ADCMT®

6240A
DC Voltage/Current Source/Monitor

Cost-effective DC voltage current source/monitor capable of 5½-digit measurement and 4A pulse generation

- Source/measurement range
  voltage: 0 to ±15V, current: 0 to ±4A (1A for DC)
- Basic source and measurement accuracy: ±0.025%
- 5½-digit display (±319999) with 10µV/10nA resolution in measurement
- Source/sink of ±4A for a maximum pulse width of 20ms
- Pulse measurement with a minimum pulse width of 500µs and 1µs step
- Sink-enabled bipolar output

The 6240A is a DC voltage and current source/monitor capable of 4½-digit generation and 5½-digit measurement with high accuracy of ±0.025%. The 6240A has a pulse measuring function with a minimum pulse width of 500μs, and fixed, linear, and random sweep functions. Thus, this product can be used for a wide range of applications as a power source for evaluation in research and development of semiconductors and other electronic components, or for characteristic test systems in a production line. In particular, the pulse source and electronic load function with the maximum capacity of 4A fully demonstrates its capability in evaluation of power devices. At the same time, the individual HI/LO limiter function is useful in evaluation of batteries and power ICs. Moreover, the new suspend function enables selection of the optimum OFF state for each application, contributing to the throughput improvement.

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Source/Measurement Function

Voltage/current source and voltage/current/resistance measurement can be selected by specifying the source and measurement functions.
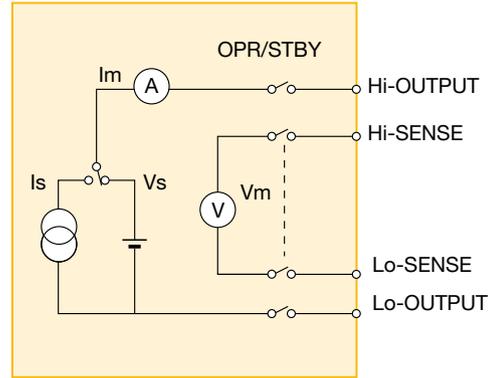
VSIM, VSVM, VSRM, ISVM, ISIM, ISRM

Output Range
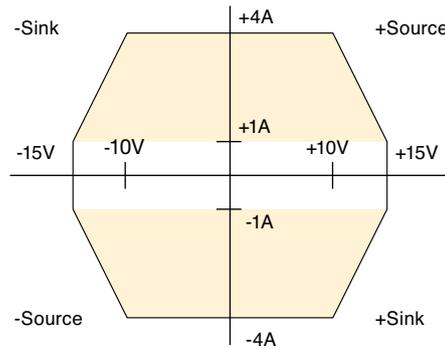
☐ DC and pulse source

▨ Pulse source or pulse load
Pulse width: 20ms or less and duty factor: 20% or less

Can generate pulse current up to 4A (20ms)
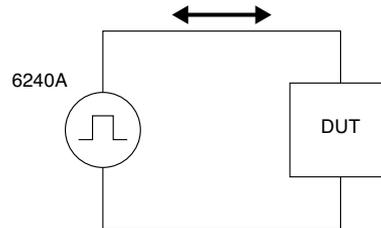
Can supply to pulse load up to 4A (20ms)
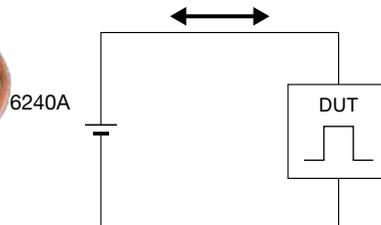
Source Mode

There are four source modes; DC, pulse, DC sweep, pulse sweep. Then, the sweep modes are classified into three sweep types: fixed sweep, linear sweep, random sweep (user programmable sweep).
The minimum pulse width is 500μs.
The minimum cycle is 2ms, or 1ms without measurement.

	DC	PULSE
Continuous spot		
Fixed sweep		
Linear sweep		
Random sweep		

Individual Settings of HI/LO Limiters

For current source, the limiter (compliance) voltage must be higher than the applied voltage. When voltage higher than the limiter voltage is applied from the outside, the 6240A detects overload and then sets standby.

When a capacitor is discharged after being charged at a constant current with the positive and negative limiter values being set to the same value, overload occurs if the limiter voltage is lowered. In addition, it is discharged down to negative voltage when applying reverse polarity current.

However, the 6240A has a function that can set the HI and LO limiters individually. Furthermore, for the voltage-limiter, both HI limiter and LO limiter can set homo-polar. This prevents a capacitor or a battery in particular from being over-discharged. The 6240A is also suitable for evaluating devices such as LDs that are used at a constant current and do not tolerate reverse voltage application.

Caution!
For IS, applying external voltage above the voltage limiter will set overload.

HI VL: Hi voltage limiter   LO VL: LO voltage limiter
CC: Constant current   CV: Constant current
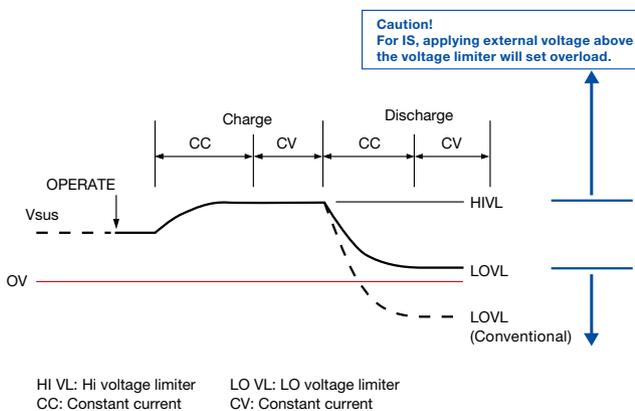
Suspend Function

The 6240A can select from three output OFF statuses; STBY (output relay OFF), HiZ (output relay ON and high resistance), and LoZ (output relay ON and low resistance). Using this function can omit unnecessary relay ON/OFF action, and provides solutions for conventional problems:
・Reduces deteriorating of the throughput due to relay operation time.
・Improves the relay life duration and increases the reliability.
In addition, the setting of a suspend voltage (voltage in HiZ and LoZ status) prevents transient current sink that occurs at a connection of a voltage output device such as a battery.
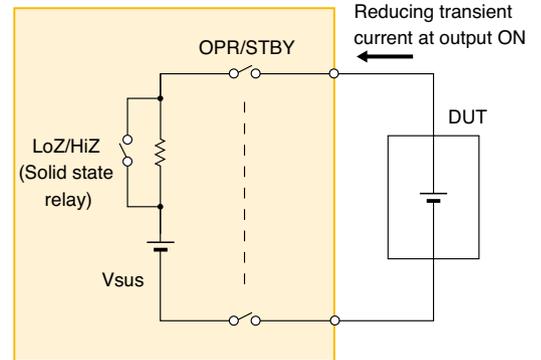
| Output OFF status	Output relay	Output status	Current-limiter setting value
LoZ	ON	Vsus, low resistance	VS: Set current limiter (IL) IS: 1/1000 of the current setting range
HiZ	ON	Vsus, high resistance	30μA
STBY	OFF	Open	—

Vsus: Setting suspend voltage (default: 0V)

When a conventional generator or electronic load is connected with a battery, the output voltage is 0V, and then the setting current starts flowing. In this case, the moment that it is connected, transient current sink occurs, causing unnecessary battery discharge. On the other hand, by setting a suspend voltage, the 6240A is connected in high-impedance state at the specified voltage and then the setting current flows. This prevents unnecessary discharge at the connection to a battery.

Transient Current Comparison at Output ON
The following figures show the comparison of transient currents when the 6240A is set to Operate ON with IS=500mA, VL=±3V, Vbatt=1.5V and load resistance=1Ω are compared.
While approximately 1A transient current flows at Vsus=0V, transient current is almost 0A at Vsus=1.5V.

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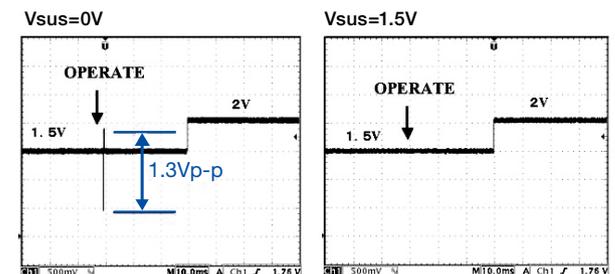
High-Speed Response and Low Noise

The typical waveform and output noise of the 6240A are shown below. The response of 0-10V is approximately 70µs at 90% rising time, and the output noise is approximately 2.4mVp-p at DC-20MHz.

• Maximum rate pulse generation
  (0-10V, pulse width: 500µs, period: 1ms)

Δ: 500µs	Δ: 10.0 V
@: 444µs	@: 9.92 V

Ch2 2.00 V M 200µs A Ch2 ⌐ 6.12 V
⊓ 12.80 %

• 0-10V response waveform

Δ: 72.4µs Δ: 9.00 V
@: 55.6µs @: 9.00 V

0—>90%
70µs

Ch1 2.00 V M 20.0µs A Ch1 ⌐ 1.32 V
⊓ 28.40 %

• Output noise

2. 4mVp-p   Δ: 2.42mV
             @: 1.00mV

BW:20MHz

Ch1 1.00mV M 10.0ms A Ch1 ⌐ 7.72mV
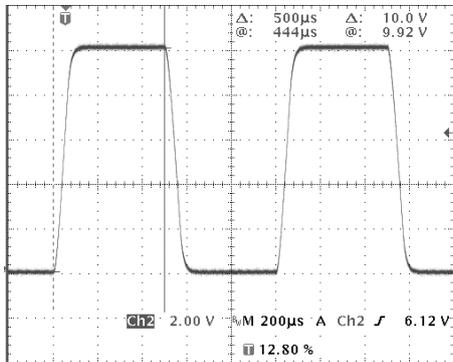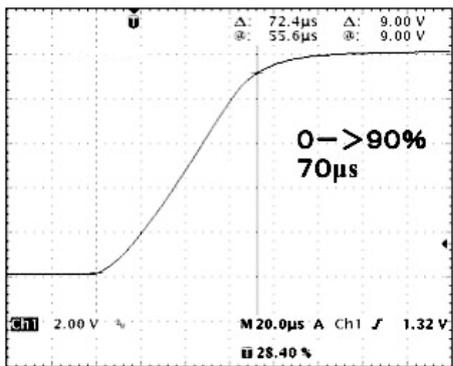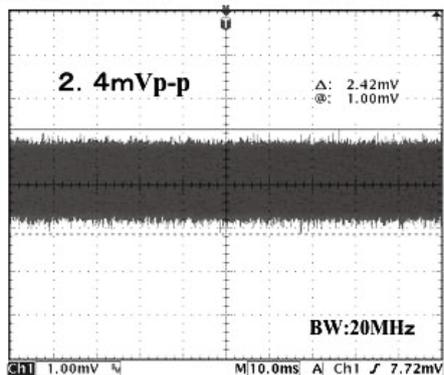
## For Battery Charge/Discharge Tests and Power Device Evaluation

The 6240A handles bipolar output and is capable of ± source and ± sink operations. Therefore, it has achieved 0V sink operation which cannot be done by a general electronic load. With its pulse source function, the 6420A can be used for evaluation of batteries and power devices that are used for various portable devices.

Connection Diagram

6240A

HI OUTPUT
HI SENSE
BATT Vo   VM   IS
LO SENSE
LO OUTPUT
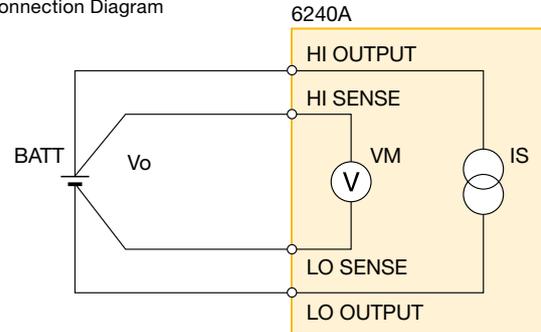
Pulse Discharge Waveform

I_{HI}
IS I_{LO}
Vo
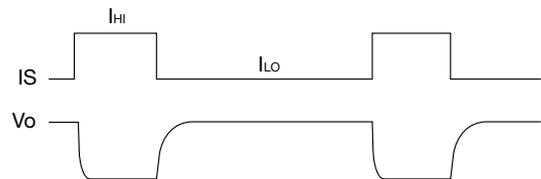
Battery Charge Waveform

Charge   Discharge
OPERATE   CC   CV   CC   CV
                        ----HI VL
Vsus   LO VL
                                  0V

HI VL: HI voltage limiter   LO VL: LO voltage limiter
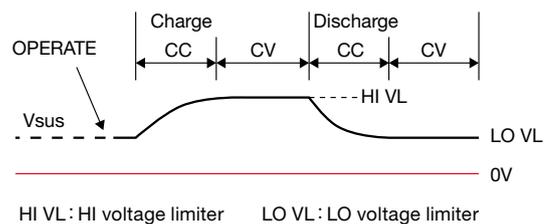
● Capable of handling pulses of cellular phones with a minimum pulse width of 500µs and 1µs step.

● Capable of CV/CC operation for both charging and discharging by using HI/LO voltage limiters.

  Both HI and LO voltage limiters can be set to + value (or – value). If HI is set to +1.8V and LO to +1.2V, for instance, the mode becomes constant voltage operation when the battery voltage reaches +1.8V, and discharging terminates when it reaches +1.2V.

● Avoids unnecessary discharge at output ON by setting a suspend voltage (Vsus).

  A general power supply is at 0V or in open status of 0V when output is OFF, and a low impedance state of 0V always occurs when output is ON. At this time, the battery is being discharged unnecessarily for a moment. However, by setting the suspend voltage of the 6240A to +1.2V, for instance, unnecessary discharge can be avoided since the voltage of the output terminal is +12V the same as that of the battery, even in a temporary low impedance state that occurs when the output is ON. This function is also useful for preventing FET from being set to ON instantaneously at output ON when it is used as a gate voltage of J-FET or GaAsFET.

For Evaluation of Solar Cells

Since the conversion efficiency of a solar cell is influenced by bias application time, measurement by pulse application is effective in finding the true conversion efficiency. By using the pulse sweep function of the 6240A, the I-V curve can be measured at high speed. Furthermore, by changing the pulse width, the change in characteristics depending on the application time can be measured easily.

- Pulse measurement with a minimum pulse width of 500μs and a minimum period of 2ms
- Maximum current 4A with the pulse width of 20ms or less
- Minimum voltage step: 100μV (3V range)

Connection Diagram

6240A
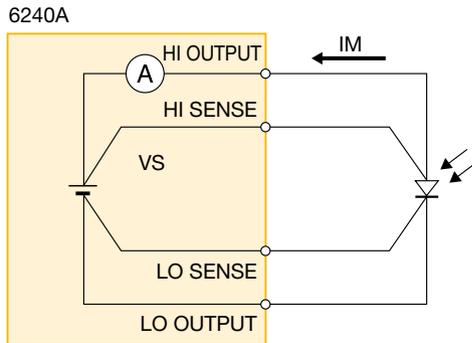
Measurement Waveform

Light I-V Characteristics

Isc: Short-circuit current
Voc: Open-circuit voltage
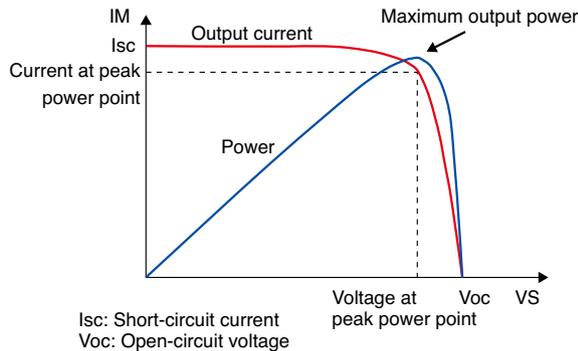
For ON-Resistance Measurement of MOSFET and Analog Switch

The following shows an example of ON-resistance measurement of MOSFET.

The drain terminal is connected by a 4-wire ISVM configuration. The current at ON state is determined by the source current (IS), and the drain voltage at OFF state is determined by the voltage limiter (VL). The gate inputs the SYNC OUT signal to TRIGGER IN of the 6240A on the drain as pulse source of VSIM. In this way, synchronous measurement by two units is achieved. The results of ON-resistance measurement can be displayed in ohms. In addition, by using the linear pulse sweep function on the gate and the fixed sweep function on the drain, gate voltage - ON resistance characteristics can be measured easily.

- Resistance measurement range: 2.5μΩ – 7.5MΩ
- Maximum current (IdMax): 4A (with pulse width of 20ms or less)
- Pulse measurement with a minimum pulse width of 500μs and a minimum period of 2ms
- Gate current measurement with a resolution of 10nA

Connection Diagram
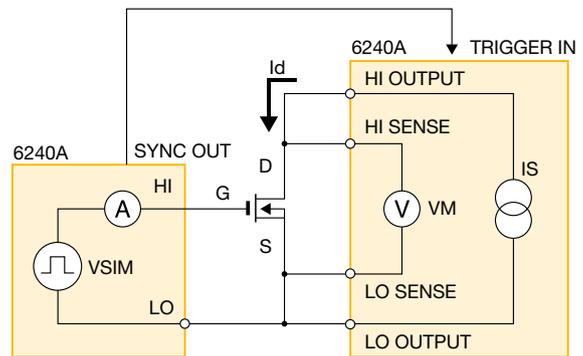
Measurement Waveform
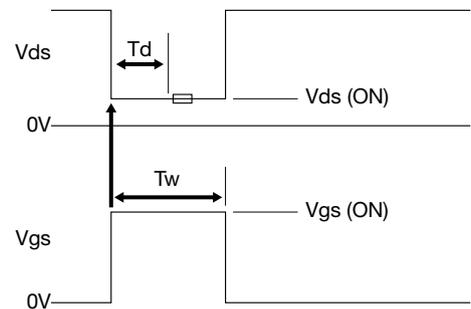
Vds: Drain voltage   Td: Measurement delay
Vgs: Gate voltage   Tw: Pulse width
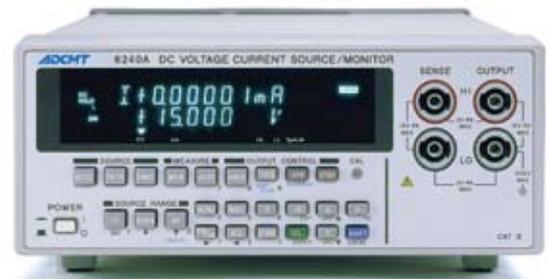
Specifications

All accuracy specifications are guaranteed for one year at a temperature of 23 ±5°C and a relative humidity of 85% or less.

Voltage source/measurement range

Range	Source range	Setting resolution	Measurement range	Measurement resolution
3V	0 to ±3.1000V	100µV	0 to ±3.19999V	10µV
15V	0 to ±15.000V	1mV	0 to ±15.1999V	100µV

Current source/measurement range

Range	Source range	Setting resolution	Measurement range	Measurement resolution
3mA	0 to ±3.1000mA	100nA	0 to ±3.19999mA	10nA
30mA	0 to ±31.000mA	1µA	0 to ±31.9999mA	100nA
300mA	0 to ±310.00mA	10µA	0 to ±319.999mA	1µA
1A	0 to ±1.0000A	100µA	0 to ±1.01999A	10µA
4A*1)	0 to ±4.0000A	200µA	0 to ±4.01999A	10µA

*1) Source range is restricted by the duty factor.
For 4A pulse source, maximum pulse width: 20ms and duty factor: 20% or less.

Resistance measurement range

Range	Source range	Setting resolution	Measurement range	Measurement resolution
Determined by voltage range and current range calculations	—	—	0 to 7.5MΩ	Minimum 2µΩ

However, the measurement resolution with integration time 100µs and 500µs will be as follows:

Integration time	100µs	500µs
Measurement resolution (digits)	10	2

Voltage limiter (compliance) range

Range	Maximum setting range	Minimum setting range *2)	Setting resolution
3V	3.100V	60mV	1mV
15V	15.00V	600mV	10mV

Current limiter (compliance) range

Range	Maximum setting range	Minimum setting range *2)	Setting resolution
3mA	3.100mA	60µA	1µA
30mA	31.00mA	600µA	10µA
300mA	310.0mA	6mA	100µA
1A	1.000A	60mA	1mA
4A	4.000A	120mA	1mA

*2) The minimum set value of the difference between HI and LO limiters.

Overall accuracy: Includes calibration accuracy, 1-day stability, temperature coefficient and linearity
1-day stability: Under constant power and load
Temperature coefficient: At temperature of 0 to 50°C

Voltage source

Range	Overall accuracy	1-day stability	Temperature coefficient
	±(% of setting+V)		±(ppm of setting+V)/°C
3V	0.025+350µV	0.01+200µV	15+30µV
15V	0.025+3mV*3)	0.01+2mV	15+300µV

Voltage limiter

Range	Overall accuracy	1-day stability	Temperature coefficient
	±(% of setting+V)		±(ppm of setting+V)/°C
3V	0.05+3mV	0.01+1mV	15+100µV
15V	0.07+30mV*3)	0.01+10mV	15+1mV

*3) In the 15V range, 100µV is added per remote sense voltage 0.1V.

Current source

Range	Overall accuracy	1-day stability	Temperature coefficient
	±(% of setting+A+A×Vo/1V)		±(ppm of setting+V)/°C
3mA	0.03+800nA+30nA	0.01+400nA+10nA	20+100nA+1nA
30mA	0.03+8µA+300nA	0.01+4µA+100nA	20+1µA+10nA
300mA	0.045+80µA+3µA	0.01+40µA+1µA	20+10µA+100nA
1A	0.05+800µA+30µA	0.02+400µA+10µA	35+100µA+1µA
4A	0.25+1mA+55µA	0.08+400µA+10µA	35+100µA+2µA

Current limiter

Range	Overall accuracy	1-day stability	Temperature coefficient
	±(% of setting+A+A×Vo/1V)		±(ppm of setting+A+A×Vo/1V)/°C
3mA	0.045+3.5µA+30nA	0.01+1µA+10nA	20+200nA+1nA
30mA	0.045+35µA+300nA	0.01+10µA+100nA	20+2µA+10nA
300mA	0.055+350µA+3µA	0.01+100µA+1µA	20+20µA+100nA
1A	0.1+3.5mA+30µA	0.02+1mA+10µA	40+200µA+1µA
4A	0.25+6mA+55µA	0.08+1mA+10µA	40+200µA+2µA

Vo: Compliance voltage (-15V to +15V)

Voltage measurement   (Auto zero: ON, integration time: 1PLC to 200ms)

Range	Overall accuracy	1-day stability	Temperature coefficient
	±(% of reading+V)		±(ppm of reading+V)/°C
3V	0.025+120µV	0.008+60µV	15+15µV
15V	0.025+2mV	0.008+250µV	15+50µV

Current measurement   (Auto zero: ON, integration time: 1PLC to 200ms)

Range	Overall accuracy	1-day stability	Temperature coefficient
	±(% of reading+V)		±(ppm of reading+V)/°C
3mA	0.03+700nA+30nA	0.01+350nA+10nA	20+70nA+1nA
30mA	0.03+7µA+300nA	0.01+3.5µA+100nA	20+700nA+10nA
300mA	0.045+70µA+3µA	0.01+35µA+1µA	20+7µA+100nA
1A	0.05+700µA+30µA	0.02+350µA+10µA	35+70µA+1µA
4A	0.25+800µA+55µA	0.08+350µA+10µA	35+70µA+2µA

Vo: Compliance voltage (-15V to +15V)

Resistance measurement (at voltage source)   (Auto zero: ON, integration time: 1PLC to 200ms)

Range	1-day stability	Temperature coefficient
±(%of reading)±(digits+digits+digits)		±(ppm of reading)±(digits+digits+digits)/°C

Reading item: (Voltage source setting item + Current measurement reading item)
Full-scale item: (Voltage source full-scale item digit value + current measurement full-scale item digit value + CMV item digit value)*4)

Resistance measurement (at current source)   (Auto zero: ON, integration time: 1PLC to 200ms)

Range	1-day stability	Temperature coefficient
±(%of reading)±(digits+digits+digits)		±(ppm of reading)±(digits+digits+digits)/°C

Reading item: (Current source setting item + Voltage measurement reading item)
Full-scale item: (Current source full-scale item digit value + Voltage measurement full-scale item digit value + CMV item digit value)*4)

*4) CMV item = (A × Vo/1V) ; source or measurement current × source or measurement voltage/1V digit value

The full-scale item tolerances listed below are added to the integration time 100µs to 10ms measurement accuracy and 1-day stability.

Measurement range		Integration time Unit: digits (at 5 ½ digit display)				
		10ms	5ms	1ms	500µs	100µs
Voltage measurement	3V	8	12	20	30	35
	15V	5	10	15	20	25
Current measurement	3mA to 1A	12	18	25	30	35
	4A	24	30	45	55	65

Source linearity: ±3 digits or less
(In the 4A range, ±0.2% of setting ±5digits or less)
Maximum output current: 0 to 15V; ±1A (DC),
        0 to 10V: ±4A
(Maximum pulse width: 20ms, duty factor: 20% or less)
Maximum compliance voltage: Up to 1A (DC): 0 to ±15V,
      Up to 4A (pulse): 0 to ±10V
Output noise: For voltage source, within the range from no load to the maximum load [Vp-p]
      For current source, at the following load [Ap-p]

Voltage source

Range	Load resistance	Low frequency noise		High frequency noise
		DC to 100Hz	DC to 10kHz	DC to 20MHz
3V	–	100µV	400µV	5mV
15V	–	1mV	3mV	6mV

Current source

Range	Load resistance	Low frequency noise		High frequency noise
		DC to 100Hz	DC to 10kHz	DC to 20MHz
3mA	1kΩ	200nA	2µA	6µA
30mA	1kΩ	2µA	15µA	20µA
300mA	1kΩ	20µA	100µA	150µA
1A	100Ω	200µA	1mA	1.5mA
4A	10Ω	200µA	1mA	1.5mA

Switching noise

		Typical value [p-p]	Load resistance
Output ON/OFF noise	Voltage source	600mV	At 100kΩ
	Current source	600mV	At 100kΩ
Range switching noise	Voltage source	50mV	–
	Current source	100digits+50mV	–
	Voltage limiter	50mV[*5]	–
	Current limiter	50mV[*5]	–
	Voltage measurement	50mV[*5]	–
	Current measurement	50mV[*5]	–
Power OFF noise		600mV	At 100kΩ

[*5] The Limiter is inactive. While the limiter is active, it is the same as the source range switching noise.

Settling time
Time to reach the final value ±0.03% when varying the output from zero to full-scale (in the 4A range, time to reach the final value ±0.1%). This applies under the conditions of resistive load, load capacity of 200pF or less, and full-scale source and limiter setting values.

	Range	Settling time
Voltage source	3V	300µs or less
	15V	700µs or less
Current source	3mA	700µs or less
	30mA	
	300mA	
	1A	2ms or less
	4A	500µs or less

3mA to 1A is for settling compliance voltage 15V. 4A is for settling compliance voltage 10V.

Over shoot: ±0.1% or less (under resistive load and at the standard cable end)
Line regulation: ±0.003% of range or less
Load regulation
Voltage source: ±0.003% of range or less (at 4-wire connection under the maximum load)
Current source: Depending on the overall accuracy CMV (A × Vo/1V)

Output resistance: At 2-wire connection (Output cable not included)
Maximum load capacitance: Maximum load capacitance that does not generate oscillation in voltage source or voltage limiter status

Range	Output resistance (Ω)		Maximum load capacitance
	Voltage source	Current source	
3mA	10mΩ or less	100MΩ or higher	100µF
30mA	10mΩ or less	10MΩ or higher	100µF
300mA	10mΩ or less	1MΩ or higher	2000µF
1A	10mΩ or less	100kΩ or higher	2000µF
4A	10mΩ or less	50kΩ or higher	2000µF

Supplied cable resistance: 100mΩ or less

Maximum inductive load: Maximum inductive load that does not generate oscillation in current source or voltage limiter status

Current source range/current limiter range	3mA to 4A
Maximum inductive load	1mH

Effective CMRR: At unbalanced impedance 1kΩ
     In DC and AC 50/60 Hz ± 0.08%

	Integration time	
	100µs to 10ms	1PLC to 200ms
Voltage measurement/current measurement	60dB	120dB

NMRR: At AC 50/60 Hz ± 0.08%

	Integration time	
	100µs to 10ms	1PLC to 200ms
Voltage measurement/current measurement	0dB	60dB

Source and measurement function

DC source and measurement	Source and measurement of DC voltage and current
Pulse source and measurement	Source and measurement of pulse voltage and current (However, measurement auto range in pulse source is impossible)
DC sweep source and measurement	Source and measurement by Linear, Random and Fixed levels
Pulse sweep source and measurement	Source and measurement by Linear, Random and Fixed levels (However, measurement auto range in pulse source is impossible)
Integration time	8 types available: 100µs, 500µs, 1ms, 5ms, 10ms, 1PLC, 100ms, and 200ms
Sweep mode	Reverse ON (round)/OFF (one way)
Sweep repeat count	1 to 1000 times or infinite
Maximum number of sweep steps	5000 steps
Maximum random sweep memory	5000 data
Measurement data memory	5000 data
Measurement auto range	Available only in VSIM or ISVM
Limiter	The HI and LO limiters can be set individually. (However, current limiters of the same polarity are not allowed)
Calculation function	NULL calculation, comparator calculation (HI, GO, or LO) Scaling calculation MAX, MIN, AVE, TOTAL calculation
Trigger style	Auto trigger, External trigger
Output terminal	Front; Safety socket HI OUTPUT, HI SENSE, LO OUTPUT, and LO SENSE
Maximum input	15V peak Max (between HI-LO) 2V peak Max (between OUTPUT and SENSE) 250V Max (between LO and chassis)
Maximum remote sensing voltage	±1 V Max; HI OUTPUT - HI SENSE, LO OUTPUT - LO SENSE (The voltage between HI SENSE and LO SENSE must be within the maximum output voltage range)
Voltage measurement input resistance	100MΩ or higher
Voltage measurement input leak current	±100nA or lower
GPIB interface	Compliant with IEEE-488.1-1978
Interface function	Interface function; SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0, E2
External control signal	● TRIGGER IN ● INTERLOCK/OPERATE IN/OPERATE OUT ● COMPLETE OUT/SYNC OUT

Setting Time

Minimum pulse width: 500μs
Minimum step (repeat) time: Under fixed source/measurement range, integration time of 100μs, measurement delay time of 100μs, calculation function OFF, and voltage/current measurement

Measurement	Memory mode	Minimum step time
OFF	—	1ms
ON	BURST	2ms
	NORMAL	10ms
	OFF	

Source delay time

Setting range	Resolution*6)	Setting accuracy
0.030ms to 60.000ms	1μs	
60.01ms to 600.00ms	10μs	±(0.1%+10μs)
600.1ms to 6000.0ms	100μs	
6001ms to 59998ms	1ms	

Period (pulse cycle)

Setting range	Resolution	Setting accuracy
1.000ms to 60.000ms	1μs	
60.01ms to 600.00ms	10μs	±(0.1%+10μs)
600.1ms to 6000.0ms	100μs	
6001ms to 60000ms	1ms	

Pulse width

Setting range	Resolution*6)	Setting accuracy
0.500ms to 60.000ms	1μs	
60.01ms to 600.00ms	10μs	±(0.1%+10μs)
600.1ms to 6000.0ms	100μs	
6001ms to 59998ms	1ms	

Measurement delay time

Setting range	Resolution*6)	Setting accuracy
0.100ms to 60.00ms	1μs	
60.01ms to 600.00ms	10μs	±(0.1%+10μs)
600.1ms to 6000.0ms	100μs	
6001ms to 59998ms	1ms	

*6) The setting resolution is determined by the period time resolution.

Hold time

Setting range	Resolution	Setting accuracy
1ms to 60000ms	1ms	±(2%+3ms)

General Specifications

Operating environment: Ambient temperature: 0°C to +50°C
                         Relative humidity: 85% or less, no condensation
Storage environment: Ambient temperature: -25°C to +70°C
                         Relative humidity: 85% or less, no condensation
Warm-up time: 60 minutes or more
Display: 16 segments × 12 digits vacuum fluorescent display
Power supply: AC power supply 100V/120V/220V/240V
                         (User selectable)

Option Number	Standard	OPT.32	OPT.42	OPT.44
Power supply voltage	100V	120V	220V	240V

Specify the option when ordering.
Use a power cable and a fuse that are compliant with the safety standard when changing the power supply voltage.

Line frequency: 50Hz/60Hz
Power consumption: 95VA or less
Dimensions: Approx. 212 (W) × 88 (H) × 400 (D) mm
Mass: 5kg or less

Supplied Accessories

Name	Model	Quantity
Power cable	A01402	1
Input/output cable (safety plug)	A01044	1
Banana adapter (for A01044)	A08531	1

Optional Accessories

Name	Model
Input cable (test probe)	A01041
Input/output cable (large current, 0.5m)	A01047-01
Input/output cable (large current, 1m)	A01047-02
Input/output cable (large current, 1.5m)	A01047-03
Input/output cable (large current, 2m)	A01047-04
Test fixture	12701A
Panel mount set	A02039
Panel mount set (twin)	A02040
JIS rack mount set	A02263
JIS rack mount set (twin)	A02264
EIA rack mount set	A02463
EIA rack mount set (twin)	A02464

• Please read through the operation manual carefully before using the products.
• All specifications are subject to change without notice.

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