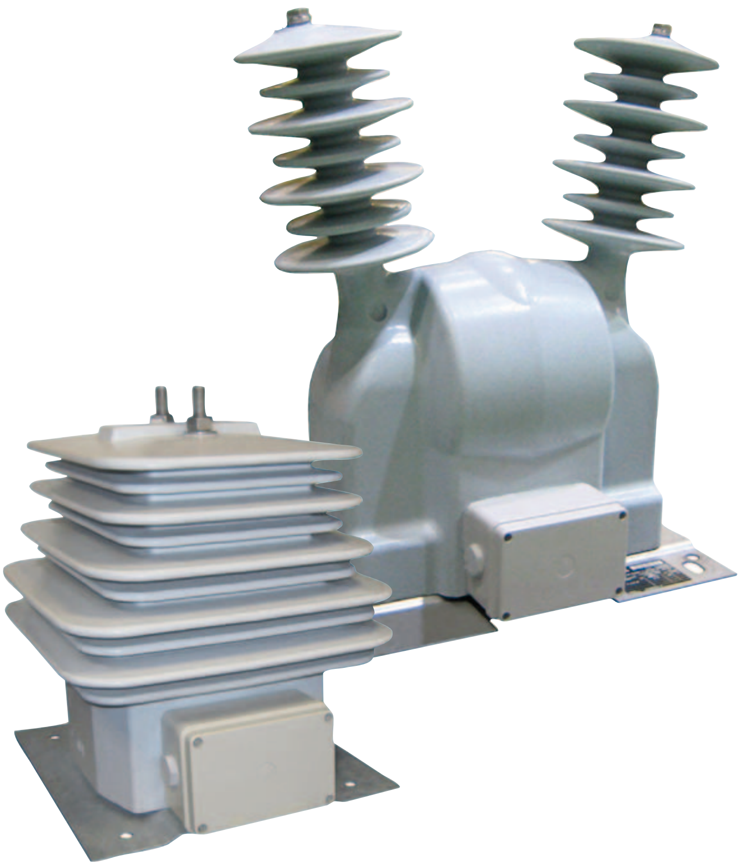
Medium Voltage Distribution
Catalogue | 2012

Outdoor instrument transformers

Current transformers
Voltage transformers



Make the most of your energy

Schneider Electric

General contents

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Presentation

The range of Schneider Electric, outdoor instrument transformers has been designed for 7.2 kV to 40.5 kV voltage and rated currents from 5 to 2500 A. In order to comply with higher short circuit levels in the systems, the current transformers have been designed to withstand 60 kA x 1 second short circuit currents.

All Schneider Electric instrument transformers are in conformity with IEC standards.

Current transformers can be in accordance with the accuracy classes “TPS-TPX-TPY-TPZ” defined by IEC 60044-6 standard refering to transformer behaviour during transient short circuit conditions.

Conformity with standards

All Schneider Electric instrument transformers are in conformity with IEC standards, sections 2099 - 2134, and recommendations 60044-1/IEC 60044-2.
Transformers in conformity with specific country standards can also be supplied (IEEE C57.13, NBR6855, NBR6856…).

Main features

The working parts (windings and magnetic cores) are entirely enclosed in an epoxy resin bloc casting, whose twofold function is to:

- guarantee electric insulation inside the device
- the highest strength.

The external surface of device is covered with silicon, whose function is to:

- insulation outside the device
- the highest strength.

Product quality over time is guarantee not only by thirty years experience in the field of resin insulated instrument transformer manufacturing but also by the use of **silica filled epoxy resin** which gives:

- high dielectric strength including at high temperatures (18 kV/mm at 180°C for 20,000 hours)
- insulation class B according to IEC 44-1 provisions
- extremely good ageing behaviour both to heat mass ageing according to IEC 216 (over 20 years at 120°C) and to surface ageing obtained in salty mist
- lack of emissions of any harmful substances in case of fire, in conformity with IEC standards IEC 60020-37, IEC 60020-22 and ASTM D 3286
- extremely effective behaviour in tropical climates
- high mechanical strength, even at high service temperatures: **Epoxy resin glass transition temperature ≥ 105°C.**

Accurate production process resulting in:

- no blisters or blowholes in the resin thanks to vacuum casting
- low constant partial discharge figure also thanks to the high quality of the other insulating materials used
- high strength and very good electric conductivity in primary and secondary terminals even at the temperatures reached during a short circuit, thanks to mechanical connections
- process parameters remaining unchanged over time thanks to computer control used to manage and monitor the whole production line.

Presentation

Quality is the result of scheduling and monitoring at each stage, from initial design through to production and testing, and right through to final delivery and after sales service.
This is expressed in terms of execution in conformity with the quality certification. This procedure allows us to supply a product that has all of the specified characteristics and also to provide the customer with a production and execution schedule that guarantees product quality.

Certified quality system

Schneider Electric's quality guarantee is certified in documents that are available on request:

- documents explaining the company's quality policy
- a schedule for each stage of each product's execution
- the continuous assessment of indicators checking all possible quality faults during the production process
- a set of technical/quality documents providing proof of what has happened throughout the production and testing processes so as to guarantee the required quality level.

The production process applies standardized methods for Quality Assurance and Control.
Quality Control plans ensure that the defined procedures are applied to the product, from testing through to delivery of equipment used in production right through to final production.
The initial phases of product design and industrialization are also subject to Quality Certification procedures.

The Schneider Electric quality system is certified by the CSQ
The CSQ (independent certification organization for quality management systems) has certified Schneider Electric's quality to be in conformity with IEC standard - EN 29001 (ISO 9001), which require a company to implement a comprehensive quality assurance system covering all aspects from product definition through to after sales service.

Protection for outdoor use

The silicon material used on Schneider Electric outdoor transformers is manufactured by world known companies.
The use of silicon for outdoor electrical equipment is a process well known in High Voltage Industry to prevent flashover and arcing, especially in severely contaminated envronments.
The experience obtained after more than 25 years of intensive use shows its efficiency and reliability, on glass and epoxy isolators.
Many additional tests were performed in Schneider's laboratories in order to verify all the properties needed for this use (dielectric strength-in volume and superficial, adhesion,ageing, ...).
The tests made show that an epoxy resin covered with silicon age less quickly than the same geometry made with cycloaliphatic resins.
The superficial breakdown strength is also higher with silicon than with resin.
In case of flashover (i.e. by overvoltage), the silicon has the unique property of maintaining hydrophobicity.
Other materials have to be changed.
Moreover, the silicon maintains its hydrophobicity during the lifetime of the transformer, as other polymeric materials which have hydrophobic properties to loose these properties after a relatively short time.

The design of Schneider Electric outdoor instruments transformers was studied in order to:
- perform the required behaviours on highest pollution level (level IV as described in document IEC815)
- perform the required behaviours for ageing, by application of silicon on the sand blasted surface of the resin.

The secondary connections are protected by an enclosure specially designed for electrical equipments, in compliance with all major standards (UL, CSA, CE, Lloyds, BV, FI). The materials used is polycarbonate which ensure the resistance to outdoor conditions.
The protection level, according with IEC529 is IP44 standard or higher level on request.

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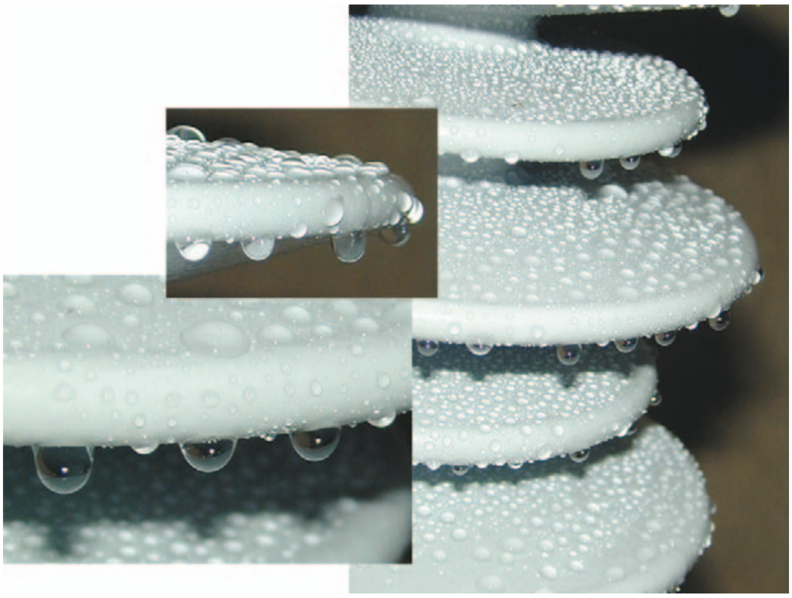

Applications and type

Protection or metering devices have to receive data on electrical values (current or voltage) from the equipment to be protected.
For technical, economic and safety reasons, this data cannot be obtained directly on the equipment's MV power supply; we have to use intermediary sensors:
- current transformers
- voltage transformers.

These devices carry out the functions of:
- reducing the size of value to be measured
- providing galvanic separation
- supplying the power needed to process the data, or even for the protection device to work.

Metering transformer applications

In MV electrical distribution, the high current and voltage values mean that they cannot be used directly by metering or protection units.
Instrument transformers are necessary to provide values that can be used by these devices which can be:
- analogue devices, directly using the supplied signal
- digital processing units with a microprocessor, after analogue/digital conversion of the input signal.

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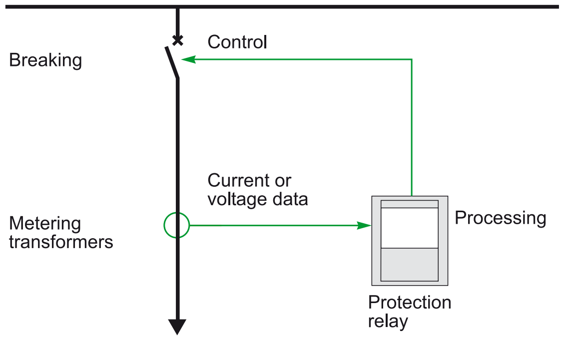

Example of metering transformer application in a protection system

Types

Instrument transformers are of the following types:

Current transformers
Connected on the MV network primary circuit, they supply a reduced current value to the secondary circuit, proportional to the network current on which they are installed.

Voltage transformers
Connected to the MV network primary, they supply the secondary circuit with a reduced voltage value, proportional to the network voltage on which they are installed.

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Technical description

Current transformers (CTs) meet standard IEC 60044-1.
Their function is to supply the secondary circuit with a current that is proportional to that of the MV circuit on which they are installed.
The primary is series-mounted on the MV network and subject to the same overcurrents as the latter and withstands the MV voltage.
The secondary generally has one of its terminals connected to earth.
The secondary must never be in an open circuit (short-circuit it if not loaded).

Current transformers
Current transformers have two basic functions:
- adapting the MV current value at the primary to the characteristics of the metering or protection devices by supplying a secondary current with a reduced, but proportional current value
- isolating power circuits from the metering and/or protection circuit.

Composition and types
A current transformer comprises a primary circuit and a secondary circuit connected via a magnetic core and an insulating coating system in epoxy-silica covered with silicon, in the case of Schneider Electric transformers.

Characteristics
These are defined in standard IEC 60044-1.

Insulation
Characterized by the rated voltage:
- of the insulation, which is that of the installation (e.g.: 24 kV)
- of the power frequency withstand 1 min (e.g.: 50 kV)
- of the impulse withstand (e.g.: 125 kV).

Rated frequency
50 or 60 Hz.

Rated primary current (Ipn)
Rms value of the maximum continuous primary current. Usual values are 25, 50, 75, 100, 200, 400, 600, 1000, 1200, 1600, 2000, 2500 A.

Rated secondary current (Isn)
This is equal to 1 A or 5 A.

Rated transformation ratio
Kn = I rated primary / I rated secondary (e.g.: 100 A / 5 A).

Short-time thermal current Ith - 1 second
This characterizes the thermal withstand under short circuit conditions for 1 second.
It is expressed in kA or in a multiple of the rated primary current (e.g.: 80 x Ipn) for 1 second.
The value for a **duration that is different to 1 second** is given by:
$I'th = Ith/\sqrt{t}$.
For example 16 kA - 1 s is equivalent for t = 2 s to $I'th = 16/\sqrt{2} = 11.3$ kA.

Selection guide
Technical description

Characteristics (cont.)

Short-time thermal current peak value
This value is standardized from Ith - 1 s at:
- IEC: 2.5 Ith at 50 Hz and 2.6 Ith at 60 Hz
- ANSI: 2.7 Ith at 60 Hz.

Accuracy load
The value of the load on which is based the metered current accuracy conditions.

Accuracy power Pn
Apparent power (VA) that the CT can supply on the secondary for the rated secondary current for which the accuracy is guaranteed (accuracy load).
Usual value 5 - 7.5 - 10 - 15 VA (IEC).

Accuracy class
Defines the limits of error guaranteed on the transformation ratio and on the phase shift under the specified conditions of power and current. Classes 0.5 and 1 are used for metering class P for protection.

Current error ε (%)
Error that the transformer introduces in the measurement of a current when the transformation ratio is different from the rated value.

Phase shift or phase error ψ (minute)
Difference in phase between the primary and secondary currents, in angle minutes.

Characteristics of voltage transformer

Characteristics	Rated values				
Rated voltage (kV)	7.2	12	17.5	24	36
Insulation level:					
■ power frequency withstand (kV) 1 min	20	28	38	50	70
■ lightning impulse withstand (kV - peak)	60	75	95	125	170
Frequency (Hz)	50 - 60				
Primary current Ipn (A)	25 - 50 - 75 - 100 - 200 - 400 - 600 - 1000 - 1200 - 1600 - 2000 - 2500				
Short-time thermal current Ith (1 s)	12.5 - 16 - 20 - 25 - 31.5 - 40 - 50 kA or 40 - 80 - 100 - 200 - 300 x In				
Secondary current Isn (A)	1 - 5				
Accuracy power Pn (VA)	2.5 - 5 - 7.5 - 10 - 15				

Selection guide
Technical description

The choice of CT is decisive in order for the overall metering or protection system to work properly.

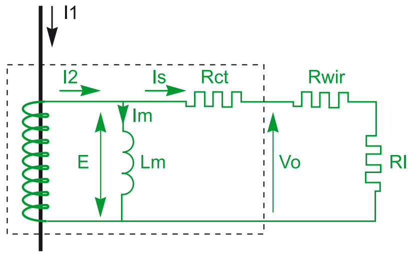
CT operation

Importance of CT selection

The operating accuracy of metering or protection devices depends directly on the CT accuracy.

Operating principle

A CT often has a load that is quite resistive (Rc + its wiring), as shown in the schematic diagram below.

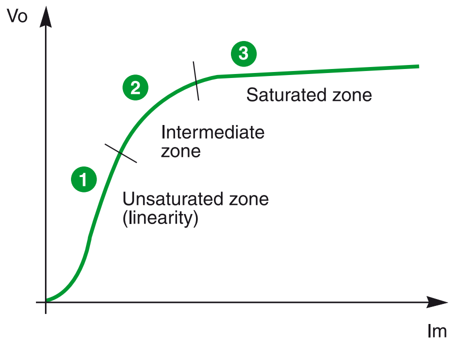


Schematic diagram for a current transformer
I1: primary current
I2 = Kn I1: secondary current for a perfect CT
Is: secondary current actually flowing through the circuit
Im: magnetizing current
E: induced electromotive force
Vo: output voltage
Lm: magnetization inductance (saturable) equivalent to the CT
Rtc: resistance at the CT secondary
Rfil: resistance of the connection wiring
Rc: load resistance

Current I2 is a perfect image of the primary current I1 in the transformation ratio. However, the actual output current (Is) is subject to an error due to the magnetization current (Im).

$\vec{I}_2 = \vec{I}_s + \vec{I}_m$ if the CT was perfect, we would have Im = 0 and Is = I2.

A CT has a unique magnetization curve (for a given temperature and frequency). With the transformation ratio, this characterizes its operation.
This magnetization curve (voltage Vo, magnetizing current function Im) can be divided into 3 zones:
1 - non-saturated zone: Im is low and the voltage Vo (and therefore Is) increases virtually proportionately to the primary current.
2 - intermediary zone: there is no real break in the curve and it is difficult to situate a precise point corresponding to the saturation voltage.
3 - saturated zone: the curve becomes virtually horizontal; the error in transformation ratio is high, the secondary current is distorted by saturation.



Magnetization curve (excitation) for a CT.
Output voltage as a function of the magnetizing current.
Vs = f (Im)

Metering CT or protection CT

We have to choose a CT with characteristics that are suited to its application.

Metering CT

This requires good accuracy (linearity zone) in an area close to the **normal service current**; it must also protect metering devices from high currents by saturating earlier.

Protection CT

This requires good accuracy at high currents and will have a higher precision limit (linearity zone) for protection relays to detect the protection thresholds that they are meant to be monitoring.

CT's for metering must have the right accuracy for the rated current.
They are characterized by their accuracy class (generally 0.5 or 1) as well as a safety factor Fs.

Example: 400/5 A, 15 VA, cl 0.5, FS 10

Primary current
Secondary current
Accuracy power
(see explanation in the example)
Accuracy class
Safety factor

Accuracy class according to application

Application	Class
Laboratory measurement	0.1 - 0.2
Accurate metering (calibration devices)	
Industrial metering	0.5 - 1
Billing metering	0.2 - 0.5 - 0.2S - 0.5S
Switchboard indicators statistical metering	0.5 - 1

Error limits according to the accuracy class

Accuracy class	% rated primary current	Current error ± %		Phase shift error ± min	
			For S		For S
0.2 / 0.2S	1 (0.2S alone)		0.75		30
	5	0.75	0.35	30	15
	20	0.35	0.2	15	10
	100	0.2	0.2	10	10
	120	0.2	0.2	10	10
0.5 / 0.5S	1 (0.5S alone)		1.5		90
	5	1.5	0.75	90	45
	20	0.75	0.5	45	30
	100	0.5	0.5	30	30
	120	0.5	0.5	30	30
1	5	3		180	
	20	1.5		90	
	100	1		90	
	120	1		90	

CT for metering

Accuracy class

A metering CT is designed to send an image as accurated as possible of currents below **120%** of the rated primary.
IEC standard 60044-1 determines the maximum error in the accuracy class for the phase and for the module according to the indicated operating range (see "error limits" table opposite).
These accuracy values must be guaranteed by the manufacturer for a secondary load of between 25 and 100% of the accuracy power.
The choice of accuracy class is related to the application (table opposite).
The usual accuracy class is 0.5 there are metering classes of 0.2S and 0.5S specifically for metering applications.

Safety factor: Fs

In order to protect the metering device connected to the CT from high currents on the MV side, instrument transformers must have early saturation characteristics.
The limit primary current (Ipl) is defined for which the current error in the secondary is equal to 10%. The standard then defines the Safety Factor FS.

$$FLP = \frac{Ip\,l}{Ip\,n}$$ (preferred value: **10**)

This is the multiple of the rated primary current from which the error becomes greater than 10% for a load equal to the accuracy power.

Example of a metering CT

Metering CT 400/5 A, 15 VA, cl. 0.5, FS 10
- rated primary current 400 A
- rated secondary current 5 A
- rated transformation ratio 400/5 A
- accuracy power 15 VA
- accuracy class 0.5.

The table or error limits given for class 0.5 for a primary current:
- between 100% and 120% of the rated current (here 400 A to 480 A), a current error ± 0.5% and the phase shift error of ± 30 min.
- at 20% (here 80 A) the error imposed by the standard is less than or equal to 0.75%
- between 20% and 100% of the rated current the standard does not give the metering point and the maximum error is between 0.5 and 0.75%, with a normally permitted linear variation between these two points
- safety factor FS = 10

For a primary current greater than 10 times the rated current, in other words here 4000 A, we will have a metering error > 10% if the load is equal to the accuracy load; for a load less than this we can still be in the linear part of the magnetization curve.

Selection guide

Technical description

CT's for protection must have suitable accuracy for fault currents. They are characterized by their accuracy class (generally 5P) and the accuracy limit factor ALF.

Example: 400/5 A, 15 VA, 5P10

Primary current
Secondary current
Accuracy power
(see explanation in the example)
Accuracy limit factor (ALF)
Accuracy class

CT for protection

Accuracy class

A protection CT is designed to send an image as reliable as possible of the **fault current** (overload or short circuit). The accuracy and the power are suited to these currents and different from those for metering applications.
IEC standard 60044-1 determines the maximum error for each accuracy class in the phase and in the module according to the indicated operating range.

Error limits according to the accuracy class

Accuracy class	Combined error for the accuracy limit current	Current error between Ipn and 2Ipn	Phase shift error for the rated current
5P	5%	± 1%	± 60 min
10P	10%	± 3%	No limit

For example for class 5P the maximum error is ⩽ ± 5% at the accuracy limit current and ⩽ ± 1% at the rated current.
Standardized classes are 5P and 10P. The choice depends on the application.
The accuracy class is always followed by the accuracy limit factor.

Accuracy class according to application

Application	Class
Zero sequence protection differential protection	5P
Impedance relay amperemetric protection	5P - 10P

Accuracy limit factor: ALF

A protection CT must saturate at sufficiently high currents to enable sufficient accuracy in the measurements of fault currents by the protection device whose operating threshold can be very high.
We define the limit primary current (Ipl) for which current errors and phase shift errors in the secondary do not exceed values in the table opposite.
The standard then defines the accuracy limit factor ALF.

$$ALF = \frac{Ip\,l}{Ip\,n}$$ (standardized values: **5 - 10 - 15 - 20 - 30**)

In practice this corresponds to the linearity limit (saturation curve) of the CT.

Example

Protection CT: **400/5 A, 15 VA, 5P10**.

- rated primary current 400 A
- rated secondary current 5 A
- rated transformation ratio 400/5 A
- accuracy power 15 VA
- accuracy class 5P.

Under a load corresponding to the accuracy power of 15 VA, the error limit table gives an error ⩽ ± 1% and ± 60 min at Ipn (400 A).

- accuracy limit factor 10.

At a load corresponding to the accuracy power, the error ⩽ ± 5% for a value of the primary current less than 10 x 400 = 4000 A.

Calculating the power (VA)

Indicative metering consumptions

Device		Max. consumption in VA (per circuit)
Ammeter	Electromagnetic	3
	Electronic	1
Transducer	Self-powered	3
	External powered	1
Meter	Induction	2
	Electronic	1
	Wattmeter, varmeter	1

Indicative protection consumption

Device	Max. consumption in VA (per circuit)
Static over-current relay	0.2 to 1
Electromagnetic over-current relay	1 to 8

Indicative secondary cabling consumption

Cables (mm^2)	Consumption (VA/m)	
	1 A	5 A
2.5	0.008	0.2
4	0.005	0.13
6	0.003	0.09
10	0.002	0.05

Selection guide
Technical description

Selection criteria

1 - Define the primary current Ipn
Use the standard values prescribed by IEC regulations:
10, 12.5, 15, 20, 25, 30, 40, 50, 60, 75 A and their decimal multiples.

2 - Define the short circuit current for 1 second Ith
The short circuit current generally refers to 1 second. Should this current be known for different time values "t", calculate the value for 1 second by applying the following formula:
Ith (for 1 sec.) = Ith x $\sqrt{t}$
e.g.: 25 kA for 3 sec. = 25 x $\sqrt{3}$ = 43.3 kA for 1 sec.

3 - Calculate the "K" coefficient
This value will be the access key to the various tables

$$K = \frac{\text{Ith x 1 sec.}}{\text{Ipn}}$$

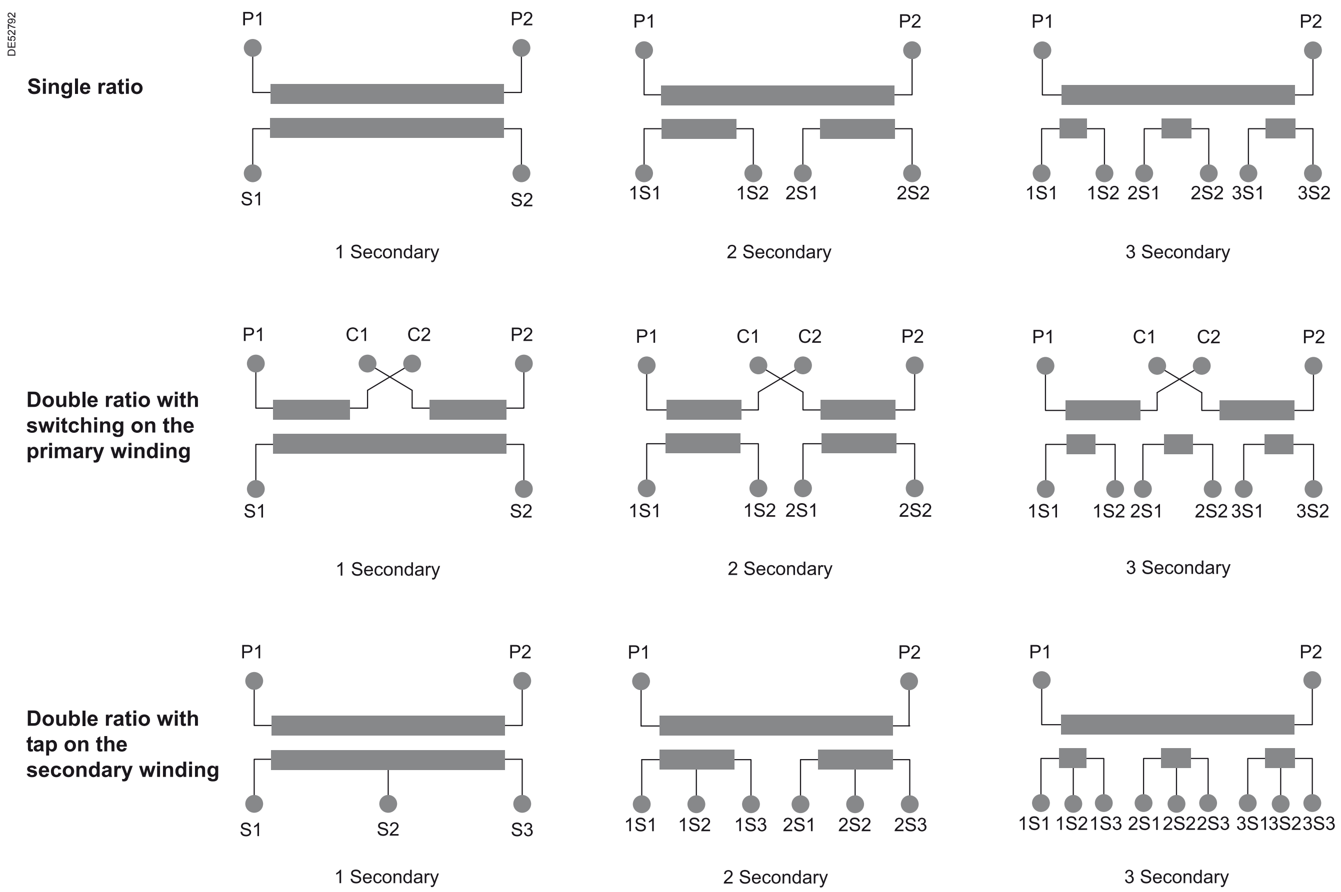
e.g.: Ipn = 100 A, Ith = 12.5 kA x 1 sec. => K = 12500/100 =125

4 - Position on the table
Enter the "K" column and position on the line corresponding to the K value immediately above the calculated value.
e.g.: calculated K = 125 = K line =150

5 - Check feasibility
A current transformer is feasible with the specifications indicated in the columns marked with .

Remarks:
For protection secondaries the following formula is guaranteed:
ALF x VA = constant K
e.g.: 10 VA / 5 P10 = 10 x 10 = 100
5 VA / 5 P20 = 5 x 20 = 100
WARNING: this equation is only guaranteed during the CTs selection phase.

Terminal markings



Current transformers
7.2 to 24 kV
Type OAM3/N1 - OAM3/N2

Single and double primary ratio

Characteristics

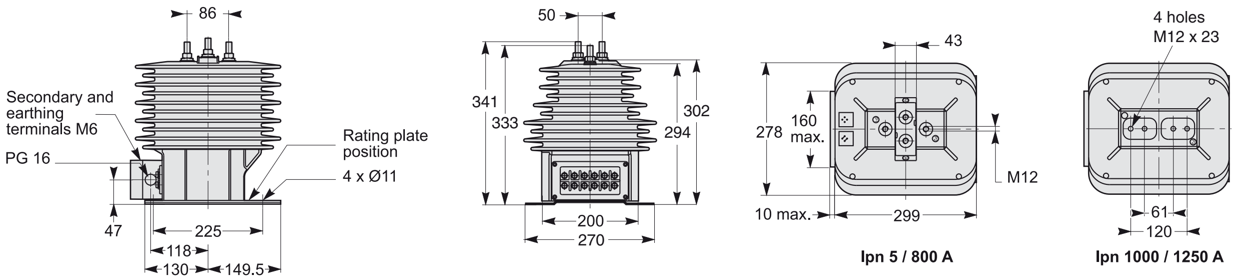
- Standard reference IEC 60044-1
- Rated highest voltage: 7.2 - 12 - 17.5 - 24 kV
- Rated continous thermal current 1.2 x Ipn
- Frequency 50 or 60 Hz
- Rated secondary current standard 5 or 1A
- For primary current < 800 A Double primary ratio through primary coupling
- For primary current > 800 A Double primary ratio through secondary reconnection
- Value “K=Ith/Ipn” must be fixed in comparison with the smaller rated primary current ratio
- Creepage distance > 700 mm
- Weight 25 kg.

Selection table

No. of secondaries per CT			1													2										
Standard types			OAM3/N1													OAM3/N2										
																1st measure secondary										
																Cl 0.5 Fs = 10										
																VA										
			Alternatively													5	7.5	10	15	20	20	30	30	30	30	30
"K" k = Ith/Ipn	Ipn Rated primary current (A)		Measure second						Protection second							2nd protection secondary										
			Cl 05						Cl 5P							Cl 5P										
Ith max 50 kA for 1 s			Fa = 10						ALF = 10							ALF = 10										
			VA						VA							VA										
	SR	DR	7.5	10	15	20	30	50	5	7.5	10	15	20	30	50	5	5	5	7.5	5	10	10	15	20	30	50
100	10 - 800	10-20 - 400-800																								
150	10 - 300	10-20 - 300-600																								
200	10 - 300	10-20 - 300-600																								
250	10 - 200	10-20 - 200-400																								
300	10 - 150	10-20 - 150-300																								
400	10 - 100	10-20 - 100-200																								
500	10 - 50	10-20 - 100-200																								
	1000																									
	1200																									
	1250																									
		500-1000																								
		600-1200																								

For other characteristics, please consult us.

Dimensions



Current transformers
7.2 to 40.5 kV
Type OAM7/N1 - OAM7/N2 - OAM7/N3

PE50725

Single and double primary ratio

Characteristics

- Standard reference IEC 60044-1
- Rated highest voltage: 7.2 - 12 - 17.5 - 24 - 36 - 40.5 kV
- Rated continous thermal current 1.2 x Ipn
- Frequency 50 or 60 Hz
- Rated secondary current standard 5 or 1 A
- For primary current < 800 A Double primary ratio through primary coupling
- For primary current > 800 A Double primary ratio through secondary reconnection
- Value “K=Ith/Ipn” must be fixed in comparison with the smaller rated primary current ratio
- Creepage distance > 1100 mm
- Weight 35 kg.

Selection table

<table>
<tr><td colspan="3">No. of secondaries per CT</td><td colspan="13">1</td><td colspan="11">2</td><td colspan="5">3</td></tr>
<tr><td colspan="3">Standard types</td><td colspan="13">OAM7/N1</td><td colspan="11">OAM7/N2</td><td colspan="5">OAM7/N3
1st measure secondary
Class 0.5
Fs = 10
VA</td></tr>
<tr><td colspan="27"></td><td>5</td><td>10</td><td>15</td><td>20</td><td>30</td></tr>
<tr><td colspan="16"></td><td colspan="11">1st measure secondary
Class 0.5
FS = 10
VA</td><td colspan="5">2nd protection secondary
Class 5P
ALF = 10
VA</td></tr>
<tr><td colspan="3"></td><td colspan="13">Alternatively</td><td>5</td><td>7.5</td><td>10</td><td>15</td><td>20</td><td>20</td><td>30</td><td>30</td><td>30</td><td>30</td><td>30</td><td>5</td><td>5</td><td>7.5</td><td>10</td><td>15</td></tr>
<tr><td>"K"
k = Ith/Ipn
Ith max 50 kA for 1 s</td><td colspan="2">Ipn
Rated primary current (A)</td><td colspan="6">Measure second
Class 0.5
Fa = 10
VA</td><td colspan="7">Protection second
Class 5P
ALF = 10
VA</td><td colspan="11">2nd protection secondary
Class 5P
ALF = 10
VA</td><td colspan="5">3rd protection secondary
Class 5P
ALF = 10
VA</td></tr>
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<tr><td>100</td><td>10 - 800</td><td>10-20 - 400-800</td><td colspan="29"></td></tr>
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<tr><td></td><td>1250</td><td></td><td colspan="29"></td></tr>
<tr><td></td><td>2000</td><td></td><td colspan="29"></td></tr>
<tr><td></td><td>2500</td><td></td><td colspan="29"></td></tr>
<tr><td></td><td></td><td>500-1000</td><td colspan="29"></td></tr>
<tr><td></td><td></td><td>600-1200</td><td colspan="29"></td></tr>
<tr><td></td><td></td><td>750-1500</td><td colspan="29"></td></tr>
<tr><td></td><td></td><td>1000-2000</td><td colspan="29"></td></tr>
</table>

For other characteristics, please consult us.

Dimensions

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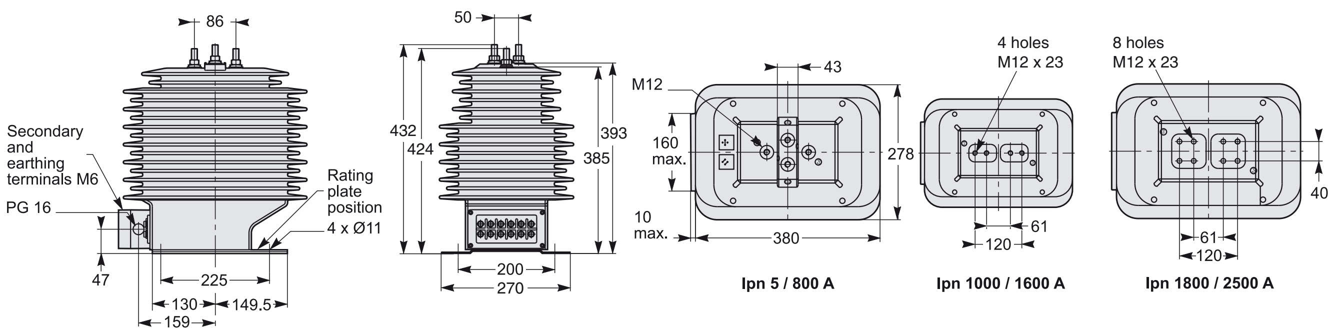

Contents

Selection guide
Technical description

Voltage transformers (VT) meet standards IEC 60044-2.
Their function is to supply a voltage proportional to the MV circuit that they are installed on to the secondary.
The primary, which is parallel mounted on the MV network between phases of from phase to earth, is subject to the same overvoltages as the latter. The secondary supplies a voltage that is virtually constant, whatever the load.
The secondary must never be placed in short circuit.

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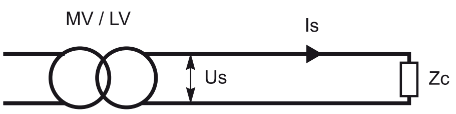

Simplified schematic diagram of a voltage transformer
IS: secondary current
Us: secondary voltage
Zc: load impedance.

Voltage transformers (VT)
Voltage transformers have two key functions:
- adapting the value of MV voltage on the primary to the characteristics of metering or protection devices by supplying a secondary voltage that is proportional and lower
- isolating power circuits from the metering and/or protection circuit.

Composition and type
These comprise a primary winding, a magnetic core, one or several secondary windings, with everything encapsulated in an insulating resin covered with silicon.
There are two types, according to how they are connected:
- phase/phase: primary connected between two phases
- phase/earth: primary connected between a phase and the earth.

Characteristics
These are defined by standard IEC60044-2.

Insulation
Characterized by the rated voltages:
- insulation voltage, which will be that of the installation (e.g.: 24 kV)
- power frequency withstand 1 min (e.g.: 50 kV)
- impulse withstand (e.g.: 125 kV)

Rated frequency
50 or 60 Hz.

Rated primary voltage (Upn)
According to their design, voltage transformers are connected:
- either between phase and earth and in this case Upn = U/3 (e.g.: 20/√3)
- or between phases and in this case Upn = U.

Rated secondary voltage (Usn)
This is equal to 100 or 110 V for phase/phase voltage transformers. For single phase, phase/earth transformers, the secondary voltage must be divided by √3 (e.g.: 100/√3).

Accuracy power Pn
Apparent power (VA) that the VT can supply the secondary for the rated secondary voltage for which the accuracy is guaranteed (accuracy load).
Standardized values 30, 50, 100 VA (IEC).

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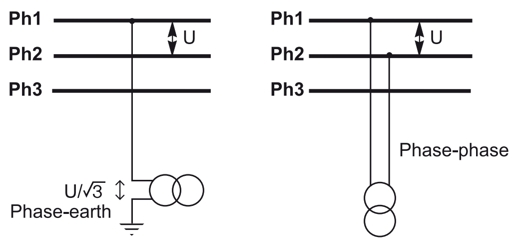


Connection of a VT

Selection guide
Technical description

Characteristics (cont.)

Accuracy class
Defines the error limits guaranteed relative to the transformation ratio and the phase shift under specified conditions of power and voltage.

Voltage error ε (%)
Error that the transformer introduces into the voltage measurement when the transformation ratio is different from the rated value.

Phase shift or phase error (ψ in minutes)
Phase difference between primary and secondary voltages, in angle minutes.

Rated voltage factor KT
This is the factor, a multiple of the rated primary voltage, which determines the maximum voltage which the transformer must meet the specified temperature rise and accuracy recommendations. The maximum operating voltage depends on the network neutral system and the earthing conditions of the primary winding.

Table of voltage factors KT

Voltage factor	Rated duration	Connection mode	Network neutral
1.2	Continuous	Between phases	Any
	Continuous	Between the star-connected transformer neutral point and earth	Any
1.2	Continuous	Between phase and earth	DIrectly earthed
1.5	30 s		
1.2	Continuous	Between phase and earth	Earthed via a limiting resistor with automatic earthing fault elimination
1.9	30 s		
1.2	Continuous	Between phase and earth	Insulated neutral without automatic earthing fault elimination
1.9	8 h		
1.2	Continuous	Between phase and earth	Earthed via a limiting resistance with automatic earthing fault elimination

Table of voltage transformer characteristics

Characteristics	Rated values				
Insulating voltage (kV)	7.2	12	17.5	24	36
Insulation level:					
■ power frequency withstand (kV) (1) 1 min	20	28	38	50	70
■ ligthning impulse withstand (kV - peak)	60	75	95	125	170
Frequency (Hz)	50 - 60				
Frequency voltage U1n (kV) divided by 3 if single phase)	3 - 3.3 - 5 - 5.5 - 6 - 6.6 - 10 - 11 - 13.8 - 15 - 20 - 22 - 30 - 33				
Secondary voltage U2n (V)	100 - 110 or 100/3 - 110/3				
Accuracy power (A)	30 - 50 - 100				

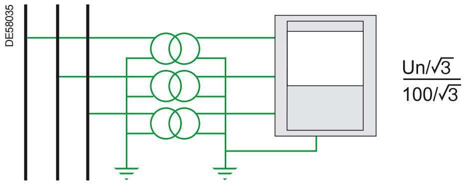
***(1)** When there is a major difference between the highest voltage for the equipment (Um) and the rated primary voltage, the power frequency must be limited to five times the rated voltage.*

VT operating characteristics

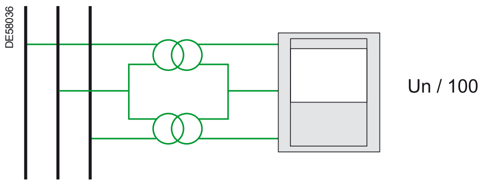
Operation of a VT is more simple than that of a CT because the secondary voltage is virtually independent of the load, due to it being connected through a high impedance (virtually used in an open circuit).
Therefore, the secondary must not be short circuited. Under these conditions an excessively high current will damage the transformer.

Selection guide
Technical description

VT connections
Several metering connection arrangements are possible (fig. opposite)
■ star-connection of 3 transformers: requires 1 isolated MV terminal for each transformer
■ connecting to 2 transformers, so-called V-connection: requires 2 isolated MV terminals per transformer.

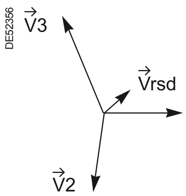


Star-connected VT and example of transformation ratio



V- connected VT and example of transformation ratio

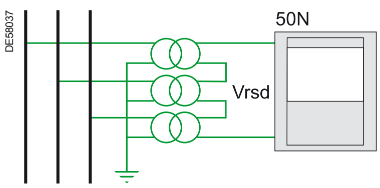
Residual voltage metering
The residual voltage. which characterizes the voltage of the neutral point relative to earth, is equal to the vectorial sum of the three phase-earth voltages.
The residual voltage is equal to 3 times the zero-sequence voltage V0.



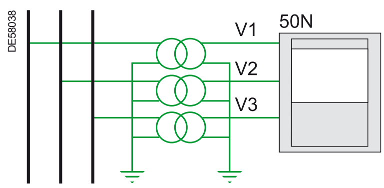
$$\overrightarrow{Vrsd} = 3 \cdot \overrightarrow{V0} = \overrightarrow{V1} + \overrightarrow{V2} + \overrightarrow{V3}$$

Please note, it is impossible to measure a residual voltage with ***phase/phase VT's***.

The appearance of this voltage signifies the existence of an earthing fault.
It is obtained by measurement or by calculation:
■ measuring by three voltage transformers whose primary circuits are star-connected and whose secondary circuits are open-delta connected, supplying the residual voltage (1)
■ calculation by the relay based on three voltage transformers whose primary and secondary circuits are star-connected (2).



(1) Direct measurement of the residual voltage



(2) Calculation of the residual voltage

Selection guide
Technical description

Voltage transformer for metering

Accuracy class

These devices are intended to send an image as accurately as possible of the rated primary voltage between 80 and 120% of the latter.
The accuracy class determines the permissible error in the phase and in the module in this range for the accuracy load.
It is valid for all loads of between 25 and 100% of the rated accuracy power with an inductive power factor of 0.8.
The table below gives the usual classes according to application.

Application	Class
Accurate laboratory metering applications (calibration devices)	0.2
Billing metering industrial measurements	0.2
Statistical switchboard metering indicators	0.5 - 1

■ Class 0.5 corresponds to an error ⩽ ± 0.5% for the rated primary voltage, with the accuracy load over the secondary.
■ Class 1 corresponds to an error ⩽ ± 1% in the same conditions.
For a given accuracy class, voltage and phase-shift errors must not exceed the values indicated in the table opposite.

Error limits according to the accuracy class

Accuracy class	Voltage error (ratio) ± %	Phase-shift error ± mm
0.2	0.2	10
0.5	0.5	20
1	1.0	40

Example:
Metering voltage transformer $\frac{20\,000}{\sqrt{3}} / \frac{110}{\sqrt{3}}$, 50 VA, cl. 0.5
■ rated primary voltage 20000 V/√3, rated secondary 110 V/√3
■ accuracy power 50 VA
■ accuracy class 0.5. The table of limit error values gives, under the specified conditions for the accuracy class:
□ a primary voltage 80% to 120% of the rated voltage (16 kV to 24 kV)
□ a load of between 25% and 100% of the accuracy power, i.e. between 12.5 VA and 50 VA with an inductive power factor of 0.8, the metering errors will be ⩽ ± 0.5% for voltage and ⩽ ± 20 min for phase shift.

Voltage transformer for protection

Accuracy class

These devices are intended to send an image that is as accurate as possible of the voltage in the case of a fault (voltage drop or overvoltage).
They must have the right accuracy and power for the fault voltages and therefore different from those used for instrument transformers.
In practice, the accuracy class 3P is used for all applications and the error limits for voltage and phase given in the table below.
These are guaranteed for all loads of between 25 and 100% of the accuracy power with an inductive power factor of 0.8.

Error limits for each accuracy class

Accuracy class	Voltage (± %) between		Phase shift error (minutes) between	
	5% Upn and KT	2% Upn and KT	5% Upn and KT	2% Upn and KT
3P	3	6	120	240
6P	6	12	240	280

KT: over-voltage coefficient.
Upn: rated primary voltage.

Example:
Protection voltage transformer $\frac{20\,000}{\sqrt{3}} / \frac{110}{3}$, 100 VA, 3P, KT = 1.9 8 h
■ the rated primary voltage 20000 V/√3, rated secondary 110 V/3
■ accuracy power 100 VA
■ accuracy class 3P. The table of limit values shows that for:
□ a primary voltage of 5% of the rated voltage at KT times the rated voltage, i.e. 20000 x 5% = 1000 V at 20000 x 1.9 = 38000 V
□ a load of between 25% and 100% of the accuracy power, in other words of between 25 VA and 100 VA with a power factor of 0.8, the metering error will be ⩽ ± 3% in voltage and ⩽ ± 120 min in phase shift.

Selection guide
Technical description

Selection criteria

1 - Define the primary voltage Upn
According to the installation voltage (U) and the type of transformer connection:
- between phase and ground (Upn = U/√3)
- between phase and phase (Upn = U)

VT accuracy is always guaranteed to be between 0.8 Upn and 1.2 Upn. Use this information to choose standard voltage values.

2 - Define the rated insulation level
The rated insulation level should be that immediately above the primary voltage level.
Note: the industrial power frequency test according to IEC standards should be carried out by applying the formula:
5 x Upn with a maximum value given by the corresponding insulation value.

3 - Define the secondary voltage Usn
The standard values are:
- 100 and 110 divided by √3, for instrument and protection Y-connected windings
- 100 and 110 divided by 3, for residual voltage open delta connection.

4 - Define the frequency
Values are either 50 or 60 Hz.

5 - Voltage factor
It is the factor by which the primary voltage Upn should be multiplied in order to determine the maximum insulation voltage for the Um device:
- 1.9 for 8 hours, for insulated pole voltage transformers (phase-ground)
- 1.2 permanent, for insulated pole voltage transformers (phase-phase).

6 - Position on the table
Enter the column corresponding to the number of secondaries and the type of (actual or relative) performance simultaneity.

7 - Check feasibility
The feasible characteristics are identified by the columns with boxes marked:

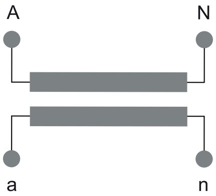
Reference voltage for insulation

Max. reference voltage for insulation	Single (grounded) pole	Two (insulated) pole
7.2 kV	3:√3 - 3.3:√3 - 6:√3 - 6.6:√3 kV	3 - 3.3 - 6 - 6.6 kV
12 kV	6:√3 - 6.6:√3 - 10:√3 - 11:√3 kV	6 - 6.6 - 10 - 11 kV
17.5 kV	10:√3 - 11:√3 - 15:√3 kV	10 - 11 - 15 kV
24 kV	15:√3 - 20:√3 - 22:√3 - 24:√3 kV	15 - 20 - 22 - 24 kV
36 kV	25:√3 - 30:√3 - 33:√3 - 36:√3 kV	25 - 30 - 33 - 36 kV

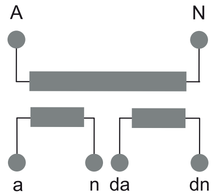
Terminal markings

DE52794

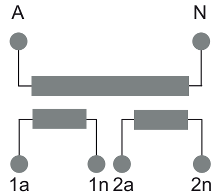
Single (grounded) pole



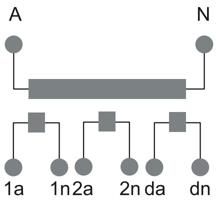
1 Secondary
(instrument or protection)



2 Secondaries
(one instrument and
one residual voltage)
SEPARATED
OPERATION

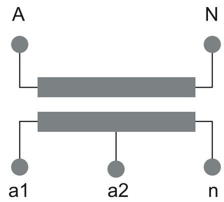


2 Secondaries
(two instrument
and/or protections)
SIMULTANEOUS
OPERATION



3 Secondary
(2 instruments and/or protections
plus 1 residual voltage)

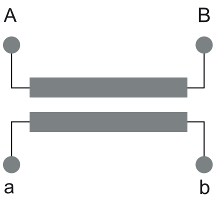
Simultaneous operation for
the first two and separate
operation for the third



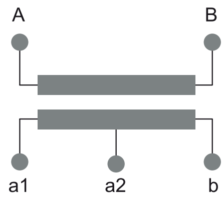
Double primary ratio
(with tap at secondary)

a1-n SMALL RATIO
a2-n HIGHT RATIO

Two (insulated) poles



1 Secondary
(instrument or protection)



Double primary ratio
(with tap at secondary)

a1-b SMALL RATIO
a2-b HIGHT RATIO

Calculating the power (VA)

Indicative metering consumption

Device		Max consumption in VA (per circuit)
Voltmeter	Electromagnetic	5
	Electronic	1
Transducer	Self-powered	5
	External power	2
Meter	Induction	5
	Electronic	4
	Wattmeter, varmeter	5

Indicative protection consumption

Device	Consumption in VA (per circuit)
Static overvoltage relay	0.2 to 1
Electromagnetic overvoltage relay	1 to 9

Voltage transformers
Phase-earth 7.2 to 24 kV
Type OVF2n/S1 - OVF2n/S2 - OVF2n/S3

PE50727

Description
Voltage transformer for phase-ground connection.

Characteristics
- Standard reference: IEC 60044-2
- Standard primary voltage Upn: 3 - 3.3 - 5 - 5.5 - 6 - 6.6 - 10 - 11 - 13.8 - 15 - 20-22:√3 kV
- Rated insulation level: 7.2 - 12 - 17.5 - 24 kV
- Rated secondary voltage Usn: 100:√3 - 100:3 - 110:√3 - 110:3 V
- Frequency: 50 or 60 Hz
- Rated voltage factor: 1.9 for 8 hours
- Thermal burden: 300 VA
- Creepage distance > 700 mm
- Weight 35 kg.

Table of options

No. of secondaries for VT		1						2												3		
Standard type		**OVF2n/S1**						**OVF2n/S2**												**OVF2n/S3**		
Application		Measuring or protection						1st measure 2nd protection or measure						1st measure or protection 2nd residual voltage						1st 2nd measure or protection 3rd residual voltage		
Standard secondary voltage (V)		100:√3 or 110:√3						100:√3 - 100:√3 or 110:√3 - 110:√3						100:√3 - 100:3 or 110:√3 - 110:3						100:√3 or 110:√3 and 100:3 or 110:3		
Operation		-						Separate						Separate						Simultaneous separate		
3rd secondary	Accuracy class	-						-						-						3P		
	Output	-						-						-						75	50	100
2nd secondary	Accuracy class	-						0.5 or 1						3P						0.5 or 1		
	Output	-						15	20	30	30	50	75	50	50	75	50	75	100	30	50	75
1st secondary	Accuracy class	0.2			0.5			0.2			0.5			0.2			0.5			0.5		
	Output	30	40	50	50	75	100	15	20	30	30	50	75	25	30	50	50	75	100	30	50	75

For other characteristics, please consult us.

Dimensions

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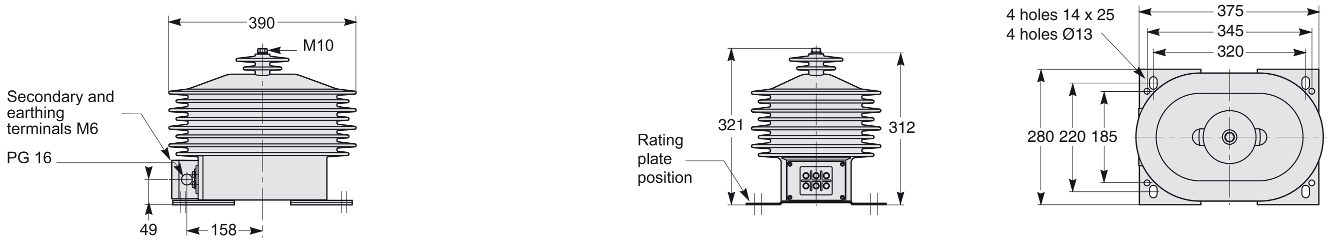
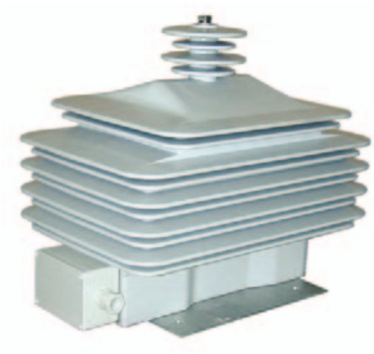


Voltage transformers
Phase-earth 36 kV
Type OVF3n/S1 - OVF3n/S2 - OVF3n/S3

PE50728



Description
Voltage transformer for phase-ground connection.

Characteristics
- Standard reference IEC 60044-2
- Standard primary voltage Upn: 30 - 33 - 35:$\sqrt{3}$ kV
- Rated insulation level: 36 kV
- Rated secondary voltage Usn: 100:$\sqrt{3}$ 100:3 110:$\sqrt{3}$ 110:3 V
- Frequency 50 or 60 Hz
- Rated voltage factor: 1.9 for 8 hours
- Thermal burden: 450 VA
- Creepage distance > 1100 mm
- Weight 45 kg.

Table of options

No. of secondaries for VT		1						2												3		
Standard type		**OVF3n/S1**						**OVF3n/S2**												**OVF3n/S3**		
Application		Measuring or protection						1st measure 2nd protection or measure						1st measure or protection 2nd residual voltage						1st 2nd measure or protection 3rd residual voltage		
Standard secondary voltage (V)		100:$\sqrt{3}$ or 110:$\sqrt{3}$						100:$\sqrt{3}$ - 100:$\sqrt{3}$ or 110:$\sqrt{3}$ - 110:$\sqrt{3}$						100:$\sqrt{3}$ - 100:3 or 110:$\sqrt{3}$ - 110:3						100:$\sqrt{3}$ or 110:$\sqrt{3}$ and 100:3 or 110:3		
Operation		-						Simultaneous						Separate						Simultaneous separate		
3rd secondary	Accuracy class	-						-						-						3P		
	Output	-						-						-						75	50	100
2nd secondary	Accuracy class	-						0.5 or 1						3P						0.5 or 1		
	Output	-						15	20	30	30	50	75	50	50	75	50	75	100	30	50	75
1st secondary	Accuracy class	0.2			0.5			0.2			0.5			0.2			0.5			0.5		
	Output	30	40	50	75	100	150	15	20	30	30	50	75	25	40	50	50	75	100	30	50	75

For other characteristics, please consult us.

Dimensions

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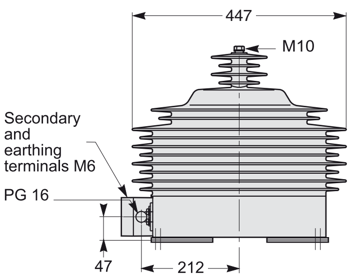
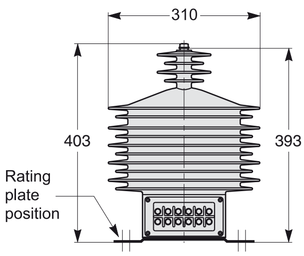
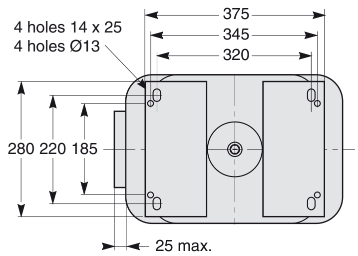


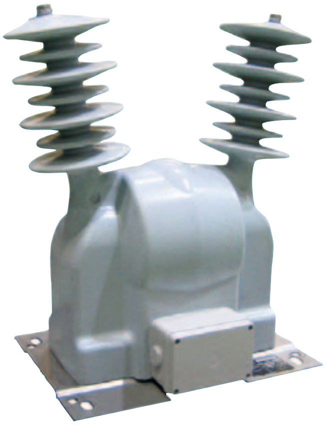




Outdoor voltage transformers (VTs)

Voltage transformers
Phase-phase 7.2 to 24 kV
Type OVC2/S1 - OVC2/S2

PE58462



Description
Voltage transformer for phase-phase connection.

Characteristics
- ■ Standard reference IEC 60044-2
- ■ Standard primary voltage Upn: 3 - 3.3 - 6 - 6.6 - 10 - 11 - 15 - 20 - 22 - 24 kV
- ■ Rated insulation level: 7.2 - 12 - 17.5 - 24 kV
- ■ Rated secondary voltage Usn: 100 -100 or 110 -110 V
- ■ Frequency 50 or 60 Hz
- ■ Rated voltage factor: 1.2 ill.
- ■ Thermal burden:
- □ OVC2/S1 = 500 VA
- □ OVC2/S2 = 250 ± 250 VA
- ■ Creepage distance phase-ground > 700 mm
- ■ Creepage distance phase-phase > 1400 mm
- ■ Weight 33 kg.

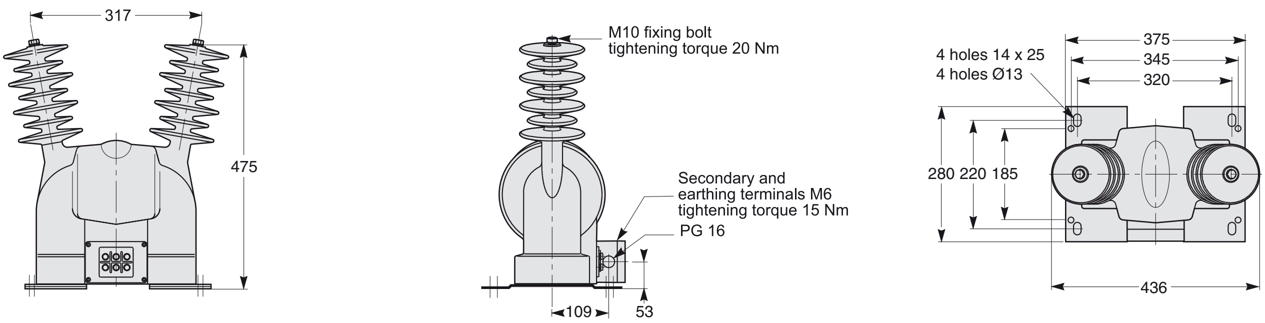
Table of options

No. of secondaries for VT		1					2				
Standard type		**OVC2/S1**					**OVC2/S2**				
Application		Measuring or protection					1 for measure or protection (1st sec.) 1 for protection (2nd sec.)				
Standard secondary voltage (V)		100 or 110					100 - 100 or 110 - 110				
Operation		-					Simultaneous				
2nd secondary	Accuracy class	-					0.5 or 1		0.5 or 1		
	Output	-					15	25	30	50	100
1st secondary	Accuracy class	0.2			0.5		0.2		0.5		
	Output	25	50	50	75	100	15	25	30	50	100
Feasibility											

For other characteristics, please consult us.

Dimensions

DE58044EN



Voltage transformers
Phase-phase 36 kV
Type OVC3/S1 - OVC3/S2

PE50730

Description
Voltage transformer for phase-phase connection.

Characteristics
- ■ Standard reference IEC 60044-2
- ■ Standard primary voltage Upn: 30 - 33 - 35 kV
- ■ Rated insulation level: 36 kV
- ■ Rated secondary voltage Usn: 100-100 or 110-110 V
- ■ Frequency: 50 or 60 Hz
- ■ Rated voltage factor: 1.2 ill.
- ■ Thermal burden:
- □ OVC3/S1 500 VA
- □ OVC3/S2 250 ± 250 VA
- ■ Creepage distance phase-ground > 900 mm
- ■ Creepage distance phase-phase > 1560 mm
- ■ Weight 43 kg.

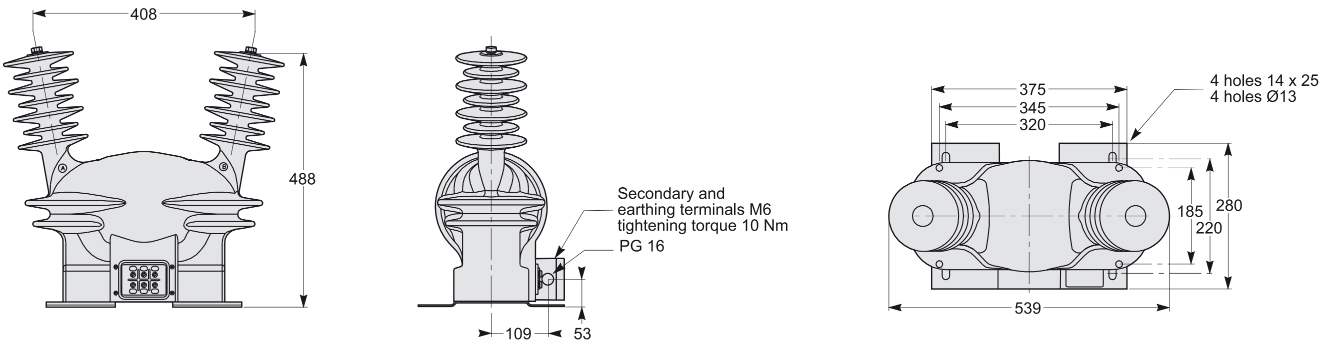
Table of options

No. of secondaries for VT		1					2				
Standard type		**OVC3/S1**					**OVC3/S2**				
Application		Measuring or protection					1 for measure or protection (1st sec.) 1 for protection (2nd sec.)				
Standard secondary voltage (V)		100 or 110					100 - 110 or 110 - 110				
Operation		-					Simultaneous				
2nd secondary	Accuracy class	-					0.5 or 1		0.5 or 1		
	Output	-					15	20	30	50	100
1st secondary	Accuracy class	0.2			0.5		0.2		0.5		
	Output	25	50	50	75	100	15	20	30	50	100
Feasibility											

For other characteristics, please consult us.

Dimensions

DE52799



Contents

Ordering informations
Current and voltage transformers

Order form

Tick the appropriate box X and fill in these [ ] the needed value
[ ] : boxes for double primary voltage

Common characteristics

Type					Quantity [ ]
Standard			IEC [ ]	ANSI [ ]	AS [ ]
Frequency			50 Hz [ ]		60 Hz [ ]
Highest voltage for equipment (kV)	7.2 [ ]	12 [ ]	17.5 [ ]	24 [ ]	36 [ ]
Number of secondaries			1 [ ]	2 [ ]	3 [ ]
Rating plate language			French [ ]	English [ ]	Spanish [ ]

CT's specifications

Primary

Rated short time current		(kA) [ ]	(kA) [ ]
Rated primary current	1st rated (A) [ ]	2nd rated (A) [ ]	3rd rated (A) [ ]

Secondary

	1st secondary		2nd secondary		3rd secondary	
	Protection [ ]	Measure [ ]	Protection [ ]	Measure [ ]	Protection [ ]	Measure [ ]
Rated secondary current		(A) [ ]		(A) [ ]		(A) [ ]
Rated output		(VA) [ ]		(VA) [ ]		(VA) [ ]
Accuracy class		[ ]		[ ]		[ ]
Security factor (FS) / accuracy limit factor (ALF)		(FS / ALF) [ ]		(FS / ALF) [ ]		(FS / ALF) [ ]

VT's specifications

Primary

Phase type		Phase / ground [ ]	Phase / phase [ ]
Rated primary voltage	1st rated (kV) [ ]	2nd rated (kV) [ ]	3rd rated (kV) [ ]

Secondary

	1st secondary		2nd secondary		3rd secondary	
	Protection [ ]	Measure [ ]	Protection [ ]	Measure [ ]	Protection [ ]	Measure [ ]
Rated secondary voltage	(V) [ ]	[ ]	(V) [ ]	[ ]	(V) [ ]	[ ]
Rated output	(VA) [ ]	[ ]	(VA) [ ]	[ ]	(VA) [ ]	[ ]
Accuracy class	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Simultaneous operation						[ ]
Separate operation						[ ]

Options accessories

Routine test	French [ ]	English [ ]	Spanish [ ]

Notes

Notes

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