

S3012H

Single-Channel Precision Source Meter

Version 1.9



Product Description

The S3012H precision source meter is compact and cost-effective bench-top Source/Measure Units (SMUs) with the capability to source and measure both voltage and current. These capabilities make the S3012H ideal for a wide variety of IV (current versus voltage) measurement tasks that require both high resolution and accuracy.

The S3012H provides best-in-class performance for a modest price. They have broad voltage (± 200 V) and current (± 3 A DC and ± 10 A pulsed) sourcing capability, excellent precision (minimum 100 fA/100 nV measuring resolution) and possess a superior color LCD graphical user interface (GUI). In addition, several task-based viewing modes dramatically improve productivity for test, debug, and characterization.

The S3012H offers unmatched measurement throughput and supports conventional SMU SCPI commands for easy test code migration. These features improve efficiency and lower the cost of ownership when integrating the SMUs into systems for production test.

Key Features

| Feature | Benefit |
|---|--|
| Integrated 4-quadrant sourcing and measuring capabilities | Easily and accurately measure current and voltage using a single instrument without the need to manually change any connections |
| Measurement range: ± 200 V, ± 3 A (DC), ± 10 A (pulsed) | A single SMU product covers both high voltage and high current measurement needs, allowing for more standardization and simplifying inventory and support concerns |
| Source and measurement resolution down to 100 fA and 100 nV | Can make low-level measurements using a low-cost bench-top SMU that were previously only possible using a more expensive semiconductor device analyzer |

| | |
|---|---|
| Fast measurement | Up to 1M ADC sampling rate, NPLC and sampling rate optional setting |
| User-friendly front panel GUI with 5.0 inch capacitive touchscreen supports both graphical and numerical view modes | Can quickly and easily perform measurements and display data on the front panel, thereby greatly speeding up interactive test, characterization and debug operations |
| Free quick V/I control software | Can make measurements remotely from a PC without the need to program |
| Supports both conventional and default SCPI commands | Conventional SCPI commands provide some compatibility with older SMU code (such as Keithley 2400 series) to minimize code conversion work |
| Synchronization | Highspeed/ low - delay multi-channel synchronization with hardware technology |
| Digital I/O | Flexibly configured High-speed Digital I/O, support threshold value triggering, so as to realize efficient interaction between output measured values and user system |
| Small form factor with USB2.0, LAN | Easy integration into rack and stack systems |

Applications

The S3012H has a broad application range that spans uses from R&D and education to industrial development, production test and automated manufacturing. Moreover, they work equally well as either standalone or system components.

Testing semiconductors, discrete and passive components

- Diodes, laser diodes, LEDs
- Photodetectors, sensors
- Field effect transistors (FETs), bipolar junction transistors (BJTs)
- ICs (analog ICs, RFICs, MMICs, etc.)
- Resistor, varistor, thermistors, switches

Testing precision electronics and green energy devices

- Photovoltaic cells
- Power transistors, power devices
- Battery
- Automotive
- Medical instruments
- Power and DC bias source for circuit test

Research and education

- New material investigations
- Nano devices characterization (e.g. CNT)
- Giant magnetic resistance (GMR)
- Organic devices
- Any precise voltage/current source and measurement Specification

Technical Specification

Temperature: $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$

Humidity :30% to 70% RH

Calibration period:1 Year

Measurement speed: 1PLC (power line cycle)

After 60 minutes warm-up, ambient temperature changes less than $\pm 3\text{ }^{\circ}\text{C}$

Voltage source specifications

| Voltage programming accuracy | Range | Programming resolution | Accuracy (1 Year) \pm (% reading+ offset) | Typical Noise (RMS) 0.1 Hz-10 Hz |
|------------------------------|--|------------------------|--|-------------------------------------|
| | $\pm 200\text{ V}$ | 1 mV | 0.02%+30 mV | 1.5 mV |
| | $\pm 20\text{ V}$ | 100 μV | 0.02%+2 mV | 160 μV |
| | $\pm 6\text{ V}$ | 50 μV | 0.02%+500 μV | 36 μV |
| | $\pm 200\text{ mV}$ | 1 μV | 0.02%+120 μV | 4 μV |
| Temperature coefficient | $\pm(0.15 \times \text{accuracy})/^{\circ}\text{C}$ (0 $^{\circ}\text{C}$ -18 $^{\circ}\text{C}$,28 $^{\circ}\text{C}$ -50 $^{\circ}\text{C}$) | | | |
| Maximum output power | 30W: $\pm 20\text{V}@1.5\text{A}$, $\pm 200\text{V}@0.1\text{A}$; 18W: $\pm 6\text{ V}@3\text{A}$ | | | |
| Settling time | <800 μs (typical) | | | |
| Overshoot | < $\pm 0.1\%$ (Typical. Normal mode. Step is 10 % to 90 % range, full range, resistive load) | | | |
| Noise 10Hz-20MHz | 6 V voltage source, 3 A resistive load, <3 mVrms | | | |

Current source specifications

| Current programming accuracy | Range | Programming resolution | Accuracy (1 Year) \pm (% reading+ offset) | Typical Noise (RMS) 0.1 Hz-10 Hz |
|------------------------------|---------------------|------------------------|--|-------------------------------------|
| | $\pm 10\text{ A}^1$ | 50 μA | 0.4% + 40 mA | NA |
| | $\pm 3\text{ A}$ | 15 μA | 0.05%+2 mA | 40 μA |
| | $\pm 1.5\text{ A}$ | 10 μA | 0.02%+500 μA | 20 μA |

| | | | | |
|--------------------------------|---|--------|--------------|--------|
| | ±150 mA | 1 µA | 0.02%+25 µA | 5 µA |
| | ±15 mA | 100 nA | 0.02%+6 µA | 700 nA |
| | ±1.5 mA | 10 nA | 0.02%+250 nA | 16 nA |
| | ±150 µA | 1 nA | 0.02%+25 nA | 1 nA |
| | ±15 µA | 100 pA | 0.02%+3 nA | 140 pA |
| | ±1.5 µA | 10 pA | 0.03%+450 pA | 25 pA |
| | ±150 nA | 1 pA | 0.05%+250 pA | 5 pA |
| Temperature coefficient | ±(0.15 × accuracy)/°C (0°C-18°C,28°C-50°C) | | | |
| Maximum output power | 30W: ±20V@1.5A, ±200V@0.1A;18W: ±6 V@3A | | | |
| Settling time | <500µs (typical) | | | |
| Overshoot | <±0.1% (Typical. Normal mode. Step is 10 % to 90 % range, full range, resistive load) | | | |

1,10 A range is available only for pulse mode, accuracy specifications for 10 A range are typical.

Voltage measurement specifications

| Voltage measurement accuracy | Range | Measurement resolution | Accuracy (1 Year) ± (% reading+ offset) |
|-------------------------------------|--------|------------------------|---|
| | ±200 V | 100 µV | 0.02% + 30 mV |
| | ±20 V | 10 µV | 0.02% + 2 mV |
| | ±6 V | 1 µV | 0.02% + 500 µV |

| | | | |
|--------------------------------|--|--------|---------------------|
| | ± 200 mV | 100 nV | 0.02% + 120 μ V |
| Temperature coefficient | $\pm(0.15 \times \text{accuracy})/^{\circ}\text{C}$ (0°C-18°C,28°C-50°C) | | |

Current measurement specifications

| | Range | Measurement resolution | Accuracy (1 Year) \pm (% reading+ offset) |
|-------------------------------------|--|------------------------|---|
| Current measurement accuracy | ± 10 A ¹ | 10 μ A | 0.4% + 25 mA |
| | ± 3 A | 10 μ A | 0.05%+2 mA |
| | ± 1.5 A | 1 μ A | 0.02%+500 μ A |
| | ± 150 mA | 100 nA | 0.02%+25 μ A |
| | ± 15 mA | 10 nA | 0.02%+6 μ A |
| | ± 1.5 mA | 1 nA | 0.02%+250 nA |
| | ± 150 μ A | 100 pA | 0.02%+25 nA |
| | ± 15 μ A | 10 pA | 0.02%+3 nA |
| | ± 1.5 μ A ² | 1 pA | 0.03%+450 pA |
| | ± 150 nA ² | 100 fA | 0.05%+250 pA |
| Temperature coefficient | $\pm(0.15 \times \text{accuracy})/^{\circ}\text{C}$ (0°C-18°C,28°C-50°C) | | |

1, 10 A range is available only for pulse mode, accuracy specifications for 10 A range are typical.

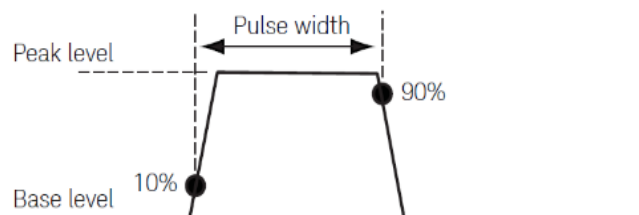
2, Low Current Measurements, Triaxial Cable is recommended to connect: Force Hi connect to core cable, Guard connects to inner shield, outer shield connects to protective ground, Force Lo connect to core cable, inner shield not connect, and outer shield connect to protective ground. Triaxial Cable rated insulation voltage is not less than 250V.

Resistance measurement specifications (4W)

| | Range | Measurement resolution | Test current | Typical accuracy (1 Year) ± (% reading+ offset) |
|---|--|------------------------|--------------|--|
| | 1 Ω | 1 μΩ | 1.5 A | 0.073% + 0.3334 mΩ |
| | 10 Ω | 10 μΩ | 150 mA | 0.057% + 3.334 mΩ |
| | 100 Ω | 100 μΩ | 15 mA | 0.08% + 33.34 mΩ |
| | 1 kΩ | 1 mΩ | 1.5 mA | 0.057% + 333.4 mΩ |
| | 10 kΩ | 10 mΩ | 150 μA | 0.057% + 3.334 Ω |
| | 100 kΩ | 100 mΩ | 15 μA | 0.06% + 33.34 Ω |
| | 1 MΩ | 1 Ω | 1.5 μA | 0.06% + 333.4 Ω |
| | 10 MΩ | 10 Ω | 0.15 μA | 0.35% + 3.334 kΩ |
| | 100 MΩ | 100 Ω | 0.05 μA | 0.95% + 10 kΩ |
| Temperature coefficient | ±(0.15 × accuracy)/°C (0°C-18°C,28°C-50°C) | | | |
| Source I mode, manual Ohm measurement (4-wire) | Total error = $V_{meas}/I_{src} = R \text{ reading} \times (\text{gain error \% of } V \text{ range} + \text{gain error \% of } I \text{ range} + \text{offset error of } I \text{ source range}/I_{src} \text{ value \%}) + (\text{offset error of } V \text{ measure range}/I_{src} \text{ value})$ Example: $I \text{ source value}=1.5A \text{ at } 1.5A \text{ range } V \text{ measure range}=6V \text{ range}$ Total error (% reading + offset) = $(0.02\%+0.02\%+500\mu A/1.5A+(500\mu V/1.5A)) \approx 0.073\%+0.3334m\Omega$ | | | |

Pulse source specifications (4W)

| | |
|------------------------------------|---|
| 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 |



| Item | Maximums | Maximum pulse width | Maximum duty cycle |
|------|--------------|---------------------|--------------------|
| 1 | 0.15 A/200 V | DC, no limit | 100% |
| 2 | 1.5 A/20 V | DC, no limit | 100% |
| 3 | 3 A/6 V | DC, no limit | 100% |
| 4 | 3 A/20 V | 1 ms | 10% |
| 5 | 10 A/6 V | 1 ms | 10% |

Typical Pulse Performance(4W)

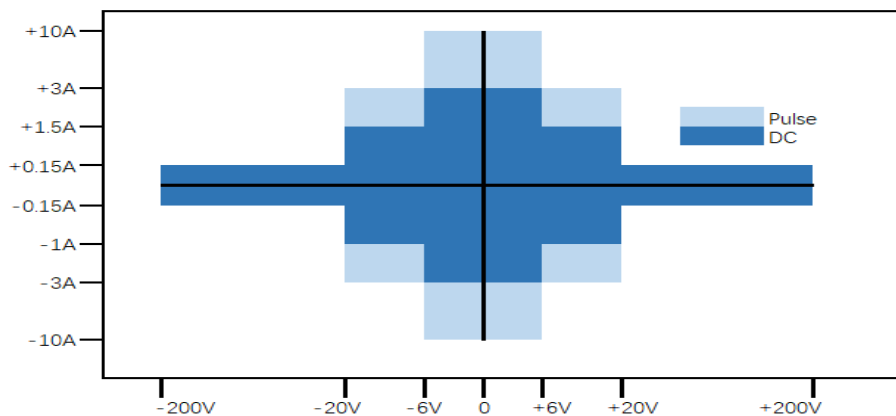
| Source | range | Typical rise time ^{1,3} | Typical Settling Time ^{2,3} | Test load |
|---------|--------|----------------------------------|--------------------------------------|-----------|
| Voltage | 200 V | 600 μ s | 1.5 ms | No load |
| | 20 V | 200 μ s | 360 μ s | No load |
| | 6 V | 160 μ s | 300 μ s | No load |
| Current | 10 A | 140 μ s | 320 μ s | Full load |
| | 3 A | 120 μ s | 280 μ s | Full load |
| | 1.5 A | 120 μ s | 280 μ s | Full load |
| | 150 mA | 120 μ s | 280 μ s | Full load |
| | 15 mA | 120 μ s | 280 μ s | Full load |
| | 1.5 mA | 120 μ s | 280 μ s | Full load |

1, Leading edge, the time from 10 % leading to 90 % leading

2, The time required from Pulse out 0 to reach within 1 % of final value

3, Pulse current source base 6V voltage range and 105 % range limit

I-V Out capability



Typical output settling time

| Source | Range | Output settling time | | | Condition |
|---------|-------------|----------------------|---------------------|-------------------|--|
| | | Fast ^{1,2} | Normal ¹ | Slow ¹ | |
| Voltage | 200 V | <1.3 ms | <1.5 ms | <2.5 ms | Time required to reach within 0.1 % of final value at open load condition. Step is 10 % to 90 % range |
| | 20 V | <300 μ s | <360 μ s | <1 ms | |
| | 6 V | <150 μ s | <250 μ s | <1 ms | |
| | 200 mV | <200 μ s | <250 μ s | <1 ms | |
| Current | 3 A | <200 μ s | <280 μ s | <1.2 ms | Time required to reach within 0.1 % (0.3 % for 3 A range) of final value at short condition. Step is 10 % to 90 % range, Pulse current source base 6V voltage range and 105% range limit |
| | 1.5 A | <200 μ s | <280 μ s | <1.2 ms | |
| | 150 mA | <200 μ s | <280 μ s | <1.2 ms | |
| | 15 mA | <200 μ s | <280 μ s | <1.2 ms | |
| | 1.5 mA | <200 μ s | <280 μ s | <1.2 ms | |
| | 150 μ A | <250 μ s | <300 μ s | <1.2 ms | |
| | 15 μ A | <250 μ s | <1.2 ms | <2 ms | |
| | 1.5 μ A | <600 μ s | <1.2 ms | <5 ms | |
| | 150 nA | <600 μ s | <5 ms | <12 ms | |

1, Output transition speed: Fast, Normal, Slow.

2, Slow mode is recommended for overshoot sensitive equipment, Fast mode may have overshoot on output in some condition

Sampling rate and NPLC setting

| Setting | Range |
|---------|----------------------|
| NPLC | 0.00005 PLC ~ 10 PLC |

| | |
|---------------|----------------|
| Sampling Rate | 5 sps ~ 1 Msps |
|---------------|----------------|

Derating accuracy with PLC setting < 1 PLC

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

| PLC | Range | | | | | | | |
|-------|--------|-------|---------------|-----------------------|------------|-------------|------------------|--------------|
| | 200 mV | 6 V | 20 V to 200 V | 150 nA to 1.5 μ A | 15 μ A | 150 μ A | 1.5 mA to 150 mA | 1.5 A to 3 A |
| 0.1 | 0.02% | 0.01% | 0.01% | 0.02% | 0.01% | 0.01% | 0.01% | 0.01% |
| 0.01 | 0.3% | 0.02% | 0.02% | 0.2% | 0.04% | 0.02% | 0.02% | 0.02% |
| 0.001 | 2.9% | 0.35% | 0.36% | 1% | 0.4% | 2.9% | 1.7% | 2.7% |

Supplemental characteristics

| | |
|--|---|
| Sensing Modes | 2-wire or 4-wire (Remote-sensing) connections |
| Maximum sense lead resistance: | 1 k Ω for rated accuracy |
| 2W internal voltage drop | <60 mV/A |
| Max voltage between Force and Sense | 2 V |
| Maximum output voltage in output connector | >range 105% (200V range>202V) |
| DC floating voltage | Max \pm 250 V DC between low force and chassis ground |
| Sweep | Sweep step time: from 20 μ s to 16 s, Max: 64K point |
| Auto range | Support, turn off output is recommended for overshoot sensitive equipment before range change |

| | |
|-----------------------------|--|
| Source delay | Support, It is recommended that users set appropriate source delay to obtain higher accuracy |
| Over temperature protection | The output will be turned off (also disable operation) when the SMU internal temperature is detected higher than 85 degrees. When the temperature returns to less than 65 degrees, operation recover |
| Over voltage protection | Turn off output when output voltage great than OVP setting value, recover operation after power reset, Accuracy: $\pm(1\%Setting+500mV)$ |
| Other abnormal protection | Power reset, recover operation or hardware damage |

WARNING: here are potentially hazardous voltages ($\pm 210V$) present at the High Force, High Sense, and Guard terminals of this instrument. To prevent electrical shock, the safety precaution must be done before turn on the instrument. Never connect the Guard terminal to any output, including chassis ground, or output LO, doing so will damage the instrument

Communication port

| | | |
|---------------------------|-----------------------|--|
| LAN | 100BASE-T / 10BASE-T | |
| USB | USB 2.0 HOST (front) | |
| | USB 2.0 DEVICE (back) | |
| Digital I/O DB9 | Pin5 | GND |
| MAX input voltage: 5.25 V | Pin6 | IO1, Digital I/O, Synchronous signal input |

| | | |
|----------------------------------|------|---|
| Min input voltage: -0.25 V | | |
| Min logic H input voltage: 2.1 V | | |
| Max logic L input voltage: 0.7 V | Pin7 | IO2, Digital I/O, Synchronous signal output |
| Max source current: 2 mA | | |
| Max sink current: -50 mA | | |

Environmental specifications

| | |
|-----------------|---|
| Environment | For use in indoor facilities |
| Operating | 0 °C to +50 °C, 30 % to 70 % non-condensing |
| Storage | -30 °C to 70 °C, 10 % to 90 % non-condensing |
| Altitude | Operating: 0 m to 2000 m, Storage: 0 m to 4600 m |
| Power | LINE: 100-240 VAC, 50/60 Hz, 250 W; FUSE: T3.15AL 250 VAC |
| Warm-up | 1 hour |
| Dimensions (mm) | 450 × 212 × 105 (with foot pad/handle/ rotary Knob) |
| Weight | Net weight 5.2 kg |

Compliance

| | |
|----|---|
| CE | <p>LVD Directive 2014/35/EU, Standards: EN 61010-1:2010+A1:2019</p> <p>EMC Directive 2014/30/EU, Standards: EN IEC 61326-1:2021</p> |
|----|---|

Front Panel

| | |
|--------------|---|
| Display | 5.0" TFT color display (800x480), Capacitive touchscreen |
| Hardkeys | Trigger, Home, Cancel, power on, output on/off, rotary Knob |
| Softkeys | LCD Mapping function keys |
| Connectivity | USB Host, output, ground |

Rear panel

| | |
|--------------|---|
| Connectivity | LAN, DB9, USB device, AC socket, Ground |
|--------------|---|

Ordering information

Power cable, USB cable, quick reference, U disk (including PDF manuals, quick I/V Measurement

Software and drivers)

| | |
|--------------|---|
| Model number | |
| S3012H | Single Channel Precision Source Meter, pulser |

Contact us

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Web

Visit www.semight.com for more information.

*This information is subject to change without notice.