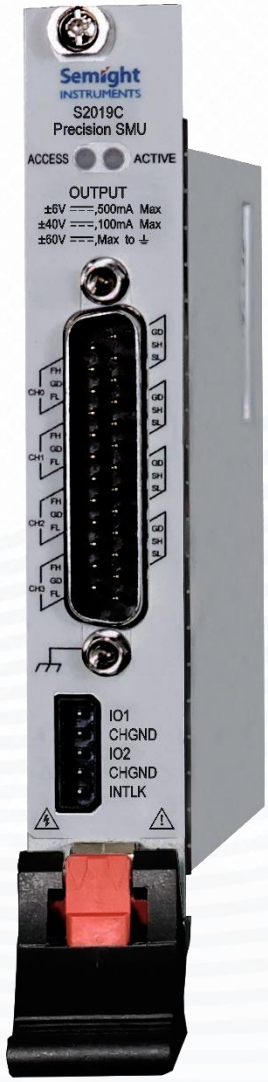
Precision SMU

S2019C

Datasheet V1.2

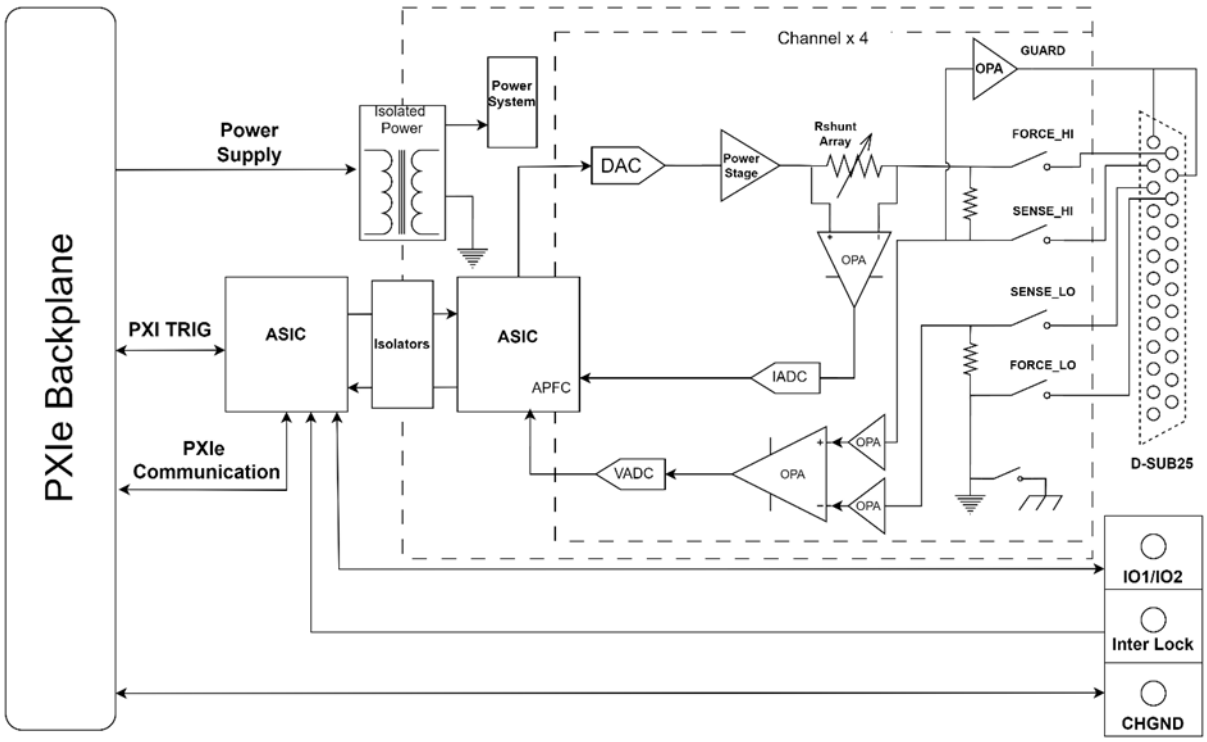


Based on SMU digital control loop technology, the S2019C achieves precise and rapid output characteristics while significantly reducing module size. It complies with PXIe standard, is compatible with existing mainstream PXIe chassis, features high integration, and enables multi-module synchronization testing. It provides four independent channels, each with ±40 V, ±500 mA (DC), ±1 A (pulsed) output, a maximum sampling rate of 1 Msps, and a minimum measurement resolution of 1 pA/1 μV.

Contents

1 Product Description

The Semight S2019C is a compact and cost-effective 4-channel Precision Source/Measure Unit (SMU) with the capability to source and measure both voltage and current. It delivers output up to ±40 V, ±500 mA (DC), and ±1 A (pulsed) and supports conventional SCPI commands for easy test code migration. Compatible with existing mainstream PXIe chassis, it offers high integration, enabling easy channel expansion and multi-module synchronization. These features improve efficiency and lower the cost when integrating the SMUs into systems for production test.



S2019C Block Diagram

2 Features and Benefits

APFC System

Supports user modification of APFC (Adaptive Precision-Fast Control) parameters. Users can adjust the parameters based on load characteristics to achieve precise and rapid output characteristics.

Waveforms Comparison Before and After APFC Adjustment

Maximum Range

Output range: ±40 V, ±500 mA (DC), ±1 A (pulsed). A single module enables easy LIV sweep testing.

Minimum Measurement Resolution

Current and voltage measurement resolution down to 1 pA/1 μV. Can make multi-channel precision measurements using a low-cost PXIe SMU that were previously only possible using multiple high-precision modules.

High-Speed Measurement

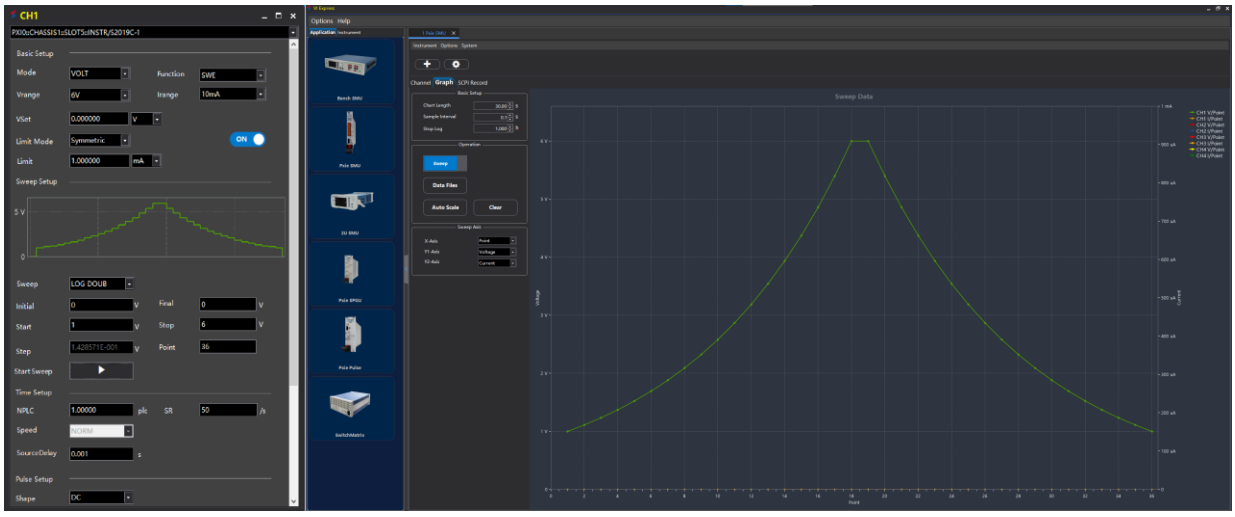
ADC sampling rates up to 1 Msps, with selectable NPLC (Number of Power Line Cycles) and sampling rate.

Sensing Mode

Supports 2-wire or 4-wire (remote-sensing) connections. Maximum sense lead resistance is 1 KΩ (for rated accuracy). Maximum voltage between output and sense terminals is 2 V.

Sweep Mode

Supports linear, logarithmic, and list sweeps in both single and double directions. The step interval is configurable from 1 µs to 16 s, with a maximum of 10^6 points per sweep.



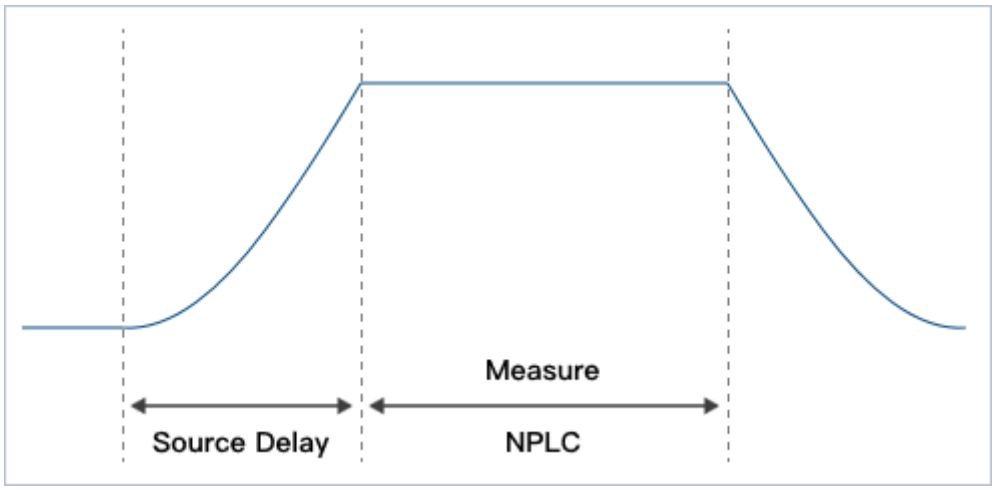
Double Logarithmic Sweep

Auto Ranging

Supports auto-ranging for both spot and sweep measurements. For overshoot-sensitive devices, it is recommended to turn off the output before switching ranges.

Source Delay

Supports Source Delay measurement. Users are recommended to set an appropriate Source Delay for more accurate measurements. Source Delay must exceed the source settling time, especially for low current ranges. When the sampling values are inaccurate, it is necessary to consider whether the Source Delay is appropriately set.



Source Delay and NPLC Setting Diagram

Protection

- Over-temperature protection: The system power shuts down at over temperature sensed internally.

- Over-current and over-voltage protection: If triggered, the module LED turns red, then operation resumes after a hardware reset command or power cycling.
- If the module LED fails to light, a problem may exist with a hardware module.

Synchronous Triggering

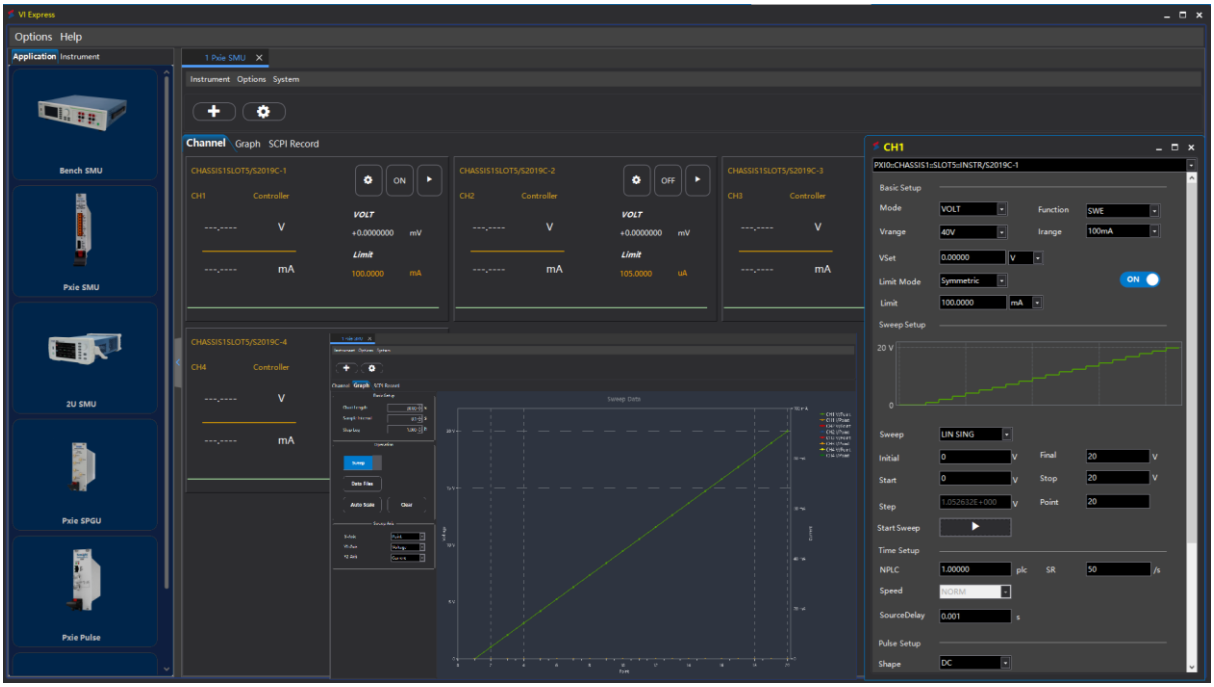
- Supports multi-module synchronous triggering using both internal (8 Trig Bus lines, 0 to 7) and external (2 Digital I/O lines, 1 to 2) trigger sources. Configure the internal Trig I/O to ensure all modules are on the same routing segment within the chassis. If not, the internal Trig I/O can be routed to the corresponding I/O via the chassis host software.
- The following principles must be adhered to for both internal and external triggering: A channel can be configured with multiple I/O ports for trigger output, but only a single I/O port can be configured for trigger input at any given time; An I/O port can be configured as a trigger input for multiple channels, but it can only be configured as a trigger output for one channel at any given time.
- Pulse width: 100 ns to 1 ms (configurable); Active high.
- External DIO trigger level:

DIO Parameters	Max Rating Value
Absolute Maximum Input Voltage	5.25 V
Absolute Minimum Input Voltage	-0.25 V
Minimum Logic High Level	2.1 V
Maximum Logic Low Level	0.7 V
Maximum Logic Output Current	2 mA

Maximum Sink Current	-50 mA

Free PC-Based GUI Control Software

Can make measurements and control remotely from a PC without the need to program.



Software GUI

PC System Configuration

- Intel Core i7 or higher
- Minimal 8 GB memory (additional memory required based on actual application)
- Windows 11 / Windows 10 (64-bit) / Windows 7 (64-bit, with required patches for driver installation)

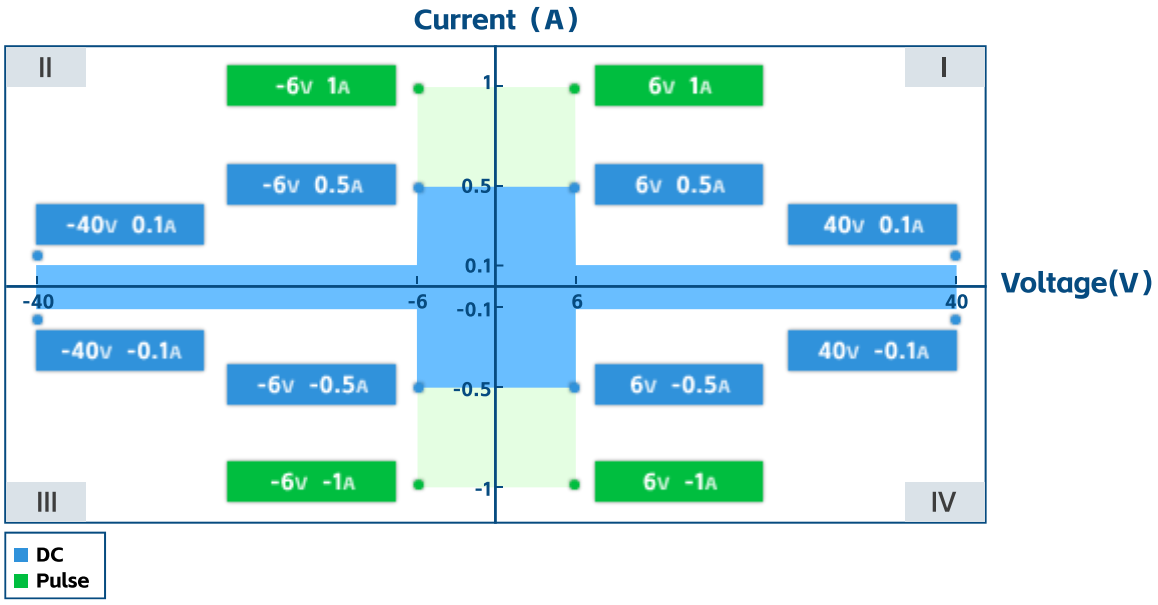
- Installation of the Semight driver is required to configure and operate the module

3 Specifications

Operating Conditions:

- Temperature: 23 °C ± 5 °C.
- Humidity: 30% to 60% (RH).
- Measure after a 60-minute warm-up; Ambient temperature change less than ±3 °C during measurement.
- Calibration period: 1 year.
- Measurement speed: 1 PLC (power line cycle).
- Fans set to the highest setting if the PXIe chassis has multiple fan speed settings.

SMU Output Capability



I-V Output Capability

Voltage Programming and Measurement Resolution/Accuracy

	Range	Resolution	Accuracy (1 Year) ± (% reading + offset)[1]	*Typical Noise (RMS) 0.1 Hz to 10 Hz*
Voltage Accuracy	±40 V[3]	10 μV	0.015% + 1.2 mV	*50 μV*
	±6 V	1 μV	0.015% + 600 μV	*10 μV*
Temperature Coefficient	± (0.15 × Accuracy)/°C (0 °C to 18 °C, 28 °C to 50 °C)			
Channel[2]	CH0 to CH3			
Output Power	Maximum power per channel: 4 W Maximum total power for four channels: 8 W			
Overshoot	< ±0.1% (Typical, Normal; Step is 10% to 90% range, full-scale, resistive load)			
Noise 10 Hz to 20 MHz	< 3 mVrms, 6 V voltage source, 0.5 A resistive load			

[1] Example of calculating accuracy: To test the accuracy of a 1 V output in the 6 V range, the tolerance is:

$$\pm\left(\underbrace{1000000}_{reading} \times 0.015\% + \underbrace{600}_{offset}\right)\mu V = \pm 750\,\mu V$$

[2] Channels are isolated from earth ground, but share a common LO.

[3] This instrument has a potentially dangerous high voltage (±42 V) output to the HI / Sense HI / Guard terminals. To prevent electric shock, relevant safety precautions must be taken before powering on. Do not connect the Guard terminal to any output, including shorting it to the chassis ground or output LO, as this will damage the instrument.

Current Programming and Measurement Resolution/Accuracy

	Range	Resolution	Accuracy (1 Year) ± (% reading + offset)	*Typical Noise (RMS) 0.1 Hz to 10 Hz*
Current Accuracy	±1 A[4][5]	500 nA	0.1% + 125 µA	*20 µA*
	±500 mA[5]			
	±100 mA	100 nA	0.03% + 25 µA	*2 µA*
	±10 mA	10 nA	0.03% + 2.5 µA	*200 nA*
	±1 mA	1 nA	0.03% + 250 nA	*20 nA*
	±100 µA	100 pA	0.03% + 25 nA	*2 nA*
	±10 µA	10 pA	0.03% + 3 nA	*200 pA*
	±1 µA	1 pA	0.03% + 500 pA	*30 pA*
Temperature Coefficient	± (0.15 × accuracy)/°C (0 °C to 18 °C, 28 °C to 50 °C)			
Channel	CH0 to CH3			
Output Power	Maximum power per channel: 4 W Maximum total power for four channels: 8 W			
Overshoot	< ±0.1% (Typical, Normal; Step is 10% to 90% range, full-scale, resistive load)			

[4] 1 A range is available only for pulse mode, with typical accuracy.

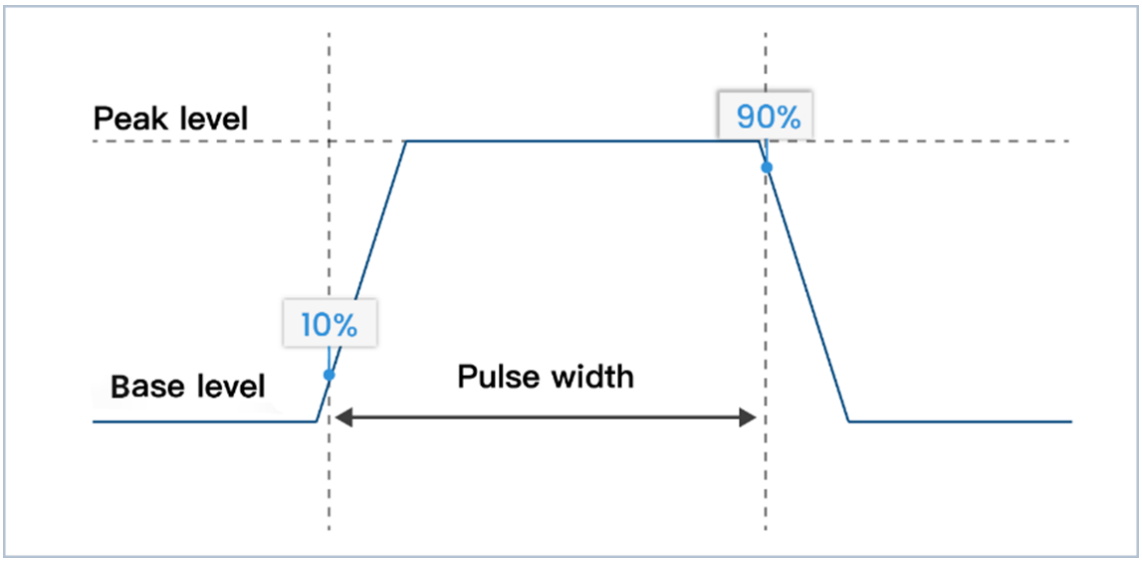
[5] 1 A and 500 mA ranges are available only for the 6 V voltage range.

Resistance Measurement Resolution/Accuracy (4-Wire)

	Range	Resolution	Default Test Current	Typical Accuracy (1 Year) ± (% reading + offset)
Resistance Measurement Accuracy	10 Ω	10 μΩ	100 mA	0.07% + 6 mΩ
	100 Ω	100 μΩ	10 mA	0.07% + 60 mΩ
	1 KΩ	1 mΩ	1 mA	0.07% + 600 mΩ
	10 KΩ	10 mΩ	100 μA	0.07% + 6 Ω
	100 KΩ	100 mΩ	10 μA	0.075% + 60 Ω
	1 MΩ	1 Ω	1 μA	0.095% + 600 Ω
Temperature Coefficient	± (0.15 × Accuracy)/°C (0 °C to 18 °C, 28 °C to 50 °C)			
Manual Current Source Resistance Measurement (4-Wire)	Total Error = Measured Voltage / Current Source Set Current = Resistance Reading x (Voltage Source Range Gain Error Percentage + Ammeter Range Gain Error Percentage + Current Source Range Offset Error / Set Current) + (Voltage Source Range Offset Error / Set Current Value) Example: Current Source Set Current = 100 mA, Voltage Measurement Range = 6 V Total Error = (0.015% + 0.03% + 25 μA / 100 mA) + (600 μV / 100 mA) ≈ 0.07% + 6 mΩ			

Pulse Source Specifications

Item	Specification
Minimum Programmable Pulse Width	100 μs
Pulse Width Programming Resolution	1 μs
Pulse Width Programming Accuracy	±10 μs
Pulse Width Jitter	2 μs
Pulse Width Definition	The time from 10% leading to 90% trailing edge as follows



Pulse Width Definition

Maximum Current Limit	Maximum Pulse Width	Maximum Duty Cycle
0.1 A/40 V	DC, no limit	100%
0.5 A/6 V	DC, no limit	100%
1 A/6 V	10 ms	10%

Pulse Source Rise Time

Output	Maximum Output	Rise Time[6]	Settling Time[7]	Test Load
Voltage Source	40 V	150 µs	< 300 µs	No load
	6 V	50 µs	< 200 µs	
Current Source	1 A to 500 mA	150 µs	< 400 µs	Full load[8]
	100 mA	80 µs	< 300 µs	
	10 mA	180 µs	< 700 µs	
	1 mA	170 µs	< 600 µs	
	100 µA	200 µs	< 800 µs	
	10 µA	1 ms	< 2 ms	
	1 µA	2.5 ms	< 5 ms	

[6] Time required for the pulse leading edge to rise from 10% to 90%.

[7] Time required for the pulse to reach within 1% of final value.

[8] Test conditions: Normal mode, resistive full load, voltage rises to 6 V.

Output Settling Time

Output	Range	Output Settling Time[9]			Condition
		Fast[10]	Normal	Slow	
Voltage Source	40 V	< 250 µs	< 350 µs	< 500 µs	Time required to reach within 0.1% of final value at open load condition. Step is 10% to 90% range.
	6 V	< 100 µs	< 200 µs	< 500 µs	
Current Source	500 mA	< 300 µs	< 400 µs	< 700 µs	Time required to reach within 0.1% of final value under Normal mode at full load with the voltage output rising to 6 V. Step is 10% to 90% range.
	100 mA	< 200 µs	< 300 µs	< 500 µs	
	10 mA	< 300 µs	< 700 µs	< 1 ms	
	1 mA	< 300 µs	< 600 µs	< 1 ms	
	100 µA	< 300 µs	< 800 µs	< 2 ms	
	10 µA	< 1 ms	< 2 ms	< 3 ms	
	1 µA	< 3 ms	< 5 ms	< 6 ms	

[9] Output slew rate: Fast, Normal, Slow modes. Users can adjust APFC parameters according to load characteristics to achieve appropriate settling time or stability. Mode switching is only supported when OUTPUT is OFF.

[10] Fast mode may exhibit significant output overshoot under different ranges or load conditions. For devices sensitive to overshoot, Normal or Slow mode is recommended.

Sampling Rate and NPLC Setting

Setting	Range
NPLC	0.00005 PLC to 10 PLC
Sampling Rate	5 sps to 1 Msps

Measurement Accuracy Derating

Add % of range using the following table for measurement with PLC < 1.

PLC	Range				
	6 V, 40 V	1 µA	10 µA	100 µA to 100 mA	500 mA
0.1	0.01%	0.02%	0.03%	0.01%	0.02%
0.01	0.03%	0.20%	0.06%	0.02%	0.04%
0.001	0.3%	2.50%	0.4%	0.3%	0.4%

Environmental Specifications

Item	Specification
Environment	For use in indoor facilities
Operating	0 °C to +50 °C, 30% to 60% RH, non-condensing
Storage	-30 °C to 70 °C, 10% to 90% RH, non-condensing
Dimensions	210 x 130 x 20 mm
Weight	Net weight: 0.46 kg
Power Supply	Full Load: 12 V/2.5 A; 3.3 V/0.5 A; 5 V/0.01 A
Altitude	Operating: 0 m to 2000 m, Storage: 0 m to 4600 m
Pollution Degree	2
Warm-Up	1 hour

4 Ordering Information

Standard Factory Accessories: Output connector (cable not included), Digital I/O connector (cable not included), Installation Software USB Drive (PC software and product driver, PDF product datasheet, PDF user manual).

Model Number	
S2019C	Precision SMU
Options	
TA-03007	Output Extension Cable, DB25 Female-to-Female (F/F), 1 m, PVC
Service	
R3C	Factory Extended Warranty Service Plan – 36 Months
R5C	Factory Extended Warranty Service Plan – 60 Months

5 Warranty

No.	Item	Content	Warranty Period
1	Main Unit	Free repair within warranty	12 months
2	Options	Consumables and accessories are not covered under warranty	3 months
3	Calibration Interval	Factory calibrated or calibrated at the nearest Semight service center	12 months

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