<table>
<thead>
<tr>
<th>Product presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milos Dvorak</td>
</tr>
<tr>
<td>Product manager</td>
</tr>
<tr>
<td>CZELS</td>
</tr>
<tr>
<td>PPMV Instrument</td>
</tr>
<tr>
<td>transformers</td>
</tr>
</tbody>
</table>
Instrument transformers

General information

Current transformers

Voltage transformers

Outdoor transformers

Sensors

Application, arguments
ABB CZELS Instrument transformers

Electric values (currents and voltages) in power supply systems are extensive. This is why it is necessary to match the respective currents and voltages to those values which shall be appropriate to the connected measuring, protection and control instrument.

MV Instrument transformers are used for
- current and voltage measurements
- insulation level from 0,72 kV to 40,5 kV
- both indoor and outdoor use

The transformers comply with IEC, DIN, BS, GOST, AS and other standards or with customer specific requirements.
Instrument transformers - product focus

- ABB USA
  GFFF - ANSI

- ABB Poland
  GFFF- LV „IEC“

- ABB Czech Republic
  GFFF- MV “IEC“
Czech Republic – country in the heart of Europe

- Area: 78,864 km²
- Shares borders with Germany, Poland, Austria, Slovakia
- Length of state border: 2,303 km
- Largest cities: Prague, Brno, Ostrava
Instrument transformers history

- **1887** Foundation of factory
- **1919** Production of instrument transformers with *oil insulation*
- **1952** Production of instrument transformers with *epoxy insulation*
- **1983** Technology of automatic pressured gelation (APG) implemented
- **1993** 100% of shares was purchased by Asea Brown Boveri Ltd.
- **1997** New production plant erected, new production technology and testing equipment
- **2002** CZELS was appointed as Global focused feeder factory (GFFF) for both indoor and outdoor MV Instrument transformers up to 40,5 kV
- **2003** CZELS was appointed as Global focused feeder factory (GFFF) for MV Instrument transformers responsibility worldwide
Inductive Instrument transformers

**TPU xx.xx** …post type
3,6kV - 40,5 kV

**Special application**
3,6kV - 40,5 kV

**TPO xx.xx** …supporting
3,6kV - 40,5 kV

**Current outdoor**

**TJC x** …single pole
**TDC x** …double pole
3,6kV - 40,5 kV

**Voltage outdoor**

**TJO x** …single pole
**TDO x** …double pole
3,6kV - 40,5 kV

**TJP x** …single pole with fuse
3,6kV - 40,5 kV
Electronic Instrument transformers (Sensors)

- Voltage sensors
- Current sensors
- Electronic instrument transformers
  - resistive or capacitive divider
- Combi sensors
- Rogowski coil

General application with REF_ – OEM, ..

Special application to ABB switchgear or apparatus
Instrument transformers according to IEC standards

IEC 60044-1…Current transformers
IEC 60044-2…Inductive voltage transformers
IEC 60044-3…Combined transformers
IEC 60044-5…Capacitor voltage transformers
IEC 60044-6…Protective current transformers for transient performance
IEC 60044-7…Electronic voltage transformers
IEC 60044-8…Electronic current transformers

IEC TC 38 - discussion to change structure of ITs norms
Instrument transformers

- General information
- Current transformers
- Voltage transformers
- Outdoor transformers
- Sensors
- Application, arguments
Current Transformers

- Wide range of types fits to many various applications
- El. ratings provided as per individual client’s needs.
- Electrical standards IEC, DIN, BS, GOST, AS.
- Many metrology certificates & approvals available.

| Un | .. 40,5 kV |
| In | .. 8000 A |
| Ithn (1s) | .. 100 kA |
Product Overview - Indoor Current ITs

**Support (post) type CTs**
- TPU 4x.xx up to 12 kV
- TPU 5x.xx up to 17.5 kV
- TPU 6x.xx up to 24 kV
- TPU 7x.xx up to 36 kV - 40.5 kV

**Bar primary bushing type CTs**
- TTR 4x.xx up to 12 kV
- TTR 6x.xx up to 24 kV

**Bus type CTs**
- KOKS up to 17.5 kV
- KOKS up to 24 kV

**Cable „ring“ core LV type for MV application**
- KOLMA, KOLA.. 0.72 kV (in PLZWA)

**Special CTs**
- IP 24 for circuit breaker (in PLZWA)
- KOLT for power transformers (in PLZWA)
Current transformers (CT) – ratings, wide range of application
Primary (rated) currents …… 10 A up to 8000 A (In according to CT type)
Secondary currents……………… 1A, 2 A, 5 A
Frequency ……………………… 50 or 60 Hz
Rated short-time thermal current \( I_{\text{thn}} \) (1sec.)
4; 6.3; 8; 12; 16; 20; 25; 31.5; 40; 50; 63; 80; 100 kA
Highest voltage for equipment up to 40.5 kV (1min..10-95 kV, BIL..20-200kV)
Accuracy: measuring winding: 0.1; 0.2; 0.2S; 0.5; 0.5S; 1; 3…
factor security (FS): 5; 10
protective winding: 5P; 10P; …. over current factor: 5; 10; 15; 20
special classes ……PX (IEC 60044-1) - \( U_k \), \( R_{CT} \), \( I_k \)
Indoor or outdoor dry type, cast resin insulated, up to 6 secondary windings
Secondary or primary reconnectable versions
Electrical standards IEC, DIN, BS, GOST, AS, etc.available
Inductive Current transformer

PRIMARY TERMINAL

PRIMARY WINDING

SECONDARY TERMINAL

EPOXY RESIN

CROSS-SECTION according to „short current“ Ith (kA)

LENGTH of the core according to burden (VA)

METERING CORE
CLASSES 0,2S 0,2 0,5S 0,5

PROTECTIVE CORE
CLASSES 5P10 5P15 5P20 10P10 10P15 10P20
**Definition:**
A current transformer so arranged that it acts as a support for the conductor in the primary circuit.

---

### Current transformers TPU xx.xx - 3,6...25kV

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>TPU 4x.xx</th>
<th>TPU 5x.xx</th>
<th>TPU 6x.xx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>3,6 7,2 12</td>
<td>13,8 17,5</td>
</tr>
<tr>
<td>Power frequency test voltage</td>
<td>kV</td>
<td>up to 28 kV</td>
<td>up to 42 kV</td>
</tr>
<tr>
<td>Lighting impulses test voltage</td>
<td>kV</td>
<td>up to 75 kV</td>
<td>up to 95 kV</td>
</tr>
<tr>
<td>Primary current</td>
<td>A</td>
<td>10 A-3200 A</td>
<td>10 A-3200 A</td>
</tr>
<tr>
<td>Rated short time thermal current</td>
<td>kA- 1sec</td>
<td>4 kA–100 kA</td>
<td>4 kA–100 kA</td>
</tr>
<tr>
<td>Burden, classes</td>
<td>VA/ cl</td>
<td>5-30/0,2-1 5-30/5P..10P..</td>
<td>5-30/0,2-1 5-30/5P..10P..</td>
</tr>
<tr>
<td>Secondary terminals</td>
<td></td>
<td>12 terminals (max. 6sec.)</td>
<td>12 terminals (max. 6sec.)</td>
</tr>
<tr>
<td>Dimensional standard</td>
<td></td>
<td>DIN (148mm) wide(184mm)</td>
<td>DIN (148mm) wide(184mm)</td>
</tr>
<tr>
<td>Electrical standards</td>
<td></td>
<td>IEC, DIN, BS, GOST,ANSI,</td>
<td>IEC, DIN, BS, GOST,ANSI,</td>
</tr>
<tr>
<td>Reconnectable (primary 400-800 A)</td>
<td></td>
<td>prim. or sec.</td>
<td>prim. or sec.</td>
</tr>
</tbody>
</table>

---

**Support (post) type current transformer**

for MV applications, indoor type

---

**without ribs**

**with ribs**
Current transformers TPU xx.xx – 36..40,5 kV

### Support (post) type current transformer

for MV applications, indoor type

**Definition:**
A current transformer so arranged that it acts as a support for the conductor in the primary circuit

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>TPU 7x.5x, TPU 7x.6x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV</td>
</tr>
<tr>
<td>Lighting impuls test voltage (BIL)</td>
<td>kV</td>
</tr>
<tr>
<td>Primary current</td>
<td>A</td>
</tr>
<tr>
<td>Rated short – time thermal current</td>
<td>kA (1sec)</td>
</tr>
<tr>
<td>Burden, classes</td>
<td>VA, cl</td>
</tr>
<tr>
<td>Secondary terminals</td>
<td></td>
</tr>
<tr>
<td>Dimensional standard</td>
<td></td>
</tr>
<tr>
<td>Electrical standards</td>
<td></td>
</tr>
<tr>
<td>Reconnectable (primary till 400-800 A)</td>
<td></td>
</tr>
</tbody>
</table>
# Current transformers TTR xx.xx - 3,6…25kV

**Bar primary bushing type current transformer** for MV applications, indoor

**Definition:**
A current transformer with bar primary conductor so constructed that it can be used as a bushing.

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>TTR 4x.xx</th>
<th>TTR 6x.xx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>3,6</td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV</td>
<td>max 28</td>
</tr>
<tr>
<td>Lighting impulse test voltage (BIL)</td>
<td>kV</td>
<td>max 75</td>
</tr>
<tr>
<td>Primary current</td>
<td>A</td>
<td>100, 200, 300, 400, 500, 600, 750, 1000, 1250, 1500, 2000, 2500</td>
</tr>
<tr>
<td>Rated short – time thermal current</td>
<td>kA (1sec)</td>
<td>50</td>
</tr>
<tr>
<td>Burden, classes</td>
<td>VA, cl</td>
<td>5-30/0.2-1</td>
</tr>
<tr>
<td>Secondary terminals</td>
<td></td>
<td>4 terminals…. max. 2 sec.</td>
</tr>
<tr>
<td>Dimensional standard</td>
<td></td>
<td>Non standard</td>
</tr>
<tr>
<td>Electrical standards</td>
<td></td>
<td>IEC, DIN, BS, GOST, ANSI,..</td>
</tr>
<tr>
<td>Reconnectable</td>
<td></td>
<td>Secondary – 1 winding only</td>
</tr>
</tbody>
</table>

**Bar primary bushing type current transformer**

© ABB s.r.o. - 17
1/30/2008
## Current transformers BB - 3,6…25 kV

**Bushing type current transformer**

For MV applications, indoor

**Definition:**
A current transformer without primary conductor, but with primary insulation of its own which can be used as a bushing

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>BB 103</th>
<th>BB 104 (BBO)</th>
<th>BB 223</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>3,6  7,2  12</td>
<td>3,6  7,2  12</td>
</tr>
<tr>
<td>Power frequency test volt. 1 min.</td>
<td>kV</td>
<td>up to 28 kV</td>
<td>up to 28 kV</td>
</tr>
<tr>
<td>Lighting impuls test voltage (BIL)</td>
<td>kV</td>
<td>up to 75 kV</td>
<td>up to 75 kV</td>
</tr>
<tr>
<td>Primary current</td>
<td>A</td>
<td>max 4000 A</td>
<td>max 5000 A</td>
</tr>
<tr>
<td>Rated short – time thermal current</td>
<td>kA (1sec)</td>
<td>max 63</td>
<td>max 63</td>
</tr>
<tr>
<td>Burden, classes</td>
<td>VA, cl</td>
<td>5-60/0.2-1 5-60/5P.. 10P..</td>
<td>5-60/0.2-1 5-60/5P.. 10P..</td>
</tr>
<tr>
<td>Secondary terminals</td>
<td></td>
<td>4 terminals… (max. 2 sec.)</td>
<td>6 terminals… (max. 3 sec.)</td>
</tr>
<tr>
<td>Dimensional standard</td>
<td></td>
<td>Non standard</td>
<td>Non standard</td>
</tr>
<tr>
<td>Electrical standards</td>
<td></td>
<td>IEC, DIN, BS, GOST, ANSI,…</td>
<td>IEC, DIN, BS, GOST, ANSI,…</td>
</tr>
<tr>
<td>Reconnectable</td>
<td></td>
<td>secondary</td>
<td>secondary</td>
</tr>
</tbody>
</table>
## Current transformers KOKS - 3,6...24 kV

**Bus type current transformer**

for MV applications, indoor  
**Definition:**

A current transformer without primary conductor, but with primary insulation, which can be fitted directly over a conductor or busbar

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>KOKS 12</th>
<th>KOKS 17,5</th>
<th>KOKS 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>12</td>
<td>17.5</td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV</td>
<td>28</td>
<td>42</td>
</tr>
<tr>
<td>Lighting impuls test voltage (BIL)</td>
<td>kV</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td>Primary current</td>
<td>A</td>
<td>1000, 1250, 1500, 2000, 3000, 4000, (5000, 6000, 7000, 8000-KOKS 24 only)</td>
<td></td>
</tr>
<tr>
<td>Rated short – time thermal current</td>
<td>kA (1sec)</td>
<td>up to 100xI_n</td>
<td></td>
</tr>
<tr>
<td>Burden, classes</td>
<td>VA, cl</td>
<td>5-30/0,2-1</td>
<td>5-30/5P..-10P..</td>
</tr>
<tr>
<td>Secondary terminals</td>
<td>8 terminals…. max. 4 sec.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensional standard</td>
<td>Non standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical standards</td>
<td>IEC, DIN, BS, GOST, ANSI,..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reconnectable</td>
<td>Primary</td>
<td>Secondary</td>
<td></td>
</tr>
</tbody>
</table>
LV Cable Current Transformers for MV applicatin (in PLZWA)

**WINDOW TYPE**

- Voltage system 0.72 kV
- Rated primary current: $I_{pn} = 50$ up to 2000 A
- Rated secondary current: $I_{sn} = 1$ or 5 A
- Mainly for protection (10P; 5P)
- Number of cores: 1
- Window size 300 x 200 mm 650 x 450 mm

**KOKM / KOLA / KOLMA**

For medium voltage systems
- Wide range of products (standard and customer’s designed)
- Indoor application
- Intended for ABB and OEM’s MV panels
- For AIS and GIS
Cable current transformers  KOKM/KOKU (in PLZWA)

KOKM – indoor type  KOKU – outdoor type
CUSTOMER DESIGNED

- Voltage system 1.2 kV
- Rated primary current: $I_{pn} = \text{up to 10 000 A}$
- Rated secondary current: $I_{sn} = 1 \text{ or } 5 \text{ A}$
- All accuracy classes for measurement and protection
- Number of cores: up to 4;
- ID $\varnothing$ 33 - 500 mm
LV Instrument transformers – special applications (in PLZWA)

New designed products
- For power transformers (KOLT); full range of products (cast resin and uncasted)

- **KOLT – without casting**  
  - Voltage system: 1.2 kV
  - Rated primary current: $I_{pn} = \text{up to 15 000 A}$
  - Rated secondary current: $I_{sn} = 1 \text{ or } 5 \text{ A}$
  - For protection and measurement
  - Number of cores: up to 6; ID $\varnothing 105 - 600 \text{ mm}$

- **KOMSH – epoxy cast resin**
Instrument transformers

General information

Current transformers

Voltage transformers

Outdoor transformers

Sensors

Application, arguments
Voltage Transformers

- For fixed and withdrawable solutions
- Single and double pole versions
- Special types for supply of aux. power.
- Electrical standards IEC, DIN, BS, GOST, AS.
- Many metrology certificates & approvals available.

<table>
<thead>
<tr>
<th>Un</th>
<th>.. 40,5 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pn</td>
<td>.. 2000 VA</td>
</tr>
<tr>
<td></td>
<td>.. 3 secondaries</td>
</tr>
</tbody>
</table>
Product Overview - Indoor Voltage ITs

**Single pole insulated VTs**
- TJC 4 .... up to 12 kV
- TJC 5 .... up to 17,5 kV
- TJC 6 .... up to 24 kV
- TJC 7 or 7.1..up to 36 kV - 40,5 kV

**Single pole insulated VTs with fuses**
- TJP 4.x .... up to 12 kV
- TJP 5.x .... up to 17,5 kV
- TJP 6.x .... up to 24 kV
- TJP 7.1 or 7.2..up to 36 kV - 40,5 kV

**Double pole insulated VTs**
- TDC 4 .... up to 12 kV
- TDC 5 .... up to 17,5 kV
- TDC 6 .... up to 24 kV
- TDC 7.....up to 36 kV
# Technical Information – MV VTs

**Voltage transformers (VT)** – ratings, wide range of application

Main primary (rated) voltages Un..3;6;10;15;20;30;33;35kV  
(Phase to earth Un/V3)

Secondary voltages...100;110;100/√3;110/√3;100/3;110/3 V

Frequency ........... 50 or 60 Hz

Highest voltage for equipment  
3.6 kV up to 40.5 kV(1min..10-95 kV, BIL..20-200kV)

**Accuracy class**:  
- Measuring winding 0.1;0.2;0.5;1  
- Protective winding 3P;6P  
- Auxiliary winding 6P

Indoor or outdoor dry type, cast resin insulated, up to 3 secondary windings  
Secondary reconnectable versions  
Electrical standards IEC, DIN, BS, GOST, AS, etc.available
Inductive Voltage transformer

- PRIMARY TERMINAL
- PRIMARY COIL
- SECONDARY COIL
- SECONDARY TERMINAL
- EPOXY RESIN
- MAGNETIC CORE

CROSS-SECTION of the core
- important for max. nominal burden (VA)
- and classes 0.2, 0.5, 1, 3P, 6P
Inductive Voltage transformer

- PRIMARY TERMINALS
- PRIMARY COILS
- MAGNETIC CORE
- EPOXY RESIN
- CROSS-SECTION of the core
  - important for max. nominal burden (VA)
  - and classes 0.2, 0.5, 1, 3P, 6P
## Earthing voltage transformer (single pole or one pole insulated)

For MV applications, indoor type

**Definition:**
A single phase voltage transformer which is intended to have one end of its primary winding directly earthed

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>TJC 4 TJP 4.x</th>
<th>TJC 5 TJP 5.x</th>
<th>TJC 6 TJP 6.x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>3,6 7,2 12</td>
<td>13,8 17,5</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>kV</td>
<td>3/V3 6/V3 10/V3</td>
<td>11/V3 15/V3</td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV</td>
<td>up to 28</td>
<td>up to 38</td>
</tr>
<tr>
<td>Lighting impuls test voltage (BIL)</td>
<td>kV</td>
<td>up to 75</td>
<td>up to 95</td>
</tr>
<tr>
<td>Max. rated burden/classes</td>
<td>VA, cl</td>
<td>20/0,2 50/0,5 100/1</td>
<td>20/0,2 50/0,5 100/1</td>
</tr>
<tr>
<td>Residual winding</td>
<td>VA, cl</td>
<td>50 – 200/6P</td>
<td>50 – 200/6P</td>
</tr>
<tr>
<td>Secondary winding</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dimensional standard</td>
<td>DIN</td>
<td>DIN</td>
<td>DIN</td>
</tr>
<tr>
<td>Electrical standards</td>
<td>IEC,BS, GOST,..</td>
<td>IEC,BS, GOST,..</td>
<td>IEC,BS, GOST,..</td>
</tr>
</tbody>
</table>
Voltage transformers TJC x, TJP x.x - 36...40,5 kV

Earthed voltage transformer (single pole or one pole insulated)
for MV applications, indoor type
Definition:
A single phase voltage transformer which is intended to have one end of its primary winding directly earthed

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>TJC 7</th>
<th>TJP 7.1</th>
<th>TJP 7.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>36 38,5 40,5</td>
<td>36 38,5</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>kV</td>
<td>30/V3,33/V3 35/V3</td>
<td>30/V3,33/V3 35/V3</td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV</td>
<td>max 95</td>
<td>max 80</td>
</tr>
<tr>
<td>Lighting impulse test voltage (BIL)</td>
<td>kV</td>
<td>max 200</td>
<td>max 180</td>
</tr>
<tr>
<td>Max. rated burden/classes</td>
<td>VA, cl</td>
<td>50/0,2 150/0,5 250/1</td>
<td>30/0,2 75/0,5 150/1</td>
</tr>
<tr>
<td>Residual winding</td>
<td>VA, cl</td>
<td>50 – 200/6P</td>
<td>50 – 200/6P</td>
</tr>
<tr>
<td>Secondary winding</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Dimensional standard</td>
<td>non standard</td>
<td>non standard</td>
<td></td>
</tr>
<tr>
<td>Electrical standards</td>
<td>IEC,BS, GOST,..</td>
<td>IEC,BS, GOST,..</td>
<td></td>
</tr>
</tbody>
</table>
### Unearthed voltage transformer (double pole or two pole insulated)

for MV applications, indoor type

**Definition:**
A voltage transformer which has all parts of its primary winding, including terminals, insulated from the earth at a level corresponding to its rated insulation level

#### Transformer type

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>TDC 4</th>
<th>TDC 5</th>
<th>TDC 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>3,6 7,2 12</td>
<td>13,8 17,5</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>kV</td>
<td>3 6 10</td>
<td>11 15</td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV</td>
<td>up to 28</td>
<td>up to 38</td>
</tr>
<tr>
<td>Lighting impuls test voltage (BIL)</td>
<td>kV</td>
<td>up to 75</td>
<td>up to 95</td>
</tr>
<tr>
<td>Max. rated burden/classes</td>
<td>VA, cl</td>
<td>20/0,2 50/0,5 100/1</td>
<td>20/0,2 50/0,5 100/1</td>
</tr>
<tr>
<td>Secondary winding</td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dimensional standard</td>
<td></td>
<td>DIN</td>
<td>DIN</td>
</tr>
<tr>
<td>Electrical standards</td>
<td></td>
<td>IEC,BS, GOST,..</td>
<td>IEC,BS, GOST,..</td>
</tr>
</tbody>
</table>
## Unearthed voltage transformer (double pole or two pole insulated transformer)

for MV applications

**Definition:**
A voltage transformer which has all parts of its primary winding, including terminals, insulated from the earth at a level corresponding to its rated insulation level

### Voltage transformers TDC x, KGUG - 36…40,5 kV

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>TDC 7</th>
<th>KGUG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>36</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>kV</td>
<td>30</td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV</td>
<td>max 80</td>
</tr>
<tr>
<td>Lighting impuls test voltage (BIL)</td>
<td>kV</td>
<td>max 180</td>
</tr>
<tr>
<td>Max. rated burden/classes</td>
<td>VA, cl</td>
<td>50/0,2</td>
</tr>
<tr>
<td>Secondary winding</td>
<td></td>
<td>2 secondary w.</td>
</tr>
<tr>
<td>Dimensional standard</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Electrical standards</td>
<td></td>
<td>IEC, BS, GOST,..</td>
</tr>
</tbody>
</table>
Outlook Instrument Transformers

- El. ratings provided as per individual client’s needs.
- Advanced epoxy resin material – HCEP
- VTs – single and double pole
- Electrical standards IEC, DIN, BS, GOST, AS.
- Many metrology certificates & approvals available.

<table>
<thead>
<tr>
<th>Un</th>
<th>.. 40,5 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td>.. 2500 A</td>
</tr>
<tr>
<td>Ithn (1s)</td>
<td>.. 100 kA</td>
</tr>
</tbody>
</table>
Main line outdoor current transformers TPO xx.xx

Outdoor current transformer

for MV applications

Definition:
Current transformer which can be used under outdoor service conditions (ambient air temperature, humidity, pollution, …)

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>TPO 6x.xx</th>
<th>TPO 7x.xx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
<td>12 17,5 24 25</td>
</tr>
<tr>
<td>Power frequency test volt., 1 min.</td>
<td>kV</td>
<td>max 55</td>
</tr>
<tr>
<td>Lighting impuls test voltage (BIL)</td>
<td>kV</td>
<td>max 125</td>
</tr>
<tr>
<td>Primary current</td>
<td>A</td>
<td>10 A – 2500 A</td>
</tr>
<tr>
<td>Rated short – time thermal current</td>
<td>kA (1sec)</td>
<td>4 kA – 100 kA</td>
</tr>
<tr>
<td>Burden, classes</td>
<td>VA, cl</td>
<td>5-30/0,2-1 5-30/5P..-10P..</td>
</tr>
<tr>
<td>Secondary terminals</td>
<td>8 terminals…. max. 4 sec.</td>
<td></td>
</tr>
<tr>
<td>Dimensional standard</td>
<td>Non standard</td>
<td></td>
</tr>
<tr>
<td>Electrical standards</td>
<td>IEC, DIN, BS, GOST, ANSI,..</td>
<td></td>
</tr>
<tr>
<td>Reconnectable (primary till 600-1200 A)</td>
<td>prim. or sec.</td>
<td></td>
</tr>
</tbody>
</table>
# Main line outdoor voltage transformers TJO 6, TDO 6

**Outdoor voltage transformers**

*for MV applications*

**Definition:**
Voltage transformers which can be used under outdoor service conditions (ambient air temperature, humidity, pollution, ...)

---

### Table: Specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>TJO 6</th>
<th>TDO 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transf. type-singly pole - doubly pole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest voltage for equipment</td>
<td>kV 12 17,5 24 25</td>
<td></td>
</tr>
<tr>
<td>Rated voltage single pole - double pole</td>
<td>kV 10/V3, 13,8/V3, 15/V3, 20/V3, 22/V3</td>
<td></td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV max 55</td>
<td></td>
</tr>
<tr>
<td>Lighting impulse test voltage (BIL)</td>
<td>kV max 125</td>
<td></td>
</tr>
<tr>
<td>Max. rated burden/classes</td>
<td>VA, cl 50/0,2 150/0,5 250/1</td>
<td></td>
</tr>
<tr>
<td>Residual winding (for single pole VTs only)</td>
<td>VA, cl 50 – 200/6P</td>
<td></td>
</tr>
<tr>
<td>Secondary terminals</td>
<td>max. 3 secondaries</td>
<td></td>
</tr>
<tr>
<td>Dimensional standard</td>
<td>Non standard</td>
<td></td>
</tr>
<tr>
<td>Electrical standards</td>
<td>IEC, DIN, BS, GOST, ANSI, ..</td>
<td></td>
</tr>
</tbody>
</table>

---

**TDO 6**

**TJO 6**
Main line outdoor voltage transformer TJO 7

**Outdoor voltage transformer**

for MV applications

**Definition:**
Voltage transformer which can be used under outdoor service conditions (ambient air temperature, humidity, pollution,…)

<table>
<thead>
<tr>
<th>Transformer type—single pole</th>
<th>TJO 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest voltage for equipment</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td>36 38,5 40,5</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td>30/V3 33/V3 35/V3</td>
</tr>
<tr>
<td>Power frequency test voltage, 1 min.</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td>max 95</td>
</tr>
<tr>
<td>Lighting impuls test voltage (BIL)</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td>max 200</td>
</tr>
<tr>
<td>Max. rated burden/classes</td>
<td>VA, cl</td>
</tr>
<tr>
<td></td>
<td>50/0,2 150/0,5 250/1</td>
</tr>
<tr>
<td>Residual winding</td>
<td>VA, cl</td>
</tr>
<tr>
<td></td>
<td>50 – 200/6P</td>
</tr>
<tr>
<td>Secondary terminals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>max. 3 secondaries</td>
</tr>
<tr>
<td>Dimensional standard</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non standard</td>
</tr>
<tr>
<td>Electrical standards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IEC, DIN, BS, GOST, ANSI,..</td>
</tr>
</tbody>
</table>
Instrument transformers

- General information
- Current transformers
- Voltage transformers
- Outdoor transformers
- Sensors
- Application, arguments
Sensors …Electronic instrument transformers

- KEVCD types easily fit into OEMs’ panels (DIN42600)
- Both protection and metering done with one double rated sec. winding
- One single standard sensor for wide range of currents and voltages.
- Comply with IEC 60044-3,7,8 (Combi, I, U Sensors)

Un .. 24 kV
In .. 3200 A
Ithn (1s) .. 63 kA
Sensors …Electronic instrument transformers

Voltage sensors → Electronic instrument transformers → Current sensors

- resistive or capacitive divider
- Rogowski coil

Combi sensors

General application with REF_ – OEM, ..

Special application to ABB switchgear or apparatus
Instrument transformers according to IEC standards

IEC 60044-1…Current transformers
IEC 60044-2…Inductive voltage transformers
IEC 60044-3…Combined transformers
IEC 60044-5…Capacitor voltage transformers
IEC 60044-6…Protective current transformers for transient performance
IEC 60044-7…Electronic voltage transformers
IEC 60044-8…Electronic current transformers

IEC TC 38 - discussion to change structure of ITs norms
Related standards to electronic instrument transformers

- **Instr. transformers**
  - IEC 60044-3
  - IEC 60044-7
  - IEC 60044-8

- **Switchgear**
  - IEC 60694

- **VDS & VPIS**
  - IEC 61243-5
  - IEC 61958

- **Relays**
  - IEC 60255-5

- **Cables**
  - IEC 60055-1
  - IEC 61442
Sensors …Electronic instrument transformers

Standards:

- Primary sensor
- Primary converter
- Transm. system
- Secondary converter
- Relay

Power supply

ABB sensors:

- U-sensor
- I-sensor

Relay
The adapter enables to utilize the full functionality of sensor + relay system. The adapter is adjusting sensor output signal to the level suitable for different applications of IED.

The criterion of selection is based on the system current:
- No adapter: $I_r = 80 - 160 \text{ A}$
- Adapter 240A/150mV: $I_r = 160 - 480 \text{ A}$
- Adapter 640A/150mV: $I_r = 480 - 1250 \text{ A}$
Current Sensors

KECA 80 A1
KECA 300 A1
KECA 800 A1

KECR 17,5 AC1

Uniformly wound coil with non-magnetic core
Output signal is proportional to the derivate of primary current
IEC 60044-8
Nominal primary current
KECA 80, 300 or 800 A
KECR 180 A
Current sensor cl. 1.0

\[ u_{out} = M \frac{di_p}{dt} \]
Current sensor principle: Rogowski coil

- **ABB** Rogowski
  - $U_{\text{nominal}} = 0.150V$ (50Hz)
  - $I_{\text{nominal}} = 80A$
  - $Z_{\text{input}} = >4M\Omega$
- Safe
  - $U_{\text{output@50kA}} = 94V$
  - $P = U^2/R = 5.6 \times 10^{-9} W$

\[
u_{out} = M \frac{di}{dt} \quad \text{or} \quad \underline{U}_{out} = M \cdot j \cdot \omega \cdot I_p\]
Rated current: KEVCD current range calculation

Example: Combination suitable for 200 A, 50 Hz switchgear:

<table>
<thead>
<tr>
<th>Adapter</th>
<th>Transm. ratio</th>
<th>Us at Ip = 0.05x200 A</th>
<th>Ip at Us = 7.5 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>No adapter</td>
<td>80 A / 0.150 V</td>
<td>18.8 mV (OK)</td>
<td>4 000 A (Too small)</td>
</tr>
<tr>
<td>Adapter 1</td>
<td>240 A / 0.150 V</td>
<td>6.3 mV (OK)</td>
<td>12 000 A (OK)</td>
</tr>
<tr>
<td>Adapter 2</td>
<td>640 A / 0.150 V</td>
<td>2.3 mV (Too small)</td>
<td>32 000 A (OK)</td>
</tr>
</tbody>
</table>

Sensor

I_{pr} = 80-1250 A

Adapter

REF 542+:
U_{smax} = 7.5 V
U_{smin} = 5 mV

KEVCD
Sensors: Fewer rated currents

Current transformers

Current sensor

80-1250 A

80 A
480 A
1250 A

One single standard sensor can be used for a range of switchgear rating currents.
Sensors: Fewer cores

Current transformer

Multi-purpose sensor

Measurement and protection can be realised with one single secondary winding with double ratings.
Technical Information – current sensors

Current sensors – parameters

Primary currents …… 4 A up to 3200 A (according to sensor type)
Secondary signal…… 150 mV…50 Hz  160 mV…60 Hz
Rated short-time thermal current \( I_{\text{thn}}(1\text{sec.}) \) …
4;6.3;8;12;16;20;25;31.5;40;50kA
Highest voltage for equipment
3.6 kV up to 24 kV (1min..10-50 kV, BIL..20-125)
Accuracy classes:
measuring or protection: 1;3 (without correction factor)
Indoor epoxi resin - KEVCD, KEVCY_RE, KECR, KEVA
(or dry type – KECA)
Different length of cable 5m, 6,5 and 7,5 m for KEVCD,
Adaptors for 3 different rated currents (KEVCD)
Sensors must be connected to ABB relay only
(RE_ family – REF, REM, etc.)
Electronic CTs (sensors) versus Inductive CTs

Sensors $\rightarrow$ absence of iron
Electronic CTs (sensors) versus Inductive CTs

Open secondary (CT)

<table>
<thead>
<tr>
<th>Current transformer</th>
<th>Current sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="CT.png" alt="CT Diagram" /></td>
<td><img src="CurrentSensor.png" alt="Current Sensor Diagram" /></td>
</tr>
</tbody>
</table>

- \( U_{\text{open}} \)
- \( 0 - 10 \text{ kV} \)
- \( I_{sc} \)
- \( I_{sc}/A_{cu} = 40 \text{ mA/mm}^2 \)
Voltage Sensors (electronic VTs)

Resistive divider
- Matched resistor pair
- 1:10 000 divider ratio
- Accuracy up to class 1

Capacitive divider
- $Z_c = \frac{1}{\omega C}$
- 1:10 000 divider ratio
- Accuracy up to class 3
- Small size ideal for bushings

KEVI 24A1, 24 kV (GIS)

KEVA 24A__, 24 kV (AIS)
Voltage sensor principle: Capacitive divider

- **ABB** Capacitive voltage sensor
  - $C_1 = 15\text{pF}$
  - $C_2 = 150\text{nF}$
  - 1:10 000 divider ratio
- Passive element
- Accuracy up to class 3
- Small size ideal for bushings

Mathematical equation:

$$u_{\text{out}} = \frac{C_1}{C_1 + C_2} u_p$$
Voltage sensor principle: Resistive divider

- **ABB** Resistive voltage sensor
  - \( R_1 = 250 \, \text{MOhm} \)
  - \( R_2 = 25 \, \text{kOhm} \)
  - 1:10 000 divider ratio
  - Divider accuracy up to class 1
  - Passive element
  - < 10 meters cable

\[ u_{out} = \frac{R_2}{R_1 + R_2} u_p \]
Voltage sensors: smaller space needed

Voltage transformer

Voltage sensor

- Very small size
- Very low weight
Voltage sensors: smaller space needed

- Small volume
- Low weight
## Voltage sensor – parameters

Primary voltages $U_n$:

- $3; 6; 10; 15; 20kV$ (phase to earth $U_n/V_3$)

Secondary voltages (signal)…according to primary voltage level, **ratio always 10 000 :1**

Highest voltage for equipment:

- **3.6 kV up to 24 kV** ($1\text{min.}..10-50kV$, BIL..20-125kV)

Accuracy class:

- **measuring or protection**: 1; 3; 3P 6P;
- according to the type of voltage divider
  - (better accuracy for resistive divider)

Sensors must be connected to **ABB relay** only

(RE_ family – REF, REM, etc.)
Sensors (Electronic VTs) versus Inductive VTs

Linearity

Voltage error

Error limit, class 3P

Typical error, voltage sensor

Typical error, voltage transformer

U/Un %
Sensors (Electronic VTs) versus Inductive VTs

Short-circuited secondary (VT)

<table>
<thead>
<tr>
<th>Voltage transformer</th>
<th>Voltage sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{sc} = I_{normal}$</td>
<td></td>
</tr>
<tr>
<td>$I_{sc}/A_{cu} = 160$ A/mm$^2$</td>
<td></td>
</tr>
<tr>
<td>Temp. $\rightarrow$ 500 °C</td>
<td></td>
</tr>
<tr>
<td>Explosion within 30 s</td>
<td></td>
</tr>
</tbody>
</table>

$$15pF$$

$$150nF$$
Combi Sensors (Electronic transformers)

- Current and voltage sensors in the same block
- Measurement and protection by one sensor
- Dimensions and primary connections same as DIN-type CTs (DIN 42600)
- 12, 17.5, 24 kV, two types:
  - A. \( \leq 1250 \, \text{A} \)
  - B. > 1250 A (max. 3200 A)

KEVCD_AE3
KEVCD_AG3
KEVCD_BE2
KEVCD_BG2

The most frequent type

24kV, 630A
Current sensor (cl 3)
Voltage sensor (cl 5)

KEVCY 24 RE1

24kV, 630A
Current sensor (cl 3)
Voltage sensor (cl 5)

KEVCY 24 SA
KEVCY 24 SB
Sensors: compactness

Current transformer

Voltage transformer

Combined sensor
Combi sensor
voltage and current sensors in one block – parameters

Primary voltages $U_{n..}$
- $3; 6; 10; 15; 20$ kV (phase to earth $U_{n/V3}$)

Highest voltage for equipment
- $3.6$ kV up to $24$ kV (1min..10-50kV, BIL..20-125kV)

Primary currents
- $4$ A up to $3200$ A (according to sensor type)

Sensors must be connected to ABB relay only
(RE_ family – REF, REM, etc.)
Electronic ITs (Sensors) versus Inductive ITs

Secondary wiring I

Instr. transf. — Terminal blocks — Relay

Wiring and screw connections

Sensor — Integrated cable and connector — IED
## Sensors - advantages

<table>
<thead>
<tr>
<th>Feature</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. secondary signal</td>
<td>Safe</td>
</tr>
<tr>
<td>Secondary wiring</td>
<td>Integrated</td>
</tr>
<tr>
<td>Burden calculations</td>
<td>No</td>
</tr>
<tr>
<td>Short-circuited secondary</td>
<td>Safe</td>
</tr>
<tr>
<td>Open secondary</td>
<td>Safe</td>
</tr>
<tr>
<td>Frequency response</td>
<td>10 - 1000 Hz</td>
</tr>
<tr>
<td>Voltage test 50 Hz</td>
<td>Yes</td>
</tr>
<tr>
<td>Remanence</td>
<td>No</td>
</tr>
<tr>
<td>DC-test of cables</td>
<td>Yes</td>
</tr>
<tr>
<td>Ferroresonance</td>
<td>No</td>
</tr>
<tr>
<td>Weight</td>
<td>2 - 15 kg</td>
</tr>
<tr>
<td>Standardisation</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Minimum energy losses reduces the need for cooling aggregates in the switchgear or in the apparatus.
Electronic ITs (Sensors) versus Inductive ITs

3 combi sensors

3 CTs and 3 VTs
Savings in material and installation

All you need with sensors is...

Sensor / phase  Integrated cable and connector (included with sensor)  IED
Instrument transformers

General information

Current transformers

Voltage transformers

Outdoor transformers

Sensors

Application, arguments
Applications of indoor Instrument transformers

**The instrument transformers** are intended for panels and installations of ABB, but also for OEMs, Utilities and the loose market outside ABB.

**MV ITs in the different business areas:**
- Air and gas insulated switchgears
  - AIS primary distribution
  - AIS secondary distribution
  - GIS primary distribution
  - GIS secondary distribution
- Railway traction

**LV ITs in the different business areas:**
- MV AIS or GIS (on the cable)
- LV switchgear
Application of outdoor MV Instrument transformers

**MV ITs in the different business areas:**
- *Outdoor substation* with outdoor CBs, disconnectors, CTs, VTs
- *Railway traction* both CTs, VTs, mainly 27 kV
- *Overhead line* with switches, mainly double pole VTs
- *Generally* Replacement of old outdoor ITs worldwide

**with old PVB**
- OHB CB, TPO CTs

**with new TPO**
- New CTs, old VTs
The sensors are intended for panels and installations of ABB, but also (with ABB relays) for OEMs, Utilities and the loose market outside ABB.

**MV sensors in the different business areas:**
- Air and gas insulated switchgears
  - AIS primary distribution (KEVCD)
  - AIS secondary distribution (KEVCD)
- Another apparatus
  - With indoor CBs

Unigear
Uniswitch
Unimix
RMU
to OEM with RE_relay
Application of electronic transformers-sensors

MV sensors in the different business areas:
- Air and gas insulated switchgears
  - AIS primary distribution (KEVCD)
  - AIS secondary distribution (KEVCD)
  - GIS secondary distribution (KEVCY_RE)

- another apparatus
  - with indoor CBs
    - with SECTOS (KEVCY 24 SA or SB)
Sales Arguments: certification, experiences, technology

- **Over 50 years** of epoxy ITs manufacturing
- Continues **product development** program
- **CVT+ calc. program** available
- **APG technology**
- **Modern design**

**ABB CZ** – **GFF**
Global focused feeder
Factory for ITs and sensors

- Production of ITs with epoxy insulation
- Production of ITs with oil insulation

**Instrument transformers history, Brno, CZ**

- New production plant erected
- **ABB - Foundation of ITs division in CZ**
- **ABB**

- **2003**
- **1997**
- **1993**
- **1952**
- **1919**

**ET1 281**
**ET4 280**

- **20.25 00.01**
- **20.06 00.06**

- **Seismic withstand test available**
- **Tested and certified** according to different standards including GOST
- **Metrology approvals** from different countries available DE, CH, PL, SI, HU, SK, RO, RU, UA, LT, LV, BG, BH, etc.
- **ITs fully comply with various customer requirements**, **DIN design** available
- **References in more than 85 countries worldwide**, in all continents, more than 600 000 units in service
Applications of Electronic ITs (sensors), arguments

- Over 10 years of sensors manufacturing
- Continues product development program
- Modern design

<table>
<thead>
<tr>
<th>KECA_ voltage sensor</th>
<th>KEVA_A voltage sensor</th>
<th>KEVCY_AE combi sensor</th>
<th>KEVCD combi sensor</th>
<th>KEVCY_RE combi sensor</th>
<th>KEVCO combi sensor</th>
<th>KEVCD_A combi sensor (redesign)</th>
<th>KECR current sensor</th>
</tr>
</thead>
</table>


- Sensors fully comply with various customer requirements, DIN design available
- References in more than 35 countries, in all continents, more than 50 000 units in service

Some advantages obtained with the use of sensors:
- Savings in material and installation
- Losses negligible
- Short delivery times.
- Linearity over a wide range of current and/or voltage, logistic process is short.
- Versatile protection and control solutions.
- The sensors are linear up to the highest currents and voltages with a good dynamic performance.

- Overvoltage and disturbance withstand. Voltage sensors do not need to be disconnected for voltage testing
- They can not cause ferroresonance and are not sensitive to ferroresonance and DC-voltages.
- A broken circuit or short-circuit in the signal cable will cause no hazards or damage.
- Sensors - savings in project lead times
Instrument transformers into OEM panels

TPU xx.xx...3,6 up to 36 kV

Combi sensor KEVCD xx x...3,6 up to 24 kV

Current and Voltage sensors KECA xx ..3,6 up to 24 kV KEVA xx . 3,6 up to 24 kV

Low voltage „cable“ CTs KOLA, KOLMA, KOKM (PLZWA)

TJP x.x.... 3,6 up to 36 kV

TDC x .. 3,6 up to 36 kV

TJC x .. 3,6 up to 36 kV
Trend of Instrument transformers in ABB CZEJF
Export of Instrument transformers

ABB Czech Republic

NAM, LAM, WE, CEE, MENA, SSA, SEA, AU
Modern, the newest technology