



GPIB

USB

Overall Evaluation System Capable of Measuring Solar Cell Dark Current

- Dark current measurement of large solar cell modules by connecting the booster unit 46015
- Precise parallel resistance measurement and bypass diode evaluation by using the reverse polarity unit
- Maximum output power of 300W (300V/±1A, 30V/±10A)
- High speed measurement at 100 points in 5ms
- 50µs to 6s/point that supports various kinds of solar cells
- Sampling for short-pulsed, middle-pulsed and long-pulsed light
- 3-slope linear sweep function to measure finely around I_{sc} , P_{max} and V_{oc}

Three-Slope Measurement

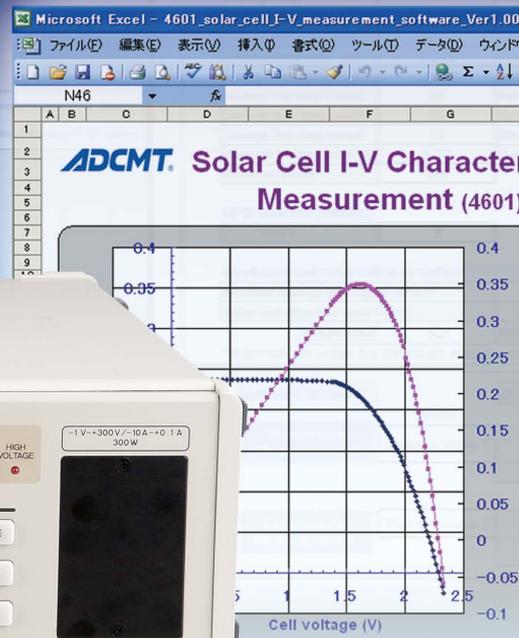
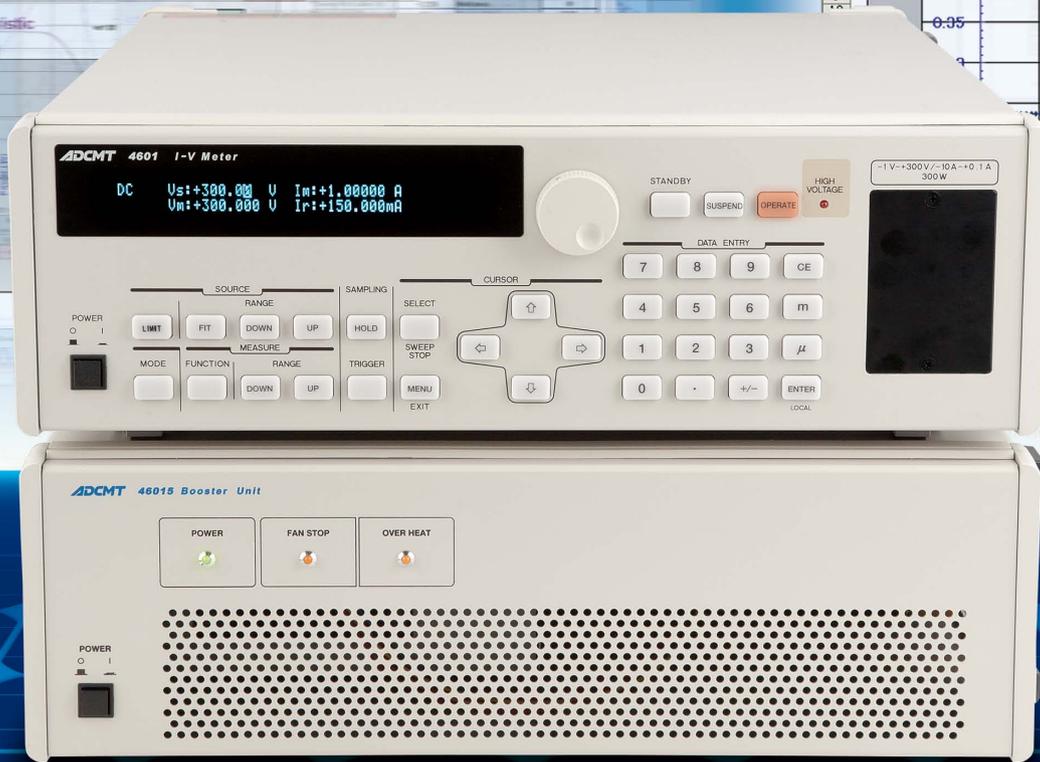
Current

Voltage

Power

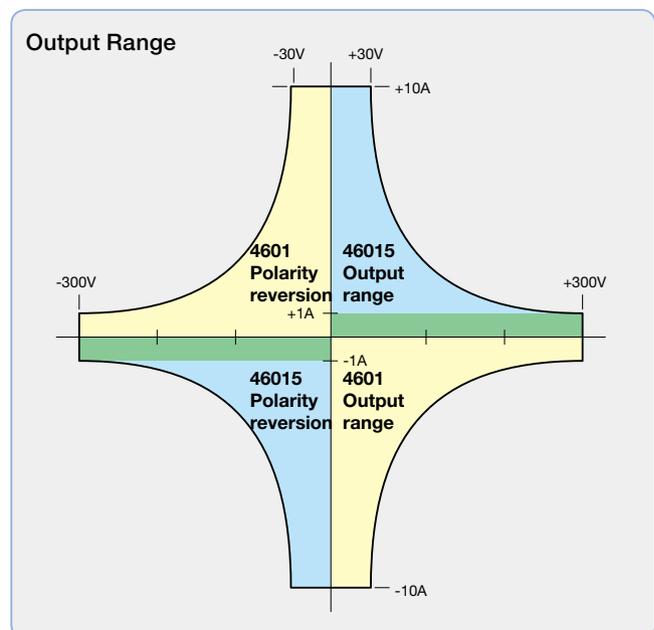


For Overall Evaluation of Solar Cell Panels



The SS9620 is an overall solar cell evaluation system that consists of the I-V meter 4601 and the booster unit 46015. Its combination makes it possible to measure the I-V characteristics and dark current of solar cells or modules by using a solar simulator. In addition, the SS9620 contains the reverse polarity unit CC046012 or CC046013, allowing precise parallel resistance measurement and bypass diode evaluation. The I-V meter 4601 supports short, middle and long light pulses and achieves I-V measurement at maximum 100 points in only 5ms. It measures voltage, current and reference cell current in parallel in the minimum 50 μ s to the maximum 6s per step. The optimal measurement timing for various kinds of solar cells can be set with integration time of the minimum 5 μ s. The SS9620 has not only the simple linear sweep function but also the 2-slope and 3-slope linear sweep functions to measure finely required points. Also, there are three types of sampling to synchronize with the solar simulator. Moreover, the 2-channel temperature measurement function selectable from thermocouple (type T), platinum resistance bulb (Pt100) and IC sensor (AD590), and the voltage measurement function usable for ther-

mobile measurement are embedded. If the I-V meter 4601 has been already installed, the booster unit 46015 can be added as required to build the SS9620.



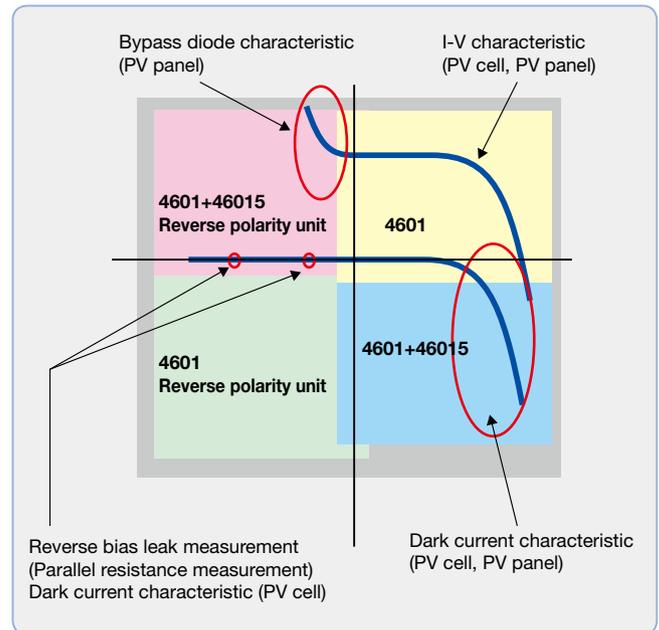
From PV Cell I-V Characteristic Test to Dark Current and Reverse Bias Test

Overall Solar Cell Evaluation

The SS9620 combines the I-V meter 4601 and the newly developed booster unit 46015, making it possible to measure the I-V characteristics and dark current of solar cells or modules by using a solar simulator.

In addition, by using the reverse polarity units CC046012 or CC046013 as output units, the output range can be formed in four quadrants as shown in the right figure.

Using these reverse polarity unit make it possible to measure the bypass diode characteristic of solar cell modules and the reverse bias leak measurement of solar cells.



More Efficient Production by High-Speed 3-Slope Measurement

Solar cell evaluation obtains I_{sc} , V_{oc} and P_{max} from measured values by I-V measurement.

Correct I_{sc} is approximated as a straight line between the value that is closest to and less than $0V$ and the value that is closest to and greater than or equal to $0V$.

Thus, the measurement needs to sweep voltages across $0V$ from negative to positive.

However, when a solar panel on which V_{oc} is $300V$ approximately is measured at 100 points, one step is $3V$ in normal linear sweep. This results in measured data far from " $V=0V$."

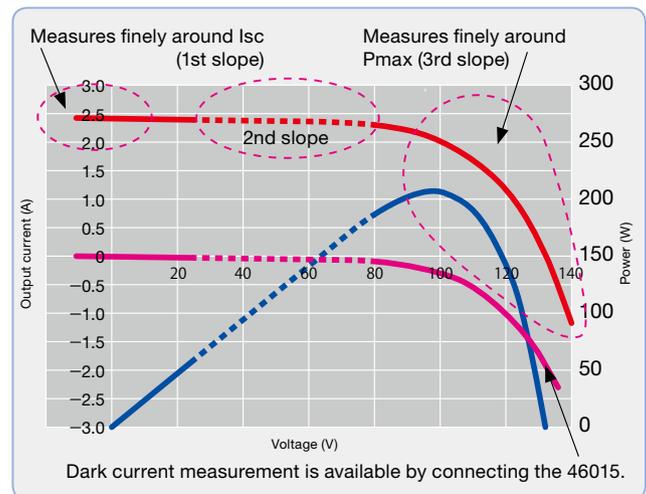
Moreover, the larger the point count is, the slower the total measurement speed becomes.

Using 2-slope or 3-slope linear sweep will allow you to measure around " $V=0V$ " finely without increasing the step count.

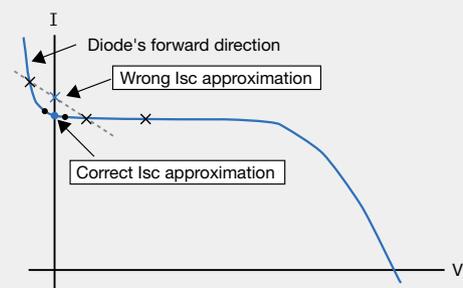
In the same way, to obtain correct V_{oc} , around $I=0A$ and P_{max} need to be measured finely. In this case, 3-slope linear sweep is effective.

As for a solar panel having bypass diodes, current flows through the bypass diodes in the forward direction at a voltage less than $-0.6V$. As the current value becomes high in the forward area, measuring the solar panel with a step of $0.5V$ or higher will bring incorrect I_{sc} approximation.

To prevent this, straight-line approximation is performed by measuring the solar panel with fine steps at a voltage from $-0.5V$.



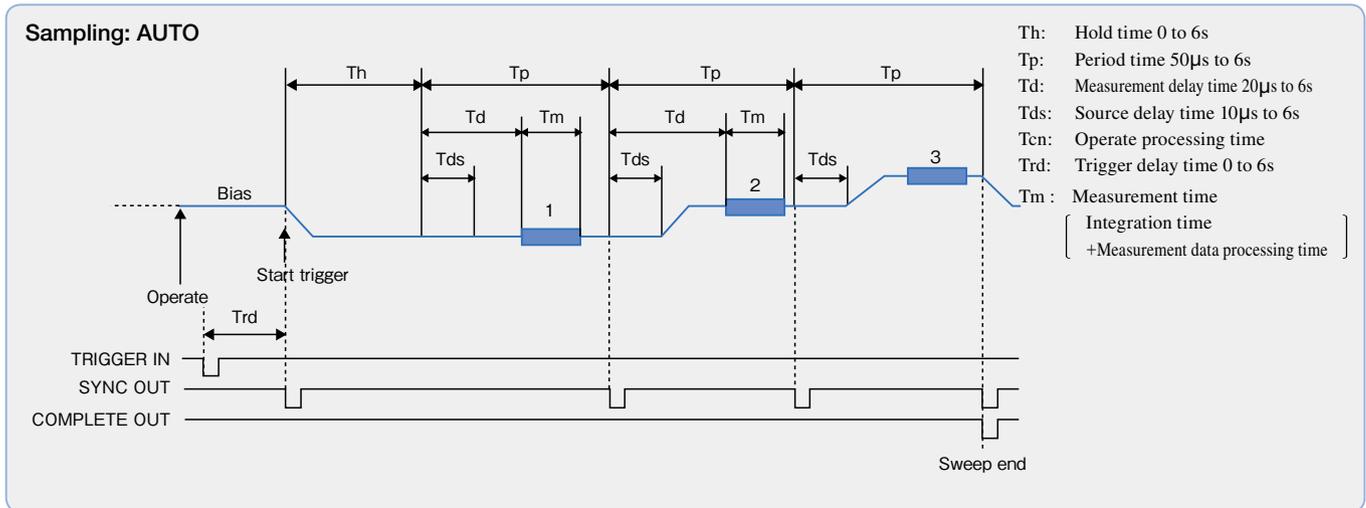
I-V characteristic of PV panel with bypass diodes



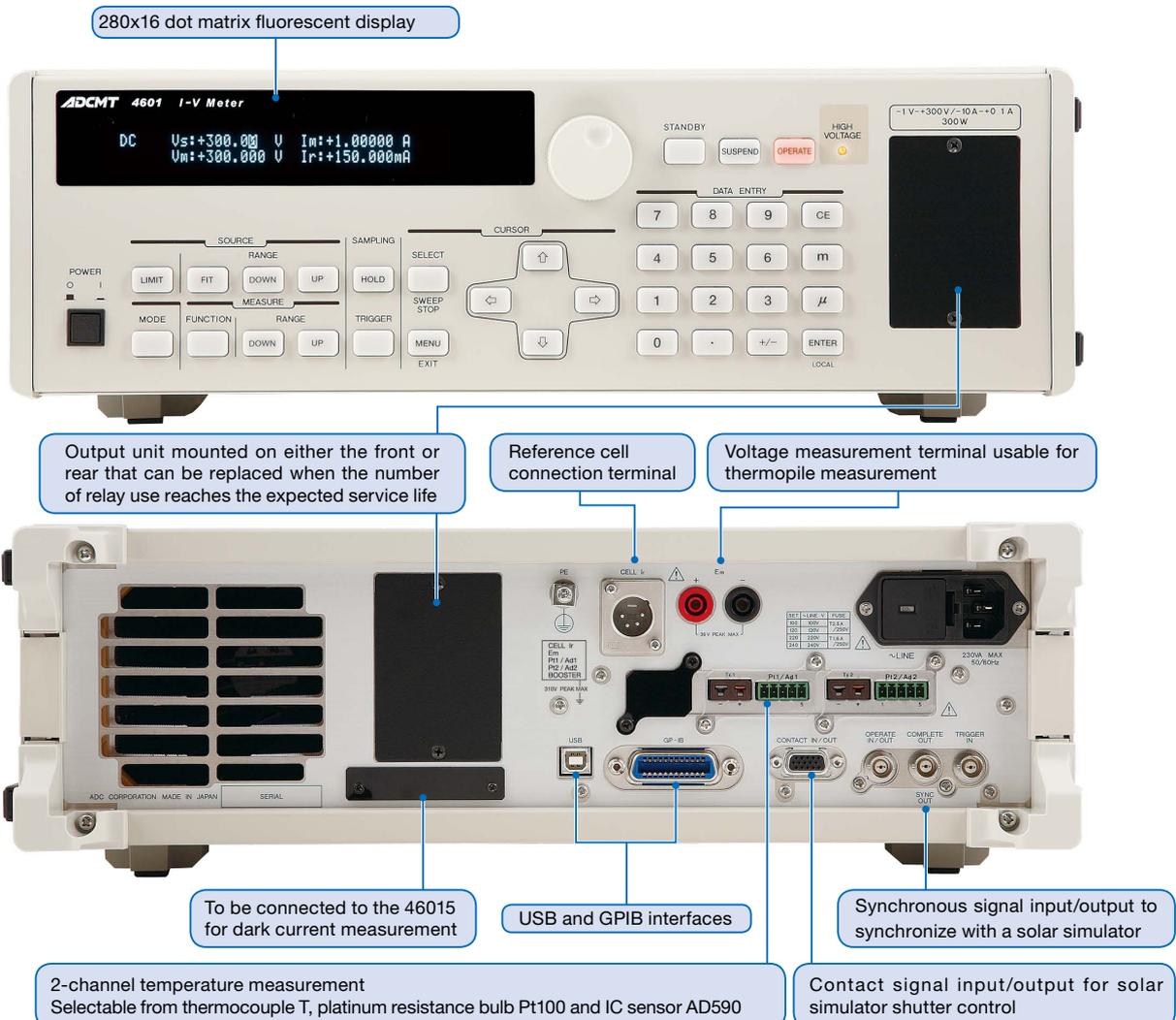
Auto Collection of Coarse and Fine Curves by 3-Slope Measurement

Basic Sweep Timing

Setting times, sweep operations and timings with external control signals are shown below:



4601 I-V Meter Major Functions



Good Connection with Solar Simulator

Synchronization with Solar Simulator

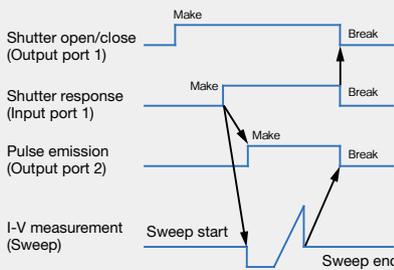
To evaluate a solar panel using pulsed light, the shutter open/close and pulse emission of a solar simulator and the sweep timings of the I-V meter need to be synchronized.

The SS9620 is equipped with four output ports and two input ports for semiconductor relay contact signals that can be used for shutter open/close control and light emission control, making it possible to synchronize with the solar simulator. In addition, in sweep mea-

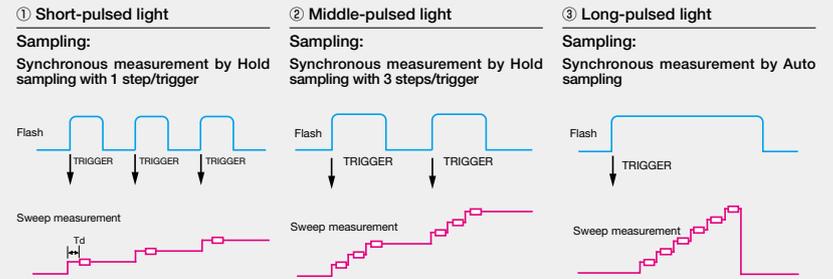
surement using external trigger input signals, the step count per pulsed light can be controlled by setting the sampling and the step count per trigger.

As the reference cell current of a solar cell, you can compensate for optical power fluctuations generated at the time of pulse emission in I-V characteristics.

Solar Simulator Example



Synchronization with Solar Simulator



46015 Booster Unit Major Functions

The left indicator goes on at power ON, the center one goes on when the cooling fan of the 4601 or the 46015 stops and the right one goes ON when the internal temperature error is detected in the 46015.



Specifications

Overall accuracy : At temperature of 23°C ± 5°C, for one year, and with integration time of 1 PLC or more.
Includes calibration accuracy, 1-day stability, temperature coefficient, and linearity.

Voltage source/voltage measurement/current measurement terminal OUTPUT/SENSE terminal

Voltage source range:

Range	Source Range			Setting resolution
	4601	4601+46015	4601+46015+Reverse unit	
5V	-1.0000V to +5.0000V	-1.0000V to +5.0000V	0 to ±5.0000V	100μV
50V	-1.000V to +50.000V	-1.000V to +50.000V	0 to ±50.000V	1mV
300V	-1.00V to +300.00V	-1.00V to +300.00V	0 to ±300.00V	10mV

Voltage measurement range:

Range	Measurement range			Measurement resolution
	4601	4601+46015	4601+46015+Reverse unit	
5V	-1.00999V to +5.00999V	-1.00999V to +5.00999V	0 to ±5.00999V	10μV
50V	-1.0999V to +50.0999V	-1.0999V to +50.0999V	0 to ±50.0999V	100μV
300V	-1.999V to +300.999V	-1.999V to +300.999V	0 to ±300.999V	1mV

Current limit/current measurement range:

Range	Limit setting range *1	Limit setting resolution	Measurement range	Measurement resolution
300μA	3μA to 320.0μA	100nA	0 to ±320.999μA	1nA
3mA	320.1μA to 3.200mA	1μA	0 to ±3.20999mA	10nA
30mA	3.201mA to 32.00mA	10μA	0 to ±32.0999mA	100nA
300mA	32.01mA to 320.0mA	100μA	0 to ±320.999mA	1μA
3A	320.1mA to 3.200A	1mA	0 to ±3.20999A	10μA
10A	3.201A to 10.20A	10mA	0 to ±10.2999A	100μA

*1: (Hi side limit value - Lo side limiter value) ≥ 20 digits

Overall accuracy

Voltage source/voltage measurement:

Range	Voltage source	Voltage measurement
	±(% of setting+V)	±(% of reading+V)
5V	0.025+1mV	0.025+500μV
50V	0.025+10mV	0.025+2mV
300V	0.025+100mV	0.025+20mV

Current limit/current measurement:

Range	Current limit *2	Current measurement
	±(% of setting+A)	±(% of reading+A+A×Vo/1V)
300μA	0.1+1μA	0.03 +70nA +5nA
3mA	0.1+10μA	0.03 +700nA +50nA
30mA	0.1+100μA	0.03 +7μA +500nA
300mA	0.1+1mA	0.03 +70μA +5μA
3A	0.1+10mA	0.05 +700μA +50μA
10A	0.3+100mA	0.15 +7mA +500μA

*2: As for the 4601, the positive current limit is limited to +0.1A and its accuracy is +0.11A ± 8% in the 300mA, 3A and 10A ranges.

Maximum output power: 4601: 30W(source: +300V/+0.1A)

4601+46015: (source: +30V/+10A to +300V/+1A)

4601+46015+reverse unit: 300W (±30V/±10A to ±300V/±1A)

Maximum load power: 300W (sink: +30V/-10A to +300V/-1A)

Maximum output current: 4601: -10.2A (sink), +0.1A (source) at -1V to +30V

(-300/Vo) A (sink), 0.1A (source) at +30V to +300V

4601+46015: ±10.2A at -1V to +30V

±(300/Vo)A at +30V to +300V

4601+46015+reverse unit: ±10.2A at ±30V or less

±(300/Vo)A at ±30V to ±300V

Output terminal: Front/rear: Safety socket/terminal block (Either type is selectable.)

HI OUTPUT, HI SENSE, LO OUTPUT, LO SENSE

Maximum remote sensing voltage: ±1V max HI OUTPUT-HI SENSE, LO OUTPUT-LO SENSE

(HI SENSE-LO SENSE voltage must be within the range of the maximum output voltage.)

Maximum input voltage: 4601: +320V/-3V peak max (HI-LO)

4601+46015: +320V/-3V peak max (HI-LO)

4601+46015+reverse unit: +320V/-3V peak max (HI-LO)

-320V/+3V peak max

(HI-LO in reverse polarity)

2V peak max (OUTPUT-SENSE)

310V peak max (LO-chassis)

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Voltage Measurement Terminal

Measurement range:

Range	Measurement range	Measurement resolution	Overall accuracy ±(% of reading+V)
30mV	±31.9999mV	0.1μV	0.025+15μV
300mV	±319.999mV	1μV	0.025+15μV
3V	±3.19999V	10μV	0.025+30μV

Maximum allowable input voltage: 36V peak (terminal-terminal)

310V peak (terminal-chassis)

Reference Cell Measurement Terminal

Measurement range:

Range	Measurement range *3	Measurement resolution	Overall accuracy ±(% of reading+A)
3mA	0 to ±3.19999mA	10nA	0.03+350nA
30mA	0 to ±31.9999mA	100nA	0.03+3.5μA
300mA	-32.000mA to +319.999mA	1μA	0.03+35μA

*3: The polarities of measured values are represented as "+" for sink and as "-" for source.

Maximum allowable input voltage: 5V peak (terminal-terminal)

310V peak (terminal-chassis)

Temperature measurement type T thermocouple measurement terminal

	Measurement range	Measurement resolution	Overall accuracy ±(% of reading+°C)
Type T thermocouple	-50.00°C to 400.00°C	0.01°C	0.1+0.8°C

4-wire connection, integration time: Not include the measurement probe accuracy with integration time of 1 PLC or more

Maximum allowable input voltage: 36V peak (terminal-terminal)

310V peak (terminal-chassis)

Thermocouple standard: JIS C1602-1995

Cold junction compensation: Internal

Temperature measurement Pt measurement terminal

Resistance bulb: Pt100 (compliant with JIS C1604-1997)

JPt100 (compliant with JIS C1604-1981)

Wire connection: 4-wire connection

Allowable lead resistance: 10Ω or less (in other than 2-wire connection)

Measurement unit: Selectable from °C, °F and K

	Measurement range	Resolution	Overall accuracy ±(% of reading+°C)	Measurement current
Pt100	-200.00°C to +850.00°C	0.01°C	0.025+0.15°C	1mA
JPt100	-200.00°C to +649.00°C			

4-wire connection, integration time: Not include the measurement probe accuracy with integration time of 1 PLC or more

Maximum allowable input voltage: 36V peak (terminal-terminal)

310V peak (terminal-chassis)

Temperature measurement AD590 measurement terminal

	Measurement range	Measurement resolution	Overall accuracy ±(% of reading+°C)
AD590	-50.00°C to 150.00°C	0.01°C	0.025+0.1°C

Maximum allowable input voltage: 4V peak (terminal-terminal)

310V peak (terminal-chassis)

Source/Measurement Functions

DC source/measurement: DC voltage source, DC voltage/current measurement

DC sweep source/measurement: Source and measurement by linear, 2-slope linear, 3-slope linear, memory, fixed level

Integration time: 5μs, 10μs, 25μs, 50μs, 100μs, 250μs, 500μs, 1ms, 2.5ms, 5ms, 10ms, 1PLC, 2PLC, 100ms, 200ms

(PLC: Power Line Cycle 50Hz: 20ms 60Hz: 16.66ms)

Sweep mode: Reverse ON (round)/OFF (one-way)

Maximum sweep step: 1999 steps

Maximum sweep memory: 2000 data

Measurement data memory: 4000 data × 3

Limit: HI and LO limit values can be set separately.

(These values cannot be set to the same polarity.)

Trigger:	Auto trigger, external trigger
GPIB interface:	Compliant with IEEE-488.2-1987
	Interface function SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, E2
	Connector Amphenol 24 pin
USB interface:	USB 2.0 Full-speed
	Connector Type B
	Connector BNC
External control signal:	TRIGGER IN
	OPERATE IN/OUT
	COMPLETE OUT, SYNC OUT
	Connector BNC
Contact signal:	Output: 4 bits Input: 2 bits
	Connector Dsub 15 pin (High-density multicore type)

Setting time

Minimum step (repeat) time: Voltage/current/reference current measurement in fixed source/measurement ranges and with the integration time of 5μs and with the minimum measurement/source delay time

Mode	Minimum step time
SWEEP	50μs
DC	5ms

Source delay time:

Setting range	Resolution *4	Setting accuracy
0.010ms to 60.000ms	1μs	±(0.1%+10μs)
60.01ms to 600.00ms	10μs	
600.1ms to 5999.8ms	100μs	

Period (cycle):

Setting range	Resolution *4	Setting accuracy
0.050ms to 60.000ms	1μs	±(0.1%+10μs)
60.01ms to 600.00ms	10μs	
600.1ms to 6000.0ms	100μs	

Measurement delay time:

Setting range	Resolution *4	Setting accuracy
0.020ms to 60.000ms	1μs	±(0.1%+10μs)
60.01ms to 600.00ms	10μs	
600.1ms to 5999.8ms	100μs	

*4: The setting resolution is decided by the period time resolution.

Hold time:

Setting range	Resolution	Setting accuracy
0ms to 6000ms	100μs	±(2%+2ms)

Trigger delay time:

Setting range	Resolution	Setting accuracy
0ms to 6000ms	100μs	±(0.1%+100μs)

General Specifications

Operating environment:	Ambient temperature 0°C to +50°C Relative humidity 85% or below, with no condensation
Storage environment:	Ambient temperature -25°C to +70°C Relative humidity 85% or below, with no condensation
Warming up time:	60 minutes or longer
Display:	Dot matrix vacuum fluorescent display
Power supply:	4601: AC power 100V/120V/220V/240V (User selectable)

Option No.	Standard	OPT. 32	OPT. 42	OPT. 44
Power voltage	100V	120V	220V	240V

Specify the option when ordering. When changing the power voltage, use only a power cable and rated fuse approved for the respective country.

Line frequency:	50Hz/60Hz
Power consumption:	4601: 230VA or less 46015: 400VA or less
Dimensions:	4601: Approx. 424(W)×132 (H)×500 (D) mm 46015: Approx. 424(W)×132 (H)×500 (D) mm
Mass:	4601: 15kg or less 46015: 15kg or less
Safety:	Compliant with IEC61010-1 Ed.3
EMI:	Compliant with EN61326-1 classA

SS9620 system configuration

Unit	Name	Quantity
4601	I-V meter	1
46015	Booster unit	1
CC00460XX	Output unit	1

All units can be sold separately or added afterwards.

Supplied accessories

4601:

Part number	Name	Quantity
A01402	Power cable (JIS 2m)	1
JCE-DA0002PX02	Thermocouple connector	2
JCS-RB0005JX03	Pt, AD590 connector (plug)	2
YEE-1000734	Pt, AD590 connector (cover)	2
DEE-100115	EMC-compliant clamp filter	4
ESM-000257	Cable tie	4

46015:

Part number	Name	Quantity
A01402	Power cable (JIS 2m)	1
DEE-100212	EMC-compliant clamp filter	1
CC012002	Booster connecting cable	1

Output unit (sold separately)

Part number	Name
CC046010	Safety socket terminal output unit
CC046011	Terminal block output unit
CC046012	Safety socket terminal reverse output unit
CC046013	Terminal block reverse output unit



CC046010

Safety socket terminal output unit



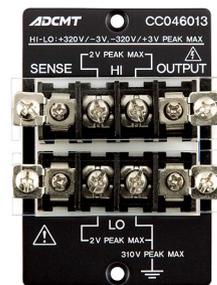
CC046011

Terminal block output unit



CC046012

Safety socket terminal reverse output unit



CC046013

Terminal block reverse output unit

Optional accessories

Part number	Name
A01044	Input and output cable (safety plug)
A08531	Banana tip adapter (for A01044)
A08532	Alligator clip adapter (for A01044)
A01047-01	Input and output cable (high current 0.5m)
A01047-02	Input and output cable (high current 1m)
A01047-03	Input and output cable (high current 1.5m)
A01047-04	Input and output cable (high current 2m)
CC022003	Rack mount set 3U EIA
CC024003	Rack mount set 3U JIS
CC028003	Front handle set 3U
A02615	Slide rail set



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