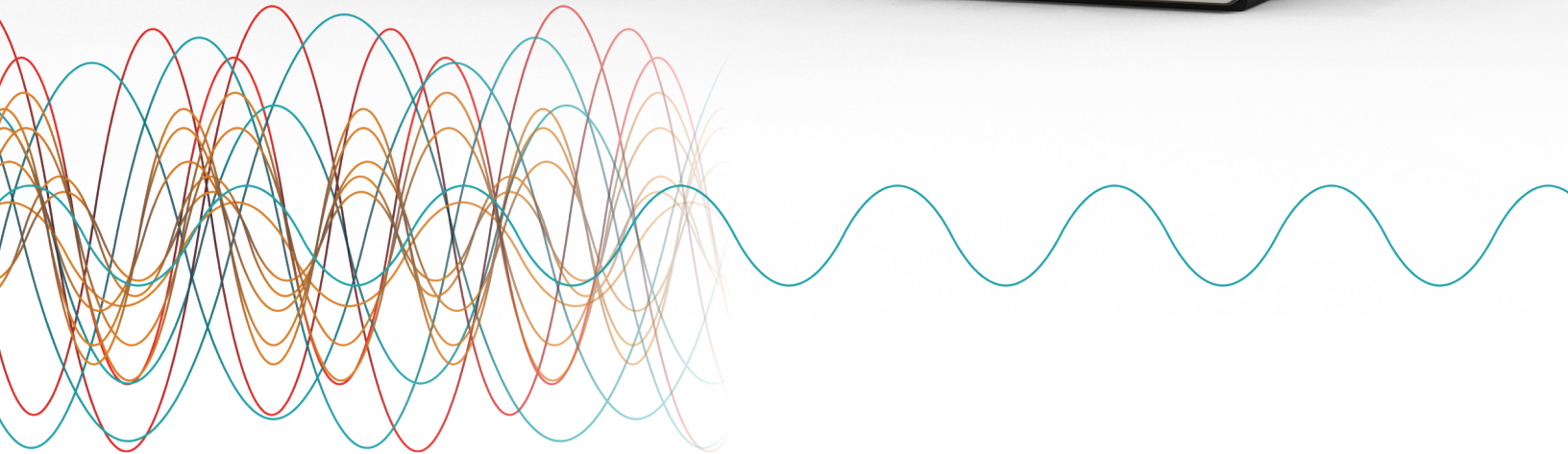


Measure Ready

M81  
SSM

SMU-10  
Low-noise DC/AC  
SMU



# First DC/AC SMU with ultra-sensitive lock-in detection

The source measure unit (SMU-10) is the latest module addition to the MeasureReady™ M81-SSM synchronous source measure system. It is specifically designed to handle the delicate nature of nano and ultra-cold samples with exceptionally low source noise and high measurement sensitivity. The SMU-10 offers both DC and AC capabilities and an integrated lock-in, providing a comprehensive suite of measurements tailored to advanced research applications.



*The SMU-10 is the latest module addition to the M81-SSM system*

Ultra-low  
noise

DC & AC  
capabilities

Integrated  
lock-in

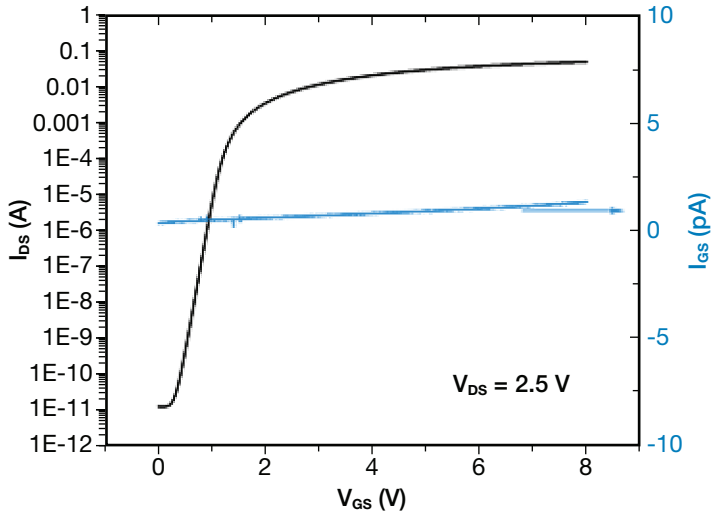
## All-in-one precision tool

The SMU-10 integrates 6 instruments into a unified solution

Measurement	Measure	Source
DC current	Down to <100 fA	Up to 100 mA
DC voltage	Down to microvolts	Up to 10 V
AC current	Sine (up to 100 kHz), triangle (up to 5 kHz), square (up to 5 kHz)	
AC voltage	Sine (up to 100 kHz), triangle (up to 5 kHz), square (up to 5 kHz)	
Lock-in	Down to nanovolts	N/A
Resistance	Milliohms to 100 GΩ	

# Ideal for multi-terminal device testing

## Three-terminal FET DC transfer curve



## Advanced resistance

The M81-SSM's advanced resistance mode compensates for phase shifts caused by parasitic capacitance in cryogenic environments, ensuring more accurate resistance measurements. This technique reduces errors significantly, improving measurement accuracy.

## Four-wire voltage monitoring

Ideal for high-current devices. The Sense-HI and Sense-LO leads enable 4-wire measurements for built-in device voltage monitoring while sourcing currents.

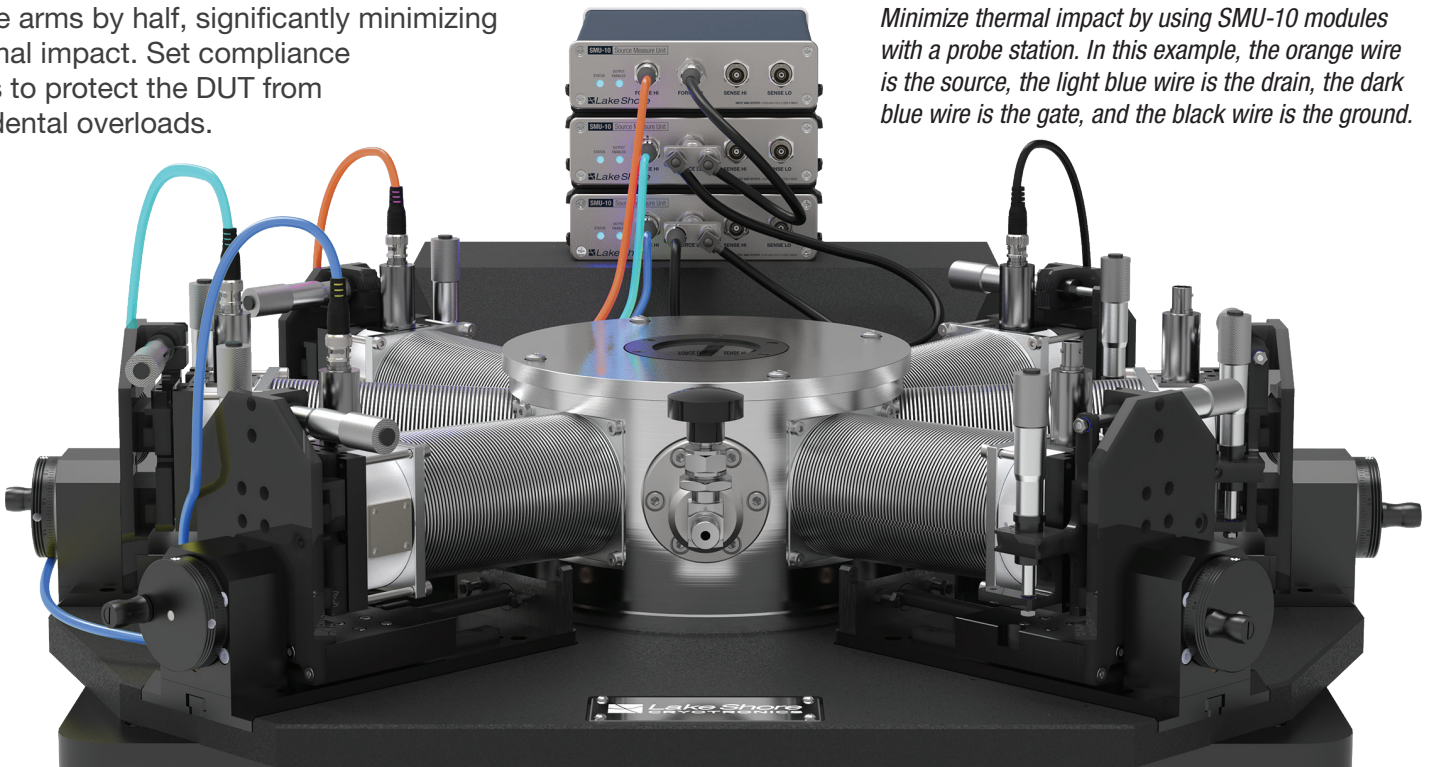
## Synchronized sampling

Patented MeasureSync™ technology ensures perfect timing coordination for AC or DC measurements across multiple SMU-10 modules, eliminating data misalignment errors.

## Source/measure

When testing multi-terminal devices in a cryogenic probe station, use the M81-SSM with SMU-10 modules to apply voltage or current to the DUT and measure the corresponding current or voltage. The SMU's topology reduces the number of probe arms by half, significantly minimizing thermal impact. Set compliance limits to protect the DUT from accidental overloads.

*Minimize thermal impact by using SMU-10 modules with a probe station. In this example, the orange wire is the source, the light blue wire is the drain, the dark blue wire is the gate, and the black wire is the ground.*





# Specifications

Voltage	Current
<b>Ranges:</b> 10 mV, 100 mV, 1 V, 10 V	<b>Ranges:</b> 1 nA, 10 nA, 100 nA, 1 $\mu$ A, 10 $\mu$ A, 100 $\mu$ A, 1 mA, 10 mA, 100 mA
<b>Measure sensitivity:</b> <3 nV <sup>1</sup>	<b>Measure sensitivity:</b> <1 fA <sup>1</sup>
<b>Source noise (DC to 10 MHz):</b> <0.2 mV RMS, <1.2 mV p-p (typical)	<b>DC output resistance:</b> >10 T $\Omega$ (typical)
	<b>Source noise (DC to 10 MHz):</b> <5 nA RMS, <25 nA p-p (typical)



SMU-10 front view

**Overvoltage protection:**  $\pm$ 200 VDC

**Maximum power:** 1 W, 4-quadrant operation

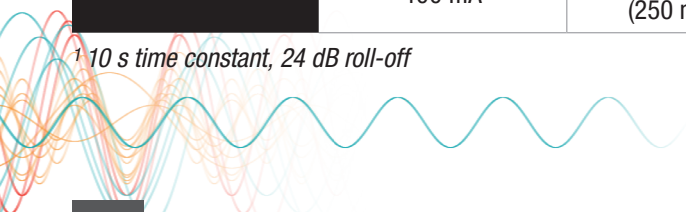
**Magnetic field exposure:** Operational up to 50 mT DC

**Size:** 142 mm (5.58 in) W  $\times$  38.9 mm (1.53 in) H  $\times$  245 mm (9.63 in) L

## Noise

	Range	Source		Measure	
		0.1 Hz to 10 Hz	1 kHz	0.1 Hz to 10 Hz	1 kHz
<b>Voltage noise (typical)</b>	10 mV	250 nV RMS	30 nV/ $\sqrt{\text{Hz}}$	250 nV RMS	27 nV/ $\sqrt{\text{Hz}}$
	100 mV	300 nV RMS	30 nV/ $\sqrt{\text{Hz}}$	300 nV RMS	28 nV/ $\sqrt{\text{Hz}}$
	1 V	550 nV RMS	30 nV/ $\sqrt{\text{Hz}}$	550 nV RMS	35 nV/ $\sqrt{\text{Hz}}$
	10 V	5 $\mu$ V RMS	80 nV/ $\sqrt{\text{Hz}}$	5 $\mu$ V RMS	165 nV/ $\sqrt{\text{Hz}}$
<b>Current noise (typical)</b>	1 nA	100 fA RMS (500 fA p-p)	6 fA/ $\sqrt{\text{Hz}}$ (at 10 Hz)	15 fA RMS (75 fA p-p)	6 fA/ $\sqrt{\text{Hz}}$ (at 10 Hz)
	10 nA	100 fA RMS (500 fA p-p)	20 fA/ $\sqrt{\text{Hz}}$ (at 100 Hz)	45 fA RMS (225 fA p-p)	20 fA/ $\sqrt{\text{Hz}}$ (at 100 Hz)
	100 nA	300 fA RMS (1.5 pA p-p)	60 fA/ $\sqrt{\text{Hz}}$ (at 100 Hz)	175 fA RMS (875 fA p-p)	60 fA/ $\sqrt{\text{Hz}}$ (at 100 Hz)
	1 $\mu$ A	1 pA RMS (5 pA p-p)	200 fA/ $\sqrt{\text{Hz}}$	1 pA RMS (5 pA p-p)	200 fA/ $\sqrt{\text{Hz}}$
	10 $\mu$ A	5 pA RMS (25 pA p-p)	1 pA/ $\sqrt{\text{Hz}}$	6 pA RMS (30 pA p-p)	1 pA/ $\sqrt{\text{Hz}}$
	100 $\mu$ A	50 pA RMS (250 pA p-p)	3 pA/ $\sqrt{\text{Hz}}$	60 pA RMS (300 pA p-p)	2 pA/ $\sqrt{\text{Hz}}$
	1 mA	500 pA RMS (2.5 nA p-p)	30 pA/ $\sqrt{\text{Hz}}$	550 pA RMS (2.75 nA p-p)	20 pA/ $\sqrt{\text{Hz}}$
	10 mA	5 nA RMS (25 nA p-p)	300 pA/ $\sqrt{\text{Hz}}$	5.5 nA RMS (27.5 nA p-p)	200 pA/ $\sqrt{\text{Hz}}$
	100 mA	50 nA RMS (250 nA p-p)	3 nA/ $\sqrt{\text{Hz}}$	55 nA RMS (1.375 $\mu$ A p-p)	2 nA/ $\sqrt{\text{Hz}}$

<sup>1</sup> 10 s time constant, 24 dB roll-off





## Accuracy

	Range	Source		Measure	
		DC <sup>2</sup> ± (% rdg + offset)	Lock-in <sup>2,3</sup> ± (% rdg + offset)	DC <sup>2</sup> ± (% rdg + offset)	Lock-in <sup>2,3</sup> ± (% rdg + offset)
Voltage accuracy	10 mV	0.15% + 300 μV	0.15% + 50 nV	0.15% + 300 μV	0.15% + 50 nV
	100 mV	0.1% + 300 μV	0.1% + 500 nV	0.1% + 300 μV	0.1% + 500 nV
	1 V	0.05% + 300 μV	0.05% + 5 μV	0.05% + 300 μV	0.05% + 5 μV
	10 V	0.05% + 500 μV	0.05% + 50 μV	0.05% + 500 μV	0.05% + 50 μV
Current accuracy	1 nA	0.5% + 300 fA	0.5% + 5 fA	0.5% + 300 fA	0.5% + 5 fA
	10 nA	0.1% + 300 fA	0.1% + 50 fA	0.1% + 300 fA	0.1% + 50 fA
	100 nA	0.1% + 300 pA	0.1% + 500 fA	0.1% + 300 pA	0.1% + 500 fA
	1 μA	0.1% + 300 pA	0.1% + 5 pA	0.1% + 300 pA	0.1% + 5 pA
	10 μA	0.05% + 3 nA	0.05% + 50 pA	0.05% + 3 nA	0.05% + 50 pA
	100 μA	0.05% + 30 nA	0.05% + 500 pA	0.05% + 30 nA	0.05% + 500 pA
	1 mA	0.05% + 300 nA	0.05% + 5 nA	0.05% + 300 nA	0.05% + 5 nA
	10 mA	0.05% + 3 μA	0.05% + 50 nA	0.05% + 3 μA	0.05% + 50 nA
	100 mA	0.05% + 10 μA	0.05% + 500 nA	0.05% + 10 μA	0.05% + 500 nA

## Settable resolution

	Range	Source	
		DC	AC <sup>4</sup>
Voltage settable resolution	10 mV	1 μV	100 nV
	100 mV	1 μV	300 nV
	1 V	10 μV	3 μV
	10 V	100 μV	100 μV
Current settable resolution	1 nA	10 fA	3 fA
	10 nA	100 fA	30 fA
	100 nA	1 pA	300 fA
	1 μA	10 pA	3 pA
	10 μA	100 pA	30 pA
	100 μA	1 nA	300 pA
	1 mA	10 nA	3 nA
	10 mA	100 nA	30 nA
	100 mA	1 μA	300 nA

<sup>2</sup> Total system accuracy, 1 year and ±5 °C from Lake Shore calibration, 24 h and ±1 °C from self-calibration, 95% confidence

<sup>3</sup> DC to 1 kHz or 10% of source range bandwidth, whichever is lower

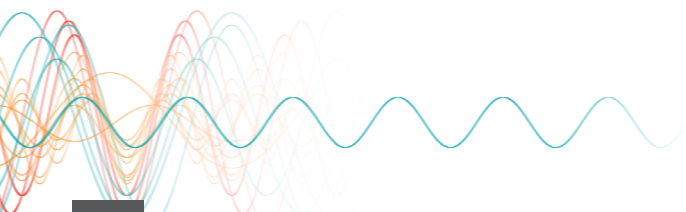
<sup>4</sup> Averaging over 60 NPLCs

## Temperature coefficient

	Range	Source <sup>2,3</sup>	Measure <sup>2,3</sup>
		$\pm$ (ppm rdg/ $^{\circ}$ C + offset/ $^{\circ}$ C)	$\pm$ (% rdg + offset)
Voltage temperature coefficient	10 mV	20 ppm/ $^{\circ}$ C + 25 $\mu$ V/ $^{\circ}$ C	25 ppm/ $^{\circ}$ C + 25 $\mu$ V/ $^{\circ}$ C
	100 mV	20 ppm/ $^{\circ}$ C + 25 $\mu$ V/ $^{\circ}$ C	25 ppm/ $^{\circ}$ C + 25 $\mu$ V/ $^{\circ}$ C
	1 V	20 ppm/ $^{\circ}$ C + 25 $\mu$ V/ $^{\circ}$ C	25 ppm/ $^{\circ}$ C + 25 $\mu$ V/ $^{\circ}$ C
	10 V	20 ppm/ $^{\circ}$ C + 25 $\mu$ V/ $^{\circ}$ C	25 ppm/ $^{\circ}$ C + 25 $\mu$ V/ $^{\circ}$ C
Current temperature coefficient <sup>1,2</sup>	1 nA	500 ppm/ $^{\circ}$ C + 25 fA/ $^{\circ}$ C	500 ppm/ $^{\circ}$ C + 25 fA/ $^{\circ}$ C
	10 nA	30 ppm/ $^{\circ}$ C + 250 fA/ $^{\circ}$ C	35 ppm/ $^{\circ}$ C + 250 fA/ $^{\circ}$ C
	100 nA	30 ppm/ $^{\circ}$ C + 3 pA/ $^{\circ}$ C	35 ppm/ $^{\circ}$ C + 2.5 pA/ $^{\circ}$ C
	1 $\mu$ A	55 ppm/ $^{\circ}$ C + 25 pA/ $^{\circ}$ C	55 ppm/ $^{\circ}$ C + 25 pA/ $^{\circ}$ C
	10 $\mu$ A	20 ppm/ $^{\circ}$ C + 130 pA/ $^{\circ}$ C	25 ppm/ $^{\circ}$ C + 125 pA/ $^{\circ}$ C
	100 $\mu$ A	20 ppm/ $^{\circ}$ C + 1.5 nA/ $^{\circ}$ C	25 ppm/ $^{\circ}$ C + 1.5 nA/ $^{\circ}$ C
	1 mA	20 ppm/ $^{\circ}$ C + 15 nA/ $^{\circ}$ C	25 ppm/ $^{\circ}$ C + 15 nA/ $^{\circ}$ C
	10 mA	20 ppm/ $^{\circ}$ C + 100 nA/ $^{\circ}$ C	25 ppm/ $^{\circ}$ C + 150 nA/ $^{\circ}$ C
	100 mA	20 ppm/ $^{\circ}$ C + 1.5 $\mu$ A/ $^{\circ}$ C	30 ppm/ $^{\circ}$ C + 1.5 $\mu$ A/ $^{\circ}$ C

## Impedance and bandwidth

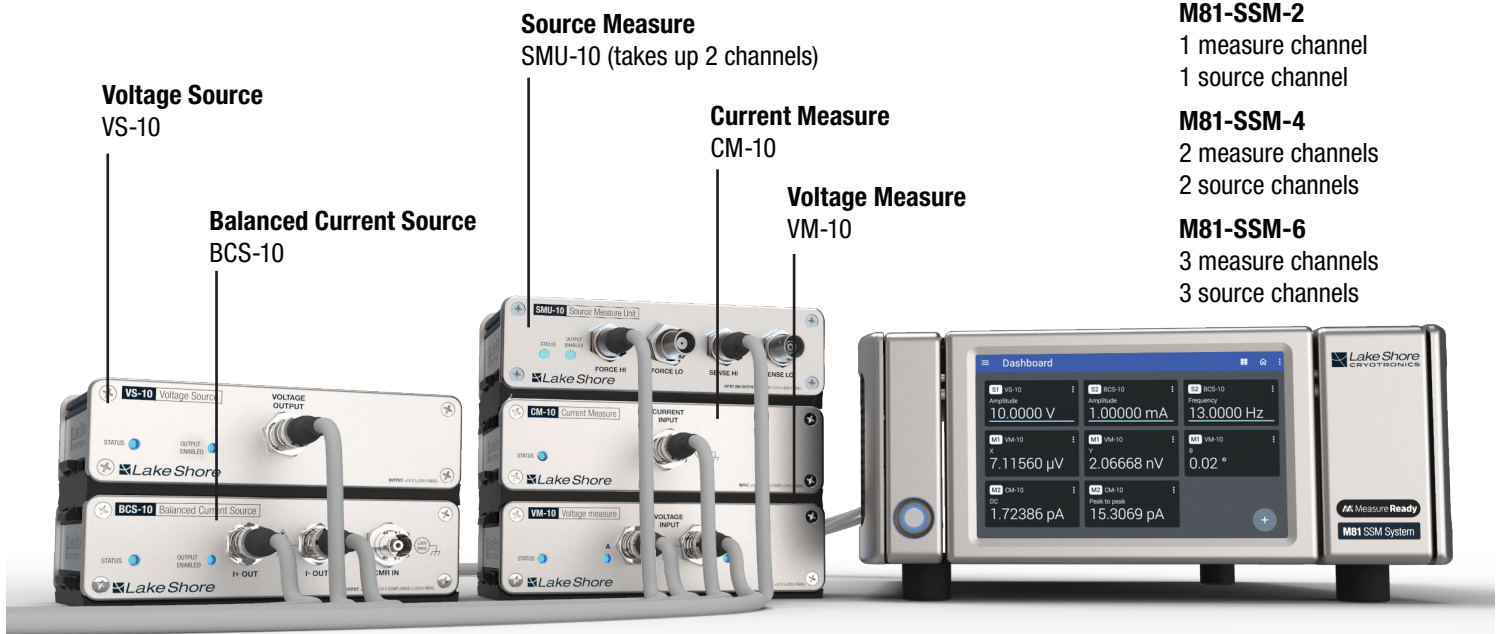
	Range	Impedance		Bandwidth (typical)	
		Output (source)	Input (measure)	Source	Measure
Voltage	10 mV	<10 m $\Omega$	>500 G $\Omega$ (typical)	60 kHz	60 kHz
	100 mV				
	1 V				
	10 V				
Current	1 nA	>10 T $\Omega$	100 k $\Omega$	100 Hz	350 Hz
	10 nA	>1 T $\Omega$	10 k $\Omega$	500 Hz	1.1 kHz
	100 nA	>100 G $\Omega$	1 k $\Omega$	1 kHz	2 kHz
	1 $\mu$ A	>10 G $\Omega$	100 $\Omega$	4 kHz	10 kHz
	10 $\mu$ A	>1 G $\Omega$	10 $\Omega$	10 kHz	25 kHz
	100 $\mu$ A	>100 M $\Omega$	1 $\Omega$	50 kHz	65 kHz
	1 mA	>10 M $\Omega$	100 m $\Omega$	100 kHz	>100 kHz
	10 mA	>1 M $\Omega$	20 m $\Omega$	100 kHz	>100 kHz
	100 mA	>100 k $\Omega$	10 m $\Omega$	100 kHz	>100 kHz



# M81-SSM system summary

The MeasureReady™ M81-SSM provides a reliable and streamlined approach for advanced measurement applications. Its modular design allows multiple compact modules to connect to the main M81-SSM instrument, enabling a variety of source and measure configurations. Available with two, four, or six channels, the M81-SSM dedicates half of its channels to measure modules and the other half to source modules.

The SMU-10, which occupies two channels (one for sourcing and one for measuring), exemplifies this flexibility. While it can operate on a single source channel, that setup limits its measurement functionality. The M81-SSM simplifies complex instrumentation setups by integrating DC/AC sourcing, DC/AC measuring, resistance measurements, and lock-in capabilities into a single, ultra low-noise solution.



Available modules	Modes	Range	Ideal for
<b>Source measure</b> SMU-10	DC, sine (up to 100 kHz), triangle (up to 5 kHz), square (up to 5 kHz); current/voltage, lock-in	0 mV to 10 V 1 nA to 100 mA	Monitoring current while forcing voltage, simplifying wiring, and multi-terminal device measurements
<b>Current measure</b> CM-10	DC, AC, lock-in	1 nA to 100 mA	Ultra-low noise current measurements
<b>Voltage measure</b> VM-10	DC, AC, lock-in	0 mV to 10 V	Differential measurements that minimize environmental noise and seamless ranging
<b>Voltage source</b> VS-10	DC, sine (up to 100 kHz), triangle (up to 5 kHz), square (up to 5 kHz)	10 mV to 10 V	Sourcing small AC signals on large DC offsets with the lowest noise
<b>Balanced current source</b> BCS-10	DC, sine (up to 100 kHz), triangle (up to 5 kHz), square (up to 5 kHz)	10 nA to 100 mA	Differential measurements that minimize environmental noise



Measure Ready

M81  
SSM

**Questions? Answers?**

Visit <http://forums.lakeshore.com/>  
and become part of the conversation!

The screenshot shows the Lake Shore Cryotronics User Group Forum website. At the top is the Lake Shore Cryotronics logo. Below it is the text "User Group Forum". There is a navigation bar with "Home" and "Search" links, and a search input field. A breadcrumb trail shows "Lake Shore > Material Characterization Products > Meas". Below this is a prompt: "Talk to fellow users and Lake Shore experts". A "Sub-Boards" section is visible, containing a table with one entry: "I/V source discussion" with a folder icon and a description: "Discuss Lake Shore I/V source applications, revie".

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