


DC Voltage/Current Generators/Calibrators

Synchronized 2-Channel Measurement Function

R6245/6246

- Synchronized 2-Channel Generation, Measurement
- Measurement Resolution of 1 μ V, 10 fA (SMU220-2), 100 pA (SMU62-20)
- Source Range ± 220 V, ± 2 A (SMU220-2, 2.4 W) ± 62 V, ± 20 A (SMU62-20, 140 W)
- Minimum Pulse Width 100 μ s, Minimum Step 700 μ s



(Photo is R6245)

R6245/6246

DC Voltage/Current Sources/Monitors

The R6245/6246 Series are DC voltage/current sources and monitors having source measurement units (SMUs) with 2 isolated channels. The series covers wide source and measurement ranges. It is ideal for measurement of DC characteristics of items ranging from separate semiconductors such as bipolar transistors, MOSFETs and GaAsFETs, to ICs and power devices. Further, due to the increased measuring speed and synchronized 2-channel measurement function, device I/O characteristics can be measured with precise timing at high speed which previously difficult to accomplish. Due to features such as the trigger link function and the sequence programming function which automatically performs a series of evaluation tests automatically, the new R6245/6246 enable much more efficient evaluation tests.

- High Measurement Accuracy of ± 620000 Columns, 0.02%
High Measurement Resolution of 1 mV, 10 fA
- High source Accuracy of ± 62000 Columns, 0.03%
Wide source Range of ± 220 V, ± 20 A
- High Throughput, 0.8 V/ μ s (At Current Measurement Range of 6 mA or more)
- Wide Variety of Measurement Functions
 - 4 Phenomenon Output (Source/Sink)
 - Up to 5 V Remote Sense
 - Minimum Step 700 μ s Sweep Measurement (Generation, Measurement, Data Storage)
 - Range Switching without Discontinuous Output
 - Pulse Measurement with Minimum Pulse Width of 100 μ s
 - Synchronized 2-Channel Measurement Function
 - Search measurement function

Unit Configuration

Model name	Channel A	Channel B
R6245	SMU220-2	SMU220-2
R6246	SMU62-20	SMU220-2

SMU220-2: 24.2 W max. ± 220 V/ ± 2 A
SMU62-20: 200 W max. ± 62 V/ ± 20 A

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Specifications

All accuracy values are for 23°C ±5°C, RH 75% max., guaranteed for 6 months. One-day stability is guaranteed for 23°C ±5°C, RH 75% max. Measurement accuracy, one-day stability and temperature coefficient are guaranteed with auto zero on, reset time from 1 to 20 PLC.

Maximum output current:

SMU220-2	SMU62-20
±2 A up to 12 V	±20 A up to 7 V
±0.62 A up to 40 V	±10 A up to 20 V
±0.11 A up to 220 V	±2.2 A up to 62 V

Maximum output voltage, maximum follow-up voltage:

SMU220-2	SMU62-20
±220 V up to 0.11 A	±62 V up to 2.2 A
±40 V up to 0.62 A	±20 V up to 10 A
±12 V up to 2 A	±7 V up to 20 A

Voltage source/measurement range:

Current source/measurement range:

Unit name	Range	Source range	Setting resolution	Measurement range	Measurement resolution
SMU62-20	600 mV	0 to ±620.00 mV	10 µV	0 to ±620.000 mV	1 µV
	6 V	0 to ±6.2000 V	100 µV	0 to ±6.20000 V	10 µV
	60 V	0 to ±62.000 V	1 mV	0 to ±62.0000 V	100 µV
SMU220-2	200 V	0 to ±220.00 V	10 mV	0 to ±220.000 V	1 mV
SMU220-2	6 nA	0 to ±6.2000 nA	100 fA	0 to ±6.20000 nA	10 fA
	60 nA	0 to ±62.000 nA	1 pA	0 to ±62.0000 nA	100 fA
	600 nA	0 to ±620.00 nA	10 pA	0 to ±620.000 nA	1 pA
SMU62-20	6 µA	0 to ±6.2000 µA	100 pA	0 to ±6.20000 µA	10 pA
	60 µA	0 to ±62.000 µA	1 nA	0 to ±62.000 µA	100 pA
	600 µA	0 to ±620.00 µA	10 nA	0 to ±620.000 µA	1 nA
	6 mA	0 to ±6.2000 mA	100 nA	0 to ±6.20000 mA	10 nA
	60 mA	0 to ±62.000 mA	1 µA	0 to ±62.0000 mA	100 nA
	600 mA	0 to ±620.00 mA	10 µA	0 to ±620.000 mA	1 µA
SMU62-20	2 A	0 to ±2.0000 A	100 µA	0 to ±2.00000 A	10 µA
	6 A	0 to ±6.2000 A	100 µA	0 to ±6.20000 A	10 µA
	20 A	0 to ±20.000 A	1 mA	0 to ±20.0000 A	100 µA

However, the measurement resolution at a reset time of 100 µs to 500 µs is as follows:

Reset time	Measurement resolution (digits)
100 ms	10
200 ms	5
500 ms	2

Voltage/current compliance range:

Unit name	Range	Maximum setting	Minimum setting	Setting resolution
SMU62-20	600 mV	620.00 mV	1 mV	10 µV
	6 V	6.2000 V	0.6201 V	100 µV
	60 V	62.000 V	6.201 V	1 mV
SMU220-2	200 V	220.00 V	62.01 V	10 mV
SMU220-2	6 nA	6.2000 nA	10 pA	100 fA
	60 nA	62.000 nA	6.201 nA	1 pA
	600 nA	620.00 nA	62.01 nA	10 pA
SMU62-20	6 µA	6.2000 µA	0.6201 µA	100 pA
	60 µA	62.000 µA	6.201 µA*1	1 nA
	600 µA	620.00 µA	62.01 µA	10 nA
	6 mA	6.2000 mA	0.6201 mA	100 nA
	60 mA	62.000 mA	6.201 mA	1 µA
	600 mA	620.00 mA	62.01 mA	10 µA
SMU62-20	2 A	2.0000 A	0.6201 A	100 µA
	6 A	6.2000 A	0.6201 A	100 µA
	20 A	20.000 A	6.201 A	1 mA

*1 100 nA for SMU62-20

Accuracy: Includes calibration accuracy, one-day stability, temperature coefficient, linearity

One-day stability: At constant power, load

Temperature coefficient: At 0°C to 40 °C, RH 75% max.

Voltage source/ compliance range	Overall accuracy	One-day stability	Temperature coefficient
	±(% of setting + range error)		±(ppm of setting + range error)/°C
600 mV	0.03 + 400 µV	0.01 + 200 µV	12 + 22 µV
6 V	0.03 + 1.3 mV	0.01 + 500 µV	12 + 55 µV
60 V	0.03 + 13 mV	0.01 + 4 mV	12 + 600 µV
200 V	0.03 + 60 mV	0.01 + 20 mV	12 + 2.5 mV

Current source/ compliance range	Overall accuracy	One-day stability	Temperature coefficient
	±(% of setting + A + A x Vo/(1V))		±(ppm of setting + A + A x Vo/(1V))/°C
6 nA	0.5 + 6.5 pA + 60 fA	0.1 + 4 pA + 23 fA	150 + 400 fA + 1.8 fA
60 nA	0.5 + 18 pA + 600 fA	0.1 + 8 pA + 230 fA	120 + 1 pA + 18 fA
600 nA	0.2 + 150 pA + 6 pA	0.035 + 50 pA + 2.3 pA	45 + 6 pA + 180 fA
6 µA	0.05 + 1.5 nA + 60 pA	0.015 + 500 pA + 23 pA	18 + 60 pA + 1.8 pA
60 µA	0.04 + 15 nA + 600 pA	0.015 + 5 nA + 230 pA	18 + 600 pA + 18 pA
600 µA	0.03 + 150 nA + 6 nA	0.01 + 50 nA + 2.3 nA	12 + 6 nA + 180 pA
6 mA	0.03 + 1.5 µA + 60 nA	0.01 + 500 nA + 23 nA	12 + 60 nA + 1.8 nA
60 mA	0.03 + 15 µA + 600 nA	0.01 + 5 µA + 230 nA	12 + 600 nA + 18 nA
600 mA	0.045 + 150 µA + 6 µA	0.015 + 50 µA + 2.3 µA	15 + 6 µA + 180 nA
2 A	0.065 + 1.5 mA + 60 µA	0.03 + 500 µA + 23 µA	22 + 60 µA + 1.8 µA
6 A	0.15 + 1.5 mA + 60 µA	0.12 + 500 µA + 23 µA	40 + 65 µA + 1.8 µA
20 A	0.18 + 15 mA + 600 µA	0.15 + 5 mA + 230 µA	40 + 650 µA + 18 µA

Voltage measurement range	Overall accuracy	One-day stability	Temperature coefficient
	±(% of reading + range error)		±(ppm of reading + range error)/°C
600 mV	0.02 + 150 µV	0.008 + 80 µV	7 + 6 µV
6 V	0.02 + 180 µV	0.008 + 100 µV	7 + 7 µV
60 V	0.025 + 1 mV	0.01 + 500 µV	13 + 40 µV
200 V	0.025 + 5 mV	0.01 + 3 mV	13 + 150 µV

Current measurement range	Overall accuracy	One-day stability	Temperature coefficient
	±(% of reading + A + A x Vo/(1 V))		±(ppm of reading + A + A x Vo/(1 V))/°C
6 nA	0.5 + 5.5 pA + 60 fA	0.1 + 3.5 pA + 23 fA	150 + 350 fA + 1.8 fA
60 nA	0.5 + 10 pA + 600 fA	0.1 + 5.5 pA + 230 fA	120 + 600 fA + 18 fA
600 nA	0.2 + 50 pA + 6 pA	0.035 + 25 pA + 2.3 pA	40 + 3 pA + 180 fA
6 µA	0.045 + 500 pA + 60 pA	0.015 + 220 pA + 23 pA	18 + 25 pA + 1.8 pA
60 µA	0.035 + 5 nA + 600 pA	0.015 + 2.2 nA + 230 pA	15 + 250 pA + 18 pA
600 µA	0.025 + 50 nA + 6 nA	0.01 + 22 nA + 2.3 nA	10 + 2.5 nA + 180 pA
6 mA	0.025 + 500 nA + 60 nA	0.01 + 220 nA + 23 nA	10 + 25 nA + 1.8 nA
60 mA	0.025 + 5 µA + 600 nA	0.01 + 2.2 µA + 230 nA	10 + 250 nA + 18 nA
600 mA	0.04 + 60 µA + 6 µA	0.01 + 32 µA + 2.3 µA	12 + 3.8 µA + 180 nA
2 A	0.06 + 600 µA + 60 µA	0.03 + 320 µA + 23 µA	20 + 38 µA + 1.8 µA
6 A	0.15 + 600 µA + 60 µA	0.12 + 320 µA + 23 µA	40 + 38 µA + 1.8 µA
20 A	0.18 + 6 mA + 600 µA	0.15 + 3.2 mA + 230 µA	40 + 380 µA + 1.8 µA

Vo: Follow-up voltage (0 V to ±220 V)

However, for current ranges, ±0.65 pA/°C is added to the above values for temperature coefficients of 28°C to 40°C.

Integration time: Measurement accuracy of 10 ms to 100 µs, the following full-scale error is added to one day stability,

Measurement range	Reset time						
	10 ms	5 ms	2 ms	1 ms	500 µs	200 µs	100 µs
600 mV	8	11	18	25	36	57	80
6 V to 200 V	5	7	11	16	22	35	50
6 nA	10	14	22	32	45	71	100
60 nA	7	9	15	21	29	47	66
600 nA	6	8	12	17	25	39	55
6 µA to 2 A	5	7	11	16	22	35	50

Generation linearity: ±0.01% of range at 23°C ± 5°C, RH 75% or less

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Output noise: At no load and maximum load for voltage generation (Vp-p), at the load resistances given for current generation (Ap-p)

Voltage/current source range	Load resistance	Ripple noise	High frequency noise		
			DC to 10 Hz	DC to 20 MHz	
				FAST	SLOW
600 mV	—	60 μ V	300 μ V	5 mV	4 mV
6 V	—	150 μ V	500 μ V	5 mV	4 mV
60 V	—	1 mV	2 mV	6 mV	5 mV
200 V	—	3 mV	4 mV	10 mV	6 mV
6 nA	100 M	500 fA	10 pA	100 pA	100 pA
60 nA	10 M	5 pA	100 pA	1 nA	1 nA
600 nA	1 M	50 pA	1 nA	10 nA	10 nA
6 μ A	100 k	500 pA	10 nA	100 nA	100 nA
60 μ A	10 k	5 nA	100 nA	1 μ A	1 μ A
600 μ A	1 k	50 nA	100 nA	10 μ A	10 μ A
6 mA	1 k	100 nA	1 μ A	10 μ A	10 μ A
60 mA	1 k	1 μ A	10 μ A	10 μ A	10 μ A
600 mA	1 k	10 μ A	20 μ A	100 μ A	100 μ A
2 A, 6 A	100	100 μ A	200 μ A	200 μ A	200 μ A
20 A	10	1 mA	2 mA	2 mA	2 mA

Switching noise:

Range switching noise		Maximum value (p-p)	Typical value (p-p)
Output on/off noise	Voltage source	250 mV + 20 nA \times R1	50 mV
	Current source	250 mV/R1 + 20 nA	100 μ A
Range switching noise	Voltage source	150 mV	50 mV
	Current source	250 mV/R1 + 20 nA	50 μ A
	Voltage measurement	150 mV	50 mV
	Current measurement	250 mV/R1	50 μ A
Polarity switching noise	Voltage source	150 mV	50 mV
	Current source	50 mV/R1 + 1 nA	50 μ A
Response switching noise	Voltage source	200 mV	50 mV
	Current source	80 mV/R1 + 20 nA	50 μ A
Power source off noise		0.6 V	0.6 V

R1 indicates load resistance (Ω)

Typical values obtained at voltage range 6 V or less, current range 6 mA to 20 A, R1 = 1 k Ω

Settling time: When the current range is 6 mA to 20 A, the time required to reach $\pm 0.03\%$ of the final value when the output is changed from zero to full-scale.
For simple resistance load, load capacity 2.5 pF max., compliance settings at full-scale

Item	FAST	SLOW
Voltage generation	300 μ s	2.5 ms
Current generation	500 μ s	5.5 ms

Line regulation: $\pm 0.0017\%$ of range, at AC 100 V $\pm 10\%$

Load regulation:

Voltage generation: $\pm 0.0017\%$ of range or less, with 4-wire connection at maximum load

Current generation: ± 5 ppm \times Vo/1V or less, Vo: follow-up voltage (0 V to ± 220 V)

Output resistance: With 2-wire connection, excluding output cable

Maximum capacity load: Maximum non-oscillating capacity load when voltage generation or voltage compliance is operating

Current range	Output resistance		Maximum load capacity
	Voltage source	Current source	
6 nA	1 k Ω	3.22 E + 13 Ω	0.01 μ F
60 nA	100 Ω	3.22 E + 12 Ω	0.01 μ F
600 nA	10 Ω	3.22 E + 11 Ω	0.01 μ F
6 μ A	1 Ω	3.22 E + 10 Ω	0.01 μ F
60 μ A	200 m Ω	3.22 E + 9 Ω	0.1 μ F
600 μ A	100 m Ω	3.22 E + 8 Ω	1 μ F
6 mA	100 m Ω	3.22 E + 7 Ω	10 μ F
60 mA	100 m Ω	3.22 E + 6 Ω	100 μ F
600 mA	100 m Ω	3.22 E + 5 Ω	1000 μ F
2 A, 6 A	100 m Ω	1 E + 5 Ω	1000 μ F
20 A	100 m Ω	1 E + 4 Ω	1000 μ F

Standard accessory cable (A01010) resistance: 0.2 Ω max.

Maximum inductive load: Maximum non-oscillating inductive load when voltage generation or voltage compliance is operating

Current source/compliance range	Maximum inductive load
6 nA to 60 μ A	50 μ H
600 μ A	300 μ H
6 mA	500 μ H
60 mA to 20 A	1000 μ H

CMRR: With 1 k Ω unbalanced impedance between LO and GUARD terminals, DC and AC 50/60 Hz $\pm 0.09\%$

Item	Reset time	
	100 μ s to 10 ms	1 PLC to 20 PLC
Voltage measurement	60 dB	120 dB
Current measurement	0.01%/1 V	1 ppm/1 V

NMR: At AC 50/60 Hz $\pm 0.09\%$

Item	Reset time	
	100 μ s to 10 ms	1 PLC to 20 PLC
Voltage measurement	0 dB	60 dB
Current measurement	0 dB	60 dB

External measurement input: When the current range is measuring an applied voltage at the MEASURE INPUT terminal, the measured voltage is displayed in the set current range

Voltage measurement accuracy $\pm(0.02\%$ of reading + 120 μ V)*1

Current display accuracy $\pm(0.375\%$ of reading + 7.6 μ A)*2

Maximum allowable applied voltage ± 250 V peak max.

External analog input: When an external analog signal is added from the ANALOG INPUT terminal, the output added to the generation value of the set generation range can be obtained. 2 types of gain can be selected. Input and output ranges are decided by the source range.

Voltage source accuracy $\pm(0.16\%$ of setting + 3.8 mV)*1

Current source accuracy $\pm(0.5\%$ of setting + 10 μ A)*2

Maximum input frequency FAST: 10 kHz, SLOW: 1 kHz, at ± 6 V output voltage, 6 mA to 6 A current range, full-scale

Maximum allowable applied voltage ± 10 V peak max.

Input resistance Approx. 10 M Ω

V monitor: Voltage between the HI SENSE and LO SENSE terminals divided at ± 6.2 V full-scale is output at V MONITOR terminal

Monitor accuracy $\pm(0.01\%$ of reading + 1 mV)*1

Output resistance 500 Ω max.

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I monitor: Voltage which has been converted from current to voltage at output current ± 6.2 V full-scale is output at I MONITOR terminal

Monitor accuracy $\pm(35\%$ of reading + 7 mV + 60 μ V \times Vo/1 V)*2

Vo; Follow-up voltage (0 V to ± 220 V)

Output resistance 500 Ω max.

*1: Typical value (at 6 V range)

*2: Typical value (at 60 mA range)

Generation/Measurement Functions

DC generation/measurement: Generation and measurement of DC voltage and current

Pulse generation/measurement: Generation and measurement of pulse voltage and current

Sweep generation/measurement: Fixed, linear, log, random, pulse, linear pulse, log pulse, random pulse

Sweep modes: Single/reverse, repeat

2-channel simultaneous generation/measurement: Synchronized channel A and B generation and measurement of DC, pulse and sweep

Search Measurement : Binary search measurement. Linear search measurement.

Programming functions : Sequence programming function.

All the above functions can be programmed.

Max. programs: 128 characters \times 100 programs

High-speed sequence programming function.

Up to 20 items of DC measurement, pulse measurement, binary/linear search measurement, time parameter, 16-bit digital output data, and conditional jumps can be programmed.

Results (Lo, Go, Hi, etc.) are output from the handler interface.

* Search measurement and programming set via GPIB only.

Generation data memory capacity: 2,048 data items/channel (when random or random pulse is used)

Measurement data memory capacity: 2,048 data items/channel

Trigger methods: Measurement or generation can be done with autotrigger (free-run) and external trigger

Output methods: Bipolar, floating & guarded

Output terminals: Tri-axial/binding post *1

Output types: HI OUTPUT, HI SENSE, LO OUTPUT, LO SENSE, DRIVING GUARD (DG), GUARD

Maximum applied voltage between terminals:

Between HI and LO; 225 Vp-p max. (SMU220-2)/65 Vp-p max. (SMU62-20)

Between LO and GUARD; 50 Vp-p max.

Between GUARD and outer casing; 500 Vp-p max.

Maximum remote sensing voltage: ± 5 V max. *2

Voltage measurement input resistance: 3.22×10^{13} Ω min. (SMU220-2)/ 3.22×10^9 Ω min. (SMU62-20)

Voltage input leakage current: ± 5 pA/ ± 1 nA max. *3

Guard offset voltage: ± 3 mV max.

Maximum allowable card capacity: 1000 PF max. *4

Maximum allowable shield capacity: 5000 PF max. *5

*1: SMU220-2/SMU62-20

*2: Voltage between the HI OUTPUT and HI SENSE terminals, between the LO OUTPUT and LO SENSE terminals and between the HI SENSE and LO SENSE terminals are within the range of the maximum output voltage. Includes voltage drop due to cable resistance.

*3: When doing ISVM measurement at current generation range of 6 nA/60 μ A

*4: Between HI (OUTPUT or SENSE) and DG terminals

*5: Between DG and LO (OUTPUT or SENSE) terminals

GPIB interface: IEEE standard, conforms with 488-1978

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, E2

Digital output: Internal status or 16 bit setting output 5 V pull-up with 10 k Ω resistance at O/C

Trigger link: Used for synchronizing 2 units of the R6245/6246 Series for generation or measurement. TTL level I/O.

Scanner control: For use in scanner control with ADVANTEST R7210 or other models. TTL level output.

Trigger input: Used at measurement start, sweep step up, pulse output trigger. TTL negative pulse 10 ms min.

Trigger output: Used at measurement end, sweep end. Output TTL negative pulse approx. 15 ms

Interlock input: Used when outputting by interlocking with a fixture

Setting Times

Hold time setting range:

Setting range	Resolution	Setting accuracy
100 ms to 65.5350 s	100 μ s	$\pm(2\% + 40 \mu\text{s})$

Measure delay time setting range:

Setting range	Resolution	Setting accuracy
100 μ s to 65.53500 s	10 μ s	$\pm(2\% + 40 \mu\text{s})$

Pulse width, pulse period setting range:

Pulse period (Tp)	Pulse width (Tw)*	Resolution
700 μ s to 655.35 ms	100 μ s to 655.35 ms	10 μ s
655.4 ms to 6.5535 s	100 μ s to 6.5535 s	100 μ s
6.554 s to 65.535 s	1 ms to 65.535 s	1 ms

* The pulse width resolution is always the same as the pulse period, so the possible setting range for the pulse width is decided by the pulse period setting.

Setting accuracy:

Pulse period (Tp) $\pm(2\% + 40 \mu\text{s})$

Pulse width (Tw) $\pm(2\% + 10 \mu\text{s})$

General Specifications

Display:

R6245/6246 Fluorescent display CRT and LED display

R6245A LED display only (POWER, ON, FAILED, CH COMMON SHORT, OPERATE, 4 WIRE, LO-G SHORT)

Setting method:

R6245/6246 By keys, GPIB remote

R6245A By GPIB remote only

Preheating time: 30 minutes or more until specified accuracy is attained

Operating conditions: 0°C to 40°C, 85% RH

Storage conditions: -25°C to +70°C

Power requirements: Specify at time of ordering

Option no.	Standard	Option32	Option42	Option44
Powervoltage	90 V to 110 V	108 V to 132 V	198 V to 242 V	216 V to 250 V

Power frequency: 48 Hz to 66 Hz

Power consumption: 350 VA (R6245/6245A)/850 VA max. (R6246)

Dimensions: Approx. 424 (W) \times 177 (H) \times 500 (R6245/6245A)/550 (R6246) (D) mm

Mass: 25 kg max. (R6245/6245A)/33 kg max. (R6246)

Accessories:

Item	Model	Stock no.	R6245/6245A	R6246
Power Cable	A01402	DCB-DD2428 \times 01	1	0
	A01437	DCB-DD5641 \times 01	0	1
Input/Output Cable	A01010	DCB-FM1645 \times 01	2	1

Accessories (Sold Separately)

PR624501-FJ Semiconductor Parameter Auto Measurement Software

R12701 Test Fixture

A01009-050 Input/Output Cable (0.5 m)

A01009-100 Input/Output Cable (1 m)

A01009-150 Input/Output Cable (1.5 m)

A01009-200 Input/Output Cable (2 m)

A01010 Input Cable (1 m)

A01038 Input/Output Cable (for R6246 channel A)

A02710 Rack Mount Set A (EIA standard, with front handle)

A02711 Rack Mount Set A (JIS standard, with front handle)

A02720 Rack Mount Set B (EIA standard, without front handle)

A02721 Rack Mount Set B (JIS standard, without front handle)

A02703 Front Handle Set

A02730 Rack Flange Set A (EIA standard)

A02731 Rack Flange Set A (JIS standard)

A02615 Slide Rail Set