

New

GPIB

USB

BCD

Factory option

**6½-digit working standard suitable for calibration
High-accuracy and highly stable with bipolar output**

- Wide dynamic range and high resolution
Voltage source: $\pm 10\text{nV}$ to $\pm 1200\text{V}$
Current source: $\pm 1\text{nA}$ to $\pm 120\text{mA}$
- High accuracy: $\pm 35\text{ppm/year}$ ($\pm 25\text{ppm/90days}$)
- High stability: $\pm 5\text{ppm/24hrs}$
- Smooth polarity switching by bipolar output
- Memory up to 1000 data sets
- JIS-compliant thermal electromotive force output function
- Compliance voltage in 1mA/10mA range can be changed from $\pm 120\text{V}$ to $\pm 1200\text{V}$. (factory option)

Bipolar Output

Working Standard



**$\pm 10\text{nV}$ to $\pm 1200\text{V}$
 $\pm 1\text{nA}$ to $\pm 120\text{mA}$**

The 6166 is a DC voltage/current source that uses a PWM system in the reference voltage generation block for high accuracy, high stability and high resolution.

The DC voltage can be output over a wide range of $\pm 10\text{nV}$ to $\pm 1199.999\text{V}$ and the DC current over a wide range of $\pm 1\text{nA}$ to $\pm 119.9999\text{mA}$. Especially with its high stability for DC voltage source of 25ppm per 90 days or 35ppm per year (typical value), the 6166 can be widely used for calibration of high-precision digital voltmeters or analog indicator instruments or as a generation source for a variety of tests.

In addition, the 6166 has a built-in function to generate thermal electromotive force of thermocouples according to the JIS table, enabling easy calibration of thermometers and other instrumentation systems.

The GPIB and USB interfaces are installed as standard so that voltage and current operations are externally programmable. Also, up to 1000 data including voltage, current, thermocouple, temperature, voltage limit and current limit can be stored by hand and read out freely. A simplified auto test system can be built by nothing but the 6166.

The BCD parallel interface is available optionally, allowing more flexible system architect.

DC Voltage/Current Sourcing in 10nV/1nA Steps

The output voltage normally can be set in four ranges of 0 to $\pm 1199.999\text{V}$ in the minimum $1\mu\text{V}$ steps. When the divider voltage function is selected, it can be set in three ranges of 0 to $\pm 1199.999\text{mV}$ in the minimum 10nV steps. This is ideal for the adjustment, test, maintenance and calibration of high-sensitivity devices and elements.

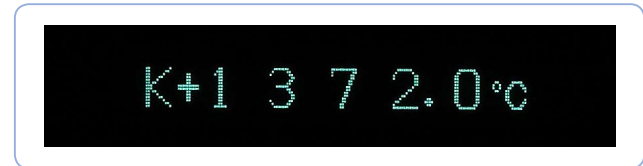
The output current can be set in three ranges of 0 to $\pm 119.9999\text{mA}$ in 1nA steps.

Both a voltage limit and a current limit can be set for voltage sourcing (except divider voltage) or current sourcing. They can protect against damage caused by an operation mistake.

JIS-Compliant Thermal Electromotive Force Output Function

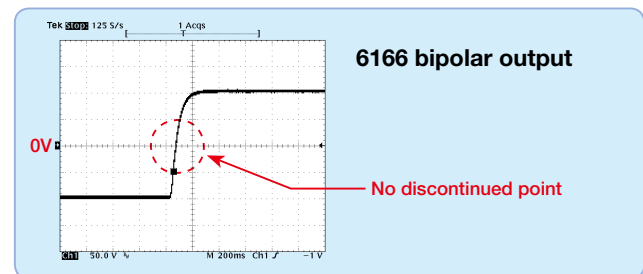
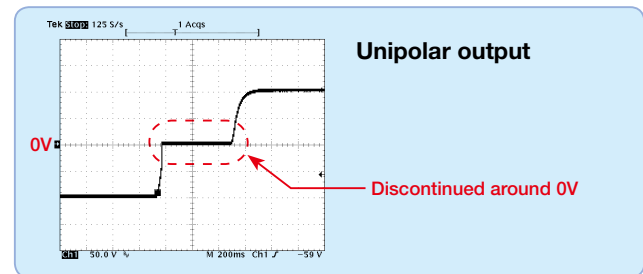
The 6166 has a function to generate thermal electromotive force of thermocouples according to the JIS table. Selecting the type of thermocouple and temperature to be generated will output voltage corresponding to the setting temperature. The type of thermocouple is selectable from eight types: T, J, E, K, S, R, B and N. The JIS standard is JISC1602-1995 or JISC1602-1981. For type N, only JISC1602-1995 is applicable. The reference junction temperature can be set arbitrarily within a range from -270°C to 120°C .

This function enables temperature calibration of thermometers and other instrumentation systems.



Smooth Polarity Switching by Bipolar Output

As the 6166 employs bipolar output, the source polarity can alternate between negative and positive without switching the internal relays. Consequently, even zero-crossing evaluation is made smoothly in a shorter time. While offering improved operability, the 6166 can be used free from the concern of the mechanical parts lifetime.



Easy Viewing Display (Dot Matrix VFD Display)

The 6166 adopts an eye-friendly dot matrix vacuum fluorescent display with increased information capacity.

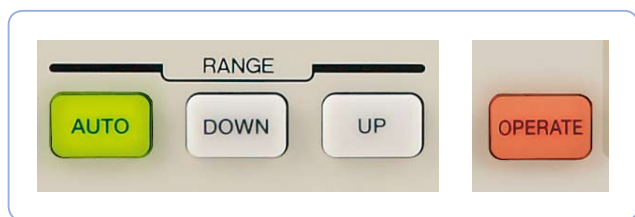
1-line display: Displays the polarity, setting value and unit for sourcing.



2-line display: Displays the voltage and current limit values and the source range in addition to the above. Menu-driven parameter setting is available, enhancing the usability.



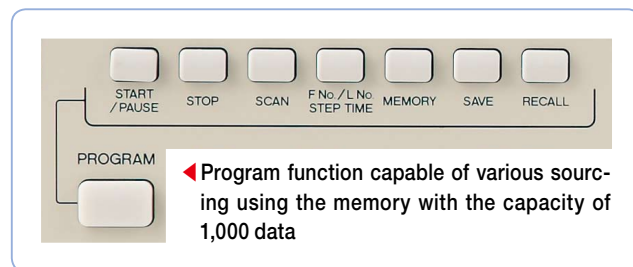
LCD backlighting is used on the primary keys. As the whole key emits light, the key operability is much improved.



Greatly Improved Operating Efficiency by Program Function

The 6166 has a memory with the capacity of 1,000 data sets for the program function. Voltage, current, thermal electromotive force, temperature, voltage limit and current limit can be stored in this memory. Any of these data can be output or the data from the first number through the last number can be scanned.

By using the function, a simplified auto test system can be built easily and the operating efficiency can be greatly improved.



Expanded Specifications for System Use

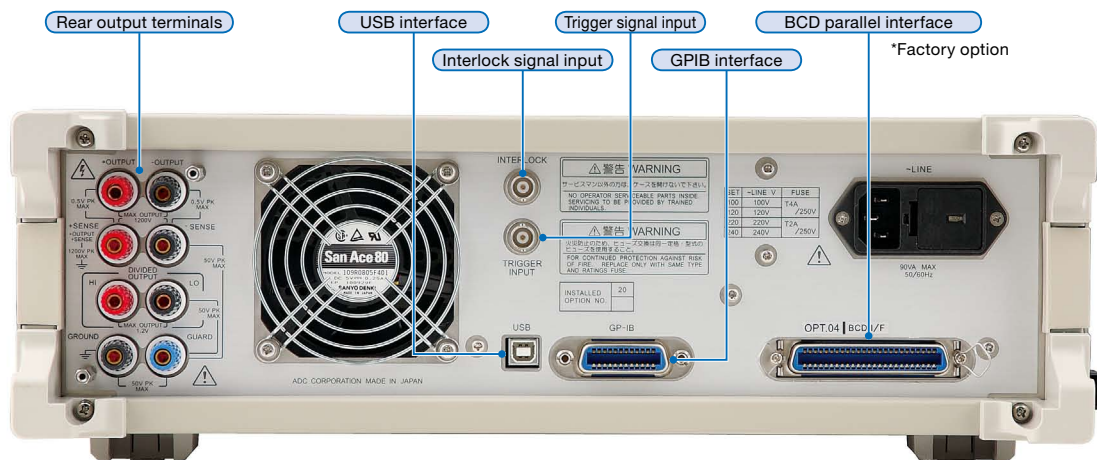
The 6166 is equipped with the GPIB and USB interfaces. The BCD parallel interface that is installed on the former model 6161 is also available optionally.

In addition to the TRIGGER IN signal input for starting the output voltage or current saved in the program memory, the INTERLOCK signal input for controlling the output status by a foot switch, etc. is newly added in consideration of voltage sourcing up to 1200V, thereby securing easily the safety control.



To give flexibility to the output lines incorporated in a system, the rear output terminals are also mounted.

For external control, the remote commands of the former model 6161 are available by using the compatible mode. The 6166 can be replaced with a minimum modification of an existing system.



Specifications

Voltage/current source

Voltage source range (The 10mV to 1000mV ranges are divided output.):

Range	Source range	Setting resolution
10mV	0 to ± 11.99999 mV	10nV
100mV	0 to ± 119.9999 mV	100nV
1000mV	0 to ± 1199.999 mV	1 μ V
1V	0 to ± 1.199999 V	1 μ V
10V	0 to ± 11.99999 V	10 μ V
100V	0 to ± 119.9999 V	100 μ V
1000V	0 to ± 1199.999 V	1mV

Current source range:

Range	Source range	Setting resolution
1mA	0 to ± 1.199999 mA	1nA
10mA	0 to ± 11.99999 mA	10nA
100mA	0 to ± 119.9999 mA	100nA

Accuracy (common) : At constant power and load, with a compliance voltage of ± 10 V or less

Overall accuracy: Includes calibration accuracy, 1-day stability, the temperature coefficient, and linearity.
At temperature of 23°C $\pm 5^\circ$ C and relative humidity of 70% or less.

Relative accuracy: A value indicating overall accuracy except for the external standard traceability.

1-day stability: At temperature of 23°C $\pm 1^\circ$ C

Temperature coefficient 1: At temperature of 23°C $\pm 10^\circ$ C

Temperature coefficient 2: At temperature of 0°C to 13°C, 33°C to 50°C

Voltage source accuracy (The 10mV to 1000mV ranges are divided output.):

Range	Overall accuracy			
	1 year	180 days	90 days	1 day
	\pm (% of setting+V)			
10mV	0.0070+2.3 μ V	0.0065+2.3 μ V	0.0060+2.3 μ V	0.0055+0.7 μ V
100mV	0.0055+2.5 μ V	0.0050+2.5 μ V	0.0045+2.5 μ V	0.0040+0.8 μ V
1000mV	0.0045+8 μ V	0.0040+8 μ V	0.0035+8 μ V	0.0030+6 μ V
1V	0.0035+12 μ V	0.0030+12 μ V	0.0025+11 μ V	0.0020+10 μ V
10V	0.0035+70 μ V	0.0030+70 μ V	0.0025+70 μ V	0.0020+60 μ V
100V	0.0035+700 μ V	0.0030+700 μ V	0.0025+700 μ V	0.0020+600 μ V
1000V	0.0040+7mV	0.0035+7mV	0.0030+7mV	0.0025+6mV

Range	Relative accuracy			
	1 year	180 days	90 days	1 day
	\pm (% of setting+V)			
10mV	0.0030+2 μ V	0.0025+2 μ V	0.0020+2 μ V	0.0010+0.5 μ V
100mV	0.0030+2 μ V	0.0025+2 μ V	0.0020+2 μ V	0.0010+0.5 μ V
1000mV	0.0030+6 μ V	0.0025+6 μ V	0.0020+6 μ V	0.0010+4 μ V
1V	0.0025+9 μ V	0.0020+9 μ V	0.0015+8 μ V	0.0005+6 μ V
10V	0.0025+50 μ V	0.0020+50 μ V	0.0015+50 μ V	0.0005+40 μ V
100V	0.0025+500 μ V	0.0020+500 μ V	0.0015+500 μ V	0.0005+400 μ V
1000V	0.0025+5mV	0.0020+5mV	0.0015+5mV	0.0008+4mV

Range	1-day stability (23°C $\pm 1^\circ$ C)	Temperature coefficient 1	Temperature coefficient 2
	\pm (% of setting+V)	\pm (% of setting+V) /°C	\pm (% of setting+V) /°C
10mV	0.0007+0.3 μ V	0.0004+0.01 μ V	0.0005+0.03 μ V
100mV	0.0007+0.3 μ V	0.0004+0.07 μ V	0.0005+0.08 μ V
1000mV	0.0007+2 μ V	0.0004+0.6 μ V	0.0005+0.8 μ V
1V	0.0005+3 μ V	0.0002+1 μ V	0.0004+1.5 μ V
10V	0.0005+20 μ V	0.0002+6 μ V	0.0004+8 μ V
100V	0.0005+200 μ V	0.0002+60 μ V	0.0004+80 μ V
1000V	0.0005+2mV	0.0003+600 μ V	0.0005+800 μ V

Current source accuracy:

Range	Overall accuracy			
	1 year	180 days	90 days	1 day
	\pm (% of setting+A)			
1mA	0.0070+9nA	0.0065+9nA	0.0060+9nA	0.0055+9nA
10mA	0.0055+90nA	0.0050+90nA	0.0045+90nA	0.0040+90nA
100mA	0.0055+900nA	0.0050+900nA	0.0045+900nA	0.0040+900nA

Range	Relative accuracy			
	1 year	180 days	90 days	1 day
	\pm (% of setting+A)			
1mA	0.0035+6nA	0.0030+6nA	0.0025+6nA	0.0015+5nA
10mA	0.0030+60nA	0.0025+60nA	0.0020+60nA	0.0010+50nA
100mA	0.0030+600nA	0.0025+600nA	0.0020+600nA	0.0010+500nA

Range	1-day stability (23°C $\pm 1^\circ$ C)	Temperature coefficient 1	Temperature coefficient 2
	\pm (% of setting+A)	\pm (% of setting+A) /°C	\pm (% of setting+A) /°C
1mA	0.0012+2nA	0.0006+0.7nA	0.0008+0.8nA
10mA	0.0007+20nA	0.0004+7nA	0.0005+8nA
100mA	0.0007+200nA	0.0004+70nA	0.0005+80nA

Source linearity:

At temperature of 23°C $\pm 10^\circ$ C, relative humidity of 70% or less and constant power and load

For the current range, with a compliance voltage of ± 10 V or less (The 10mV to 1000mV ranges are divided output.)

Range	Linearity
10mV	$\pm 0.03\mu$ V
100mV	$\pm 0.3\mu$ V
1000mV	$\pm 4\mu$ V
1V	$\pm 3\mu$ V
10V	$\pm 30\mu$ V
100V	$\pm 400\mu$ V
1000V	± 5 mV
1mA	± 3 nA
10mA	± 30 nA
100mA	± 500 nA

Load regulation/output resistance: In 2-wire connection

(The 10mV to 1000mV ranges are divided output.)

	Range	Load regulation (Load condition)	Output resistance	Maximum output
Voltage source	10mV	-	180 Ω $\pm 0.5\%$	-
	100mV		198 Ω $\pm 0.5\%$	
	1000mV		200 Ω $\pm 0.5\%$	
	1V	$\pm 0.0008\%$ (10 Ω or higher)	100m Ω or less	Output current ± 120 mA
	10V	$\pm 0.0002\%$ (100 Ω or higher)	100m Ω or less	
	100V	$\pm 0.0002\%$ (1k Ω or higher)	100m Ω or less	
1000V	$\pm 0.0002\%$ (100k Ω or higher)	100m Ω or less		
Current source	1mA	$\pm 0.0002\%$ (10k Ω or higher)	5G Ω or higher*1	Compliance voltage: ± 120 V*2
	10mA	$\pm 0.0002\%$ (1k Ω or less)	5G Ω or higher*1	
	100mA	$\pm 0.0002\%$ (100 Ω or less)	1G Ω or higher	

*1 : 1G Ω or higher when the compliance voltage exceeds 120V

*2 : Up to ± 1200 V for the 1mA and 10mA ranges of the OPT6166+20

Output noise: Voltage source: within the range from no-load to maximum load

Current source: at load resistance of 1k Ω

(The 10mV to 1000mV ranges are divided output.)

	Range	Low frequency noise		High frequency noise
		0.1Hz to 10Hz (rms)	10Hz to 10kHz (rms)	DC to 20MHz (p-p)
Voltage source	10mV	0.2 μ V	20 μ V	1mV
	100mV	0.5 μ V	20 μ V	1mV
	1000mV	1 μ V	20 μ V	1mV
	1V	2 μ V	100 μ V	3mV
	10V	10 μ V	100 μ V	3mV
	100V	100 μ V	100 μ V	3mV
Current source	1000V	1mV	1mV	10mV
	1mA	5nA	50nA	2 μ A (10 μ A)*3
	10mA	20nA	200nA	2 μ A (10 μ A)*3
	100mA	200nA	500nA	10 μ A

*3 : The values in parentheses are for the 1mA and 10mA ranges of the OPT6166+20

Settling time:

Time to settle to the final value $\pm 0.001\%$ when varying from zero to the full scale.
(For the 100mA range, time to settle to the final value $\pm 0.0015\%$)
(The 10mV to 1000mV ranges are divided output.)

	Range	Settling time	Load condition	
Voltage source	10mV	1sec or less	—	
	100mV			
	1000mV			
	1V			
	10V			
	100V			
Current source	1000V	10sec or less ^{*4}	—	
	1mA	1sec or less		100k Ω or less
	10mA			10k Ω or less
	100mA			1k Ω or less

*4: Time to settle to the final value $\pm 0.05\%$ in the 1000V range is within 3s.

For the OPT6166+20, time to settle to the final value $\pm 0.005\%$ in the 1mA and 10mA ranges is within 5s (at load of 1M Ω or less and 100k Ω or less respectively).

Line regulation: $\pm 0.0003\%$ of range or less for 100VAC change of 10%
Maximum load capacitance: Maximum value that does not oscillate in voltage source

Range	Maximum load capacitance
10mV to 10V	1000 μ F
100V	10 μ F
1000V	1 μ F

Maximum load inductance: Maximum value that does not oscillate in current source
Current source: 1mH

CMRR: At unbalanced impedance of 1k Ω between -OUTPUT/-SENSE terminal and GUARD terminal

Voltage output	DC	140dB or more
	50/60Hz $\pm 1\%$	80dB or more
Current output	DC	140dB or more
	50/60Hz $\pm 1\%$	80dB or more

Voltage/current limiter:

	Setting range	Resolution	Setting accuracy
Voltage limiter	10V to 1250V	1V	$\pm 3\%$ of setting $\pm 5V^{*5}$
Current limiter	1mA to 125mA	1mA	$\pm 3\%$ of setting $\pm 0.8mA$

*Available except for the divider voltage ranges (10mV, 100mV and 1000mV)

*5: 1V is added for current source.

Thermal electromotive force

Thermal electromotive force source range:	Thermocouple	Source range	Setting resolution
	T (CC)	-220.0°C to +400.0°C	0.1°C
	J (IC)	-210.0°C to +1200.0°C	0.1°C
	E (CRC)	-220.0°C to +1000.0°C	0.1°C
	K (CA)	-220.0°C to +1372.0°C	0.1°C
	S (PR10)	-10.0°C to +1768.0°C	0.1°C
	R (PR13)	-10.0°C to +1768.0°C	0.1°C
	B (PR30)	+280.0°C to +1820.0°C	0.1°C
	N	-220.0°C to +1300.0°C	0.1°C

Reference junction temperature (cold junction compensation) setting range:
-270°C to +120°C except for the following:

Thermocouple type J: less than -210°C is deemed to be -210°C

Thermocouple type S: less than -50°C is deemed to be -50°C

Thermocouple type R: less than -50°C is deemed to be -50°C

Thermocouple type B: less than 0°C is deemed to be 0°C

Standard setting: JIS C1602-1995 or JIS C1602-1981

For type N, JIS C1602-1995 is applied.

Thermal electromotive force overall accuracy: At temperature of 23°C $\pm 5^\circ$ C and relative humidity of 70% or less for one year

Thermocouple	Source temperature - Reference junction temperature	Accuracy	
		Range	\pm (% of setting+°C)
T (CC)	-220.0°C to +400.0°C	-220.0°C to -190.1°C	0.012+0.2°C
		-190.0°C to -70.1°C	0.009+0.2°C
		-70.0°C to +50.0°C	0.006+0.1°C
		+50.1°C to +400.0°C	0.005+0.1°C
J (IC)	-210.0°C to +1200.0°C	-210.0°C to -170.1°C	0.006+0.1°C
		-170.0°C to -100.1°C	0.008+0.1°C
		-100.0°C to +1200.0°C	0.011+0.2°C
E (CRC)	-220.0°C to +1000.0°C	-220.0°C to -190.1°C	0.012+0.2°C
		-190.0°C to -80.1°C	0.009+0.1°C
K (CA)	-220.0°C to +1372.0°C	-80.0°C to +1000.0°C	0.006+0.1°C
		-220.0°C to -190.1°C	0.012+0.3°C
		-190.0°C to -130.1°C	0.010+0.2°C
		-130.0°C to -80.1°C	0.006+0.1°C
S (PR10)	-10.0°C to +1768.0°C	-80.0°C to +1240.0°C	0.006+0.1°C
		+1240.1°C to +1372.0°C	0.007+0.1°C
		-10.0°C to +50.0°C	0.006+0.5°C
R (PR13)	-10.0°C to +1768.0°C	+50.1°C to +200.0°C	0.006+0.4°C
		+200.1°C to +1768.0°C	0.006+0.3°C
		-10.0°C to +40.0°C	0.006+0.5°C
B (PR30)	+280.0°C to +1820.0°C	+40.1°C to +160.0°C	0.006+0.4°C
		+160.1°C to +1768.0°C	0.006+0.3°C
		+280.0°C to +500.0°C	0.004+0.9°C
		+500.1°C to +650.0°C	0.004+0.7°C
N	-220.0°C to +1300.0°C	+650.1°C to +950.0°C	0.004+0.5°C
		+950.1°C to +1550.0°C	0.004+0.4°C
		+1550.1°C to +1820.0°C	0.004+0.3°C
		-220.0°C to -210.1°C	0.015+0.4°C
		-210.0°C to -180.1°C	0.013+0.3°C
		-180.0°C to -30.1°C	0.009+0.2°C
		-30.0°C to +1300.0°C	0.006+0.1°C

Source Function

Program function:

Recall Specifies an arbitrary memory number.

Scan Scans memory numbers one by one by trigger input.

Increments memory numbers at step time intervals.

Scan operation Hold Scans memory numbers one by one by trigger input.

Single Scans from the first number to the last number.

Repeat Scans repeatedly from the first number to the last number.

Maximum memory: 1000 data

Step time: Setting range 1s to 99s

Setting resolution 1s

Limiter: Current limiter

Voltage limiter

Output system: Floating, bipolar

Output terminal: Front/rear, biding post
+OUTPUT, +SENSE,
-OUTPUT, -SENSE,
DIVIDED OUTPUT HI,
DIVIDED OUTPUT LO
GUARD, GND

For thermal electromotive force sourcing, the DIVIDED OUTPUT terminals are used.

Maximum input between:

{+OUTPUT} and {-OUTPUT} 1200V output max

{+SENSE} and {-SENSE} 0.5V peak max

{OUTPUT} and {SENSE} 0.5V peak max

{DIVIDED OUTPUT HI} and {LO} 2V peak max

{-OUTPUT} and {GUARD} 50V peak max

{-SENSE} and {GUARD} 50V peak max

{DIVIDED OUTPUT LO} and {chassis} 50V peak max

Maximum remote sensing voltage between:

{+OUTPUT} and {+SENSE} $\pm 0.1V$ peak max

{-OUTPUT} and {-SENSE} $\pm 0.1V$ peak max

*The voltage between [\pm OUTPUT] and [\pm SENSE] must be 0.1V or less including voltage drop due to cable resistance.

(Approx. 10ppm error at 0.1V)

GPIB interface :	Compliant with IEEE-488.2-1987
	Interface function SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT1, C0, E2
	Connector Amphenol 24 pin
USB interface :	USB 2.0 Full-speed
	Connector Type B
BCD parallel interface (factory option):	Remote programming
	Output level, polarity, range, Operate, V/I mode, divider output, voltage limit, current limit, remote operate input, operate flag output, limit flag output
	Connector Amphenol 50 pin
External control signal :	TRIGGER IN
	INTERLOCK
	Connector BNC

General Specifications

Operating environment conditions: Ambient temperature 0°C to +50°C
Relative humidity 85% or below, no condensation

Storage environment conditions: Ambient temperature -25°C to +70°C,
Relative humidity 85% or below, no condensation

Warming up time : 60 minutes or longer (until the specified accuracy is reached.)

Display: Dot matrix vacuum fluorescent display

Power supply: AC power 100V/120V/220V/and240V (User selectable)

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

Specify the option number 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: 90VA or less

Dimensions: Approx. 424 (width) × 132 (height) × 450 (depth) mm

Mass: 17kg or less

Safety: Compliant with IEC61010-1 Ed.3

EMI: Compliant with EN61326 classA

Supplied accessory

Part number	Name
A01402	Power cable (JIS 2m)

Options

	Option number
Compliance voltage 1200V (1mA and 10mA ranges) (factory option)	OPT6166+20
BCD parallel interface (factory option)	OPT6166+04

Optional accessories

Part number	Name
CC022003	Rack mount set (JIS 3U)
CC024003	Rack mount set (EIA 3U)
CC028003	Front handle set (3U)
A02615	Slide rail set

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



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