MEDIUM VOLTAGE PRODUCT

KEVCD A

Indoor combined sensor; Indoor current sensor

Parameters for Application	Value
Rated primary current of application	80 up to 1 250 A
Rated primary voltage of application	6/√3 up to 24/√3 kV

Sensor Parameters	Value
Rated primary voltage, U_{pn}	11/√3; 15/√3; 22/√3 kV
Highest voltage for equipment, U_m	12; 17.5; 24 kV
Rated power frequency withstand voltage	28 (42); 38; 50 kV
Rated lightning impulse withstand voltage	75; 95; 125 kV
Rated primary current, I_{pr}	80 A
Rated continuous thermal current, I_{cth}	1 250 A
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	0.5/5P630
Voltage accuracy class	0.5/3P
Length of cable	5.0; 6.5; 7.5 m

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

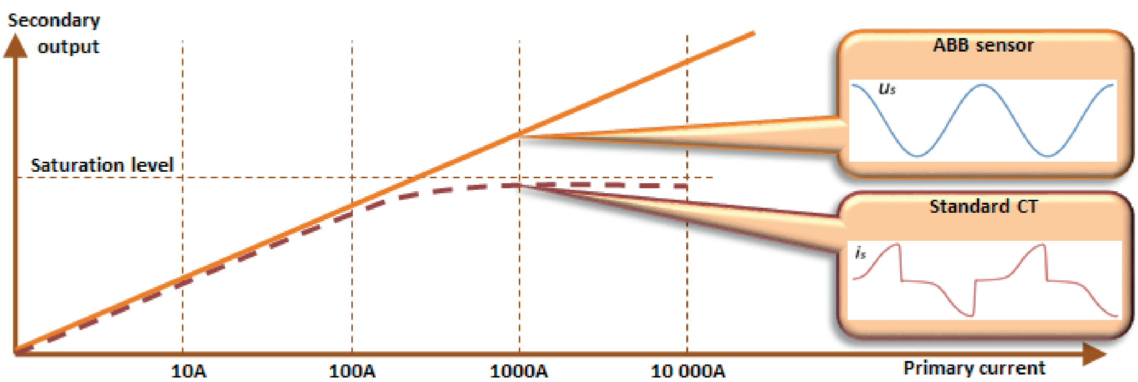
Construction of ABB's current and voltage sensors is done without the use of a ferromagnetic core.This fact results in several important benefits for the user and the application.

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 KEVCD A 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 KEVCD A fulfills requirements of protection class **5P up to an impressive value reaching the rated short-time thermal current I_{th}**. That provides the possibility to designate the corresponding accuracy class as **5P630**, proving excellent linearity and accuracy measurements.

Current sensor

Current measurement in KEVCD A sensors is based on the Rogowski coil principle. A Rogowski coil is a toroidal coil, without an iron core, placed



01 Sensor characteristics

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02 Rogowski coil principle
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03 Resistive divider principle
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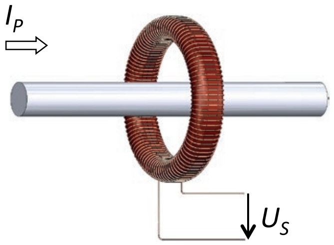
04 Sensor and IED

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:



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

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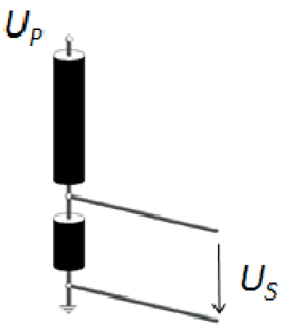
In all cases, a signal that represents the actual primary current waveform is easily obtained by integrating the transmitted output signal.

Voltage sensor
Voltage measurement in KEVCD A sensors is based on the resistive divider principle. The output voltage is directly proportional to the input voltage:



$$U_s = \frac{R_2}{R_1 + R_2} U_p$$

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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 0.5/5P630 as well as voltage sensing with combined accuracy class 0.5/3P).

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Sensor design
KEVCD A is a block type sensor designed according to the DIN 42600 size requirements. Two versions could be selected: one providing current measurement together with voltage indication capability, or a second one, providing, in addition to these, also the possibility of voltage measurement.

Type designation	Functions included		
	Voltage sensor	Current sensor	Voltage indication
KEVCD 12 AE3	■	■	■
KEVCD 12 AG3		■	■
KEVCD 17.5 AE3	■	■	■
KEVCD 17.5 AG3		■	■
KEVCD 24 AE3	■	■	■
KEVCD 24 AG3		■	■

Tab. 1. Sensor variants

— 05 Accuracy limits
— 06 Example of voltage measurement range for metering accuracy class 0.5 and protection accurace class 3P
— 07 Combined sensors

Differences between Sensors and Instrument Transformers

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

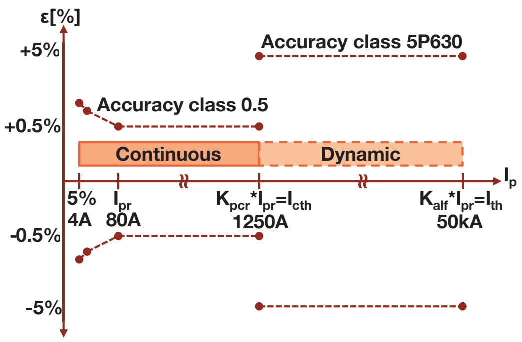
Linearity

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 Ipr up to the rated short-time thermal current Ith is within the limits specified by IEC 60044-8.

Example of current measurement range with rated current 80 A and accuracy class 0.5/5P630:

Metering accuracy class 0.5 is, according to the IEC 60044-8 standard, guaranteed from 5% of I_{pr} up to K_{pcr} x 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 KEVCD A sensor the K_{pcr} factor is several times higher and equals 15.625. Protection accuracy 5P630 is guaranteed, for the advanced KEVCD A sensor, from the current equal to K_{pcr} x I_{pr} up to the current corresponding to K_{alf} x 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} x I_{pr} is equal to the rated continuous thermal current Icth (1250 A) and the value of K_{alf} x I_{pr} is equal to the rated short-time thermal current Ith (50 kA). The accuracy limits are described on the graph below.



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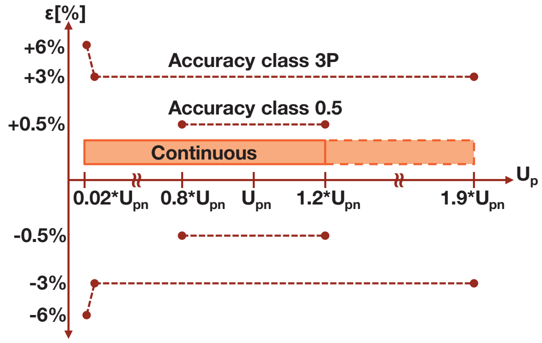

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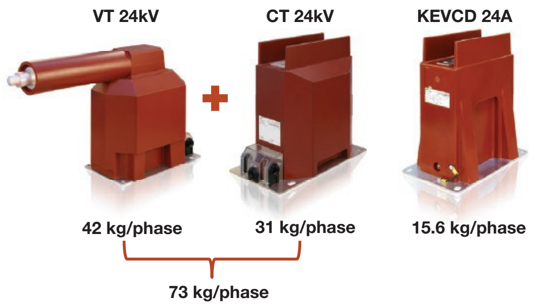
Compactness

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 KEVCD A sensor designed for 24kV is only 15.6 kg and designs for lower voltage levels are even lighter. This enables much easier handling without the need for special lifting devices.



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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.

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08 Example of a sensor label
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09 Connector RJ-45
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10 Direct connection between the sensor and IED

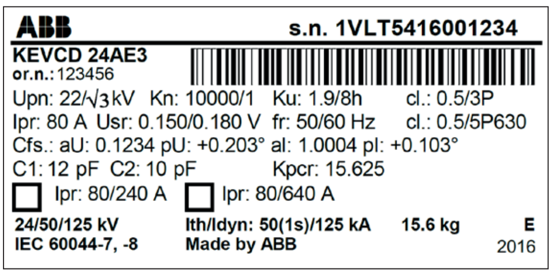
Energy savings concept

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, KEVCD A 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 label (for more informations please refer to the 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.



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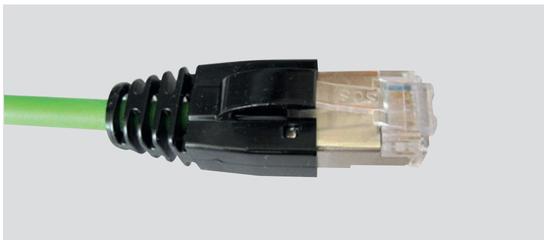
Secondary cables

The sensor is equipped with a cable for connection with the IED. The cable connector is type RJ-45. The sensor accuracy classes are verified up to the RJ-45 connector, i.e. considering also its secondary cable. These cables are 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. The polarity of the sensor is determined just by the type of the used cable. The polarity of the sensor could be normal (P1-P2) or reverse (P2-P1) depending on the used cable. Standard cable lengths: 5.0; 6.5 and 7.5 m

Polarity	Length		
	5 m	6.5 m	7.5 m
Normal P1-P2	1VL5300749R0101	1VL5300749R0102	1VL5300749R0103
Reverse P2-P1	1VL5300749R0106	1VL5300749R0107	1VL5300749R0108



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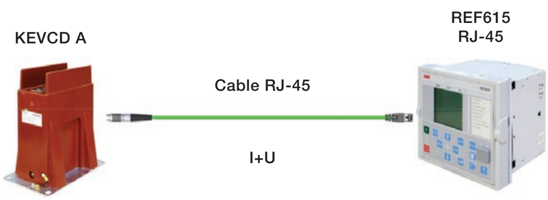

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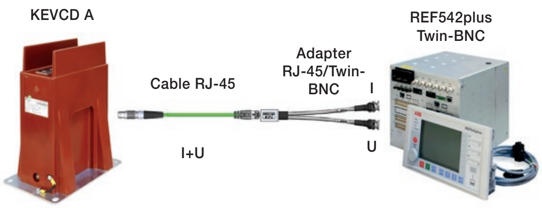
Current adapters

If the transmitted signal from the current sensor is too high to be processed properly by the IED, a current adapter is to be inserted between the sensor cable and the IED adapter unit. Simply said, the current adapter operates as a highly accurate voltage divider giving a higher transformation ratio of the current sensor. The current adapters have to be matched to the actually used

IED and must be ordered as accessories. For IEDs from the Relion® product family (REF615, etc.) no current adapter is needed. The current range could be changed in the IED using a higher transformation ratio parameter.

Rated primary current of application	Current adapter to be used	Resulting transformation ratio at 50Hz (60Hz)	Maximal linearity limit
(80 – 160) A	Not needed	80 A/150 mV (180 mV)	4 000 A
(160 – 480) A	AR1/240 AR2/240	240 A/150 mV (180 mV)	12 000 A
(480 – 1250) A	AR1/640 AR2/640	640 A/150 mV (180 mV)	32 000 A

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.



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11 Connection between sensor and IED which requires adapter

For more information about current adapters and 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. The sensor is delivered with an earthed coupling electrode.

Electrode	Sensor Highest voltage for equipment	
	12 and 17.5 kV	24 kV
C1	(23 – 40) pF	(10 – 48) pF
C2	≤25 pF	≤ 25 pF

Tab. 4. Capacitance values

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

Sensor name code

KEVCD 12 A E 3

- 3 – **Design number**
- E – **Sensor function:**
  E = voltage and current sensors and coupling electrode
  G = current sensor and coupling electrode
- A – **Use of sensors and current range:**
  A: I_{cth} = 1 250 A
- 12 – **Highest voltage for equipment:**
  Voltage rating: 12kV, 17.5kV and 24kV
- KEVCD – **Cast resin insulated combisensor:**
  KE = sensors
  V = voltage
  C = current
  D = block type sensor according to the DIN 42600 size requirements

Type	Highest voltage for equipment U_m	Rated power frequency test voltage	Rated lightning impulse test voltage
KEVCD 12_	12 kV	28; (42) kV	75 kV
KEVCD 17.5_	17.5 kV	38 kV	95 kV
KEVCD 24_	24 kV	50 kV	125 kV

Note: For KEVCD 12_ the extended rated power frequency test voltage 42kV shall be specified.

Voltage sensor, rated values

Type	Rated primary voltage U_{pn}	Maximum rated primary voltage U_{pnmax}
KEVCD 12_	12 kV	75 kV
KEVCD 17.5_	17.5 kV	95 kV
KEVCD 24_	24 kV	125 kV

Tab. 6. Rated primary voltage

- 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/150 mV at 50 Hz 80 A/180 mV 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}: 1 250 A
- Rated short-time thermal current, I_{th}: 50 kA/1 s
- Rated dynamic current, I_{dyn}: 125 kA
- Rated frequency, f_r: 50/60 Hz
- Rated extended primary current factor, K_{pcr}: 15.625
- Accuracy limit factor, K_{alf}: 630
- Accuracy class: 0.5/5P630
- Rated burden, R_{br}: 10 MΩ

Temperature category

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

Cable

- Length: 5.0; 6.5; 7.5 m
- Connector: RJ-45 (CAT-6)

Ordering data / specification of sensor

- Sensor name code
- Rated primary current of application
- Used IED
- Polarity
- Cable length
- Accessories (Current adapter; Connector adapter)

Dimensional Drawings

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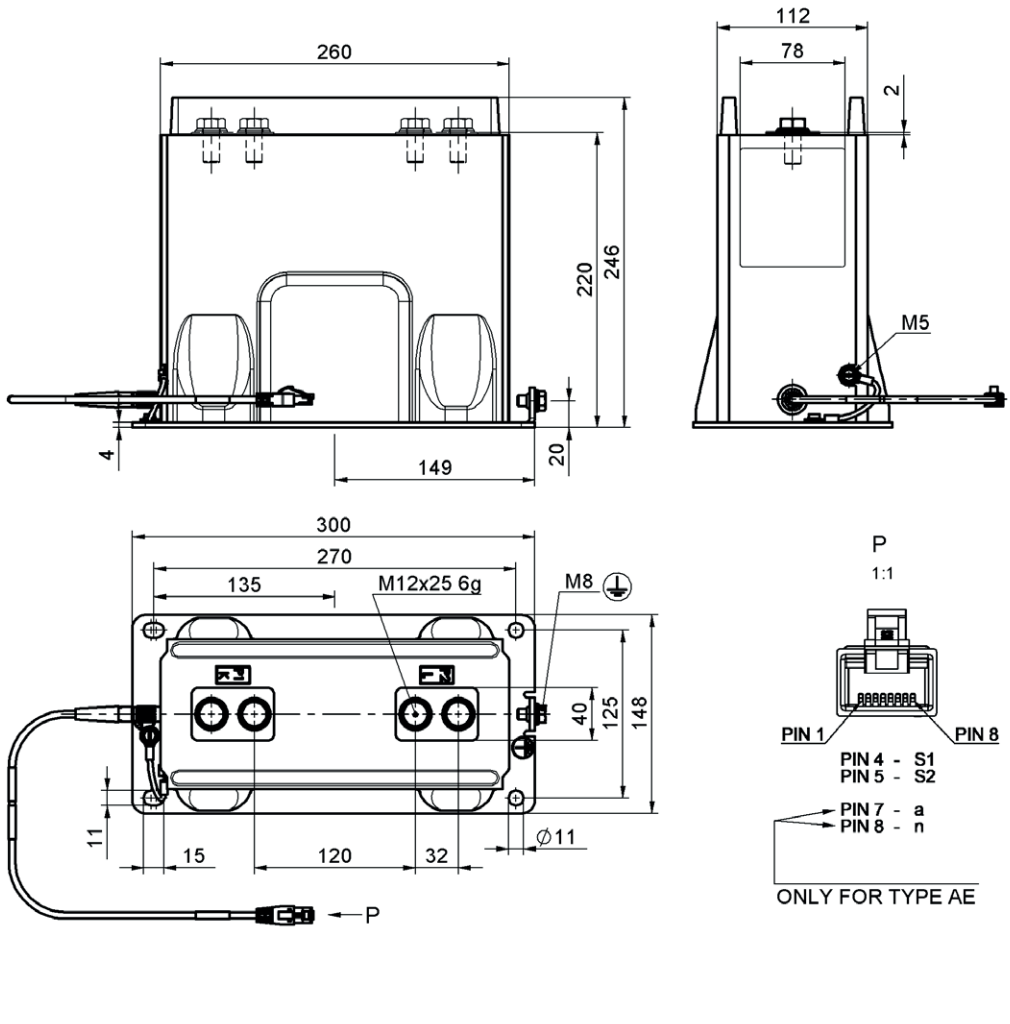
KEVCD 12_
KEVCD 17.5_

Drawing No.: 1VL5300733R0101
Weight: 12.5 kg



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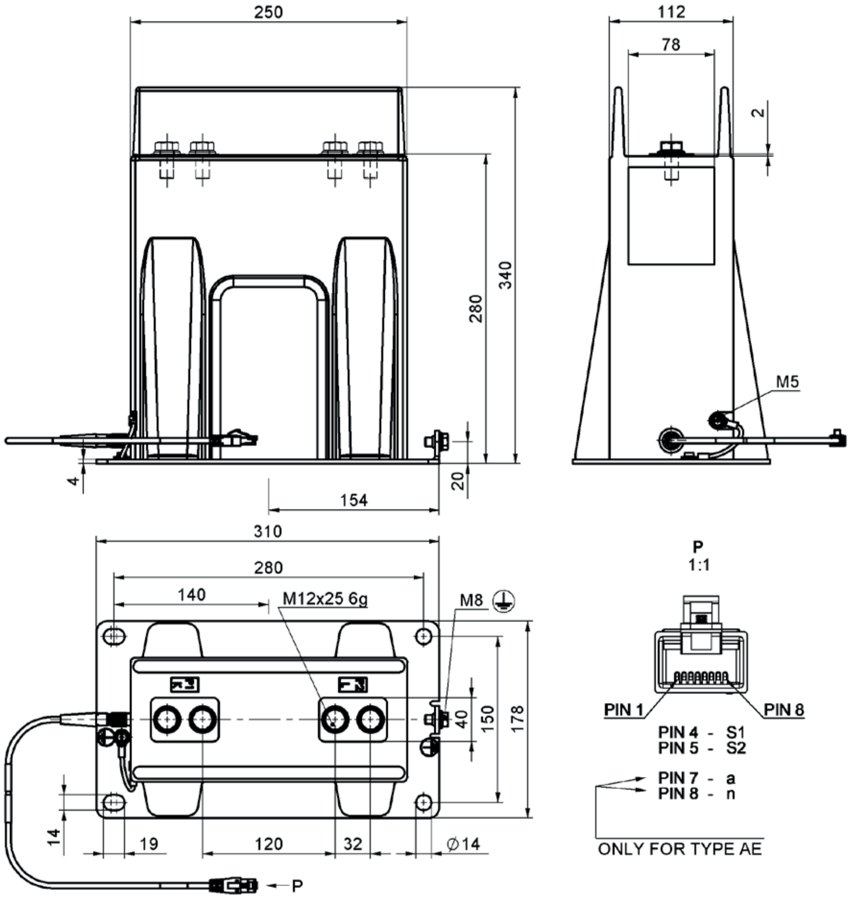
KEVCD 24_

Outline drawing number: 1VL5300734R0101
Weight: 15.6 kg



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