

KEVCY 24 RE1; KEVCY 24 RF1

Indoor combined sensor; Indoor voltage sensor

Parameters for Application	Unit	Value
Rated primary current of application	A	up to 630
Rated primary voltage of application	kV	up to 24

Sensor Parameters	Unit	Value
Rated primary voltage, U_{pn}	kV	$22/\sqrt{3}$
Highest voltage for equipment, U_m	kV	24
Rated power frequency withstand voltage	kV	50
Rated lighting impulse withstand voltage	kV	125
Rated primary current, I_{pr}	A	80
Rated continuous thermal current, I_{cth}	A	630
Rated transformation ratio, K_{ra} for current measurement	-	80 A / 150 mV at 50 Hz 180 mV at 60 Hz
Rated transformation ratio, K_n for voltage measurement	-	10 000 : 1
Current accuracy class	-	0.5/5P100
Voltage accuracy class	-	0.5/3P
Length of cable for sensor	m	2.2
Length of cable for capacitive divider	m	0.45

Sensor principles

Electronic Instrument Transformers (Sensors) offer an alternative way of making the current and voltage measurements needed for the protection and monitoring of medium voltage power systems. Sensors based on alternative principles have been introduced as successors to conventional instrument transformers in order to significantly reduce size, increase safety, and to provide greater rating standardization and a wider functionality range. These well known principles can only be fully utilized in combination with versatile electronic relays.

Sensor characteristics

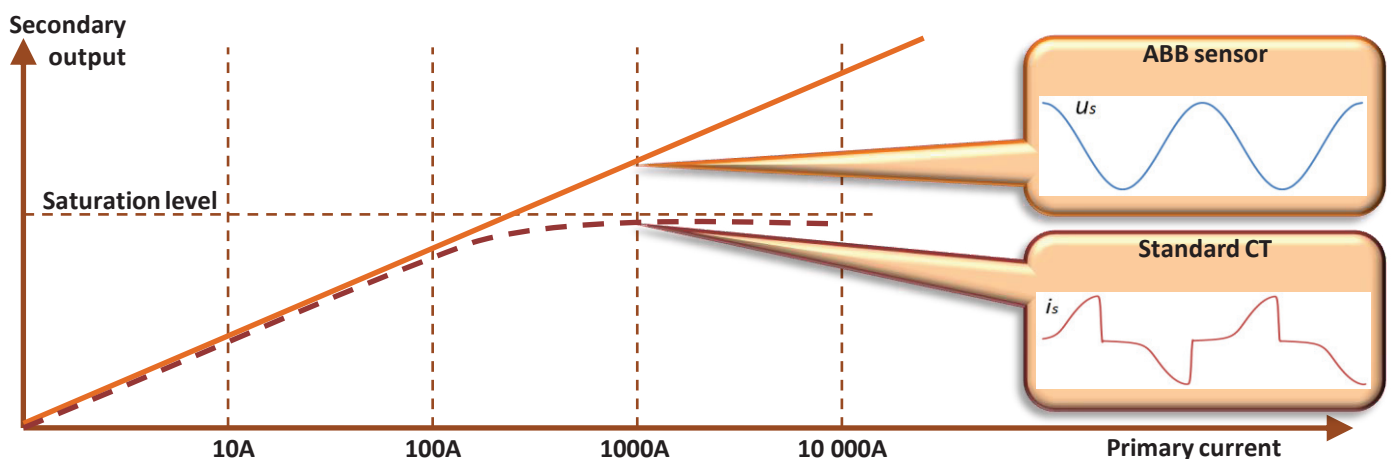
Construction of ABB's current and voltage sensors is done without the use of a ferromagnetic core.



This fact results in several important benefits for the user and the application.

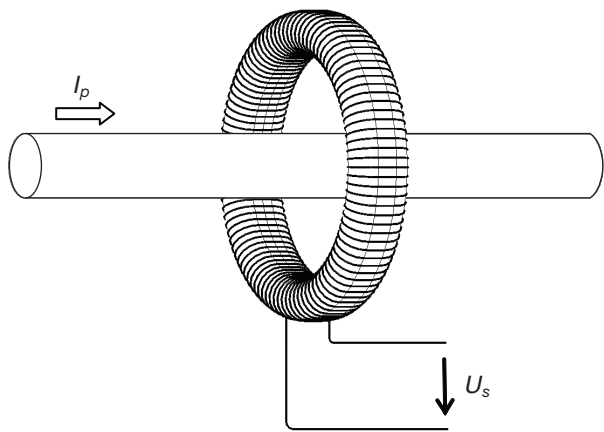
The main benefit is that the behavior of the sensor is not influenced by non-linearity and width of hysteresis curve, which results in a highly accurate and linear response over a wide dynamic range of measured quantities. A linear and highly accurate sensor characteristic in the full operating range enables the combination of metering and protection classes in one winding.

With KEVCY 24 RE1 sensor measuring **class 0.5** is reached for continuous current measurement in the extended accuracy range from 5% of the rated primary current I_{pr} **not only up to 120% of I_{pr}** (as being common for conventional current transformers), **but even up to the rated continuous thermal current I_{cth}** . For dynamic current measurement (protection purposes) the ABB sensor KEVCY 24 RE1 fulfills requirements of protection class **5P** up to an impressive value **8000 A**. That provides the possibility to designate the corresponding accuracy class as **5P100**, proving excellent linearity and accuracy measurements.



Current sensor

Current measurement in KEVCY 24 RE1 sensors is based on the Rogowski coil principle. A Rogowski coil is a toroidal coil, without an iron core, placed around the primary conductor in the same way as the secondary winding in a current transformer. However, the output signal from a Rogowski coil is not a current, but a voltage:

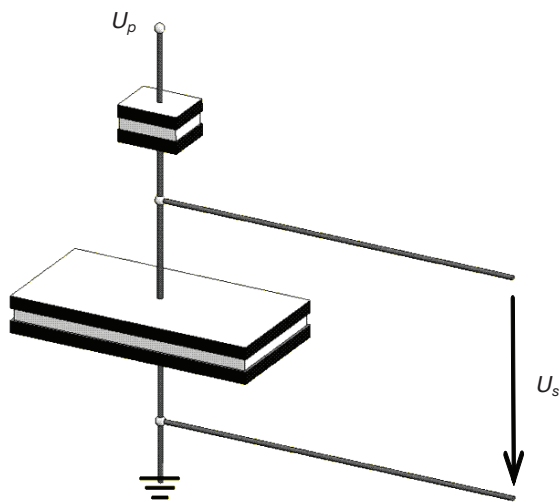


$$u_s(t) = M \frac{di_p(t)}{dt}$$

In all cases, a signal that represents the actual primary current waveform is easily obtained by integrating the transmitted output signal.

Voltage sensor

Voltage measurement in KEVCY 24 RE1 and KEVCY 24 RF1 sensors is based on the capacitive divider principle. The output voltage is directly proportional to the input voltage:



$$U_s = \frac{C_1}{C_1 + C_2} U_p$$

In all cases, the transmitted output signal reproduces the actual waveform of the primary voltage signal.

Protection and control IEDs (Intelligent Electronic Devices)

Protection and control IEDs incorporate the functions of a traditional relay, as well as allow new additional functions. The information transmitted from the sensors to the IED is very accurate, providing the possibility of versatile relay functionality.

However, the IED must be able to operate with sufficient accuracy at a sensor's low input signal level, and the signal from the Rogowski coil must be integrated. Modern IEDs (such as ABB's 615 series relays) are designed for such sensor use, and they are also equipped with built-in integrators for Rogowski coil sensor inputs.

Modern digital apparatuses (microprocessor based relays) allow protection and measurement functions to be combined. They fully support current and voltage sensing realized by the single sensor with double the accuracy class designation (e.g.: current sensing with combined accuracy class 0.5/5P100 as well as voltage sensing with combined accuracy class 0.5/3P).



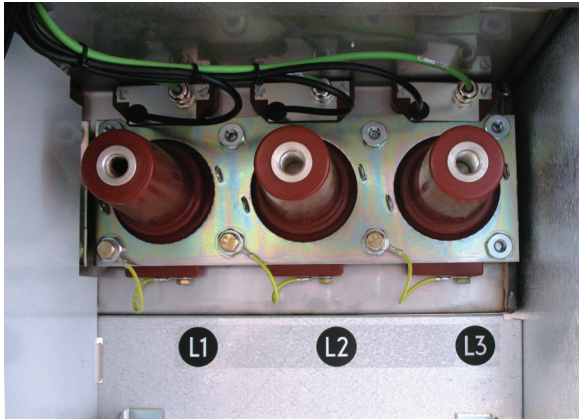
Sensor variants

Two versions could be selected: one providing voltage measurement together with voltage indication capability (KEVCY 24 RF1), or a second one, providing, in addition to these, also the possibility of current measurement (KEVCY 24 RE1).

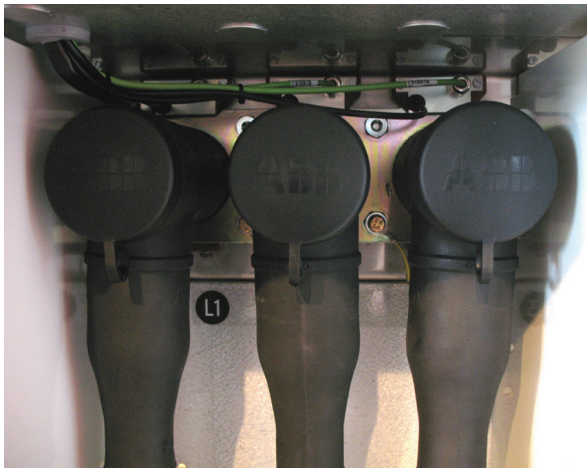
Type designation	Functions included		
	Voltage sensor	Current sensor	Voltage indication
KEVCY 24 RE1	☒	☒	☒
KEVCY 24 RF1	☒	☐	☒

Sensor application

KEVCY 24 RE1 & RF1 are compact and very small bushing type sensors designed to be used in SF₆ gas insulated Switchgear type SafePlus and SafeRing.



The external cone type of the sensor is designed according to the standard EN 50181, Interface C (400 series 630 A, M16 bolt), and therefore enables connection of all compatible cable plugs.



Differences between Sensors and Instrument Transformers

There are some noticeable differences between Sensors and conventional Instrument Transformers:

Linearity

Due to the absence of a ferromagnetic core the sensor has a linear response over a very wide primary current range, far exceeding the typical CT range. Thus, current sensing for both measurement and protection purposes could be realized with single secondary winding with a double rating. In addition, one standard sensor can be used for a broad range of rated currents and is also capable of precisely transferring signals containing frequencies different from rated ones.

For this type of sensor, the variation of amplitude and phase error or composite error in a current range from 5% of rated primary current I_{pr} up to the value 8 kA is within the limits specified by IEC 60044-8.

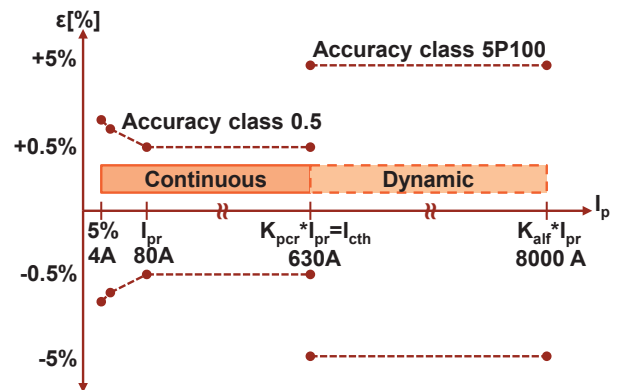
Example of current measurement range with rated current 80 A and accuracy class 0.5/5P100:

Metering accuracy class 0.5 is, according to the IEC 60044-8 standard, guaranteed from 5% of I_{pr} up to $K_{pcr} \times I_{pr}$, where K_{pcr} is rated extended primary current factor and I_{pr} is rated primary current. Factor K_{pcr} is in the case of conventional CTs usually just 1.2, but in the case of the KEVCY 24 RE1 sensor the K_{pcr} factor is several times higher and equals 7.875.

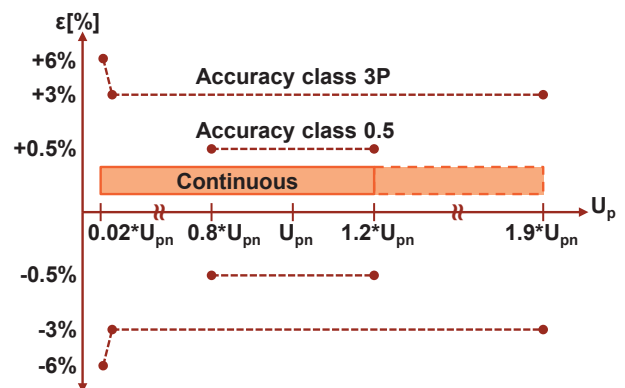
Protection accuracy 5P100 is guaranteed, for the advanced KEVCY 24 RE1 sensor, from the current equal to $K_{pcr} \times I_{pr}$ up to the current corresponding to $K_{alf} \times I_{pr}$ value, where K_{alf} is, according to IEC 60044-8, the accuracy limit factor.

For this type of sensor the value of $K_{pcr} \times I_{pr}$ is equal to the rated continuous thermal current I_{cth} (630 A) and the value of $K_{alf} \times I_{pr}$ is equal to the value 8 kA.

The accuracy limits are described on the graph below.



Example of voltage measurement range for metering accuracy class 0.5 and protection accuracy class 3P: The accuracy limits are described on the graph below.



Compactness

Since the sensing elements are particularly small, and the same elements are used for both measurement and protection, the current and voltage sensors can easily be combined in one device – the Combined Sensor, which is still smaller and far lighter than the conventional Instrument Transformer. The weight of the combined KEVCY 24 RE1 sensor designed for 24 kV is only 1.75 kg.

This enables much easier handling without the need for special lifting devices.

Rated parameters

Because the sensors are highly linear within a very wide range of currents and voltages, the same single sensor can be used for the various rated currents and voltages associated with each specific application up to the specified maximum voltage for equipment. There is no need to specify other parameters such as burden, safety factor, etc. since they are standard over the defined range. To achieve the correct function of the protection and control IED, the selected rated current and voltage, as well as the rated transformation ratio, must be properly set into the IED.

Energy savings concept

As there is no iron core, no necessity for high burden values and thus a possibility for low current losses and only one secondary winding needed, KEVCY 24 RE1 & RF1 sensors exhibit extremely low energy consumption that is just a fraction of that transferred to heat in conventional CTs/VTs. This fact contributes to huge energy savings during its entire operating life, supporting the world-wide effort to reduce energy consumption. Furthermore, the temperature rise caused by internal heating up due to current flowing through the sensor is very low and creates a further possibility of upgrading current ratings of the switchgear, or the other applications, and/or reduces the need for artificial ventilation.

Correction factors

The amplitude and phase error of a current and a voltage sensor is, in practice, constant and independent of the primary current and primary voltage. Due to this fact it is an inherent and constant property of each sensor and it is not considered as unpredictable and influenced error. Hence, it can be easily corrected in the IED by using appropriate correction factors, stated separately for every sensor. Values of the correction factors for the amplitude and phase error of a current and a voltage sensor are mentioned on the sensor Routine tests report (for more information please refer to Instructions for installation, use and maintenance) and should be uploaded without any modification into the IED before the sensors are put into operation (please check available correction in the IED manual). To achieve required accuracy classes it is recommended to use all correction factors (Cfs): amplitude correction factor (aU) and phase error correction factor (pU) of a voltage sensor; amplitude correction factor (aI) and phase error correction factor (pI) of a current sensor.

Secondary cables

The sensor is equipped with two cables:

- Cable for coupling electrode with BNC connector
- Current and voltage signal cable with RJ-45 connector for connection with the IED

The cable connector for connection with the IED is type RJ-45. The sensor accuracy classes are verified up to the RJ-45 connector, i.e. considering also its secondary cable. This cable is intended to be connected directly to the IED, and subsequently neither burden calculation nor secondary wiring is needed. Every sensor is therefore accuracy tested when equipped with its own cable and connector.

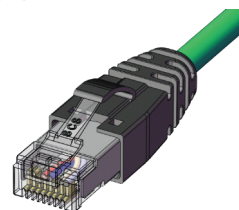
Standard cable length for connection with IED: 2.2 m

Standard cable length for connection with coupling electrode: 0.45 m

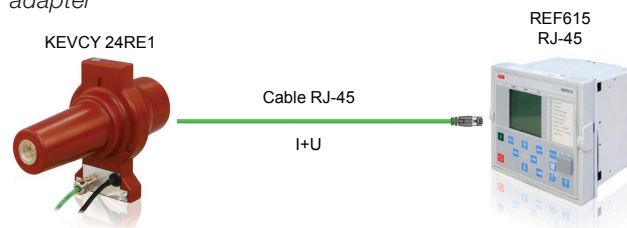
Connector BNC for voltage detection system



Connector RJ-45 for combined current and voltage measurement



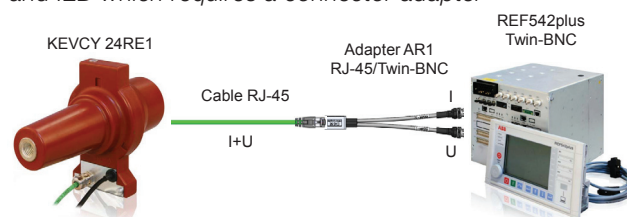
Example: Direct connection of connectors between the sensor and new IED family without the need for an adapter



Connector adapters

To provide connectivity between a sensor with a RJ-45 cable connector and IEDs with Twin-BNC connectors a group of adapters were designed. The use of an adapter has no influence on the current and/or voltage signal and accuracy of the sensor with the cable.

Example: Connection of connectors between a sensor and IED which requires a connector adapter



For more information about connector adapters refer to Doc. No. 1VLC000710 - Sensor accessories.

Coupling electrode for voltage detection system

Intended to be used in:

- Voltage detection system (VDS) according to IEC 61243-5
- Voltage presence indication system (VPIS) according to IEC 62271-206

If there is no connection of the coupling electrode to the coupling system the electrode must be earthed.

Capacitance values

Electrode	Capacitance values
C1	(8 – 12) pF
C2	(15 – 40) pF

Standards

Voltage sensors: IEC 60044-7 (1999-12)

Instrument transformers –

Part 7: Electronic voltage transformers

Current sensors: IEC 60044-8 (2002-07)

Instrument transformers –

Part 8: Electronic current transformers

Highest voltage for equipment and test voltages

- Highest voltage for equipment, U_m : 24 kV
- Rated power frequency withstand voltage: 50 kV
- Rated lightning impulse withstand voltage: 125 kV

Voltage sensor, rated values

- Rated primary voltage, U_{pn} : 22/√3 kV
- Maximum rated primary voltage, U_{pnmax} : 24/√3 kV
- Rated frequency, f_n : 50/60 Hz
- Accuracy class: 0.5/3P
- Rated burden, R_{br} : 10 MΩ
- Rated transformation ratio, K_n : 10 000:1
- Rated voltage factor, k_u : 1.9/8 h

Current sensor, rated values

- Rated primary current, I_{pr} : 80 A
- Rated transformation ratio, K_{ra} : 80 A/0.150 V at 50 Hz
80 A/0.180 V at 60 Hz
- Rated secondary output, U_{sr} : 3 mV/ Hz
i.e. 150 mV at 50 Hz
or 180 mV at 60 Hz
- Rated continuous thermal current, I_{cth} : 630 A
- Rated short-time thermal current, I_{th} : 25 kA/3 s
- Rated dynamic current, I_{dyn} : 63 kA
- Rated frequency, f_r : 50/60 Hz
- Rated extended primary current factor, K_{pcr} : 7.875
- Accuracy limit factor, K_{all} : 100
- Accuracy class: 0.5/5P100
- Rated burden, R_{br} : 10 MΩ

Temperature category

- Operation: - 5°C / + 40°C
- Transport and storage: -40°C / + 70°C

Cables

- Current and voltage sensing
 - Length: 2.2 m
 - Connector: RJ-45 (CAT-6)
- Coupling electrode
 - Length: 0.45 m
 - Connector: BNC

Ordering data for sensor

- Combined sensor KEVCY 24 RE1
1VL5400004V0102
- Voltage sensor KEVCY 24 RF1
1VL5400004V0104

Ordering data for Accessories

(only for IEDs with Twin-BNC input connectors)

- Connector adapter AR1 (RJ-45/Twin-BNC)
for sensor KEVCY 24 RE1 1VL5300685R0101
- Connector adapter AR3 (RJ-45/Twin-BNC)
for sensor KEVCY 24 RF1 1VL5300685R0103

1VL5300701R0102

1VL5300701R0103

1.75 kg



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