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# Instruction Manual

## Rogowski Coil Current Probe SS-293S/293L/294S/294L SS-295S/295L/296S/296L

**IWATSU TEST INSTRUMENTS CORPORATION**

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Memo

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## Introduction

- ◇ Thank you for purchasing this instrument of IWATSU TEST INSTRUMENTS CORPORATION. We hope that you will enjoy it for years to come.
- ◇ We ask you to thoroughly read this manual before commencing operation and to keep it at a readily accessible location for future reference.

## To ensure Safe Operation

To ensure safe operation of this instrument and to prevent injury to the user or damage to property, read and carefully observe  Warnings and  Cautions in the following sections.

### Definition of Warning and Caution as used in this manual

 <b>Warning</b>	Incorrect operation or failure to observe a warning may result in death or serious injury.
 <b>Caution</b>	Incorrect operation or failure to observe a caution may result in bodily injury or damage to the instrument.

## Notes

- ◇ Some of the contents of this manual may be modified without notice for improvements in specifications and functions.
- ◇ Reproduction or reprinting of the contents of this manual without prior permission from IWATSU TEST INSTRUMENTS CORPORATION is prohibited.
- ◇ If any question arises about this instrument, contact Iwatsu office or our sales distributors.

## Revision History

- ◇ April 2015: 1st edition

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Read the following safety information.



## Warnings

- **Do not use this instrument in an environment with explosive gases.**

Failure to do so may cause an explosion.
- **If you notice smoke, foul odor, or abnormal noise, immediately remove this instrument from the target to be measured, power off the equipment connected with this instrument, and then turn the POWER switch to the O side to turn off the power to this instrument.**

Continued use under these circumstances may result in an electric shock or fire. Contact Iwatsu office or our sales distributors for repair. Do not attempt to repair this instrument yourself.
- **Never use this instrument for measurement where current or frequency to be measured exceeds the specifications (refer to the absolute maximum di/dt in Section 5.1 of this manual).**

If the measurement is performed without considering the specifications, an electric shock or failure may occur.
- **Never use the coil and sensor cable of this instrument's input part for the measurement where voltage exceeds the following value (the voltage is described on the input part of this instrument).**

An electric shock or failure may occur.

  - 10 kV<sub>peak</sub>
- **Use caution not to wet this instrument or allow entry of water or foreign objects into it.**

Continued use under these circumstances may result in an electric shock, fire, or failure. If water, foreign objects, or other substances enter this instrument or the instrument is wet with water, immediately remove this instrument from the target to be measured, power off the equipment connected with this instrument, and turn the POWER switch to the O side to turn off the power to this instrument. After that, contact Iwatsu office or our sales distributors for repair.
- **Do not use this instrument with wet hands.**

If not, an electric shock, fire, or failure may occur.
- **Do not modify or disassemble this instrument.**

Modification or disassembly of this instrument could result in an electric shock, fire, or failure. Repair of a modified product may be refused. Contact Iwatsu office or our sales distributors for repair.

[Read the next page.]

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Read the following safety information. (continued)



## Warnings

- **Use the accessory size AA alkaline batteries or equivalent for this instrument. Do not use new batteries in combination with old ones.**

Using a battery that does not comply with the above requirements may result in a fire or failure.

For information on the recommended batteries, refer to Notes 1 and 2 of Section 5.1 "Specifications."

- **Observe the following when handling the coil, sensor cable, or BNC cable of this instrument.**

If not, an electric shock, fire, or failure may occur. Do not use any of the cables if damaged. Contact Iwatsu office or our sales distributors for repair.

- Do not modify any cable.
- Do not pull on any cable.
- Do not forcibly bend any cable.
- Do not heat any cable.
- Do not twist any cable.
- Do not wet any cable.
- Do not tie any cable in a bundle.
- Do not put heavy objects on any cable.

- **Do not use this instrument in a highly humid environment where condensation may occur.**

If not, an electric shock, fire, or failure may occur.

[Read the next page.]

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Read the following safety information. (continued)



## Warnings

- **Avoid the generation of Corona discharge in an environment where high voltage is applied to the sensor part for a long time.**

Depending on the frequency of the applied voltage and installation conditions of the sensor part, Corona discharge may be generated even when a voltage lower than resisting voltage is applied to the sensor part. This generation may lead to degrading the insulating outer sheath, causing an electrical shock, fire, or failure.

Corona discharge tends to be generated due to electric field concentration. Take some measures to avoid the generation; for example, keep the sensor part away from high-voltage parts as far as possible or achieve insulation.

- **Do not put on this instrument a container that water, medicine, etc. has entered or a small metallic object.**

If not, an electric shock or fire may occur. If this instrument is wet with water, or metal and other objects enter the instrument, immediately remove this instrument from the target to be measured, power off the equipment connected with this instrument, and turn the POWER switch to the O side to turn off the power to this instrument. After that, contact Iwatsu office or our sales distributors for repair.

- **When thunder begins, pull out the power plug of a device to which this instrument is connected from the outlet. Then, detach this instrument from the target to be measured, and do not use it.**

Lightning may be a cause of an electric shock, fire, or failure.

- **Do not use this instrument when it has failed.**

Using a failed main unit or cable may be a cause of an electric shock or fire. In the event of a failure, contact Iwatsu office or our sales distributors for repair.

- **Turn off the power to the target to be measured before attaching or detaching the Rogowski Coil Sensor part of this instrument to or from the target to be measured.**

Failure to do so is very dangerous for targets to be measured that use high voltage and high current.

- **Insert the end of the Rogowski Coil into the joint hole to fix the coil with the screw lock. Do not apply a high voltage exceeding the specifications (refer to Section 5.1 "Specifications") to the Rogowski Coil Sensor.**

Failure to do so may cause an electric shock, fire, or failure.

- **The sensor cable cannot be removed because it is integral with (connected inside of) the main unit. Do not attempt to disconnect the sensor cable.**

Failure to do so may cause an electric shock, fire, or failure.

[Read the next page.]



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Read the following safety information. (continued)



## Cautions

- **Do not expose to rapidly-changing temperature, mechanical stress, or impact.**

The main unit, coil, sensor and BNC cable will be damaged if exposed to these. This will be a cause of a failure.

- **Do not use or store this instrument in a location with direct sunlight, high temperature, high humidity, or dew condensation.**

Operation or storage outside the ratings could result in deformation, deteriorated insulation, or a failure due to heat. The ranges of operating and storage temperature and humidity are as follows:

- Operating temperature: 0 to +40°C (coil part: -40 to +125°C), no dew condensation
- Operating humidity: 80%RH or less
- Operating altitude: 2000 m or less (at 25°C or less)
- Storage temperature: -10 to +60°C, no dew condensation
- Storage humidity: 80%RH or less

- **Do not place this instrument in a location with excessive humidity or dust.**

If not, an electric shock, fire, or failure may occur.

- **Do not put this instrument in a place exposed to lamp soot or steam generated by counters, humidifiers, etc.**

If not, an electric shock, fire, or failure may occur.

- **Avoid pulling or bending the Rogowski Coil Sensor part with excessive force as much as possible. The Rogowski Coil has a coil structure consisting of an extra-fine wire rod wound tight.**

Pulling or bending the Rogowski Coil Sensor part with excessive force may degrade the specifications of the sensor part due to the change of the coil structure.

- **For your safety, when this instrument is not used for a long time, turn the POWER switch to the O side to turn off the power to this instrument, and then remove the batteries from this instrument.**

[Read the next page.]

Read the following safety information. (continued)



## Cautions

● **Use caution when handling this instrument.**

The cables of this instrument are long. Take care not to catch your feet or objects on the cables during measurement and installation.

This instrument can measure high current in high-voltage circuits. Operators require a basic knowledge of the voltage and current, because using this instrument will be a cause of human injury depending on the measurement environment. Before using this instrument, they must obtain the basic knowledge and receive training on using it safely.

● **Before moving this instrument, make sure that the coil, sensor, BNC cable, and other external connection lines are removed.**

Failure to do so will damage the cable, causing an electrical shock, fire, or failure.

● **To use this instrument, connect it to the ground (output side).**

Ground GND terminals of monitoring devices, which are the connection destination of the output terminal.

Do not energize a target to be measured with nothing connected to the output terminal. This may be a cause of an electrical shock.

● **Pay attention to the polarity indication (plus and minus signs) when placing batteries in this instrument.**

A reversely placed battery will result in battery explosion or leakage. This may cause a fire, injury, failure, or contamination of the surrounding environment.

● **Do not throw used batteries in the fire.**

Batteries thrown in the fire may explode, causing a fire or burn.

For information on disposing of used batteries, refer to "Management of product" on page 8.

● **Before transporting this instrument, remove the batteries, house this instrument in the accessory hard case, and then pack the housed instrument in the packing material used at the time of purchase, or the equivalent or better.**

This instrument may fail if a large vibration or impact is applied during transportation, possibly causing a fire. If you do not have a proper packing or shock-absorbing material for transportation, contact Iwatsu office or our sales distributors. If transportation is to be handled by a forwarding agent, display "Contains a precision machine" on each side of the packing box.

● **For your safety, remove the batteries, monitoring devices, and the target to be measured from this instrument before maintenance. In addition, wipe off with a dry cloth when water droplets are attached.**

If not, an electric shock or failure may occur.

● **We recommend that you contact Iwatsu office or our sales distributors for periodic inspection and calibration about once a year.**

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## Checking packed materials

When receiving this instrument, check the packed materials while referring to the following "Components." If there is a missing item or an item damaged during transportation, immediately contact Iwatsu office or our sales distributors.

## Components

- Main unit ..... 1
- Accessories (See the accessories table below.)

Accessories table

Item	Quantity
Hard case	1
BNC cable	1
Screw driver (flat tip)	1
AA dry battery	4
Instruction Manual (this document)	1

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## **Management of product**

When disposing of this instrument, it must be recycled or disposed of properly in accordance with local laws or regulations. When disposing of it, request a recycling company to dispose of it in accordance with local laws or regulations.

When disposing of and recycling batteries, separate dry batteries from rechargeable batteries to observe the following:

- Dry batteries (alkaline and manganese)  
Dispose of the batteries in accordance with instructions provided by local governments.
- Rechargeable batteries (nickel metal-hydride and nickel-cadmium)  
Request a recycling company in accordance with local laws or regulations.

## **Repair and sending instrument to be repaired**

If a failure occurs, send the instrument to Iwatsu office or our sales distributors.

When sending an instrument to be repaired, clearly write the instrument name, serial number (in the label on the rear of this instrument), description of the failure, and the name, division, and telephone number of the responsible person.

## **Cleaning of this instrument**

To clean this instrument, wipe it gently with a soft cloth moistened with a small amount of water or mild detergent. Never use solvents such as benzene, alcohol, acetone, ether, ketones, thinners, or gasoline, as they can deform and discolor the case.

## Chapter 1 Overview

### 1.1 Instrument Overview

This instrument is a current probe that uses the Rogowski Coil as a sensor.

It allows measurement of current in high-voltage and large-current facilities, such as train inverters, as well as in high-voltage and large-current applications such as development and maintenance of infrastructures of the automotive and other industries.

The coil of this instrument detects a change in magnetic flux caused by the current (target to be measured) flowing through the inside of the coil that forms a closed loop. The change in magnetic flux generates an electromotive force in the coil. The electromotive force is proportional to a differential value of the current. The output (electromotive force) of the Rogowski Coil is the differential waveform of the current. To detect the current waveform, the waveform is integrated by the main unit of this instrument (for details, refer to Chapter 3 “Measurement Principle”).

This series has four models, which differ in sensitivity (mV/A), peak current (A), low frequency cutoff (Hz), and other specifications. Each model has two types, which differ in length of the Rogowski Coil; that is, this series has a lineup of eight models.

Connecting the output part of this instrument and an oscilloscope and other monitoring devices with the BNC cable allows observation of the current waveform that flows through a target to be measured.

## 1.2 Features

The following describes the features of this instrument.

○ **Target of measurement**

- Train inverters etc.
- Development and maintenance of infrastructure facilities of the automotive and other industries

○ **Easy measurement**

Current in facilities (such as switchboards) can be measured easily. A thin and removable Rogowski Coil (two types of the coils, which have lengths of 300 mm and 700 mm, respectively, are available, and the maximum cross sectional diameter of the coil is 8.5 mm) designed to detect current has the following advantages:

- Wide applications of measurement are possible in any place
- Superior heat resistance and insulation property around the coil

○ **This instrument has the following specifications** (for details, refer to Section 5.1 “Specifications”).

- Frequency bandwidth:  $f_L$  to 20 MHz [-3 dB] L = 300 mm,  $f_L$  to 10 MHz [-3 dB] L = 700 mm ( $f_L$ : Low-Frequency cutoff)
- Peak current: 1.2 kA to 12 kA  
(Four models of 1.2 kA, 3 kA, 6 kA, and 12 kA × two types: Total of eight models)
- Sensitivity accuracy:  $\pm 2\%$  (at the center of the coil loop)
- Linearity:  $\pm 0.05\%$  of full scale

○ **Power supply**

- This instrument operates with the supplied alkaline batteries or equivalent four AA dry batteries.

### 1.3 Usage Example

To measure current using this current probe, place a conductor to be measured through the coil loop, and detect a change in magnetic flux caused by the current flowing through the conductor with the Rogowski Coil as an electromotive force, as shown in the following usage example (conceptual illustration). The electromotive force (differential value of the current) passes through the input part of the main unit, and it is integrated by the integrator of the main unit.

The integrated current value is converted to voltage with a sensitivity (mV/A) set for each main unit. The converted voltage is output from the output terminal of the main unit. Inputting the output voltage to an oscilloscope and other monitoring devices allows observation of the current waveform.

The sensor cable cannot be removed, because it is integral with (connected inside of) the main unit. Connect the main unit and monitoring devices with the BNC cable.

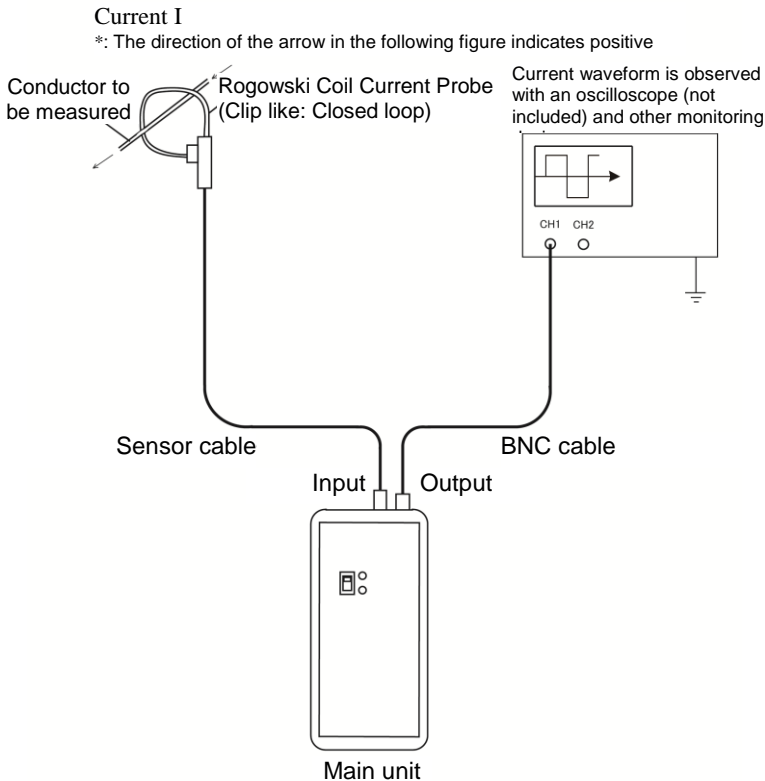
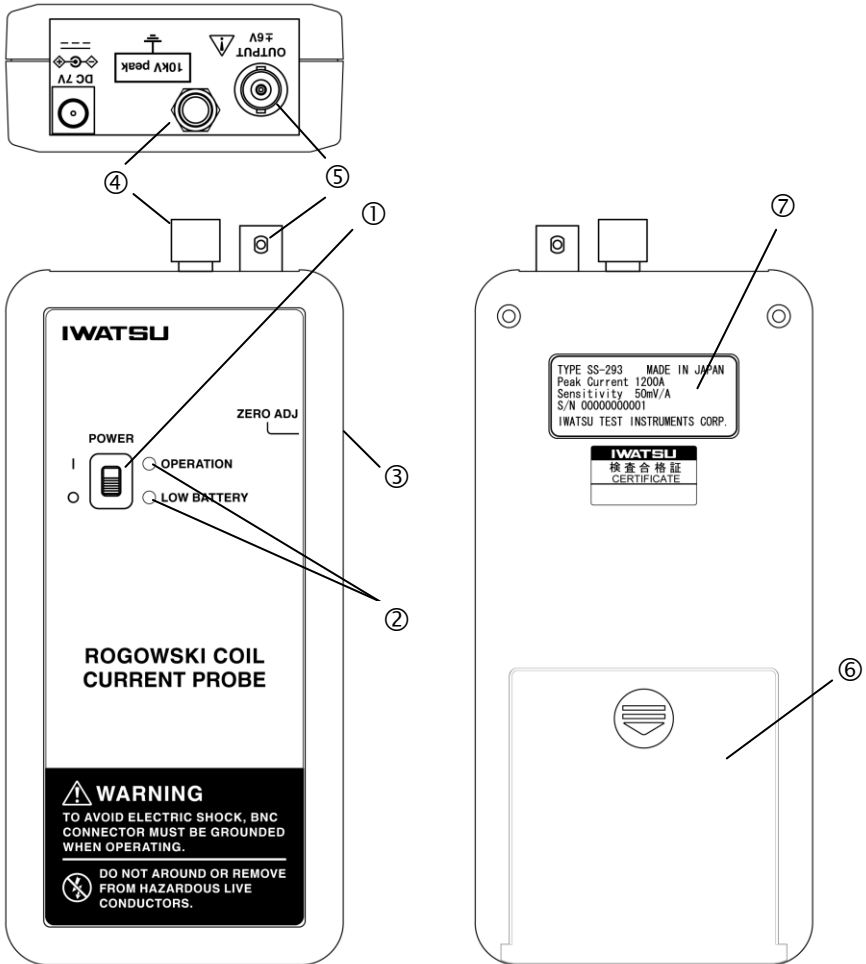


Figure 1.1 Usage Example of This Current Probe (Conceptual Illustration)

## Chapter 2 Names and Functions of Parts

### 2.1 Main Unit

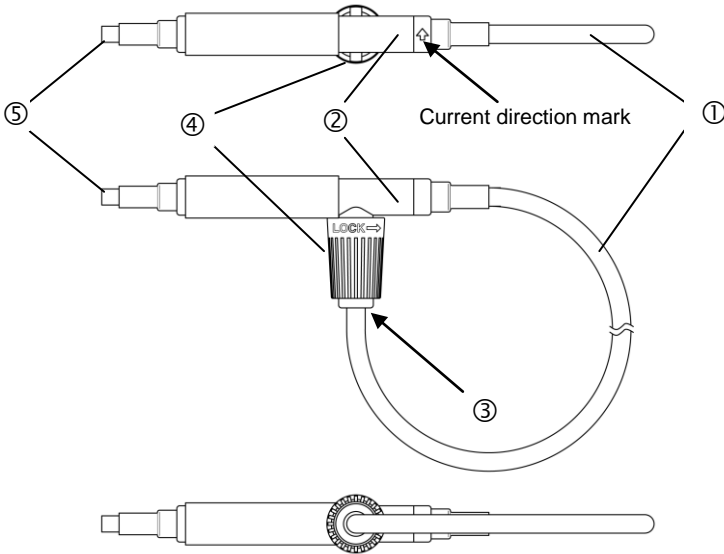




## 2.2 Names and Functions of Parts of Main Unit

No.	Name	Description	Reference
①	POWER switch	Turns this instrument on and off. This instrument is turned on when this slide switch is moved to the I side and is turned off when moved to the O side. This instrument operates with four AA dry batteries placed in its back (battery case ⑥).	▶ Section 4.2
②	LED lamps OPERATION  LOW BATTERY	Indicates the operating condition of the power supply of this instrument. Comes on green when this instrument is turned on and comes off when turned off. Indicates the state of AA dry batteries. This lamp turns yellow when the batteries are consumed. Replace them when the lamp lights up yellow.	
③	ZERO ADJ	Used to adjust the zero point of the output ⑤. There is a hole for zero point adjustment on the side of ZERO ADJ. Insert the accessory screw driver into the hole to perform zero point adjustment.	▶ Section 4.2
④	Input part	The sensor cable (refer to Section 2.3) integral with the main unit is connected to this part.	▶ Section 2.1
⑤	Output part	BNC output connector. Outputs the voltage (current waveform) of the main unit.	▶ Section 2.1
⑥	Battery case	Located on the back of the main unit and used to house four AA dry batteries. To open this battery case, push its lid downward. Place the batteries in this case while paying attention to their orientation, and then close the lid.	▶ Section 2.1
⑦	Back label	There is a label placed on the back of the main unit. The label describes the following: <ul style="list-style-type: none"> <li>• TYPE: One of the eight models, SS-293S/L, 294S/L, 295S/L, 296S/L</li> <li>• Peak Current: One of the current values that the above model handles, 1.2 kA, 3 kA, 6 kA, or 12 kA</li> <li>• Sensitivity: Voltage sensitivity (mV/A) of the current that the above model handles.</li> <li>• S/N: 11-digit serial number</li> </ul>	▶ Section 2.1

### 2.3 Rogowski Coil Sensor Part



No.	Name	Description
①	Rogowski Coil	A coil for detecting the current in conductors to be measured. Forms a closed loop during measurement. Covered with an insulating outer sheath for heat resistance and insulation.
②	Joint box	The sensor cable ⑤ is secured to one end so that the Rogowski Coil forms a closed loop. There is a screw lock ④ and joint hole ③ to secure the other end of the coil.
③	Joint hole	A part of the joint box ② and has a hole to insert the Rogowski Coil and a screw lock to lock and release the coil. The one end of the coil ① can be removed from this hole by hand by releasing the lock.
④	Screw lock	A rotary locking mechanism used to lock and release one end of the Rogowski Coil.
⑤	Sensor cable	A coaxial cable used to input the electromotive force (differential value of the current) that is generated in the Rogowski Coil to the main unit.

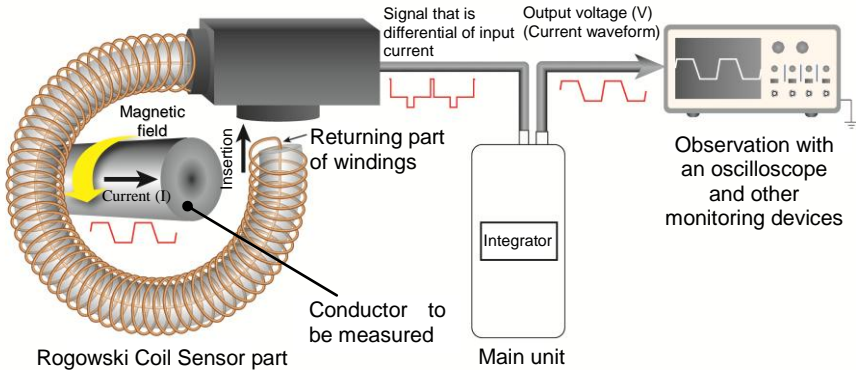
## **Chapter 3 Measurement Principle**

This instrument is designed to measure the current (current waveform) in conductors to be measured.

It consists of the Rogowski Coil Sensor part and the main unit (integrator). Sections 3.1 and 3.2 in this chapter describe measurement principles and functions of each part and are concluded with an explanation of a process of measuring the current (current waveform).

### 3.1 Rogowski Coil Sensor Part

Figure 3.1 shows that the current  $I$  flows through the conductor to be measured. This section describes the principle of detecting this current by the Rogowski Coil step by step.



Note) The above figure is a conceptual illustration to explain this measurement principle. The Rogowski Coil Sensor part is actually covered with the insulating outer sheath. During measurement, one end of the Rogowski Coil is inserted into the joint hole on the joint box and locked by the screw lock.

Figure 3.1 Conceptual Illustration of Rogowski Coil

It is assumed that the conductor to be measured is placed inside of the loop of the Rogowski Coil. A magnetic field is generated around the conductor to be measured. It moves around the conductor in a clockwise direction in relation to the current direction (Ampere's right-handed screw law).

The magnetic field changes with time, because alternating current flows in the conductor to be measured. In the Rogowski Coil, magnetic flux changes along the loop. When it changes, an electromotive force is generated and current flows in the coil by electromagnetic induction.

Provided that the entire length of the wound Rogowski Coil is  $l$ , small radius of the coil turn is  $r$ , turn of the coil is  $N$ , and current flowing through the coil is  $i$ , the electromotive force generated in the coil is expressed by Equation 3.1:

$$e = \frac{\pi r^2 \mu_0 N}{l} \frac{di}{dt} \quad [\text{V}] \quad \dots (3.1)$$

$$\text{Where, } \mu_0 = 4\pi \times 10^{-7} \quad [\text{H/m}]$$

(Permeability of Vacuum)

As shown in Equation 3.1, the electromotive force induced in the coil is determined by the shape and turn of the coil and time differentiation of the current. Thus, the electromotive force must be integrated to determine the current.

### 3.2 Main Unit

As illustrated in Figure 3.2, the electromotive force  $e$  induced in Section 3.1 is brought in the input part of the main unit through the sensor cable.

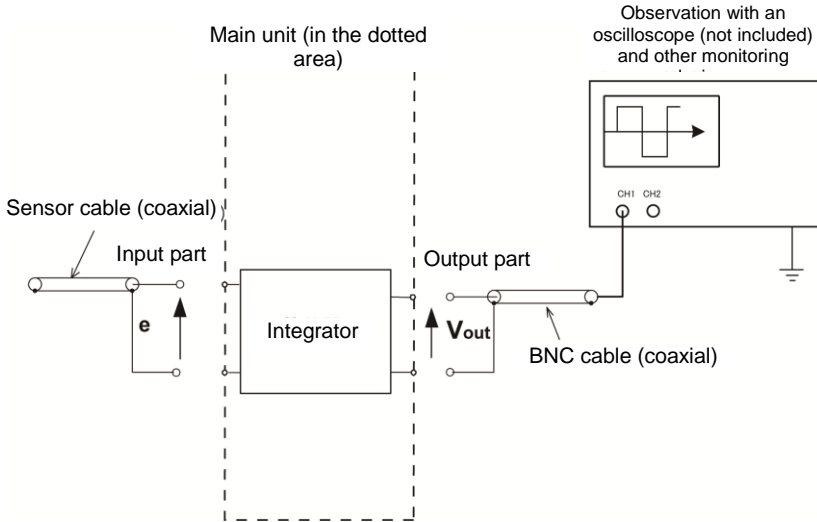


Figure 3.2 Illustration of Rogowski Coil Operation

As explained in Equation 3.1 in Section 3.1, the electromotive force  $e$  is integrated by the integrator of the main unit, because it is the time differentiation of the current.

The output voltage of the main unit  $V_{out}$  is expressed by Equation 3.2.

$$V_{out} = A \int e \, dt \quad \dots\dots (3.2)$$

**A:** Constant determined by the component constants of the circuit of the main unit

The output voltage of the main unit (current waveform) is observed by an oscilloscope and other monitoring devices through the BNC cable.

As expressed by the following Equation 3.3, the voltage component  $V_{out}$  observed by monitoring devices can be converted to the current  $I$  with a sensitivity  $S$  (mV/A) described on the label affixed to the back of the main unit.

$$I = V_{out} / S \quad \dots\dots (3.3)$$

The current  $I$  (current waveform) of the conductor to be measured is determined by the measurement principle described in this chapter.

## Chapter 4 Measurement

### 4.1 Preparation for Measurement

- (1) Have this instrument, a monitoring device, and a target to be measured ready.

\*: A monitoring device means an oscilloscope, DVM, recorder, and other devices.

- (2) Place four AA dry batteries in the main unit.

<For batteries>

- a) To open the case, push downward on the lid of the battery case on the back of the main unit (refer to ⑥ in the appearance in Section 2.1).
- b) Place four AA dry batteries in the battery case.  
Note) Do not place them in the wrong orientation.
- c) Close the lid of the battery case.

- (3) Connect the accessory BNC cable to this instrument.

- a) Connect one end of the BNC cable to the output part on the top of this instrument (refer to ⑤ in the appearance in Section 2.1).
- b) Attach the other end of the BNC cable to the monitoring device.

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#### Caution

- **To use this instrument, connect it to the ground (output side).**

Ground GND terminals of monitoring devices, which are the connection destination of the output terminal. Do not energize a target to be measured with nothing connected to the output terminal. This may be a cause of an electrical shock.

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## 4.2 Measurement Procedure

- (1) Make sure that all preparations described in the previous section are completed.
- (2) Set up a target to be measured so that it can be used.

**Do not energize the target to be measured even when it is ready to be used.**

**⚠ Warning** • **Do not energize a target to be measured before attaching the Rogowski Coil of this instrument to the target. It is dangerous to apply power to the target to be measured before the attachment.**

- (3) Place the target to be measured through the Rogowski Coil Sensor part.
  - a) As illustrated in Figure 4.1, to release the lock of the Rogowski Coil, be sure to turn the screw lock in a direction opposite the direction indicated by "LOCK" until you feel a click. After releasing the lock, remove the one end of the Rogowski Coil from the joint hole.

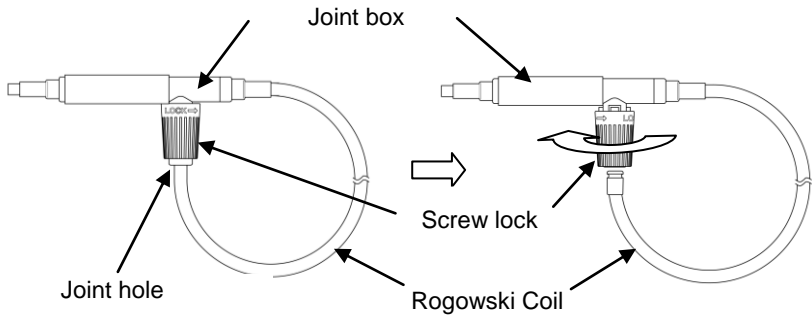


Figure 4.1 How to Release Rogowski Coil

- b) Loop the Rogowski Coil around the conductor to be measured.
- c) Insert the Rogowski Coil into the joint hole.
 

\*: The insertion length of the coil is about 32 mm from the joint hole end. Insert the coil until it clicks into place. To lock the Rogowski Coil after the insertion, be sure to turn the screw lock in the direction indicated by "LOCK" until you feeling a click. To achieve accurate measurement, be sure to insert the end of the coil into the joint hole securely.

The current detection polarity is shown as in the following figure. Positive polarity is output by current flowing in the direction indicated by the current direction mark shown on the joint box.

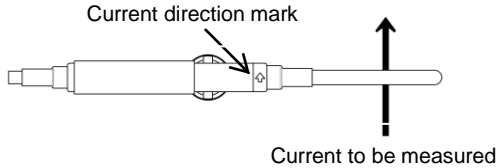
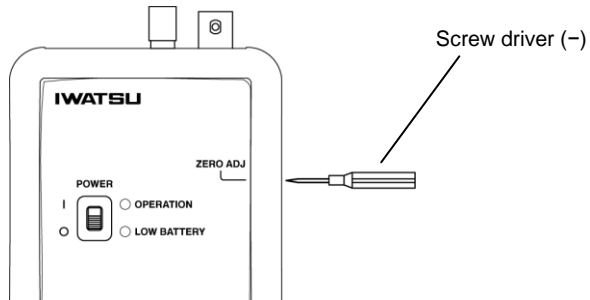


Figure 4.2 Current Detection Polarity

- (4) Turn on this instrument (this instrument is turned on by turning the slide switch shown in the following figure to the I side and off by moving the switch to the O side).



- (5) Adjust the zero point of the output observed by monitoring devices.
- Have the accessory screw driver (-) ready.
  - As shown in the figure below, there is a hole for zero point adjustment on the side of ZERO ADJ on the main unit panel. Insert the screw driver (-) into the hole.



- Turn the screw driver while watching the monitoring device to perform zero point adjustment.
- (6) Energize the target to be measured, and then observe and measure the output with the monitoring device.



## 4.3 Before Measurement

This section describes notes on accuracy and the handling of the Rogowski Coil Sensor part when measuring the current using this instrument.

### 4.3.1 To Achieve Accurate Measurement

As explained in Chapter 3 “Measurement Principle,” the Rogowski Coil is a wire rod wound tight around a tube-like wick material, as illustrated in Figure 3.1. The coil formed into a ring body detects a change in magnetic flux caused by the current passing through the inside of the coil. The evenly wound coil causes no error even when the current to be measured does not flow through the center of the coil. In addition, each turn of coil enables the cancellation of external magnetic fields.

Note that the uniformity of the Rogowski Coil is slightly disturbed at the Rogowski Coil connection part on the joint hole, which is designed to maintain the coil as a ring body. The area around this part is not suited to measure current. In addition, the coil cannot sufficiently cancel a magnetic field produced by external current flowing through in the vicinity of this part.

This instrument is calibrated by current that flows through the center of the Rogowski Coil. Avoid measuring current in the vicinity of the joint hole as much as possible in order to achieve accurate measurement. It is recommended to measure current at the center of the Rogowski Coil.

For reference, Figure 4.3 shows the position of the connection part of the Rogowski Coil.

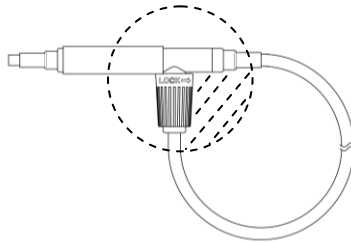


Figure 4.3 Rogowski Coil Connection Part

The connection part of the Rogowski Coil is in the center of the dotted circle. It is known that a larger measurement error is caused as the current to be measured comes closer to this part. Avoid measuring current in the dotted area, because a measurement error of  $-4\%$  or more may be caused by the measurement performed in the area. In addition, the coil cannot sufficiently cancel the magnetic flux produced by external current. Before measuring current, place conductors in which current flows other than the conductor to be measured away from the Rogowski Coil connection part as much as possible.

### 4.3.2 Resisting Voltage Guarantee Range of Rogowski Coil Sensor Part

The resisting voltage guarantee range of the Rogowski Coil Sensor part is illustrated in Figure 4.4. The sensor cable's resisting voltage guarantee range is the section covered with a gray tube (approx. 500 mm). Keep the section of the sensor cable where the resisting voltage is not guaranteed away from high-voltage parts.

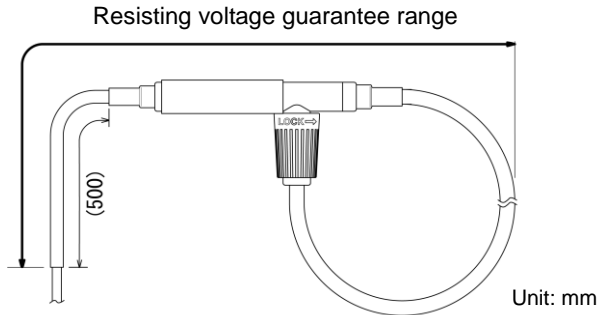


Figure 4.4 Resisting Voltage Guarantee Range

### 4.3.3 To Minimize Influence of Fluctuations in Voltage

If there is a part whose voltage fluctuates around the Rogowski Coil Sensor part, electrostatic coupling between the part and the Rogowski Coil will occur. This may influence the output from this instrument.

If possible, place the Rogowski Coil Sensor part away from the part whose voltage fluctuates. This will improve noise caused by electrostatic coupling.

### 4.3.4 Handling of Rogowski Coil Sensor Part

The Rogowski Coil has a coil structure consisting of an extra-fine wire rod wound tight around a wick material of Teflon tube. Avoid pulling or bending the Rogowski Coil Sensor part excessively as much as possible. Application of excessive force to the Rogowski Coil may cause plastic deformation of part of the coil. Use caution when attaching and detaching the coil from a target to be measured. Deformation of the coil structure will degrade the specifications of the sensor part.

In order to measure current, the one end of the Rogowski Coil is required to be inserted into the joint hole so that the coil forms a loop that circles around the current to be measured. The insertion length of the coil is about 32 mm from the joint hole end. Insert the Rogowski Coil until it clicks into place. To securely lock the Rogowski Coil after the insertion, turn the screw lock in the direction indicated by "LOCK" until you feel a click.



#### **Warning**

- **Avoid the generation of corona discharge in an environment where high voltage is applied to the sensor part for a long time.**

Depending on the frequency of the applied voltage and installation conditions of the sensor part, Corona discharge may be generated even when a voltage lower than the resisting voltage is applied to the sensor part. This generation may lead to degrading the insulating outer sheath, causing an electrical shock, fire, or failure.

Corona discharge tends to be generated due to electric field concentration. Take some measures to avoid the generation; for example, keep the sensor part away from high-voltage parts as far as possible to achieve insulation.

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#### **Caution**

- **Stop using the Rogowski Coil with its sheath damaged, because the resisting voltage for insulation of the coil cannot be guaranteed.**
- 

The Rogowski Coil has a structural life. The duration of use of the coil depends on the use environment and use conditions.

We recommend that you replace a deformed coil or a coil with its surface damaged, in order to maintain safety and accurate measurement. Contact Iwatsu office or our sales distributors for replacement.

## Chapter 5 Specifications

### 5.1 Specifications

#### Basic specifications

	SS-293S/L	SS-294S/L	SS-295S/L	SS-296S/L
Sensitivity [mV/A]	5	2	1	0.5
Peak current [kA]	1.2	3	6	12
Peak di/dt [kA/μs]	S:60/L:32	80	80	80
Absolute maximum di/dt				
Peak [kA/μs]	80	80	80	80
RMS [kA/μs]	3.0	3.0	3.0	3.0
Frequency bandwidth	$f_L$ to 20 MHz [-3 dB] SS-29xS $f_L$ to 10 MHz [-3 dB] SS-29xL $f_L$ : Low frequency cutoff			
Low frequency cutoff [Hz]	1	0.8	0.6	0.4
Noise [mV rms]	3.5	2.0	1.4	1.2
Sensitivity accuracy	$\pm 2\%$ At the center of the coil loop with sensor part temperature of $-10^\circ\text{C}$ to $+70^\circ\text{C}$ *: Add an error of $\pm 250$ ppm/ $^\circ\text{C}$ when the temperature is $-10^\circ\text{C}$ or less or $+70^\circ\text{C}$ or more.			
Output	Maximum voltage range: $\pm 6$ V (load $\geq 100$ k $\Omega$ )			
Connector	BNC			
Linearity	$\pm 0.05\%$ of full scale			
Zero point adjustment range	$\pm 300$ mV or more			

#### Sensor part

Coil length	SS-29xS: 300 mm $\pm 10$ mm, SS-29xL: 700 mm $\pm 10$ mm
Wire rod diameter at coil part	8.5 mm (max.)
Maximum rating voltage between ground	10 kV peak (resisting voltage guarantee range: Refer to Section 4.3.2)
Sensor cable length	3.0 m $\pm 100$ mm
Operating temperature range	$-40$ to $125^\circ\text{C}$ (including sensor cable)

#### General specification

Dimensions	Approx. 80 (W) $\times$ 165 (H) $\times$ 35 (D) mm (excluding protrusions)
Weight	SS-29xS: Approx. 0.48 kg, SS-29xL: Approx. 0.50 kg
Power supply	Four AA dry batteries <sup>Note 1</sup>
Battery longevity <sup>Note 2</sup>	Approx. 30 hours (when alkaline batteries are used)

Accessories BNC cable (1), screw driver (1), AA dry battery (4),  
Instruction Manual (1), and hard case (1)

**Environmental characteristics**

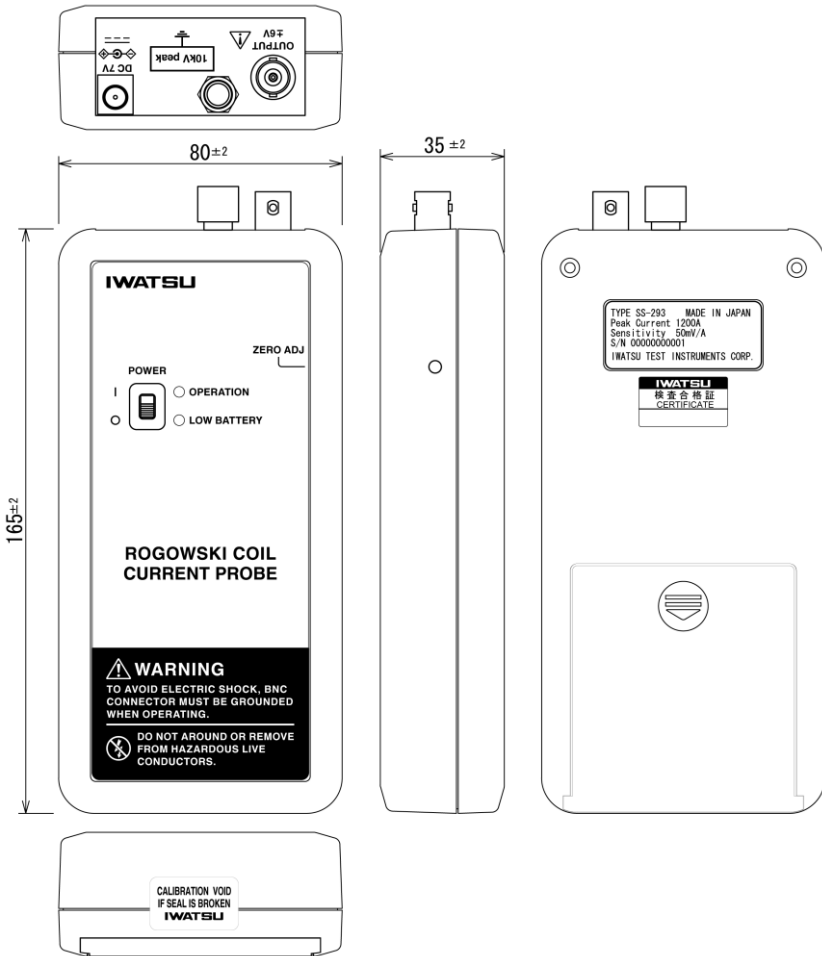
Operating temperature and humidity range 0°C to 40°C, 80%RH or less  
Storage temperature and humidity range -10°C to 60°C, 80%RH or less  
Operating altitude ≤ 2,000 m at ≤ 25°C

Note 1) Equivalent nickel metal-hydride, nickel-cadmium battery, and other rechargeable batteries can also be used.

Note 2) Operation time of this instrument during the use of batteries  
The continuous operation time of this instrument is about 30 hours when alkaline batteries are used. The LOW BATTERY LED lamp lights up when batteries are consumed. About 30 minutes after the illumination, this instrument will be automatically shut down to avoid over discharge. Note that from the time the LOW BATTERY LED lamp comes on until the time this instrument is automatically shut down may be shortened when nickel metal-hydride batteries are used.  
When using with the accessory batteries, the operation time of this instrument may be shorter than that described above.

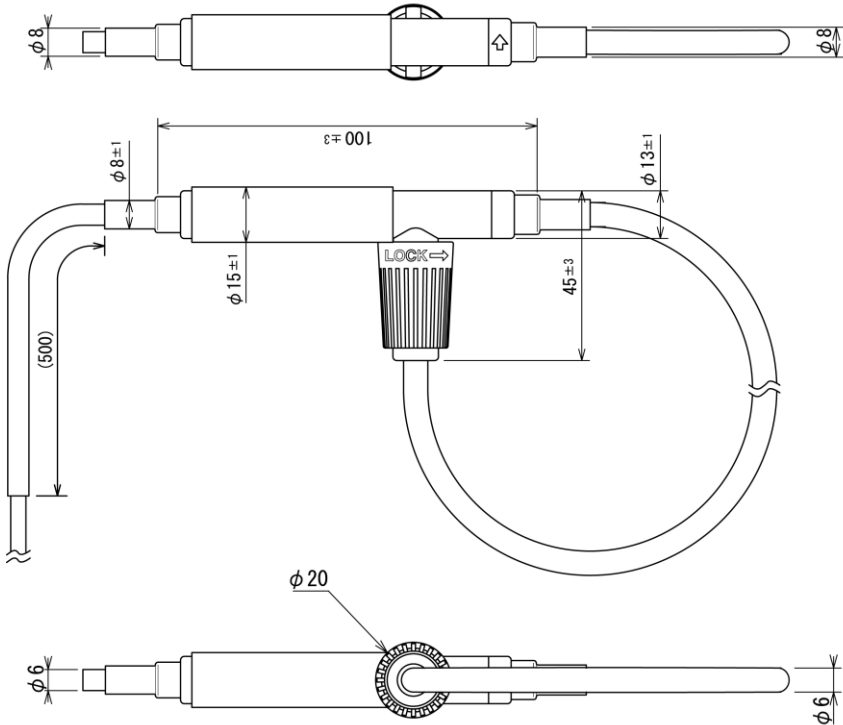
## 5.2 Appearance

### (1) Main Unit



Unit: mm

(2) Rogowski Coil Sensor Part



Unit: mm

Memo



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SS-293S/293L/294S/294L/295S/295L/296S/296L

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