 50-100 µA step	300 µs
	(to 1% of the specified range with down-ranging)
Down-ranging from 3 A range to:	
1 mA range	200 µs
100 µA range	2 ms

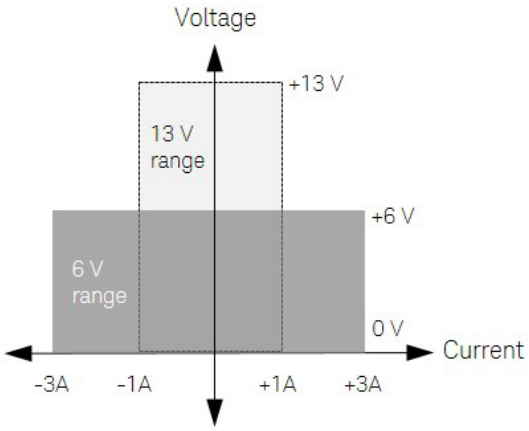
1. Response time applies from the occurrence of the over-voltage condition to the start of output shutdown.

Supplemental Characteristics (continued)

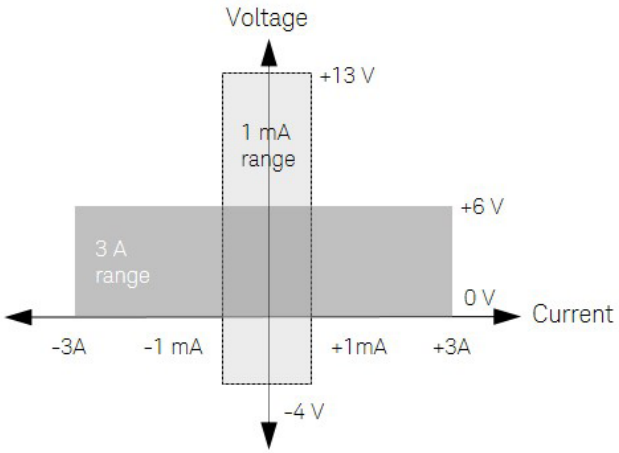
M9111A	
Current measurement small signal bandwidth:	
–3 dB	
3 A range	DC to 28 kHz
1 mA range	DC to 10 kHz
100 µA range	DC to 1 kHz
–1 dB	
3 A range	DC to 16 kHz
100 mA range	DC to 6 kHz
100 µA range	DC to 800 Hz
Current priority transient characteristic: (with 4.25' twisted pair load leads)	
3A range with a 1.5-3.5 V step	
Current settling band	40 mA
Recovery time	5 µs
Common mode current from 20 Hz – 20 MHz: (with negative output connected to chassis)	
CC peak-to-peak	< 1 mA
CC rms	< 75 µA
Remote sense capability:	
Outputs can maintain specifications with up to a 1-volt drop per load lead. The load lead drop reduces the maximum available voltage at the load.	
Measurement digitizer:	
Digitize voltage and current at ~200 ksamples/s, 1M readings	
Regulatory compliance:	
EMC	Complies with European EMC Directive 2014/30/EU – IEC/EN 61326-1 – CISPR 11, Group 1, class A – AS/NZS CISPR 11 Complies with South Korea KC mark This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme à la norme NMB-001 du Canada.
Safety	Complies with European Low Voltage Directive 2014/35/EU.
Environmental conditions:	
Temperature range	0°C to 45°C
Relative humidity	Up to 95% (non-condensing)
Altitude	Up to 2000 meters
Storage temperature	–40°C to 70°C
Output terminal isolation:	
Maximum rating	No output terminal may be more than 60 VDC from any other terminal or chassis ground.
Net weight:	
	0.41 kg (0.90 lbs)
Dimensions:	
	3U, 1-slot, PXIe module 19.9 mm W x 128.4 mm H x 212.6 mm D (0.784 in. x 5.06 in. x 8.37 in.)

Output Quadrant Characteristic

Voltage Priority Mode



Current Priority Mode

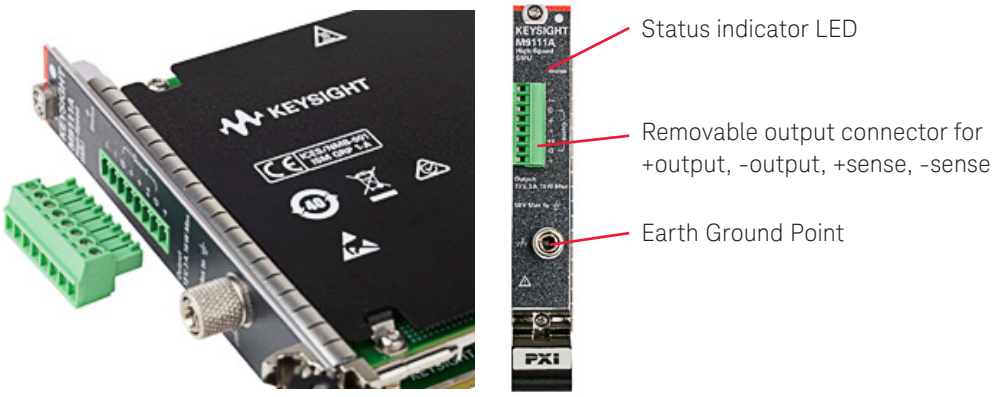


Measurement Accuracy and Resolution
(with shorter measurement intervals)

The following table shows changes to the short-term measurement accuracy and resolution with various number of power line cycle (NPLC) measurement settings. Changes are due to the A-to-D converter's noise performance. The table's baseline is 1 NPLC with no added noise. To determine the measurement accuracy at shorter averaging intervals, simply add the noise value to the fixed accuracy value in the specification table.

NPLC @ 60 Hz:	0.0003	0.003	0.006	0.010	0.031	0.06	0.1	0.6	1
Time:	5.1E-6	51.2E-6	102.4E-6	169E-6	512E-6	998.4E-6	1.7E-3	10E-3	16.7E-3
Averaged points:	1	10	20	33	100	195	325	1953	3255
3A range noise:	305.2E-6	119.5E-6	73.8E-6	72.8E-6	34.8E-6	30.3E-6	19.2E-6	7.8E-6	7.6E-6
Resolution (bits):	13.3	14.6	15.3	15.3	16.4	16.6	17.3	18.5	18.6
1mA range noise:	1.1E-6	290.6E-9	193.0E-9	191.0E-9	45.8E-9	28.7E-9	18.0E-9	3.2E-9	2.9E-9
Resolution (bits):	9.8	11.7	12.3	12.4	14.4	15.1	15.8	18.3	18.4
100 uA range noise:	25.0E-9	20.9E-9	17.0E-9	10.3E-9	5.9E-9	3.2E-9	2.3E-9	547.5E-12	417.9E-12
Resolution (bits):	12.0	12.2	12.5	13.2	14.1	14.9	15.4	17.5	17.9

Front Panel Details



Ordering Information

Model	Description
M9111A	PXIe high-speed source/measure unit

Related Products

Model	Description
M9018A	PXIe 18-slot chassis
M9037A	PXIe high performance embedded controller

Web Resources

Visit our web sites for additional product information and literature.

M9111A PXIe High-Speed Source/Measure Unit
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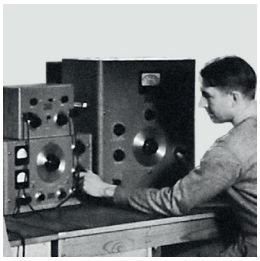

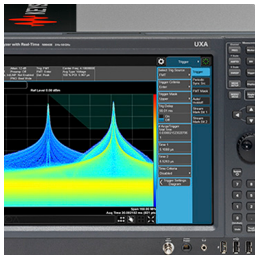

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Published in USA, February 21, 2018
5992-1541EN
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