
**User's
Manual**

**Model 701928/701929
PBC100/050
Current Probe**

Thank you for purchasing the PBC series current probe.

This user's manual contains useful information about the functions and operating procedures of the PBC series current probe and lists the handling precautions of the instrument. To ensure correct use, please read this manual thoroughly before beginning operation.

After reading this manual, keep it in a convenient location for quick reference in the event a question arises during operation.

List of Manuals

The following manuals are provided for the PBC series current probe.

| Manual Title | Manual No. | Notes |
|--|----------------|--------------------|
| Model 701928/701929 PBC100/050 Current Probe User's Manual | IM 701928-01E | This manual. |
| Model 701928/701929 PBC100/050 Current Probe User's Manual | IM 701928-92 | Document for China |
| Model 701928/701929 PBC100/050 Current Probe User's Manual | IM 701928-93Z2 | Document for Korea |

The "E" and "Z2" in the manual numbers are the language codes.

Contact information of Yokogawa offices worldwide is provided on the following sheet.

| Document No. | Description |
|--------------|----------------------------|
| PIM113-01Z2 | List of worldwide contacts |

Revisions

1st Edition: October 2007

2nd Edition: October 2013

3rd Edition: November 2015

4th Edition: January 2016

5th Edition : October 2017

Checking the Contents of the Package

If any of the contents are incorrect, missing, or appear to be abnormal, please contact your nearest YOKOGAWA dealer.

Current Probe (Model 701928/701929) Main Body: 1

User's manuals: 1 set

Carrying case: 1

Safety Precautions

This instrument satisfies the requirements for IEC-61010.

The general safety precautions described herein must be observed during all phases of operation. If the instrument is used in a manner not specified in this manual, the protection provided by the instrument may be impaired. YOKOGAWA assumes no liability for the customer's failure to comply with these requirements.

The following safety symbols are used in this manual.



Warning: Handle with care. Refer to the user's manual. This symbol appears on dangerous locations on the instrument which require special instructions for proper handling or use.

The same symbol appears in the corresponding place in the manual to identify those instructions.



Do not apply around or remove from HAZARDOUS LIVE conductors.

Failure to comply with the precautions below could lead to injury or death or damage to the instrument.



WARNING

- To avoid shorting or bodily injury when opening the tip of the sensor head or when performing measurement, avoid applying the clamp to bare conductors.
- Do not damage the insulating coating of the conductor under test.
- Never use the probe with wet hands, or when the probe itself is wet. Electric shock can result.
- Use a digital oscilloscope equipped with the YOKOGAWA probe interface to power the probe.



CAUTION

- The sensor head has undergone a precision assembly process. Take sufficient care when handling the probe as sudden changes in ambient temperature and physical shocks can damage it.

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- The matching surfaces of the sensor head are polished to high precision. Take care when handling. Scratching these surfaces can affect the performance of the probe.
 - Dirt and other particles on the sensor head can affect the probe's performance. Gently wipe such particles off using a dry, soft cloth.
 - Do not inadvertently twist or pull the cable. The wires inside the cable can break, causing malfunction.
 - Current sensors can be damaged by static electricity. Be careful not to apply static electricity to current sensors. Below are some ways you could apply static electricity.
 - Touching the sensor head with an object charged with static electricity
 - Touching the sensor head with an object whose electric potential is different
 - A user charged with static electricity touching the core surface when cleaning the matching surfaces of the sensor head
(When cleaning the surfaces, take static electricity measures such as wearing an antistatic wrist strap.)
 - Avoid vibration, shock, and static electricity during shipping and handling. Take extra care not to drop the probe.
 - Avoid storing or using the probe in direct sunlight, or in areas with high temperature, humidity, or condensation. Deformation and deterioration of insulation can occur resulting in failure to retain product specifications.
 - Inspect the probe before use to ensure that damage has not occurred during shipping and storing. If damage is found, contact your nearest Yokogawa dealer.
 - This probe is not water or dust resistant. Do not use the probe in areas with a lot of dust, or near water.
 - When the probe is under power, always keep the sensor closed except when positioning the clamp around the conductor under test. Leaving the clamp open can result in damage.

Note

- Depending on the current frequency that is measured, oscillation may occur, but this has no effect on measurements.
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Sales in Each Country or Region

Waste Electrical and Electronic Equipment



Waste Electrical and Electronic Equipment (WEEE), Directive

(This directive is valid only in the EU.)

This product complies with the WEEE directive marking requirement. This marking indicates that you must not discard this electrical/ electronic product in domestic household waste.

Product Category

With reference to the equipment types in the WEEE directive, this product is classified as a “Monitoring and control instruments” product.

When disposing products in the EU, contact your local Yokogawa Europe B.V. office.

Do not dispose in domestic household waste.

Authorized Representative in the EEA

Yokogawa Europe B.V. is the authorized representative of Yokogawa Test & Measurement Corporation for this product in the EEA. To contact Yokogawa Europe B.V., see the separate list of worldwide contacts, PIM 113-01Z2.

Symbols and Notation Used in This Manual



Improper handling or use can lead to injury to the user or damage to the instrument. This symbol appears on the instrument to indicate that the user must refer to the user's manual for special instructions.

The same symbol appears in the corresponding place in the user's manual to identify those instructions. In the manual, the symbol is used in conjunction with the word "WARNING" or "CAUTION."

WARNING

Calls attention to actions or conditions that could cause serious or fatal injury to the user, and precautions that can be taken to prevent such occurrences.

CAUTION

Calls attention to actions or conditions that could cause light injury to the user or damage to the instrument or user's data, and precautions that can be taken to prevent such occurrences.

Note

Calls attention to information that is important for proper operation of the instrument.

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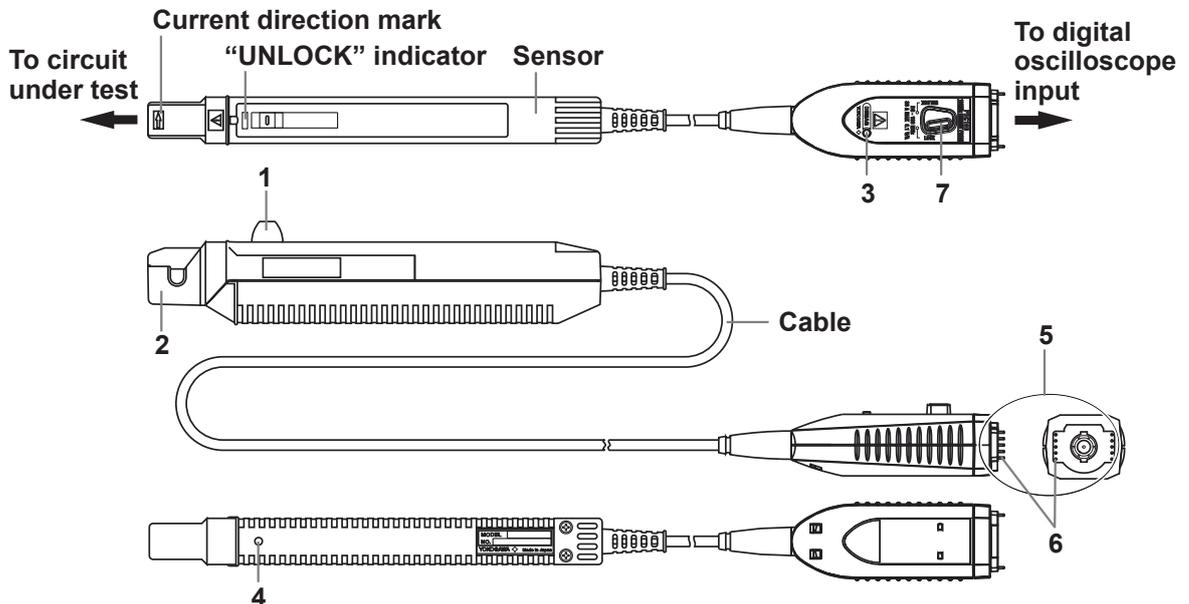
Product Overview

The PBC series of current probes are 100 MHz/50 MHz bandwidth active current probes that are used in combination with DLM series or other digital oscilloscopes equipped with the YOKOGAWA probe interface. The probe can be used simply by connecting it to the BNC input terminal on the DLM series or other digital oscilloscope equipped with the YOKOGAWA probe interface. The probe provides for easy current waveform observation simply by clamping it around the conductor under test.

Features

- Highly accurate current detection
- Easy current measurement
- Wide frequency bandwidth (DC to 100 MHz/50 MHz)
- Power can be supplied to the probe from DLM series and other digital oscilloscopes equipped with the YOKOGAWA probe interface.
- The probe is automatically recognized by the DLM series and other digital oscilloscopes equipped with the YOKOGAWA probe interface.
- Small size and light weight
- Enables measurement of low currents.
- Simple protection function for excessive input

Names of Parts



A description of each part is given on the following page.

Description of Parts

1. Open/Close Lever

This lever opens and closes the sensor head. Always use this lever when opening and closing the sensor head.

2. Sensor Head

The sensor head clamp is positioned around the conductor under test to detect current. It is a precision-assembled component consisting of various parts including plastic molded parts, a ferrite core, and a Hall element. Take proper care when handling the probe to avoid damage as a result of sudden sharp changes in ambient temperature, mechanical stress, or physical shocks.

3. Demagnetization Switch (DEMAG)

This switch demagnetizes the core which can become magnetized when turning the power ON or OFF, or when applying excessive input. You must always use this switch prior to performing measurement. The time required for demagnetization is approximately one second. During demagnetization, a degaussing waveform is output.

4. Zero Adjust Trimmer

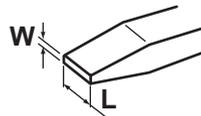
DLM series and other digital oscilloscopes utilize an automatic zero adjustment function. Normally, the zero adjustment trimmer is not used for the adjustment. However, if the residual offset exceeds the automatic adjustment range and automatic zero adjustment fails, you can turn the trimmer to carry out the zero adjustment. This compensates for the effects of the probe's offset voltage, temperature drift, and other phenomena. Before performing measurement, demagnetize the probe then carry out zero adjustment (see page 4).

- **Adjustment with the Zero Adjust Trimmer**

You can adjust the offset voltage using an appropriate driver as described below. Use a driver that fits the adjustment groove. Using a driver with a large grip or a small head, or applying excessive force can result in damage to the adjustment turn stop or grooves.

- **Example Driver Bit Dimensions (Reference value)**

Head thickness (W): 0.4 mm, head length (L): 1.8 mm (driver length: 10 mm or more), head shape: minus.



5. Probe Interface

The point of connection to the input of the digital oscilloscope. Outputs the measured current waveform at a constant rate (0.1 V/A, in combination with 1 M Ω impedance). The output terminal is a BNC connector. Connect to a digital oscilloscope that supports the YOKOGAWA probe interface.

6. Interface Spring Pins

When the probe interface is connected, it touches the pad on the interface board of the oscilloscope. The probe's power and offset voltage are supplied through this interface component. It also automatically recognizes the probe type.

7. Latch Release Lever

Release the lock when connecting the probe interface to the oscilloscope input.

Operating Procedures

Usage Precautions



WARNING

If the waveform measuring instrument to be connected to the output terminal (BNC) of this probe has other measuring terminals, the probe's connection terminals and internal circuits may become hazardous live depending on the types of devices that are connected to the instrument's measuring terminals.

To avoid this, note the following:

- Ensure that basic insulation equivalent to that of the circuit under test in terms of measurement category, operational voltage, and pollution degree is used between the measuring terminal to which the probe is connected and other measuring terminals.
 - If the basic insulation across measuring terminals does not meet this requirement, do not apply an input exceeding the safety voltage level to any of the other measuring terminals.
 - Always ground the measuring instrument.
 - Take care to avoid electric shock whenever connecting the probe to a measuring terminal. Also, never disconnect the probe from the measuring instrument while the probe is connected to the circuit under test.
 - Before connecting the probe to the circuit under test, confirm that the measuring instrument is correctly grounded, and that the probe interface is properly connected to the measuring instrument's input.
 - Make sure to read all safety precautions and warnings such as information concerning electric shock for any instruments to which the probe will be connected.
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CAUTION

To clean the instrument, wipe using a soft cloth with a small amount of water or mild detergent. Never use detergents that contain benzene, alcohol, acetone, ethyl compounds, ketones, thinner, or gasoline as deformation or discoloration can result.

Preparing for Measurement



CAUTION

- When using this probe, restrictions on the maximum allowable power supply current of the DLM series' YOKOGAWA probe interface may prohibit using multiple active probes simultaneously depending on the current being measured.
- The probe's current consumption depends on the current being measured. Make sure that the total current consumption of each of the active probes does not exceed the probe power's maximum allowable current. See the user's manual of the digital oscilloscope being used for the probe power's maximum allowable current. For this probe's current consumption, see page 10, "Measured Current Values and Current Consumption (Typical)."

1. Set up the probe and a DLM series or other digital oscilloscope with the YOKOGAWA probe interface.
2. Before measurement, insert the probe interface completely into the input of the oscilloscope and confirm that a secure connection has been established between the BNC connector and interface pins. When inserted, you will hear a click as the latch closes, indicating that the connection has been made.

Warm Up

Immediately after connecting the probe, heat emitted from the probe itself causes the output offset voltage to drift. After applying power, the probe should nearly stabilize about thirty minutes after connecting it. Before using the probe, allow it to warm up for at least thirty minutes.

Demagnetization and Zero Adjustment



CAUTION

- When removing the probe from the oscilloscope, be sure to release the lock first, then pull out the probe by the connector. The probe interface can be damaged if you pull forcibly without releasing the lock, or if you pull by the cable.
 - Do not demagnetize the probe while the clamp is positioned around the conductor under test. The demagnetization procedure can inject current into the conductor under test, possibly resulting in damage to connected components. For the same reason, make sure that the probe clamp is not positioned around a conductor under test when connecting this probe to the oscilloscope. A demagnetizing waveform can be generated when power is supplied.
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1. Connect the probe's output terminal to the input terminal of the digital oscilloscope.
 2. Without positioning the probe clamp around the conductor under test, press the open/close lever until the unlocked indicator goes out, then confirm that the sensor head is securely closed.

Demagnetization

3. Press the demagnetization switch (DEMAG) on the probe interface.

Note

- Oscillation may occur when you execute DEMAG, but this has no effect on measurements.
 - The positive side of the waveform that is generated when you execute DEMAG may not be symmetrical to the negative side, but this has no effect on measurements.
-

Zero Adjustment (Residual Offset Adjustment)

4. Confirm the input coupling of the digital oscilloscope to DC. For instructions on selecting the input coupling, see the user's manual of the digital oscilloscope.
5. Select the menu on the digital oscilloscope for performing automatic zero adjustment on the current probe to adjust the residual offset. For instructions on performing automatic zero adjustment, see the user's manual of the digital oscilloscope.
6. If an error message appears during step 5 and you are unable to adjust the trace to the GND level, turn the zero adjustment trimmer so that the trace approaches the GND level, then repeat step 5.

Note

If the digital oscilloscope supports the current probe's automatic adjustment function*, perform automatic zero adjustment on the digital oscilloscope. However, if the residual offset exceeds the automatic adjustment range and automatic zero adjustment fails, turn the trimmer to carry out the zero adjustment. Upon shipment from the factory, the zero adjustment trimmer is adjusted so that it can be used for automatic zero adjustment in a 23°C environment after a 30 minute warm-up.

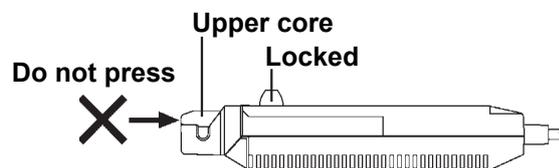
* With the DL9000 series, the function is supported with firmware version 3.66 or later.

Performing Measurement



CAUTION

- The maximum continuous input range is determined from the rise in temperature resulting from self-heating during measurement. Do not input currents exceeding this range. Doing so can cause damage.
- The maximum continuous input range differs depending on the frequency of the measured current (see page 9, “Product Specifications”).
- If a current exceeding the maximum continuous input range, heat from the input the sensor will trigger the probe’s internal protection function which will interfere with normal output. If this occurs, immediately remove the sensor from the conductor under test, or set the input current to zero. A sufficient cooling off period must be given until normal operation is restored.
- Heat generated by an input current whose frequency is 1 kHz or higher is mainly due to self-heating of the sensor head. In this case, the protection function is not activated. Therefore, be careful of burns, short circuits, and other accidents or sensor damage and the like caused by the temperature increase.
- The overcurrent protection function may activate under high temperatures, resulting in measured currents at or below the maximum continuous input range.
- Continuous input exceeding the maximum continuous input range, or continual activation of the protection function can damage the probe.
- Product specifications showing the maximum continuous input range also indicate a maximum peak current value of $50 A_{peak}$, non-continuous. This shows that the upper limit of the waveform response is $50 A_{peak}$. Ensure that the current (RMS) does not exceed the maximum continuous input range.
- When opening the sensor head, always use the open/close lever. If you press the upper core while the sensor head is locked, the open/close mechanism can be damaged.
- Do not apply force to the sensor head in the direction indicated in the figure below.



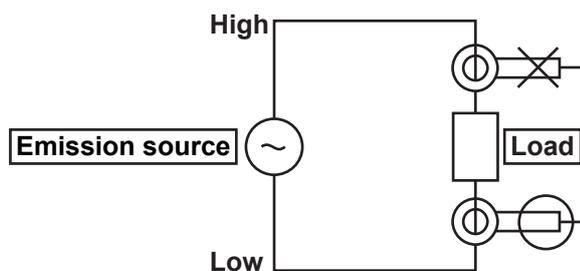
- To maintain the probe accuracy within the specifications and to verify that correct measurement results are being obtained, periodic calibration is necessary. The calibration period varies depending on your operating environment and the frequency of use. We recommend that you set a calibration period according to the frequency of use and ask us to calibrate it periodically.

1. Perform all safety checks, and ensure that the preparations for measurement (see page 4) have been taken.
2. Pull the open/close lever to open the sensor head.
3. Orient the probe so that the current direction arrow on the tip of the sensor points in the same direction as the flow of current in the conductor under test. Position the probe clamp around the conductor under test so that the conductor is centered in the clamp hole.
4. Press the open/close lever until the unlocked indicator goes out, then confirm that the open/close lever is securely locked and that the sensor head is securely closed.
5. The current waveform can now be observed on the digital oscilloscope. The output voltage rate of this probe is 0.1 V/A. For example, if the digital oscilloscope's voltage sensitivity is 10 mV/DIV, the current sensitivity would be 100 mA/DIV.

Digital oscilloscopes that support the YOKOGAWA probe interface automatically detect the probe and convert the display unit to current sensitivity.

Note

- When the probe is used with a DLM series or other digital oscilloscope equipped with the YOKOGAWA probe interface, the probe sensitivity is automatically detected by the digital oscilloscope. If not automatically detected by the digital oscilloscope, set the input impedance to 1 M Ω .
- If the probe is connected to the digital oscilloscope while the power is ON, oscillations may occur very occasionally but this does not indicate a malfunction. If this occurs, opening and closing the sensor head with the open/close lever will stop the oscillations and restore normal functioning.
- Resonant sound can be generated depending on the frequency of the measured current. This will not affect measurement.
- The positive side of the waveform that is generated when you execute DEMAG may not be symmetrical to the negative side, but this has no effect on measurements.
- The position of the conductor under test within the clamp hole can affect measurement. Keep the conductor in the center of the clamp hole.
- During measurement, press the open/close lever until the unlocked indicator goes out, then confirm that the lever is securely locked and that the sensor head is securely closed. Accurate measurements cannot be obtained if the sensor head is not securely closed.
- In the high frequency domain, positioning the probe clamp on the high side of the circuit can introduce common mode noise. As necessary, limit the bandwidth of the waveform observation instrument, or position the probe clamp on the low side.



- Accurate measurements may not be possible if operated within close proximity to strong magnetic fields such as those produced by transformers, circuits with large currents, and wireless devices.

Malfunction? First, Investigate.

If you are unable to correct problems using the troubleshooting information in this section, servicing is required and you should contact the dealer from whom you purchased the instrument.

| Description | Possible Problem | Corrective Action |
|--|--|--|
| Cannot measure direct current (or low frequencies of up to several hundred Hz), or the amplitude at that bandwidth is small. | Power is not ON. | Turn ON the power. |
| | The oscilloscope or other measuring instrument is set for AC coupling | Set the instrument to DC coupling. |
| | The sensor is not locked (the closing mechanism is not properly aligned). | Lock the sensor. |
| Cannot adjust to the zero point. | The sensor is magnetized. | Demagnetize the sensor, and try the adjustment again. |
| | The zero adjust is out of range (due to drift or other causes). | Use the probe's zero adjust trimmer. |
| The amplitudes across all frequencies are small. | Input of the digital oscilloscope is 50 Ω | Set for 1 M Ω . |
| If using a DL9000 series digital oscilloscope, the probe automatic adjustment menu does not appear. | The firmware version does not support the probe automatic adjustment function. | Upgrade the firmware to version 3.66 or later. You can check the version of the firmware on the DL9000 series instrument under "Soft Version" in the Overview screen by pressing the SYSTEM key followed by the Overview soft key. For instructions on upgrading the firmware, see the URL* below. |

* <http://www.yokogawa.com/tm/dl/tm-dl.htm>

Specifications

Product Specifications

| | |
|--|---|
| Bandwidth* | PBC100 (701928): DC to 100 MHz (–3 dB) PBC050 (701929): DC to 50 MHz (–3 dB) (See the typical characteristics shown on page 11) |
| Rise time* | PBC100 (701928): 3.5 ns or less PBC050 (701929): 7.0 ns or less |
| Maximum continuous input range | 30 Arms (AC and DC components) (See pages 11 and 12, Derating according to frequency) |
| Maximum peak current | 50 A _{peak} , non-continuous |
| Output voltage rate* | 0.1 V/A |
| Amplitude accuracy* | ±1.0% rdg ±1 mV; 0 to 30 Arms ±2.0% rdg; 30 Arms to 50 A _{peak} (DC, 45 to 66 Hz) |
| Noise* | Equivalent to 2.5 mArms or less (with a 20 MHz bandwidth measuring instrument) |
| Input impedance | (See typical characteristics on page 12) |
| Compatible interface | YOKOGAWA probe interface |
| Temperature coefficient for sensitivity* | Within ±2% (input: 50 Hz, 30 Arms, within a range of 0 to 40°C) |
| Propagation delay (Typical) | 701928: 13 ns 701929: 13 ns |
| Maximum rated power | PBC100 (701928): 5.5 VA (within maximum input range) PBC050 (701929): 5.9 VA (within maximum input range) |
| Rated supply voltage | ±(12.3 ± 0.3) V, supplied from the YOKOGAWA probe interface |
| Operating temperature and humidity | 0 to 40°C 80% RH or less (no condensation) |
| Storage temperature and humidity | –10 to 50°C, 80% RH or less (no condensation) |
| Operating altitude | Up to 2000 m, indoors |
| Effect of external magnetic fields | Equivalent to a maximum of 5 mA (in a DC or 60 Hz, 400 A/m magnetic field) |
| Diameter of measurable conductor | φ 5 mm |
| Guaranteed accuracy period | 1 year (up to 10000 open and close operations) |
| Cable lengths | Approx. 1.5 m (full length: approx. 1.755 m) |
| External dimensions | Sensor: approx. 175 (W) x 18 (H) x 40 (D) mm Probe interface: approx. 80 (W) x 30 (H) x 28 (D) mm |
| Weight | Approx. 190 g |
| Accessories | User's manual, carrying case |

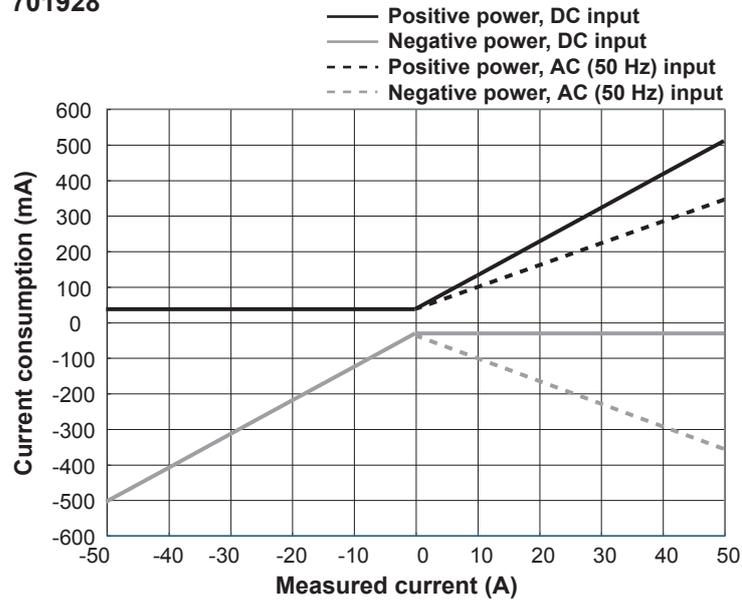
* Accuracy: 23 ±3°C, thirty minutes after turning ON the power. When used with a digital oscilloscope having an input impedance of 1 MΩ ±1%.

Standards Compliance

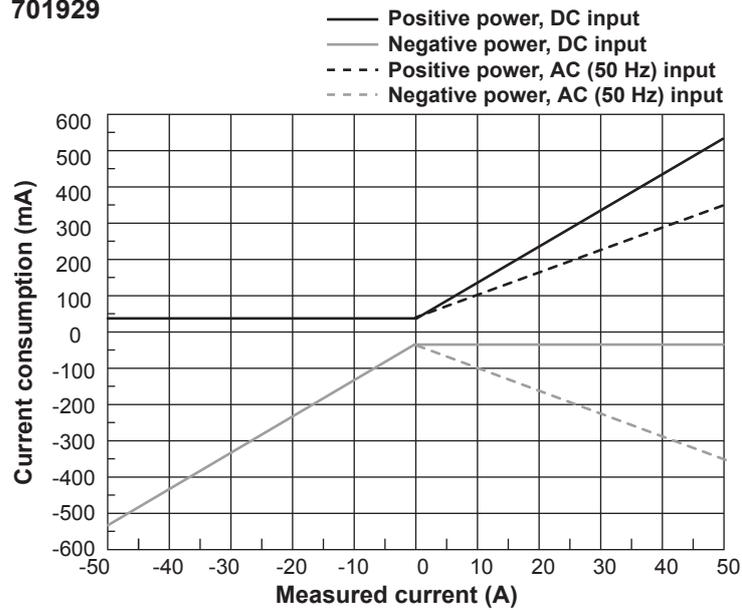
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|--------|-----------|---|
| Safety | EN61010 | |
| EMC | Emissions | EN61326-1 Class B EN55011 Class B, Group 1 EMC Regulatory Arrangement in Australia and New Zealand EN 55011 Class B, Group 1 |
| | Immunity | EN61326-1 Table 1 (Basic immunity requirement) |

Measured Current Values and Current Consumption (Typical)

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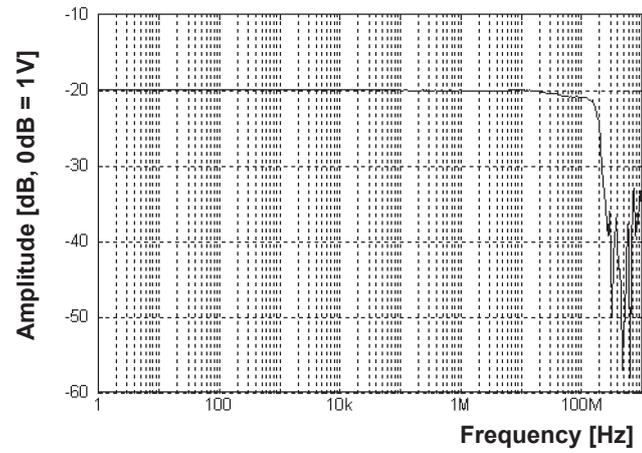


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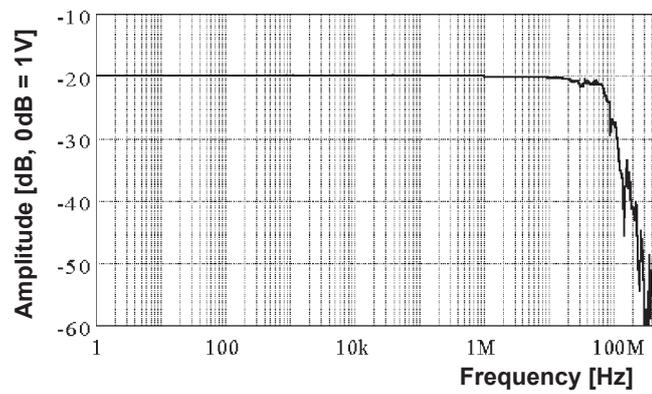


Frequency Characteristics (Typical)

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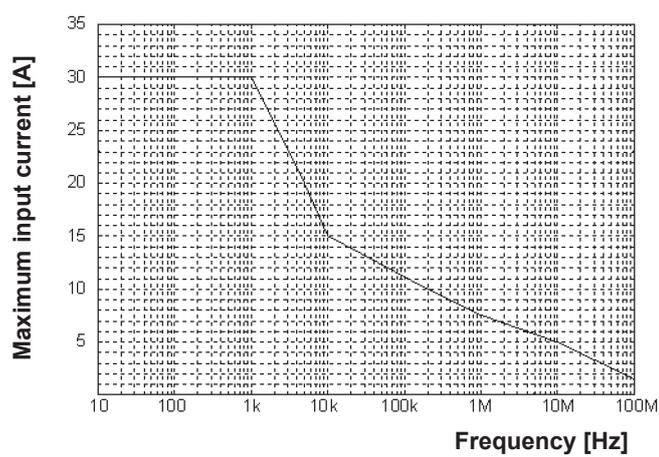


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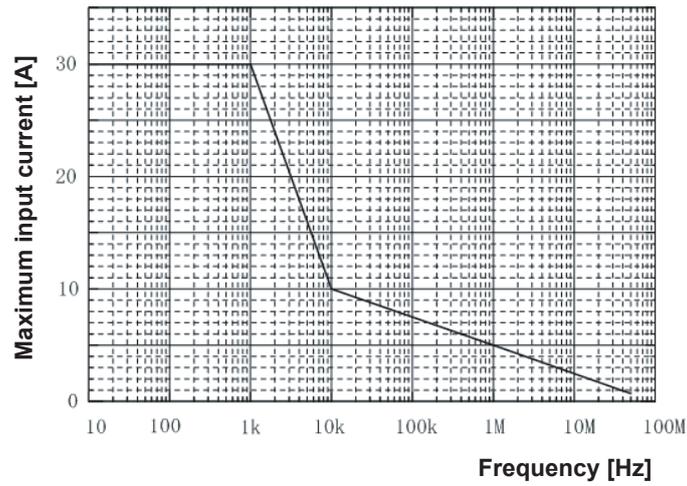


Derating According to Frequency

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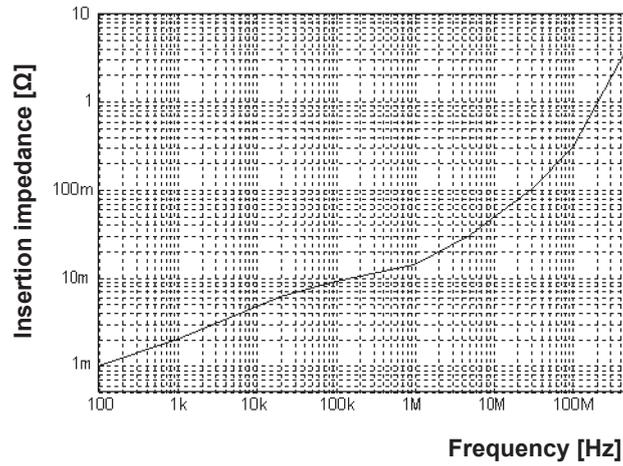


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Input Impedance (Typical)

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