RIGOL

User's Guide

RP1003C/RP1004C/RP1005C

Current Probe

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RIGOL Technologies, Inc

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RIGOL guarantees this product conforms to the national and industrial standards in China as well as the ISO9001:2008 standard and the ISO14001:2004 standard. Other international standard conformance certification is in progress.

Contact Us

If you have any problem or requirement when using our products, please contact RIGOL Technologies, Inc. or your local distributors, or visit: www.rigol.com.

General Safety Summary

Please review the following safety precautions carefully before putting the instrument into operation so as to avoid any personal injuries or damages to the instrument and any product connected to it. To prevent potential hazards, please use the instrument only specified by this manual.

Ground The Instrument.

The instrument is grounded through the Protective Earth lead of the power cord. To avoid electric shock, it is essential to connect the earth terminal of power cord to the Protective Earth terminal before any inputs or outputs.

Observe All Terminal Ratings.

To avoid fire or shock hazard, observe all ratings and markers on the instrument and check your manual for more information about ratings before connecting.

Do Not Operate Without Covers.

Do not operate the instrument with covers or panels removed.

Avoid Circuit or Wire Exposure.

Do not touch exposed junctions and components when the unit is powered.

Do Not Operate With Suspected Failures.

If you suspect damage occurs to the instrument, have it inspected by qualified service personnel before further operations. Any maintenance, adjustment or replacement especially to circuits or accessories must be performed by **RIGOL** authorized personnel.

Keep Well Ventilation.

Inadequate ventilation may cause increasing of temperature or damages to the device. So please keep well ventilated and inspect the intake and fan regularly.

Do Not Operate in Wet Conditions.

In order to avoid short circuiting to the interior of the device or electric shock, please do not operate in a humid environment.

Do Not Operate in an Explosive Atmosphere.

In order to avoid damages to the device or personal injuries, it is important to operate the device away from an explosive atmosphere.

Keep Product Surfaces Clean and Dry.

To avoid the influence of dust and/or moisture in air, please keep the surface of device clean and dry.

Electrostatic Prevention.

Operate in an electrostatic discharge protective area environment to avoid damages induced by static discharges. Always ground both the internal and external conductors of the cable to release static before connecting.

Safety Terms and Symbols

Terms in this Manual. These terms may appear in this manual:

WARNING

Warning statements indicate the conditions or practices that could result in injury or loss of life.

CAUTION

Caution statements indicate the conditions or practices that could result in damage to this product or other property.

Terms on the Product. These terms may appear on the Product:

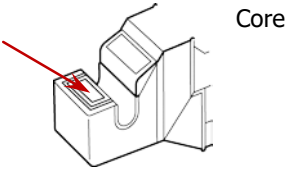
DANGER	indicates an injury or hazard may immediately happen.
WARNING	indicates an injury or hazard may be accessible potentially.
CAUTION	indicates a potential damage to the instrument or other property might occur.

Symbols on the Product. These symbols may appear on the product:

Double Safety Ground **Protective Ground** **Chassis Ground** **Test Terminal** **Insulation** **Warning** **Earth**

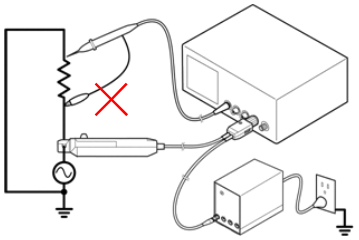
Precautions

- ✧ To avoid short circuits and potentially life-threatening hazards, never connect the current probe to a circuit that operates at greater than the maximum rated voltage or over bare conductors.
- ✧ When conductors being measured carry in excess of the safe voltage level and not more than the maximum rated voltage, to prevent short circuits and electric shock while the core section is open, make sure that conductors to be measured are insulated with material conforming to the requirements of measurement category, working voltage and pollution degree.
- ✧ Isolate the output terminal of the probe from other terminals on the measuring instrument using basic insulation conforming to the requirements of measurement category, working voltage and pollution degree.
- ✧ The core and shield case of the current sensor are not insulated. Please do not use the current sensor on bare conductors.

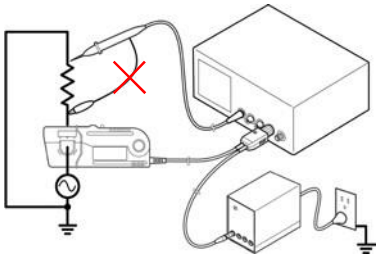


- ✧ Be careful to avoid damaging the insulation surface while taking measurements.
- ✧ Please use the power supply provided with this product or other power supply conforming to the specifications of this product. Make sure that the power supply has a protective earthing with double-insulation construction.
- ✧ Make sure that the measuring instrument connected to the output terminal of the current probe is equipped with a protective earthing with double-insulation construction.
- ✧ If the measuring instrument connected to the output terminal (BNC) of the current probe is equipped with any other measurement terminals, take the following precautions to ensure that the other instrument does not form a bridge between the probe and any hazardous live of a part.
  a) Isolate the terminal of the probe from other terminals on the measuring instrument using basic insulation conforming to the requirements of measurement category, working voltage and pollution degree.
  b) If basic insulation requirement cannot be met between the terminal to which the current probe is connected and other terminals on the measuring instrument, make sure that the voltage input to the measurement terminal does not exceed the safe voltage level.
- ✧ When using a measuring instrument that does not provide isolation between its input terminals and chassis or other input terminals, please do not connect the ground terminal to any non-ground potential. Otherwise, short-circuit current will flow through the power adaptor or current probe from the ground terminal, which could cause an electrical accident or damage.

  RP1003C and RP1004C:



RP1005C:



- ✧ To avoid electric shock, do not allow the device get wet and do not take measurement with wet hands.
- ✧ To avoid electric shock when measuring live lines, wear appropriate protective gear, such as insulated gloves, boots and a safety helmet.
- ✧ The device is not designed to be entirely water-proof or dust-proof. To avoid damage, do not use it in a wet or dusty environment.
- ✧ The current sensor is a precision assembly including a molded component, a ferrite core and a Hall effect element. It may be damaged if subjected to sudden changes in ambient temperature, or mechanical strain or shock.
- ✧ The mating surfaces of the current sensor are precisely ground and should be treated with care. If these surfaces are scratched, the performance may be impaired.
- ✧ Measurements are degraded by dirt on the mating surfaces of the current sensor, so keep the surfaces clean by gently wiping with a soft cloth.

- ✧ To avoid damaging the current probe cable, do not bend or pull the cable.
- ✧ Keep the current sensor closed, except when clamping it onto the conductor to be measured. The mating surface of the core can be scratched when it is open.
- ✧ Avoid stepping on or pinching the cable, which could damage the cable insulation.
- ✧ Keep the cables well away from heat sources, as bare conductors could be exposed if the insulation melts.
- ✧ Correct measurement may be impossible in the presence of strong magnetic fields, such as near transformers and high-current conductors, or in the presence of strong electromagnetic fields such as near radio transmitters.
- ✧ Do not store or use the device where it could be exposed to direct sunlight, high temperature, humidity or condensation. Under such conditions, the device might be damaged and insulation may deteriorate so that it no longer meets specifications.

General Inspection

1. Inspect the shipping container for damage

Keep the damaged shipping container or cushioning material until the contents of the shipment have been checked for completeness and the probe has passed both electrical and mechanical tests.

The consigner or carrier shall be liable for the damage to probe resulting from shipment. **RIGOL** would not be responsible for free maintenance/rework or replacement of the unit.

2. Inspect the probe

In case of any damage, or defect, or failure, notify your **RIGOL** sales representative.

Contents

Current Probe Overview

RP1003C, RP1004C and RP1005C current probes can detect the current flowing through the conductor and convert it to voltage that can be displayed on and measured by the measuring instrument.

Main Features:

- Highly accurate current detection
- Easy current measurement
- Broadband frequency characteristics (RP1003C: DC to 50MHz; RP1004C: DC to 100MHz; RP1005C: DC to 10MHz)
- Compact design, permits measurement of low current levels
- Easy protect function at excessive input
- Unique thin film Hall effect element

RP1003C Parts Overview

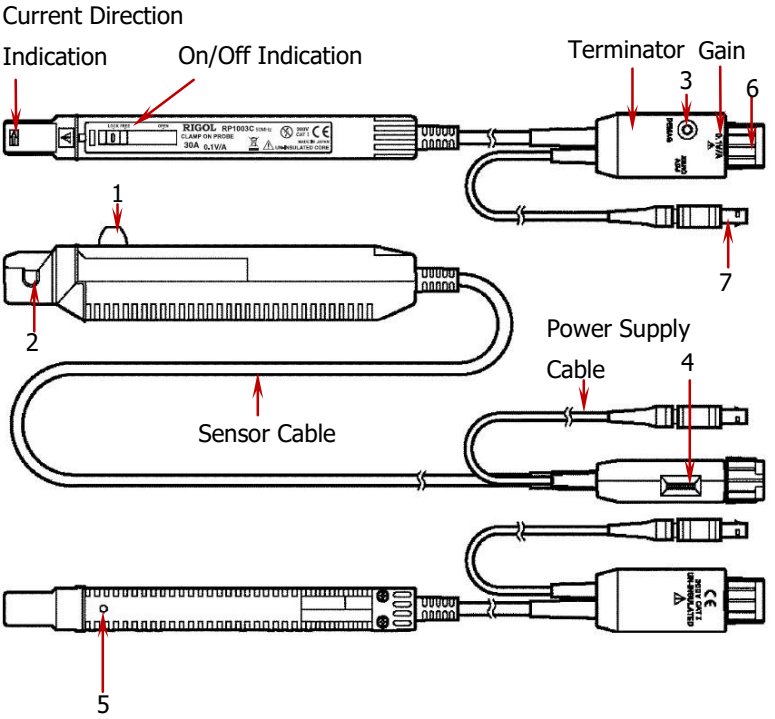


Figure 1 RP1003C Parts

Note: For more information of parts 1 to 7 in the figure above, refer to the introductions on page 4.

RP1004C Parts Overview

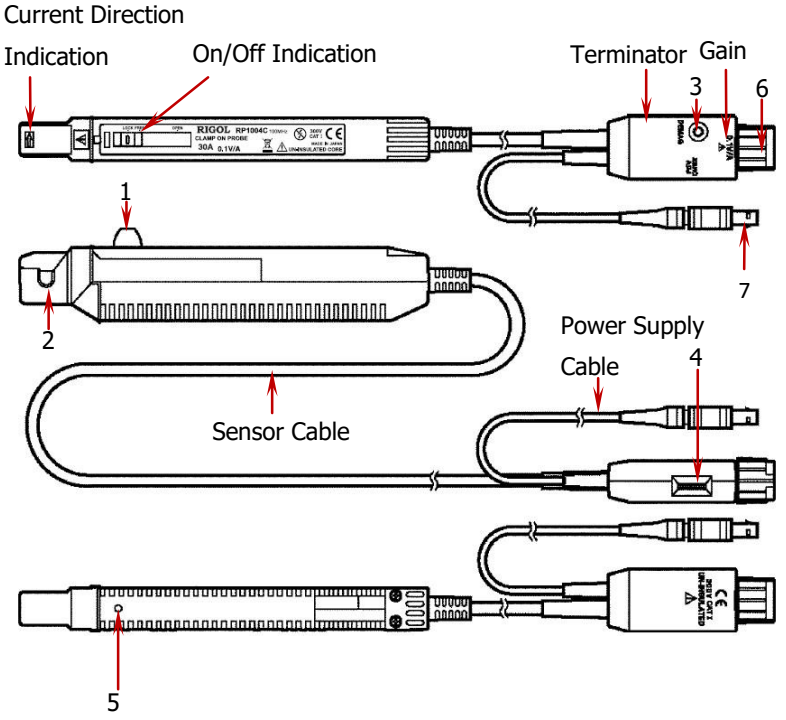


Figure 2 RP1004C Parts

Note: For more information of parts 1 to 7 in the figure above, refer to the introductions on page 4.

RP1005C Parts Overview

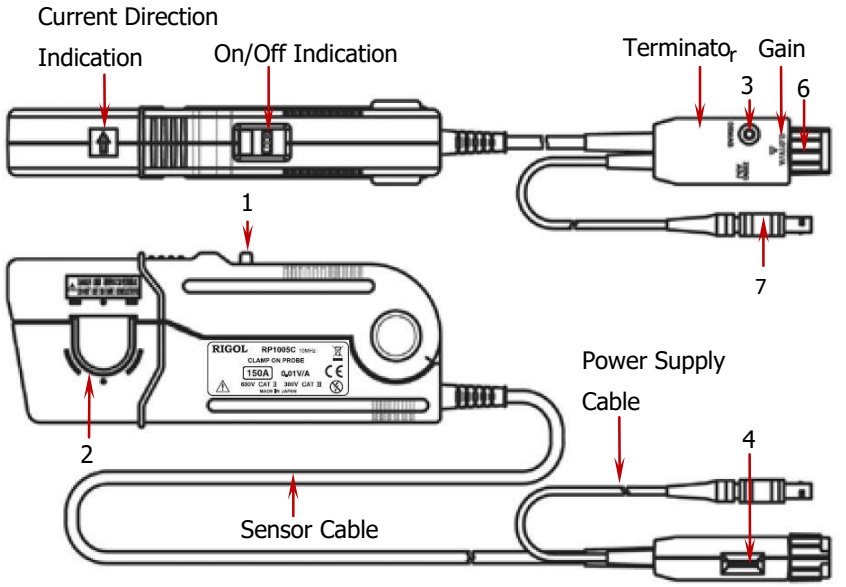


Figure 3 RP1005C Parts

1. Slide Switch

It is used to open and lock the current sensor. You are recommended to lock the current sensor when measuring the conductor to be measured to avoid danger.

For RP1003C and RP1004C, there are OPEN, FREE and LOCK indications on one side of the slide switch. The on/off status of the current sensor is related to the position of the slide switch.

- ✧ When the slide switch is at the OPEN position, the current sensor is open and at this point, the conductor to be measured can be connected to the current sensor;

- ✧ When the slide switch is at the FREE position, the current sensor is closed but not locked;
- ✧ When the slide switch is at the LOCK position, the current sensor is locked and at this point, the UNLOCK indication is covered (cannot be seen).

For RP1005C, there are LOCK and UNLOCK indications on the slide switch. The current sensor is locked when the LOCK indication is displayed on the slide switch (the UNLOCK indication disappears).

2. **Current Sensor**

It is used to clamp the conductor to be measured and carries out the actual current measurement. It is a precision assembly including a molded component, a ferrite core and a Hall effect element. It may be damaged if subjected to sudden changes in ambient temperature, or mechanical strain or shock, and therefore great care should be taken in handling it.

3. **Demagnetizing Switch**

It is used to demagnetizing the core if it has been magnetized by switching the power on and off, or by an excessive input. Always carry out demagnetizing before measurement. The demagnetizing process takes about one second. During demagnetizing, the current probe outputs a demagnetizing waveform.

4. **Zero Adjustment Dial**

Use the zero adjustment dial to correct for the effect of a DC voltage offset or temperature drift on the device. When beginning measurement, after demagnetizing always carry out zero adjustment to adjust the baseline to zero.

5 . Coarse Adjustment Trimmer (only applicable to RP1003C and RP1004C)

When adjustment is not possible within the range of zero adjustment dial, use a nonconductive screwdriver to (such as ceramic screwdriver) to adjust the baseline to the adjustable range of the zero adjustment dial via the coarse adjustment trimmer; then, use the zero adjustment dial to adjust the baseline to zero.

6. Output Connector

This connector can be directly connected to the BNC input terminal of the measuring instrument (such as oscilloscope or recorder), or be connected to other measuring instrument via BNC-to-Banana plug adaptor or similar adaptor. At this point, the current waveform of the conductor under measurement is output at a constant gain.

Note:

a) For RP1003C and RP1004C, 0.1V/A on the output connector is the gain when the input impedance of the measuring instrument is 1MΩ; the corresponding gain is 1/2×0.1V/A=0.05V/A when the input impedance of the measuring instrument is 50Ω.

b) For RP1005C, 0.01V/A on the output connector is the gain when the input impedance of the measuring

instrument is 1MΩ; the corresponding gain is 1/2×0.01V/A=0.005V/A when the input impedance is 50Ω.

7. **Power Plug**

Connect the power plug to the corresponding receptacle of the power adaptor to supply power to the current probe terminator.

Note: To avoid electric shock, do not touch the portion beyond the protective barrier during use.

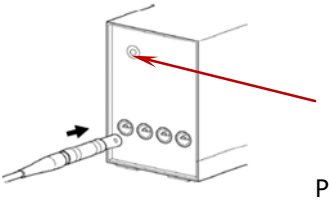
To Use the Current Probe

Before using the current probe to measure the current of the device under measurement, make measurement preparations and perform demagnetizing and zero adjustment. Then, make measurements according to the method described in **Measurement Steps**.

Note: You are recommended to read the **Precautions during Measurements** before making measurements to avoid unnecessary loss.

Measurement Preparations

1. Connect the power plug of the current probe to the power adaptor.



Power Indicator

2. Turn off the power adaptor and connect it to the power supply. Note: The voltage of the power supply used should match the rated supply voltage of the power adaptor.

3. Turn on the power adaptor and check whether the power indicator lights.

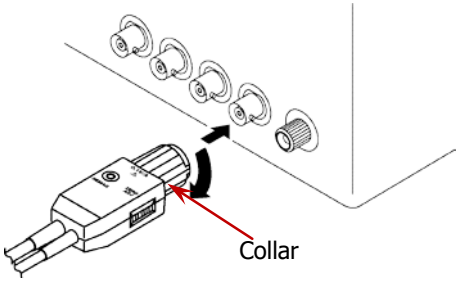
Demagnetizing

The core can be magnetized by switching the power on and off, or by an excessive input. Therefore, perform demagnetizing before making measurements.

1. With the input of the measuring instrument at ground, set the coupling of the measuring instrument to GND and adjust the baseline to the zero position.

2. Set the coupling of the measuring instrument to DC.

3. Connect the output connector of the current probe to the BNC input terminal of the measuring instrument. Turn the collar of the output connector as shown in the figure below and check whether it is locked securely.



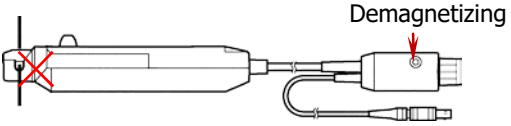
Note: When disconnecting the output connector and the measuring instrument, be sure to release the lock by rotating the collar in the opposite direction of the arrow as shown in the figure above before pulling off the connector. Forcibly pulling the connector without releasing the lock or pulling on the cable can damage the terminator.

4. Make sure the current sensor is locked (for RP1003C and RP1004C, the slide switch should be at the LOCK position; for RP1005C, LOCK should be displayed on the slide switch and UNLOCK should disappear.

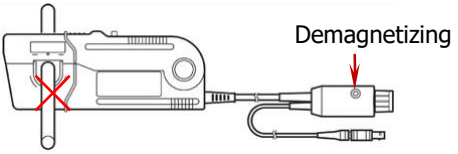
5. Turn on the power adaptor and press the demagnetizing switch on the terminator. The demagnetizing process takes about one second. During the demagnetizing, the current probe outputs a demagnetizing waveform.

   Note: Do not demagnetize the current probe when it is clamping a conductor to be measured. Demagnetizing causes current to flow into the conductor, which may damage the parts in the circuit to be measured.

   RP1003C and RP1004C:



RP1005C:



Zero Adjustment

As the voltage offset and temperature drift might affect the position of the baseline of the current probe, perform zero adjustment after performing demagnetizing when beginning measurements.

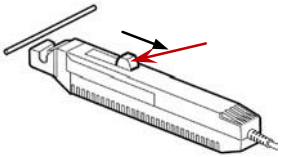
1. Turn the zero adjustment dial on the terminator to adjust the baseline to the zero position.

2. When adjustment is not possible within the range of zero adjustment dial, use a nonconductive screwdriver to (such as ceramic screwdriver) to adjust the baseline to the adjustable range of the zero adjustment dial via the coarse adjustment trimmer; then, use the zero adjustment dial to adjust the baseline to the zero position (only applicable to RP1003C and RP1004C).

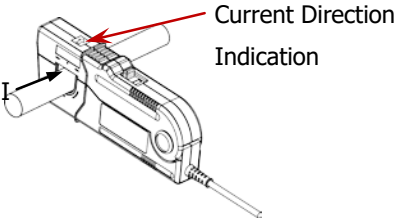
Measurement Steps

Make measurements after the above operations are finished.

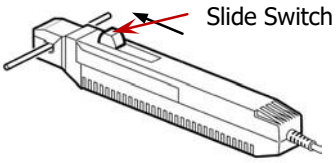
1. Open the current sensor by pushing the slide switch in the direction of the arrow as shown in the figure below (for RP1003C and RP1004C, the slide switch should be at the OPEN position; for RP1005C, UNLOCK should be displayed on the slide switch and LOCK should disappear).



2. Align the current sensor so that the current direction indication corresponds to the direction of current flowing through the conductor to be measured. Clamp the conductor to be measured so that the conductor is in the center of the sensor aperture.



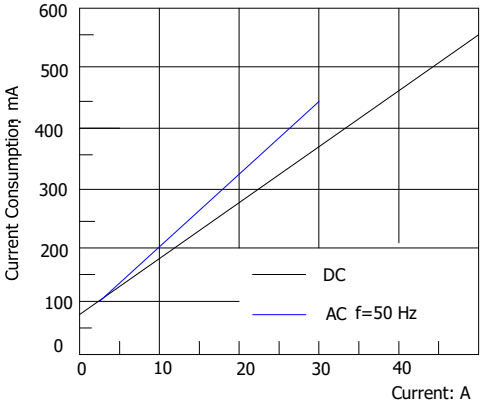
3. Lock the current sensor by pushing the slide switch in the direction of the arrow as shown in the figure below (for RP1003C and RP1004C, the slide switch should be at the LOCK position; for RP1005C, you need to first press the current probe to close the current sensor and then push the slide switch until LOCK is displayed and UNLOCK disappears).



4. At this point, you can view the voltage amplitude of the waveform measured by the measuring instrument and calculate the actual current amplitude (current amplitude=voltage amplitude measured/gain of the current probe). For example, when the voltage amplitude measured is 2V and the gain of the current probe is 0.1V/A, the actual current amplitude is 2V/(0.1V/A)=20A.
   Note: The current sensitivity can be derived from the voltage sensitivity of the measuring instrument. The current sensitivity equals the ratio of the voltage sensitivity of the measuring instrument to the gain of the current probe. For example, when the voltage sensitivity of the measuring instrument is 0.001V/div and the gain of the current probe is 0.1V/A, the current sensitivity is (0.001V/div)/(0.1V/A)=0.01A/div.

Precautions during Measurements

1. The current consumption of the current probe depends on the current to be measured. Make sure that the total current consumption of the current probes do not exceed the rated output current of the power adaptor when multiple current probes are connected to the same power adaptor. The figure below is the relation curve between the output current and current consumption.



Note: The current consumption is the algebraic sum of the positive and negative current consumption.

2. The maximum continuous input range is based on the heat that is internally generated during the measurement. Note that the input current should not exceed this range; otherwise, the current probe might be damaged.

3. The linear response range of the input current varies according to the frequency of the current being measured. For the variation relation curve between them, refer to **Appendix 2 Relation between Max Input Current and Frequency**.

4. If excess current is input, generated heat activates a built-in safety function that blocks normal output. If this happens, disconnecting the current sensor and the conductor under measurement or reduce the input current to zero. Wait until the current sensor has had sufficient time to cool before resuming operation.
   Note: Even if the input current does not exceed the maximum continuous input range, continuous input for an extended

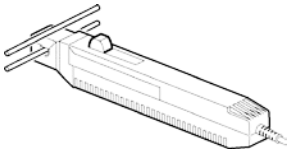
period of time may result in activation of the safety circuit to prevent damage resulting from heating of the current sensor.

5. At high ambient temperatures, the built-in safety circuit may activate at current input levels below the maximum continuous input range.

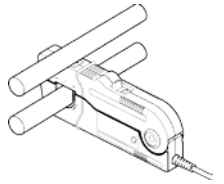
6. Continuous input of current exceeding the maximum continuous input range or repeated safety circuit activation will degrade the performance of the safety circuit, possibly resulting in damage to the device.

7. Do not place any unclamped conductor with an electric current of a frequency of 10kHz or higher near the current sensor (as shown in the figures on the next page). Current flowing in the conductor nearby may heat up the sensor and cause its temperature to rise, leading to damage to the current sensor.

RP1003C and RP1004C:

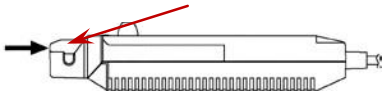


RP1005C:



8. Be sure to use the slide switch to open the current sensor. For RP1003C and RP1004C, please do not press the upper core in the direction of the arrow as shown in the figure below to avoid damaging the internal structure of the slide switch.

Upper Core

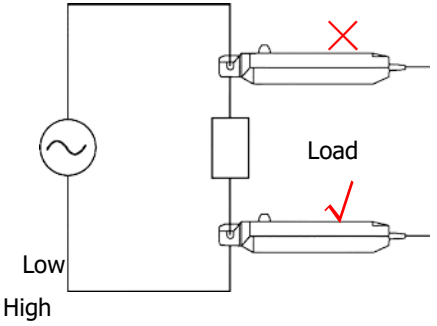


9. Immediately after powering on, the device may be subject to an appreciable DC drift due to the effect of self-heating. To counteract this, allow the current probe to warm up for more than 30 minutes before carrying out measurements.

10. Under certain circumstances, oscillation may occur when the probe is connected to the power adaptor when the power supply is on. This does not indicate a malfunction. Oscillation can be stopped and operation restored to normal by opening and closing the current sensor.

11. When the frequency of the input signal is relatively high, the common mode voltage range corresponding to the signal measured by the current probe reduces. At this point, connect the current probe to the low-voltage side of the circuit, as shown in the figures on the next page.

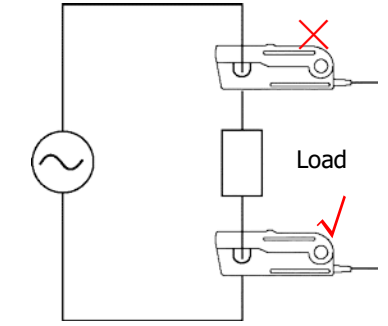
    RP1003C and RP1004C:



Signal

Source

RP1005C:



Signal

Source

Low

Specifications

Technical Parameters

RP1003C:

Bandwidth	DC to 50MHz (-3dB), refer to **Appendix 1 Amplitude Characteristics** (RP1003C)
Rise Time	≤7ns
Linear Response Range of Input Current	30Arms, refer to **Appendix 2 Relation between Max Input Current and Frequency** (RP1003C)
Maximum Peak Current	50A peak, non-continuous
Gain	0.1V/A
Gain Accuracy	±1.0%rdg±1mV, ≤30A ±2.0%rdg, 30A to 50A peak non-continuous (DC and 45Hz to 66Hz, within the linear response range of the input current)
Noise	≤2.5mArms (for 20MHz band measuring instrument)
Input Impedance	Refer to **Appendix 3 Input Impedance**
	(Typical) (RP1003C)

Gain Accuracy Drift	≤±2% (0℃ to 40℃ temperature, input of 50Hz, 30A)
Rated Power	5.6W
Supply Voltage	+12V±0.5V
Maximum Rated Voltage	300V, CAT I (insulated conductor)
Gain Accuracy Period	1 year (opening/closing up to 10,000 times)
Effect of External Magnetic Fields	≤20mA (DC and 60Hz, magnetic field of 400A/m)

RP1004C:

Bandwidth	DC to 100MHz (-3dB), refer to **Appendix 1 Amplitude Characteristics** (RP1004C)
Rise Time	≤3.5ns
Linear Response Range of Input Current	30Arms, refer to **Appendix 2 Relation between Max Input Current and Frequency** (RP1004C)
Maximum Peak Current	50A peak, non-continuous
Gain	0.1V/A
Gain Accuracy	±1.0%rdg±1mV, ≤30A ±2.0%rdg, 30A to 50A peak (DC and 45Hz to 66Hz, within the linear response range of the input current)
Noise	≤2.5mArms (for 20MHz band measuring

	instrument)
Input Impedance	Refer to **Appendix 3 Input Impedance (Typical)** (RP1004C)
Gain Accuracy Drift	≤±2% (0℃ to 40℃ temperature, input of 50Hz, 30A)
Rated Power	5.3W
Supply Voltage	+12V±0.5V
Maximum Rated Voltage	300V, CATI (insulated conductor)
Gain Accuracy Period	1 year (opening/closing up to 10,000 times)
Effect of External Magnetic Fields	≤5mA (DC and 60Hz, magnetic field of 400A/m)

RP1005C:

Bandwidth	DC to 10MHz (-3dB), refer to **Appendix 1 Amplitude Characteristics** (RP1005C)
Rise Time	≤35ns
Linear Response Range of Input Current	150A, refer to **Appendix 2 Relation between Max Input Current and Frequency** (RP1005C)
Maximum Peak Current	300A peak, non-continuous 500A peak, pulse width≤30μs
Gain	0.01V/A

Gain Accuracy	±1.0%rdg±1mV, ≤150A ±2.0%rdg, 150A to 300A peak (DC and 45Hz to 66Hz)
Noise	≤25mArms (for 20MHz band measuring instrument)
Input Impedance	Refer to **Appendix 3 Input Impedance (Typical)** (RP1005C)
Gain Accuracy Drift	≤±2% (0℃ to 40℃ temperature, input of 55Hz, 150A)
Rated Power	5.5W
Supply Voltage	+12V±1V
Maximum Rated Voltage	600V: CATII; 300V: CATIII (insulated conductor)
Gain Accuracy Period	1 year (opening/closing up to 10,000 times)
Effect of External Magnetic Fields	≤150mA (DC and 60Hz, magnetic field of 400A/m)

General Specifications

Probe Dimensions	Current Sensor	RP1003C: approx. 175mmx18mmx32mm RP1004C: approx. 175mmx18mmx32mm RP1005C: approx. 176mmx69mmx34mm

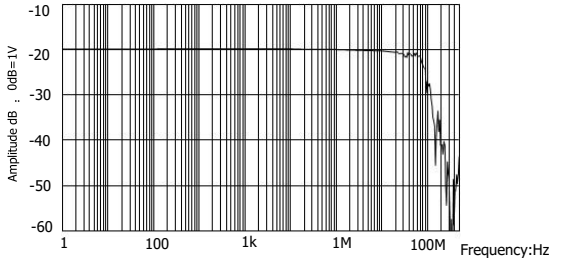
Terminator	RP1003C: approx.

Maximum Dimensions of Conductor to be Measured	RP1003C: approx. 5mm RP1004C: approx. 5mm RP1005C: approx. 20mm	
Cable Length	Current Sensor Cable	RP1003C: approx. 150cm RP1004C: approx. 150cm RP1005C: approx. 200cm
	Power Supply Cable	RP1003C: approx. 100cm RP1004C: approx. 100cm RP1005C: approx. 100cm
Weight	RP1003C: approx. 230g RP1004C: approx. 240g RP1005C: approx. 500g	
Working Temperature and Humidity	0℃ to +40℃, 0 to 80%RH	
Storage Temperature and Humidity	-10℃ to +50℃, 0 to 80%RH	
Location for Use	Indoor, altitude up to 2000m	
Electromagnetic Compatibility	EN61326	
Measurement Category	RP1003C: CAT I (anticipated transient voltage 1500V) RP1004C: CAT I (anticipated transient voltage 1500V) RP1005C: CAT II, CAT III (anticipated transient voltage 4000V)	
Pollution Degree	Degree 2	
Safety	EN61010	

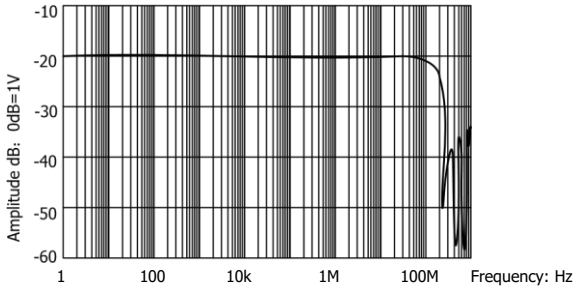
Appendix

Appendix 1 Amplitude-frequency Characteristics

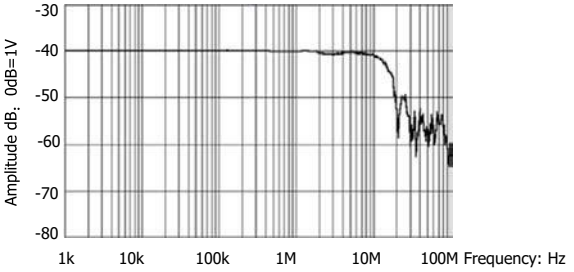
RP1003C:



RP1004C:

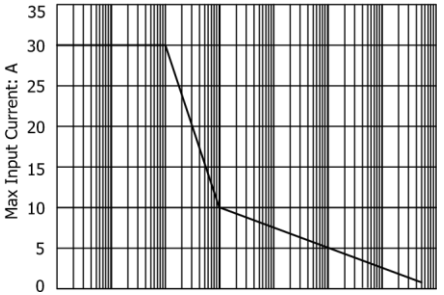


RP1005C:

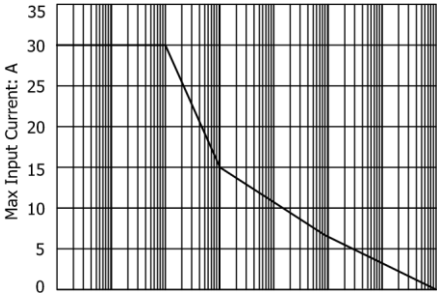


Appendix 2 Relation between Max Input Current and Frequency

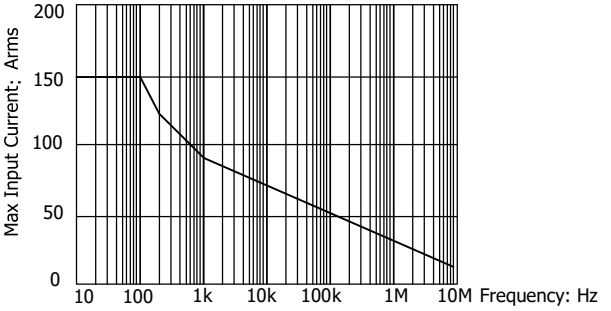
RP1003C:



RP1004C:

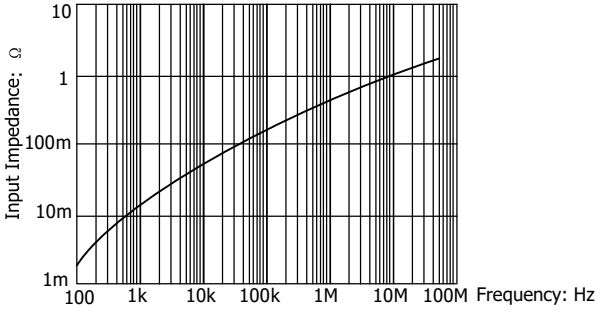


RP1005C:

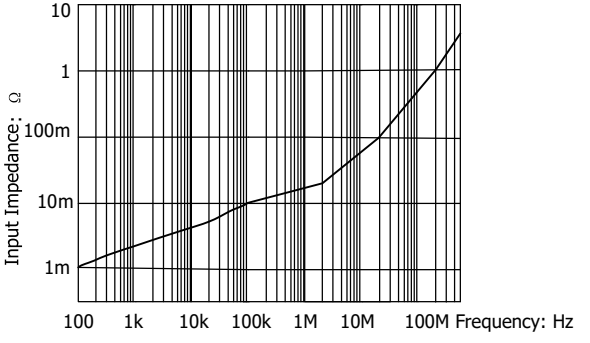


Appendix 3 Input Impedance (Typical)

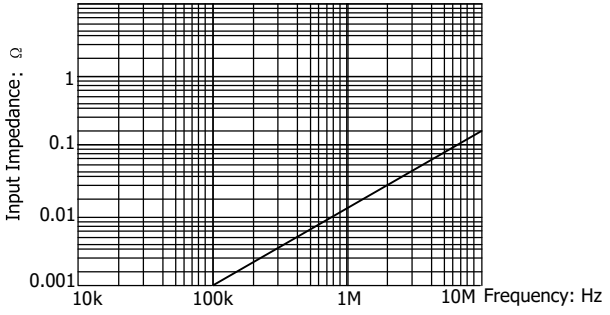
RP1003C:



RP1004C:



RP1005C:


Input Impedance: Ω
1
0.1
0.01
0.001
10k
100k
1M
10M
Frequency: Hz