MEDIUM VOLTAGE PRODUCT

KEVCD A
Indoor combined sensor;
Indoor current sensor
### Parameters for Application

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated primary current of application</td>
<td>80 up to 1,250 A</td>
</tr>
<tr>
<td>Rated primary voltage of application</td>
<td>6/√3 up to 24/√3 kV</td>
</tr>
</tbody>
</table>

### Sensor Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated primary voltage, $U_{pn}$</td>
<td>11/√3; 15/√3; 22/√3 kV</td>
</tr>
<tr>
<td>Highest voltage for equipment, $U_m$</td>
<td>12; 17.5; 24 kV</td>
</tr>
<tr>
<td>Rated power frequency withstand voltage</td>
<td>28 (42); 38; 50 kV</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage</td>
<td>75; 95; 125 kV</td>
</tr>
<tr>
<td>Rated primary current, $I_{pr}$</td>
<td>80 A</td>
</tr>
<tr>
<td>Rated continuous thermal current, $I_{cth}$</td>
<td>1,250 A</td>
</tr>
<tr>
<td>Rated transformation ratio, $K_r$ for current measurement</td>
<td>80 A / 150 mV at 50 Hz</td>
</tr>
<tr>
<td>Rated transformation ratio, $K_n$ for voltage measurement</td>
<td>10,000 : 1</td>
</tr>
<tr>
<td>Current accuracy class</td>
<td>0.5/5P630</td>
</tr>
<tr>
<td>Voltage accuracy class</td>
<td>0.5/3P</td>
</tr>
<tr>
<td>Length of cable</td>
<td>5.0; 6.5; 7.5 m</td>
</tr>
</tbody>
</table>

### 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...
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:

\[ I_p \Rightarrow u_s(t) = M \frac{di_p(t)}{dt} \]

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

\[ U_p = R_2 \frac{U_s}{R_1 + R_2} \]

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/SP630 as well as voltage sensing with combined accuracy class 0.5/3P).

**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.

<table>
<thead>
<tr>
<th>Type designation</th>
<th>Functions included</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Voltage sensor</td>
</tr>
<tr>
<td>KEVCD 12 AE3</td>
<td>■</td>
</tr>
<tr>
<td>KEVCD 12 AG3</td>
<td>■</td>
</tr>
<tr>
<td>KEVCD 17.5 AE3</td>
<td>■</td>
</tr>
<tr>
<td>KEVCD 17.5 AG3</td>
<td>■</td>
</tr>
<tr>
<td>KEVCD 24 AE3</td>
<td>■</td>
</tr>
<tr>
<td>KEVCD 24 AG3</td>
<td>■</td>
</tr>
</tbody>
</table>

**Tab. 1. Sensor variants**
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 rated short-time thermal current $I_{th}$ 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 $K_{pcr} \times I_{pr}$ 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 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 $K_{alf} \times I_{pr}$ 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 $I_{cth}$ (1250 A) and the value of $K_{alf} \times I_{pr}$ is equal to the rated short-time thermal current $I_{th}$ (50 kA). 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 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.

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, 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.

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

<table>
<thead>
<tr>
<th>Polarity</th>
<th>Length</th>
<th>Length</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>5 m</td>
<td>6.5 m</td>
<td>7.5 m</td>
</tr>
<tr>
<td>P1-P2</td>
<td>1VL5300749R0101</td>
<td>1VL5300749R0102</td>
<td>1VL5300749R0103</td>
</tr>
<tr>
<td>Reverse</td>
<td>5 m</td>
<td>6.5 m</td>
<td>7.5 m</td>
</tr>
<tr>
<td>P2-P1</td>
<td>1VL5300749R0106</td>
<td>1VL5300749R0107</td>
<td>1VL5300749R0108</td>
</tr>
</tbody>
</table>

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.

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

**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.

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.

**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**

<table>
<thead>
<tr>
<th>KEVCD</th>
<th>12</th>
<th>A</th>
<th>E</th>
<th>3</th>
</tr>
</thead>
</table>

**Design number**

**Sensor function:**

E = voltage and current sensors and coupling electrode

G = current sensor and coupling electrode

**Use of sensors and current range:**

A: \( I_{th} = 1250 \) A

**Highest voltage for equipment:**

Voltage rating: 12kV, 17.5kV and 24kV

**Cast resin insulated combisensor:**

KE = sensors

V = voltage

C = current

D = block type sensor according to the DIN 42600 size requirements
<table>
<thead>
<tr>
<th>Type</th>
<th>Highest voltage for equipment $U_m$</th>
<th>Rated power frequency test voltage</th>
<th>Rated lightning impulse test voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>KEVCD 12_</td>
<td>12 kV</td>
<td>28; (42) kV</td>
<td>75 kV</td>
</tr>
<tr>
<td>KEVCD 17.5_</td>
<td>17.5 kV</td>
<td>38 kV</td>
<td>95 kV</td>
</tr>
<tr>
<td>KEVCD 24_</td>
<td>24 kV</td>
<td>50 kV</td>
<td>125 kV</td>
</tr>
</tbody>
</table>

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

### Voltage sensor, rated values

<table>
<thead>
<tr>
<th>Type</th>
<th>Rated primary voltage $U_{pm}$</th>
<th>Maximum rated primary voltage $U_{pmx}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>KEVCD 12_</td>
<td>12 kV</td>
<td>75 kV</td>
</tr>
<tr>
<td>KEVCD 17.5_</td>
<td>17.5 kV</td>
<td>95 kV</td>
</tr>
<tr>
<td>KEVCD 24_</td>
<td>24 kV</td>
<td>125 kV</td>
</tr>
</tbody>
</table>

Tab. 6. Rated primary voltage

- Rated frequency, $f_r$: 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, $K_{tr}$:
  - 80 A/150 mV at 50 Hz
  - 80 A/180 mV at 60 Hz
- Rated secondary output, $U_{st}$: 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, $I_{sth}$: 50 kA/1 s
- Rated dynamic current, $I_{dyn}$: 125 kA
- Rated frequency, $f_r$: 50/60 Hz
- Rated extended primary current factor, $K_{per}$: 15.625
- Accuracy limit factor, $K_{af}$: 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

KEVCD 12
KEVCD 17.5

Drawing No.: 1VL5300733R0101
Weight: 12.5 kg
Outline drawing number: 1VL5300734R0101
Weight: 15.6 kg