
**User's
Manual**

**701933
Current Probe**

Foreword

Thank you for purchasing the 701933 Current Probe.

This user's manual contains useful information about the functions and operating procedures of the 701933 Current Probe as well as precautions that should be observed during use. To ensure proper use of the instrument, please read this manual thoroughly before beginning operation.

After reading this manual, please keep it in a convenient location for reference whenever a question arises during operation.

Revisions

1st Edition: November 2004

The following markings are 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

Describes precautions that should be observed to prevent the danger of injury or death to the user.

CAUTION

Describes precautions that should be observed to prevent minor or moderate injury, or damage to the instrument.

Note

Provides important information for the proper operation of the instrument.

Checking the Contents of the Package

If some items are missing or otherwise inconsistent with the contents description, please contact your dealer or nearest YOKOGAWA representative.

701933 Current Probe (Main Unit)

Accessories

- User's manual (this document) 1
- Soft Case

Contents

- Foreword 1
- Revisions 1
- The following markings are used in this manual. 2
- Checking the Contents of the Package 2
- Symbols Used on This Instrument 4
- The instrument is marked with the following symbols. 4
- Important Information for Users 5

- Product Overview 7
- Features 7
- Names of Parts 7
- Description of Parts 8
- Operating Procedure 9
 - Handling Precautions 9
 - Preparing for Measurement 10
 - Demagnetization and Zero Adjustment 11
 - Performing Measurement 12
- Specifications 14
 - Product Specifications 14
 - Standards Compliance 14
- Malfunction? First, Investigate. 16

- Appendix 17

Symbols Used on This Instrument

This instrument satisfies the requirements for IEC-61010 measurement category I, and pollution degree 2.

The following general safety precautions must be taken during all phases of operation, service, and repair of this instrument. If this instrument is used in a manner not specified in this manual, the protective features provided by the instrument may be impaired. Also, Yokogawa Electric Corporation assumes no liability for the customer's failure to comply with these requirements.

The instrument is marked with the following symbols.



To avoid injury, death of personnel or damage to the instrument, the operator must refer to an explanation in the User's Manual or Service Manual.



Do not apply around or remove from HAZARDOUS LIVE conductors.

Important Information for Users

Please heed the following warnings and cautions to ensure safe use of the instrument and to obtain maximum performance.



WARNING

- To avoid shorting or bodily injury, use the probe only for circuits carrying 300 V or less.
- To avoid shorting or bodily injury when opening the tip of the sensor head or when performing measurement, if the conductor under measurement exceeds the safety voltage level (when measurement exceeds 300 V), make sure the conductor under measurement has basic insulation that satisfies measurement category I at an operating voltage of 300 V, and pollution degree 2. Avoid applying the clamp to bare conductors. This is dangerous because the core and shield casing are not insulated.
- Do not damage the insulating coating of the conductor under test.
- The model 700938 or 701934 should be used as the power supply. However, other power supplies can be used if the contacts, pin arrangement, and power supply specifications match those of the 700938 or 701934. For safety reasons, you must also make sure that any power supply used has double insulation and protective grounding.
- The power supply used for the waveform measuring instrument to be connected to the output terminal (BNC) of this probe must be of double-insulated construction, and be equipped with protective grounding.
- 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 measurement terminal to which the probe is connected and other measuring terminals.
 - If the basic insulation across measurement terminals does not meet this requirement, do not apply an input exceeding the safety voltage level to any of the other measurement 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 and power supply are correctly grounded, and that the probe's output connector and power supply plug are properly connected to the measuring instrument's BNC connector and power supply receptacle, respectively.
 - 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.
- Never perform measurement if the instrument or operator's hands are wet as electric shock can result.



CAUTION

- Do not expose the instrument to vibration or physical shock during shipping and handling. Take particular caution never to drop the instrument.
- Avoid storing or using the instrument in locations that are exposed to direct sunlight, high temperatures, or condensation. These conditions can result in deformation, discoloring, or failure to meet product specifications.
- Before using the instrument, please perform an inspection and operational test to check for any damage that may have occurred due to improper storage or shipping. If damage is found, contact your nearest dealer or Yokogawa representative.
- This instrument is not waterproof or dustproof. Do not use the instrument in locations with a large amount of water or dust.
- The sensor head 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.
- 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.
- When handling the probe, take care not to fold or pull the power supply cable as this can cause breakage resulting in instrument malfunction.
- 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.
- 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

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.

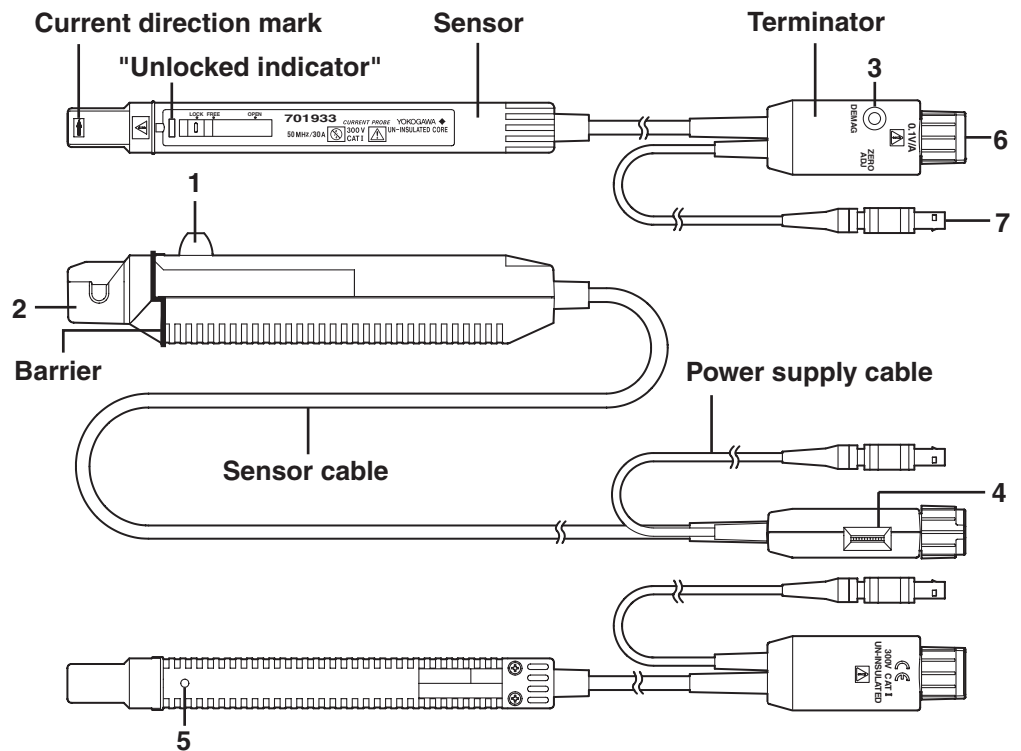
Product Overview

This probe can be connected directly to digital oscilloscopes or the BNC input terminals of DL series instruments. The probe can be used to easily observe current waveforms by simply positioning the clamp around the conductor under test.

Features

- Highly accurate current detection
- Easy current measurement
- Wide frequency bandwidth (DC to 50 MHz)
- Small size enables measurement of small currents
- Convenient protection function for excessive input

Names of Parts



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 Dial (ZERO ADJ)

The zero adjust dial lets you compensate for effects including the probe's offset voltage and temperature drift. Before performing measurement, demagnetize the probe then carry out zero adjustment.

5 Coarse Adjustment Trimmer

This is used only when zero adjustment cannot be performed using the zero adjust dial alone.

6 Output Terminal

This terminal is connected to a waveform measuring instrument (of 0.1 V/A, input impedance 1 M Ω) and outputs the current waveform of the conductor under test at a constant rate. The terminal connects to the BNC input terminal of the waveform observation instrument.

7 Power Plug

The power plug connects to the power supply receptacle of the model 700938 or 701934 Power Supply, and supplies power to the sensor and terminator.

Note

- The output from this probe is terminated internally. Use the probe with a waveform measuring instrument of high input impedance. Accurate measurement cannot be obtained at an input impedance of 50 Ω .
- When using an input terminal other than the BNC terminal (for example via a BNC-to-banana plug or other adapter), make sure the polarity of the input terminal is correct.
- Turn the connector until it clicks into place, and confirm that it is securely locked.



WARNING

To prevent electric shock, never touch anything beyond the barrier during use.

Operating Procedure

Handling Precautions



WARNING

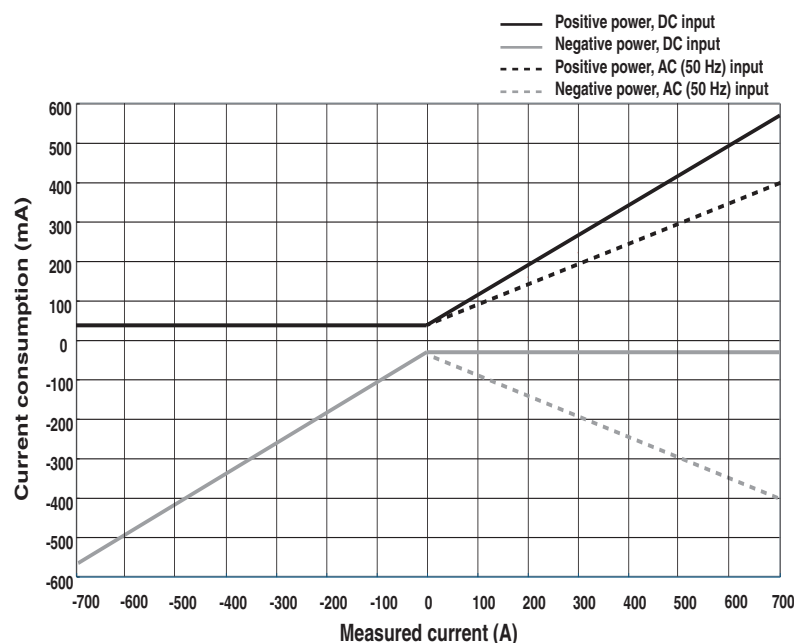
- To avoid shorting or bodily injury, use the probe only on circuits carrying 300 V or less.
 - To avoid shorting or bodily injury when opening the tip of the sensor head or when performing measurement, if the conductor under measurement exceeds the safety voltage level (when measurement exceeds 300 V), make sure the conductor under measurement has basic insulation that satisfies measurement category I at operating voltage of 300 V, and pollution degree 2. Avoid applying the clamp to bare conductors. This is dangerous because the core and shield casing are not insulated.
 - Do not damage the insulating coating of the conductor under test.
 - The model 700938 or 701934 should be used as the power supply. However, other power supplies can be used if the contacts, pin arrangement, and power supply specifications match those of the 700938 or 701934. For safety reasons, you must also make sure that any power supply used has double insulation and protective grounding.
 - The power supply used for the waveform measuring instrument to be connected to the output terminal (BNC) of this probe must be of double-insulated construction, and be equipped with protective grounding.
 - 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 measurement terminal to which the probe is connected and other measuring terminals.
 - If the basic insulation across measurement terminals does not meet this requirement, do not apply an input exceeding the safety voltage level to any of the other measurement 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 and power supply are correctly grounded, and that the probe's output connector and power supply plug are properly connected to the measuring instrument's BNC connector and power supply receptacle, respectively.
 - 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.
-

Preparing for Measurement



CAUTION

- Before turning ON the power, make sure that the power supply voltage indicated on the back of the 700938 or 701934 matches that of the power outlet you are using.
- When using the 701933 Current Probe, depending on the current value being measured, it may not be possible to use multiple active probes simultaneously with the model 700938 or 701934 Power Supply or the probe power supply connector on the back of the DL series instrument. The power consumption of the 701933 Current Probe depends on the current value being measured. Make sure that the sum of the current consumption from each active probe does not exceed the current rating of the 700938 or 701934 Probe Power Supply or the probe power connector on the back of the DL series instrument. Refer to the following diagram.



Measured Current Values and Current Consumption
of the 701933 Current Probe (Typical)

- See the appendix (page 17) for usage restrictions by DL series model.

1. Prepare the probe, a power supply (model 700938 or 701934), and a waveform measuring instrument such as a digital oscilloscope or recorder.
2. Turn the power switch OFF, then connect the power cord.
3. Connect the power plug of the 701933 you are using to a power receptacle on the 700938 or 701934.
4. Turn ON the power switch to the 700938 or 701934, and confirm that the power indicator on the front panel illuminates.

Note

The output from this probe is terminated internally. Use the probe with a waveform measuring instrument of high input impedance. Accurate measurement cannot be obtained at an input impedance of 50 Ω .

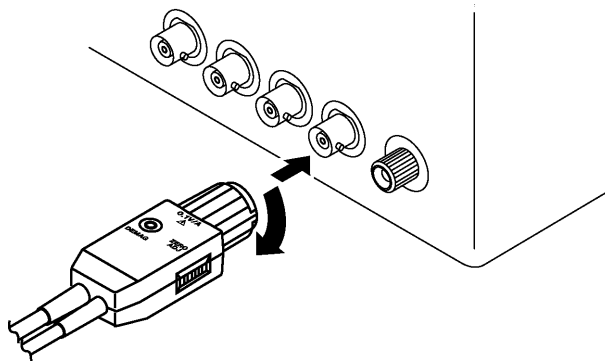
Demagnetization and Zero Adjustment



CAUTION

- When unplugging the output terminal, always release the lock first, then pull the terminal out while holding the connector. Damage can result if you forcibly pull the terminal without releasing the lock, or pull by the cable instead of the connector.
 - When using an input terminal other than a BNC terminal, make sure the polarity of the input terminal is correct.
 - 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 supplying power to the 701933. A demagnetizing waveform can be generated when power is supplied.
-

1. Ground the input of the waveform observation instrument and adjust the trace to the zero position.
2. Set the input coupling of the waveform measuring instrument to DC.
3. Connect the output terminal of the 701933 to the input terminal of the waveform observation instrument. Turn the connector until it clicks into place, and confirm that it is securely locked.



4. 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.
5. Press the demagnetization switch (DEMAG) on the terminator.
6. Turn the zero adjust dial on the terminator to adjust the trace to the zero position.
7. If you are unable to adjust the trace to zero in the step above, turn the coarse adjustment trimmer until the trace comes within a range that can be zeroed using the zero adjust dial.

Note

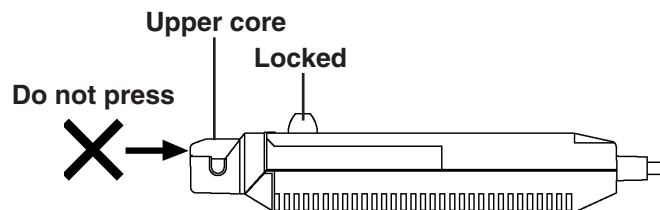
The output from this probe is terminated internally. Use the probe with a waveform measuring instrument of high input impedance. Accurate measurement cannot be obtained at an input impedance of 50 Ω .

Performing Measurement



CAUTION

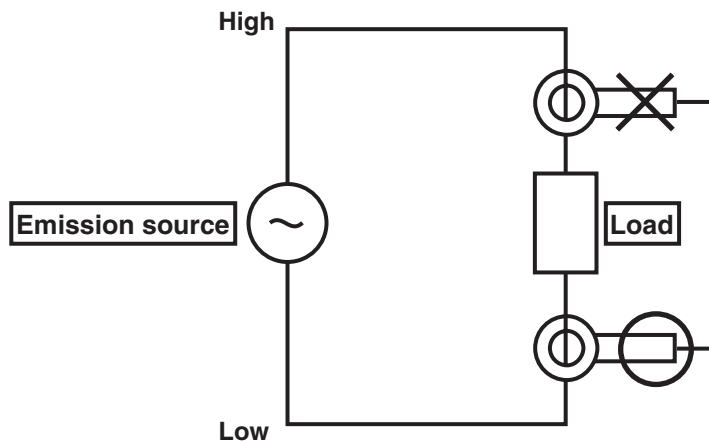
- The maximum continuous input range is determined from the rise in temperature resulting from self-heating during measurement. Do not input currents exceeding this range. Doing so can cause damage.
- The maximum continuous input range differs depending on the frequency of the measured current (see page 14, “Product Specifications”).
- If a current exceeding the maximum continuous input range is input the sensor will heat up, triggering the probe’s internal protection function which can interfere with normal output. Discontinue input 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.
- The overcurrent protection function may activate under high temperatures, resulting in measured currents at or below the maximum continuous input range.
- If a current exceeding the maximum continuous input range is input continuously, the protection function can be activated repeatedly, potentially causing damage to 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.



1. Perform all safety checks, and ensure that the above-mentioned preparations for measurement 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. You can now perform observation of the current waveform on the waveform measuring instrument. The output voltage rate of the 701933 is 0.1 V/A. Convert the voltage sensitivity on the waveform observation instrument to current sensitivity. For example, if the waveform observation instrument's voltage sensitivity is 10 mV/DIV, the current sensitivity would be 100 mA/DIV.

Note

- The output from this probe is terminated internally. Use the probe with a waveform measuring instrument having an input impedance of 1 MΩ or more.
- Immediately after turning the power ON, the probe may experience a large offset drift due to self-heating, but this will mostly stabilize after approximately thirty minutes.
- Please note that during continuous measurement, the offset voltage can drift depending on ambient temperature and other factors.
- In rare instances, connecting the power plug to a power supply that is ON can cause oscillations, but malfunctions will not occur. If this occurs, opening and closing the sensor head using the open/close lever will stop the oscillations and restore normal functioning.
- Resonance can be generated depending on the frequency of the measured current. This will not affect measurement.
- 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.

Specifications

Product Specifications

Accuracy of $23\pm 3^{\circ}\text{C}$, thirty minutes after turning ON the power.

Bandwidth*	DC to 50 MHz (-3 dB) (see the typical characteristics shown on page 15, figure 1)
Rise time*	7 ns or less
Maximum continuous input range	30 Arms (AC and DC components) (See page 15, figure 2 for derating according to frequency)
Maximum peak current	50 A _{peak} , non-continuous
Output voltage rate*	0.1 V/A
Amplitude accuracy*	$\pm 1.0\%$ rdg ± 1 mV; 0 to 30 Arms $\pm 2.0\%$ rdg; 30 Arms to 50 A _{peak} (DC, 45 to 66 Hz)
Noise*	Equivalent to 2.5 mArms or less (for a 20 MHz band measuring instrument)
Input impedance	(See typical characteristics on page 15, figure 3)
Temperature coefficient for sensitivity*	Within $\pm 2\%$ (input: 50 Hz, 30 Arms, within a range of 0 to 40°C)
Maximum rated power	5.6 VA (within maximum input range)
Rated supply voltage	$\pm(12 \pm 0.5)$ V
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 20 mA (in a DC or 60 Hz, 400 A/m magnetic field)
Maximum permitted circuit voltage	300 V (insulated conductor use)
Diameter of measurable conductor	5 mm
Recommended calibration interval	6 months
Cable lengths	Sensor cable: approx. 1.5 m; power supply cable: approx. 1 m
External dimensions	Sensor: approx. 175 (W) \times 18 (H) \times 40 (D) mm Terminator: approx. 27 (W) \times 55 (H) \times 18 (D) mm
Weight	Approx. 230 g
Accessories	User's manual, soft case

Standards Compliance

Safety	EN61010-2-032 Measurement category I (anticipated transient overvoltage 1500 V), pollution degree 2
EMC	EN61326
Measurement category I	Secondary circuits connected to an outlet via a power transformer or other item.

* When used with a waveform measuring instrument having an input impedance of $1\text{ M}\Omega \pm 1\%$.

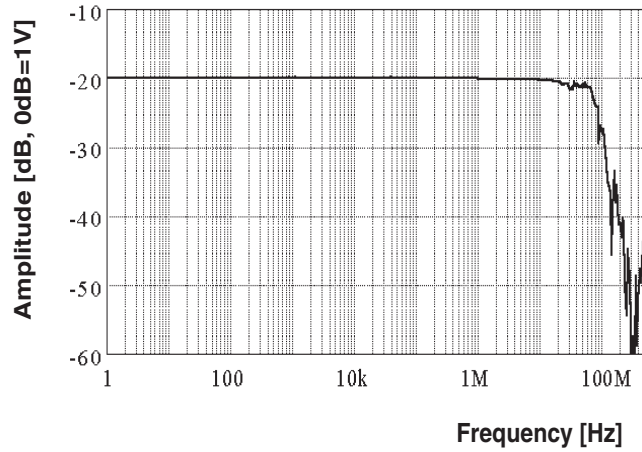


Figure 1 Frequency characteristic (typical)

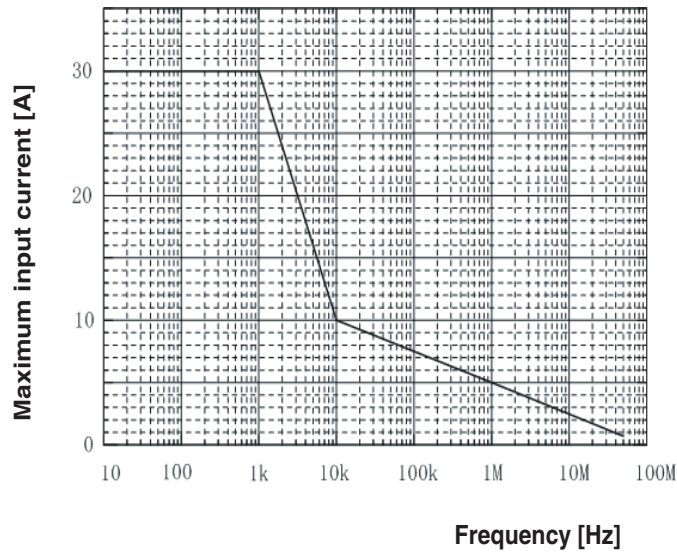


Figure 2 Derating according to frequency

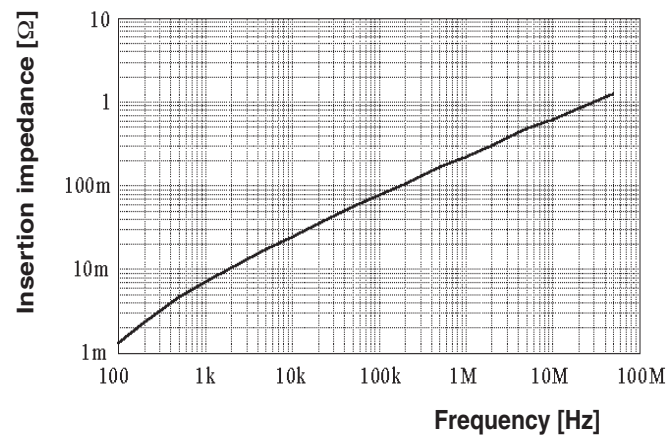


Figure 3 Input impedance (typical)

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 zero the probe with the zero adjust dial.	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 coarse adjustment trimmer.
The amplitudes across all frequencies are small.	Input to the oscilloscope or other measuring instrument is 50 Ω .	Set for 1 M Ω or higher.

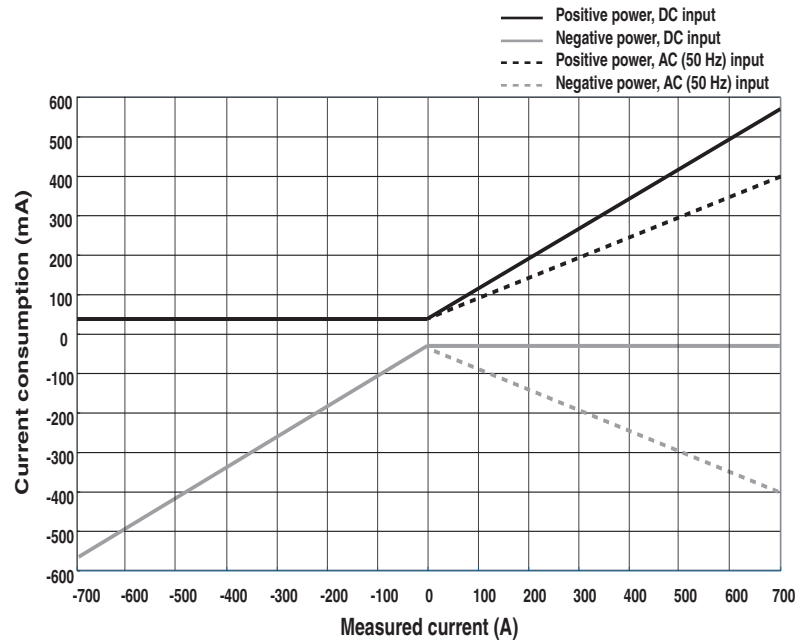
Appendix

Maximum Current and Number of 701933 Probes That Can Be Used with the DL Power Supply Terminal

Type	Option	No. of Probes*	Max Current
DL7400	Standard	4	30 A (DC + ACpeak)
DL7400	/P4	8	30 A (DC + ACpeak)
DL7100/DL7200	Standard	1	30 A (DC + ACpeak)
DL1700	/P2/P4	1	30 A (DC + ACpeak)
DL1600	/P2/P4	1	30 A (DC + ACpeak)
DL750	/P4	2	30 A (DC + ACpeak)
700938 (Probe Power Supply)	_	1	30 Arms, 50 Apeak
701934 (Probe Power Supply)	_	4	30 Arms, 50 Apeak

* If additional probes are required, use the 700938 or 701934 as an auxiliary power supply.

Current Consumption of the Model 701933 Current Probe (Typical Values)



Measured Current Values and Current Consumption of the 701933 Current Probe (Typical)