MEILHAUS ELECTRONIC

Product Datasheet - Technical Specifications

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Your contact

Technical and commercial sales, price information, quotations, demo/test equipment, consulting:

Tel.: **+49 - (0)81 41 - 52 71-0**

FAX: **+49 - (0)81 41 - 52 71-129**

E-Mail: **sales@meilhaus.com**

Meilhaus Electronic GmbH
Am Sonnenlicht 2
82239 Alling/Germany

Tel. **+49 - (0)81 41 - 52 71-0**
Fax **+49 - (0)81 41 - 52 71-129**
E-Mail **sales@meilhaus.com**

www.meilhaus.com

HIOKI

CURRENT PROBE series

CT6700, CT6701, 3273-50, 3274, 3275, 3276

DC to 120 MHz / 1 mA to 500 Arms

Advanced Lineup of Current Probes

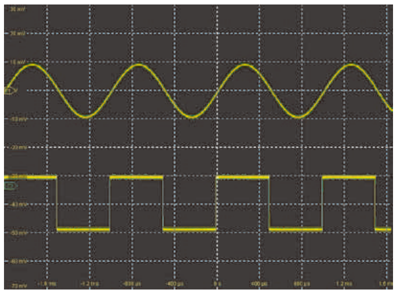
Current probes are key to the successful design of electrical devices, medical instruments, and electronic parts. In combination with an oscilloscope or HIOKI MEMORY HiCORDER, probes are ideal for measuring currents with high accuracy and wide bandwidths, making them indispensable tools for evaluating current consumption and control current.

CE

Key Features of Current Probes

High S/N Ratio

By using Hall elements manufactured in-house, Hioki is able to design probes characterized by low noise despite offering broadband performance. They can measure current at a high signal-to-noise ratio, ensuring that even minuscule currents don't get lost in the noise.

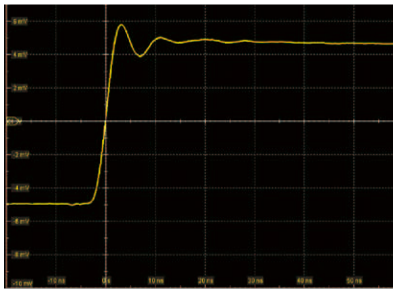


Current waveform of 20 mAp-p (CT6700/CT6701)

Input: 20 mAp-p, 1 kHz, sine wave/square wave
(Oscilloscope bandwidth 2 GHz, 10 mV/div)

Wide Frequency Band

Current transformer (CT) operation is characterized by a frequency band that extends to a maximum of 120 MHz, allowing observation of current waveforms that include a broad range of frequency components.



[Transient response]
Waveform with a rising edge of approx. 3.5 ns (3276)

Oscilloscope bandwidth: 200 MHz
Time axis:10 ns/div

Broad measurement coverage and excellent linearity

Hioki current probes make use of the zero-flux method, which consists of a negative feedback circuit, so that they can provide broad measurement coverage and excellent linearity.

→ See "Operating principle" on the following page.

Waveform observation from DC

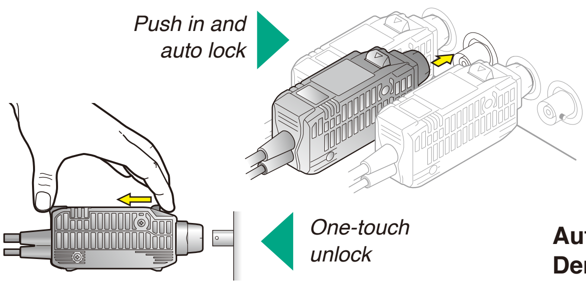
In the low-frequency region, a Hall element is used to detect the magnetic flux that the current under measurement causes to flow in the magnetic core. Since Hall elements also respond to DC magnetic flux, both DC and low-frequency current waveforms can be observed.

Low insertion loss* thanks to low operating magnetic flux levels

The zero-flux method is characterized by a small amount of magnetic flux flowing in the magnetic core, which serves to detect the current under measurement. This feature makes it possible to reduce the effect on the circuit under measurement caused by the current probe when it is clamped over the conductor under measurement.

*Clamping the probe onto the conductor under measurement is equivalent to inserting the inductor L into the circuit. This insertion affects the operation of the circuit under measurement.

One touch easy operation streamlines measurement [CT6700/CT6701]



One-touch Disconnection from the BNC Terminal

The BNC connector does not need to be rotated when connecting to an oscilloscope or recorder. Insert the connector until it automatically locks into place. To disconnect it, just pull the unlock lever toward you.

Automatic Zero-Adjustment and Demagnetization in One Button

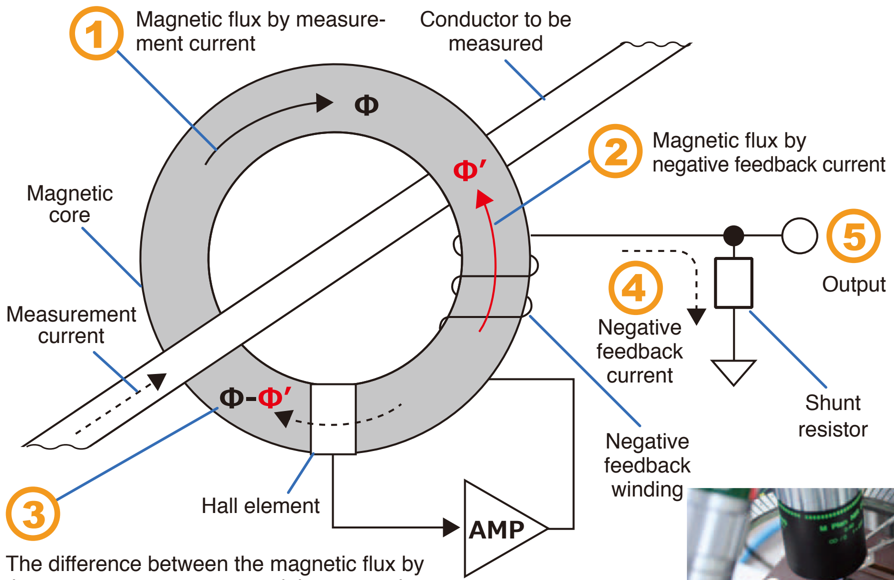
With the CT6700/CT6701, you can automatically perform zero-adjustment, which must be done before each use, by pressing a single button.
By pressing and holding the button for demagnetization, you can cancel an offset margin of error after measuring a large current.

High-precision measurement, from DC to high frequencies

High-performance sensors that combine a proprietary thin-film Hall element and the zero-flux method

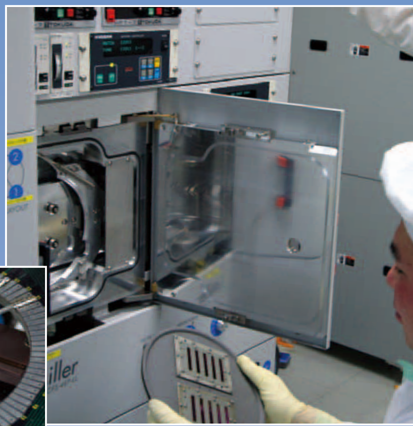
Reference
Operating Principle

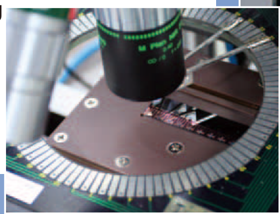
Operating principle



In-house production

Hioki current probes use thin-film Hall elements of a proprietary design that are manufactured in-house. By combining these thin-film Hall elements with the zero-flux method, it is possible to measure minuscule currents over a broad frequency range, from DC to the megahertz band. In this way, Hioki provides high-performance sensors that meet the full array of market needs.





Production process of hall alement

Operating Principle

Operation of CT (Current Transformer)

① The current flowing in the conductor under measurement generates the magnetic flux φ in the magnetic core.

② A negative feedback current corresponding to the number of turns in the winding flows to cancel the magnetic flux φ.

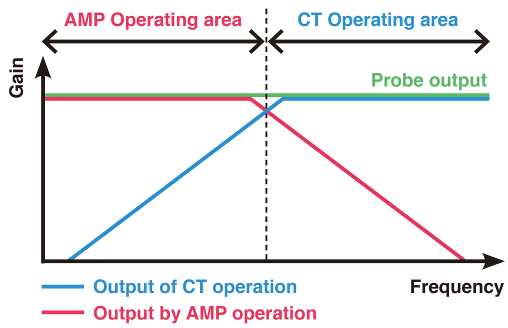
Operation of AMP

③ From DC to the low-frequency region, the magnetic flux φ is not completely canceled, leaving the magnetic flux magnetic flux φ-φ' in the magnetic core.

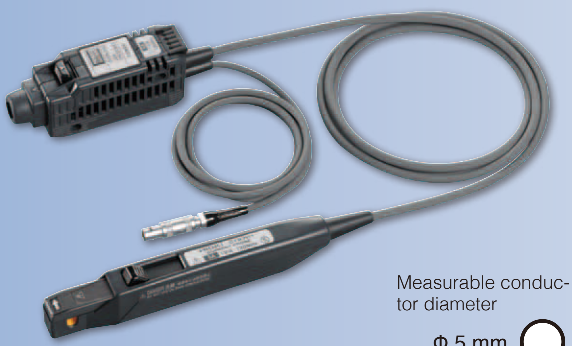
④ This remaining magnetic flux φ-φ' is detected by the Hall element, and the amp circuit generates a negative feedback current so as to cancel the magnetic flux φ-φ'.

Output

⑤ The current flowing through the winding to the shunt resistor is the sum of the currents resulting from CT operation (i.e., the current from the winding) and amp operation (i.e., the feedback current from Hall element detection). This current results in a voltage across the shunt resistor's terminals, and that voltage is proportional to the current flowing in the conductor under measurement.



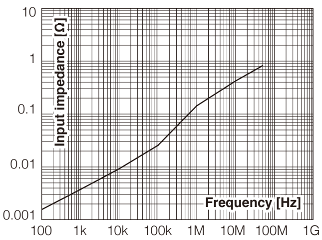
High sensitivity Clearly observe even 1 mA waveforms



Measurable conductor diameter
Φ 5 mm (0.20 in)

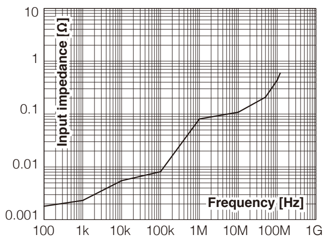
50 MHz / 5A
CT6700

Continuous allowable input	: 5 Arms
Max. allowable peak input	: ±7.5 Apeak (non-contimuous)
Output rate	: 1 V/A
Frequency bandwidth	: DC to 50 MHz
Shield type	: Magnetic shield

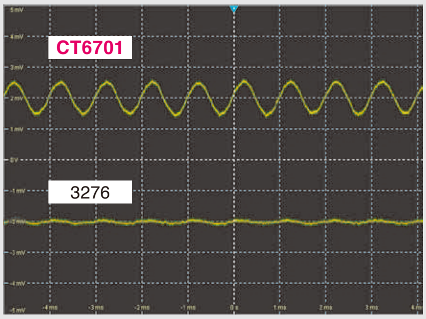


120 MHz / 5A
CT6701

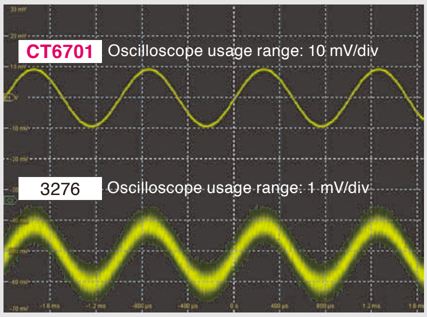
Continuous allowable input	: 5 Arms
Max. allowable peak input	: ±7.5 Apeak (non-contimuous)
Output rate	: 1 V/A
Frequency bandwidth	: DC to 120 MHz
Shield type	: Magnetic shield (Low insertion loss)



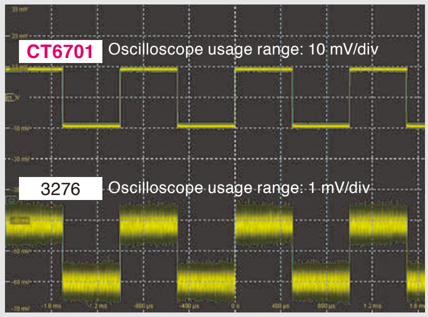
Clearly observe even low current signals waveforms, and analyze the current in finer detail



Input: 1 mAp-p, 1 kHz, sine wave
Oscilloscope: Bandwidth 20 MHz, 1 mV/div

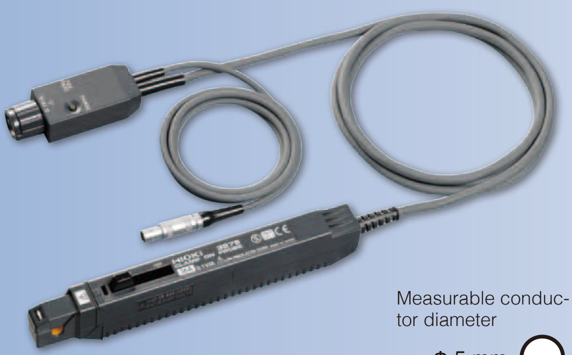


Input: 20 mAp-p, 1 kHz, sine wave
Oscilloscope: Bandwidth 2 GHz, 10 mV/div



Input: 20 mAp-p, 1 kHz, square wave
Oscilloscope: Bandwidth 2 GHz, 10 mV/div

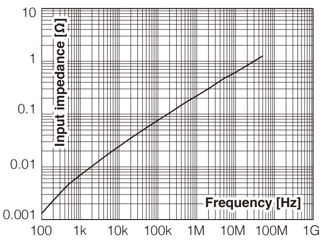
High S/N Ratio 10 mA order waveform observation



Measurable conductor diameter
Φ 5 mm (0.20 in)

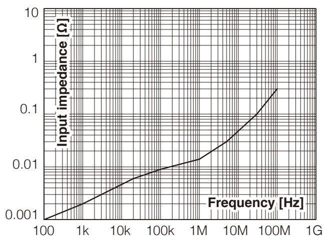
50 MHz / 30A
3273-50

Continuous allowable input	: 30 Arms
Max. allowable peak input	: ±50 Apeak (non-contimuous)
Output rate	: 0.1 V/A
Frequency bandwidth	: DC to 50 MHz
Shield type	: Magnetic shield



100 MHz / 30A
3276

Continuous allowable input	: 30 Arms
Max. allowable peak input	: ±50 Apeak (non-contimuous)
Output rate	: 0.1 V/A
Frequency bandwidth	: DC to 100 MHz
Shield type	: Magnetic shield (Low insertion loss)

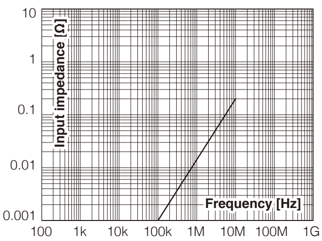


Waveform observation of large current

Measurable conductor diameter
Φ 20 mm (0.79 in)

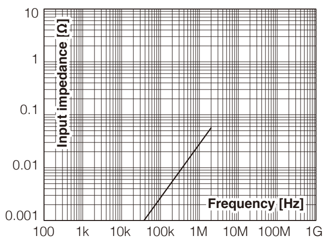
10 MHz / 150A
3274

Continuous allowable input	: 150 Arms
Max. allowable peak input	: ±300 Apeak (non-contimuous)
Output rate	: 0.01 V/A
Frequency bandwidth	: DC to 10 MHz
Shield type	: Magnetic shield



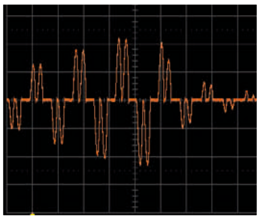
2 MHz / 500A
3275

Continuous allowable input	: 500 Arms
Max. allowable peak input	: ±700 Apeak (non-contimuous)
Output rate	: 0.01 V/A
Frequency bandwidth	: DC to 2 MHz
Shield type	: Standard



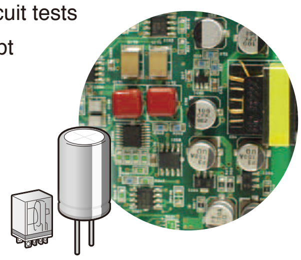
Observe load current and control current waveforms in industrial equipment

- Secondary side of inverters and motor load currents
- Electric pump solenoid control currents
- Solenoid valve operating current and control currents
- Actuator load currents
- Motor coil instantaneous current waveforms
- Fan consumed currents and inrush currents
- Power supply system load current waveforms


Forming machine load current
50A/div, 10ms/div

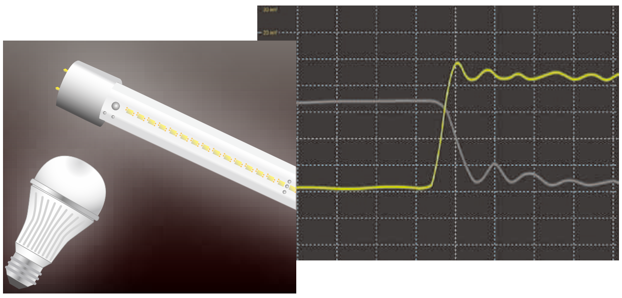
Evaluate current characteristics in circuit components and other parts

- Switching power supply board current waveforms
- Circuit board current waveforms
- Ripple current waveforms flowing to capacitors
- Current waveforms from short-circuit tests
- Evaluate EV batteries under abrupt load changes
- Inrush current waveforms



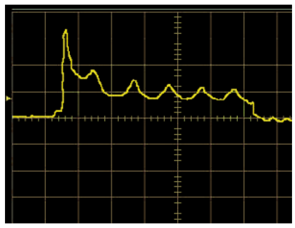
Evaluate high-speed switching characteristics

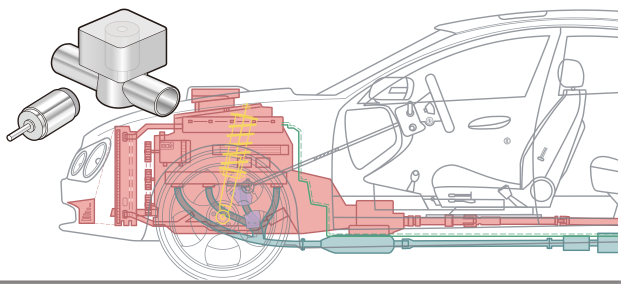
- Observe waveforms when switching LED driver control
- Observe waveforms of on/off cycles in semiconductor devices driven at high speeds
- Observe waveforms of control current and load current in light control circuits
- Observe waveforms of control current and load current in DC/DC converters or inverters



Confirm transient response waveforms during control switching

- Measure current in automotive electric components
- Measure switch and relay control currents
- Evaluate ECU and observe control signal currents
- Observe engine ignition timing
- Actuator control current waveforms
- Monitor solenoid valve control currents
- Confirm response during control changes


Starting current in a car starter
100A/div, 1s/div



How Shields Function

There are two types of shielding: standard and magnetic. Magnetic shielding is also available in a low-insertion-loss variant with reduced insertion loss.
Choose the type of probe shielding that best suits your application and measurement environment.

Measuring in proximity to High-voltage switching control equipment such as an inverter or motor

For measurement in environments in which the probe will be subjected to the effects of nearby magnetic fields

Standard type (Electrostatic shield)

3275

Effect of shield

Reduces the effects of electric fields (Other shielding types also yield electrostatic shielding benefits)

Measuring low currents

Measuring in proximity to high-current lines

For measurement in environments in which the probe will be subjected to the effects of nearby magnetic and electric fields

Magnetic shield type

(Shield with high permeability material)

CT6700 3273-50 3274

Effect of shield

Reduces the effects of external magnetic fields and electric fields

Measuring current of low impedance circuits

Waveforms that include high frequency components

Low insertion loss type CT6701 3276

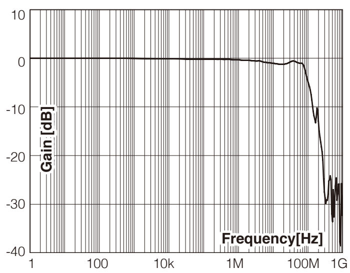
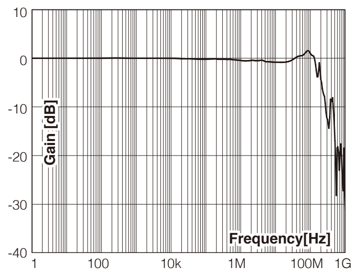
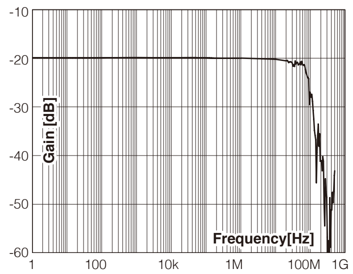
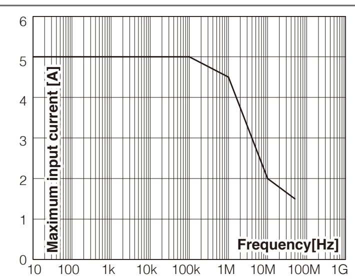
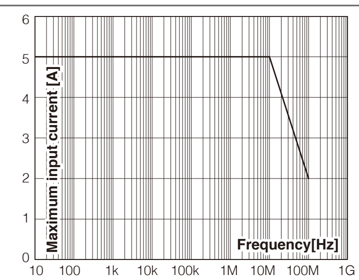
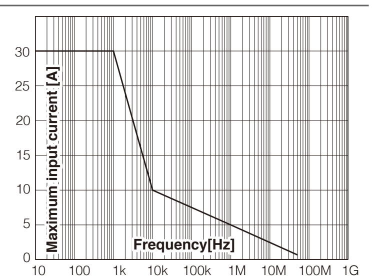
When probing a conductor, impedance is added to the measurement - a phenomenon known as insertion loss - and this effect increases in magnitude when measuring high frequencies.

Effect of shield

- Reduces insertion loss
- Reduces derating that may result from increased sensor head heating caused by eddy currents

Specifications

Accuracy guaranteed for 1 year (Opening/closing up to 10,000 times), Post-adjustment accuracy guaranteed for 6 months

	CT6700	CT6701	3273-50
Frequency range	DC to 50 MHz (-3dB)	DC to 120 MHz (-3dB)	DC to 50 MHz
Rise time (10 % to 90 %)	7.0 ns or less	2.9 ns or less	7.0 ns or less
Maximum rated current (*1)	5 Arms		30 Arms
Maximum peak current	±7.5 Apeak (non-continuous)		±50 Apeak (non-continuous)
Measurable conductor diameter	5 mm (0.20 in) dia. or less		
Measurable conductors	Insulated conductors		
Output voltage rate	1V/A		0.1 V/A
Amplitude accuracy	±3.0 %rdg. ±1 mV (*3), Typical ±1 %rdg. ±1 mV (*3)		±1.0 %rdg. ±1 mV (*4)
Output resistance	50 Ω ±10% (DC)		-
Noise	75 µA rms max (*7), 60 µA rms typical (*7)		2.5 mArms or less (measured with 20 MHz bandwidth equipment)
Temperature coefficient for sensitivity	±2 %rdg. or less (*8)		±2 %rdg. or less (*9)
Maximum rated power (*12)	3.2 VA		5.6 VA
Supply voltage	±12 V ±0.5 V		
Operating temperature and humidity range	0 to +40 °C, 80 % RH or less (no condensation)		
Storage temperature and humidity range	-10 to +50 °C, 80 % RH or less (no condensation)		
Location for use	Indoor, pollution degree 2, altitude up to 2000 m		
Effect of external magnetic fields (*13)	20 mA max	5 mA max	20 mA max
Effect of radiated radio-frequency electromagnetic field	±10 mA max (at 3 V/m)		-
Effect of conducted radio-frequency electromagnetic field	±10 mA max (at 3 V)		-
DEMAG/AUTO ZERO function	✓		✓ (Zero adjustment: manual)
JAW UNLOCKED detection	✓		-
OVERLOAD detection	✓		-
Cord lengths	Sensor cord: 1.5 m (4.92 ft), Power cord: 1.0 m (3.28 ft)		
Dimensions: Sensor	155 mm (6.10 in)W × 18 mm (0.71 in)H × 26 mm (1.02 in)D		175 mm (6.89 in)W x 18 mm (0.71 in)H x 40 mm (1.57 in)D
Dimensions: Terminator	29 mm (1.14 in)W × 83 mm (3.27 in)H × 40 mm (1.57 in)D		27 mm (1.06 in)W x 55 mm (2.17 in)H x 18 mm (0.71 in)D
Mass	250 g (8.8 oz)		230 g (8.1 oz)
Accessories	Instruction manual, Carrying case		Instruction manual, Soft case
Frequency characteristics			
Frequency derating			

Annotation of specifications

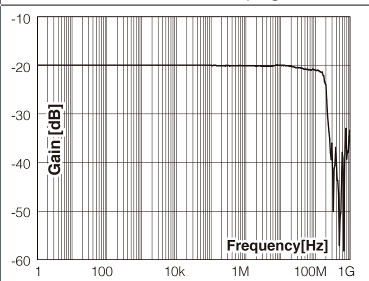
*1 DC and sine wave, refer to the frequency derating properties graph
*2 ± 500 A peak at pulse width of ≤ 30 µs
*3 DC, 45 to 66 Hz sine wave, 0 to 5 A rms
*4 DC, 45 to 66 Hz sine wave, 0 to 30 A rms. ±2.0 % rdg. (30 Arms to 50 Apeak)
*5 DC, 45 to 66 Hz sine wave, 0 to 150 A rms. ±2.0 % rdg. (150 Arms to 300 Apeak)
*6 DC, 45 to 66 Hz sine wave, 0 to 550 A rms. ±2.0 % rdg. (500 Arms to 700 Apeak)
*7 75 µA rms max (for 30 MHz band measuring instrument)
*8 After automatic zero-adjustment with 50 Hz 5 A rms input, except at 23 ± 5˚C
*9 At 50 Hz / 30 Arms input, 0 to 40˚C [32 to 104˚F])
*10 At 55 Hz / 150 A input, 0 to 40˚C (32 to 104˚F)
*11 At 50 Hz / 500 A input, 0 to 40˚C (32 to 104˚F)
*12 Input within the maximum input range
*13 DC and 60 Hz, Magnetic field of 400 A/m

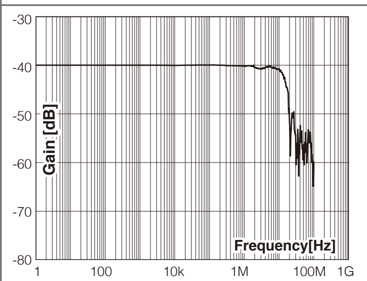
Specifications

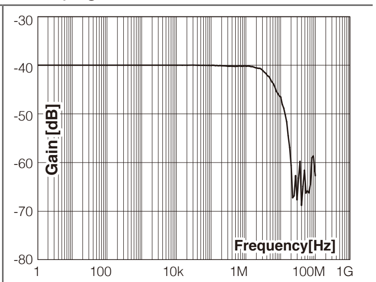
Accuracy guaranteed for 1 year (Opening/closing up to 10,000 times), Post-adjustment accuracy guaranteed for 6 months

	3276	3274	3275
Frequency range	DC to 100 MHz	DC to 10 MHz	DC to 2 MHz
Rise time (10 % to 90 %)	3.5 ns or less	35 ns or less	175 ns or less
Maximum rated current (*1)	30 Arms	150 Arms	500 Arms
Maximum peak current	±50 Apeak (non-continuous)	±300 Apeak (non-continuous) (*2)	±700 Apeak (non-continuous)
Measurable conductor diameter	5 mm (0.20 in) dia. or less	20 mm (0.79 in) dia. or less	
Measurable conductors	Insulated conductors		
Output voltage rate	0.1 V/A	0.01 V/A	
Amplitude accuracy	±1.0 %rdg. ±1 mV (*4)	±1.0 %rdg. ±1 mV (*5)	±1.0 %rdg. ±5 mV (*6)
Output resistance	-	-	
Noise	2.5 mArms or less (measured with 20 MHz bandwidth equipment)	25 mArms or less (measured with 20 MHz bandwidth equipment)	
Temperature coefficient for sensitivity	±2 %rdg. or less (*9)	±2 %rdg. or less (*10)	±2 %rdg. or less (*11)
Maximum rated power (*12)	5.3 VA	5.5 VA	7.2 VA
Supply voltage	±12 V ±0.5 V	±12 V ±1 V	±12 V ±0.5 V
Operating temperature and humidity range	0 to +40 °C, 80 % RH or less (no condensation)		
Storage temperature and humidity range	-10 to +50 °C, 80 % RH or less (no condensation)		
Location for use	Indoor, pollution degree 2, altitude up to 2000 m		
Effect of external magnetic fields (*13)	5 mA max	150 mA max	800 mA max
Effect of radiated radio-frequency electromagnetic field	-	-	
Effect of conducted radio-frequency electromagnetic field	-	-	
DEMAG/AUTO ZERO function	✓ (Zero adjustment: manual)	✓ (Zero adjustment: manual)	
JAW UNLOCKED detection	-	-	
OVERLOAD detection	-	-	
Cord lengths	Sensor cord: 1.5 m (4.92 ft), Power cord: 1.0 m (3.28 ft)	Sensor cord: 2.0 m (78.74 ft), Power cord: 1.0 m (3.28 ft)	
Dimensions: Sensor	175 mm (6.89 in)W × 18 mm (0.71 in)H × 40 mm (1.57 in)D	176 mm (6.93 in)W × 69 mm (2.72 in)H × 27 mm (1.06 in)D	
Dimensions: Terminator	27 mm (1.06 in)W × 55 mm (2.17 in)H × 18 mm (0.71 in)D	27 mm (1.06 in)W × 55 mm (2.17 in)H × 18 mm (0.71 in)D	
Mass	240 g (8.5 oz)	500 g (17.6 oz)	520 g (18.3 oz)
Accessories	Instruction manual, Carrying case	Instruction manual, Carrying case	

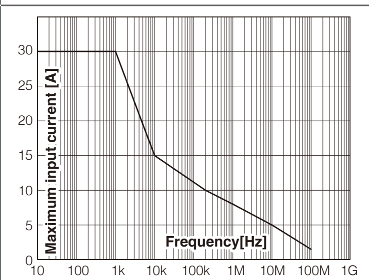
Frequency characteristics

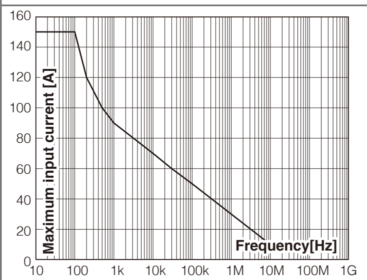


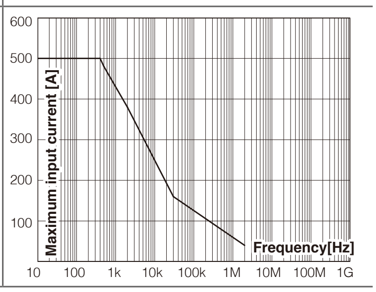




Frequency derating







Power Supply for Current Probes

	3269	3272
Compatible sensors	Model CT6700, CT6701, 3273-50, 3274, 3275 or 3276: up to 4 units	Model CT6700, CT6701: up to 2 units Model 3273-50, 3274, 3275 or 3276: up to 1 unit *Note: May be used with up to 2 units of Model 3273 (not -50 type), and up to 2 units of Models 3273-50, 3274, 3275 or 3276 on condition that the measurement current is sufficiently low.*
Number of power supply connectors	4	2
Output	±12 V ±0.5 V, ±2.5 A (sum total of all channels)	±12 V ±0.5 V, 600 mA (sum total of all channels)
Power supply	100 to 240 V AC (free), 50/60 Hz, 170 VA max.	100 V or 120/220/240 V AC (specify when ordring), 50/60 Hz, 20 VA max.
Dimensions and mass	80 mm (3.15 in) W × 119 mm (4.69 in) H × 200 mm (7.87 in) D 1.1 kg (38.8 oz)	73 mm (2.87 in)W × 110 mm (4.33 in) H × 186 mm (7.32 in) D 1.1 kg (38.8 oz)

3272

	Model No. (Order Code)	Note
CURRENT PROBE	CT6700	DC to 50MHz, 5 Arms
	CT6701	DC to 120MHz, 5 Arms
CLAMP ON PROBE	3273-50	DC to 50 MHz, 30 Arms
	3274	DC to 10 MHz, 150 Arms
	3275	DC to 2 MHz, 500 Arms
	3276	DC to 100 MHz, 30 Arms

	Model No. (Order Code)	Note
POWER SUPPLY	3269	Supports up to 4 current probes
	3272	Supports 1 current probe*

*Model CT6700, CT6701: up to 2 units
*Model 3273-50, 3274, 3275, 3276: up to 1 unit (may be used with up to 2 units on condition that the measurement current is sufficiently low)

Precautions when choosing and using current probes

Please review the following precautions concerning selection and use of current probes to facilitate safe measurement and maintain product performance.

Conductor under measurement

- These current probes cannot be used with bare conductors. Doing so may result in electric shock or a short-circuit. Measure conductors that are sufficiently insulated for the voltage they carry.

Handing the sensor head

- The sensor head, which consists of components such as molded parts, a ferrite core, and a Hall element, is a precision-assembled part. To prevent damage, avoid subjecting the sensor head to abrupt temperature changes, mechanical shock, static electricity, and other potential hazards.
- The complementary surfaces of the mating portion of the sensor head have a precisely polished finish. Exercise care concerning dirt and damage as these will affect the probe's performance.

Derating

- When a current probe is clamped onto a conductor carrying current with a high-frequency component, the probe's sensor will heat up due to eddy current loss. To ensure safety, a lower continuous maximum input current applies when the frequency increases (this is known as a derating). To avoid risk of burns, equipment damage, accident, or fire, consult the derating characteristics when choosing a probe.
- Deratings are defined for single-frequency sine waves. Input that does not take the form of a sine wave can be assumed to include a high-frequency component that will cause the sensor temperature to rise, requiring caution during measurement.

Effects of nearby strongly magnetic bodies

- Use of the probe's sensor in proximity to strongly magnetic bodies such as sheet steel will affect measurement results.

Offset drift

- Hioki current probes use Hall elements to detect DC and low-frequency current. Since Hall elements' unbalanced voltage varies with the temperature, the devices exhibit offset drift caused by factors such as ambient temperature variations and heating of the sensor during measurement. Consequently, it is necessary to perform zero-adjustment before each measurement.
- Offset drift may introduce an error component when measuring a minuscule DC current over an extended period of time.

Introduction of AC non-contact voltage probe

NEW Capture Voltage Signals from Outside the Wire Cover

*The world's first **non-contact** voltage probe transforms the conventional approach to electric equipment maintenance*

- Measure insulated wires with outside diameters ranging from 1 mm to 2.5 mm
- Frequency band: 10 Hz to 100 kHz
- Rated measurement voltage: 5 Vrms 14 Vp-p

NON-CONTACT AC VOLTAGE PROBE

Model No. (Order Code) **SP3000-01**

Simply attach the probe to covered wires

Note: Company names and product names appearing in this catalog are trademarks or registered trademarks of various companies.

HIOKI E. E. CORPORATION