Medium Voltage Instrument Transformers
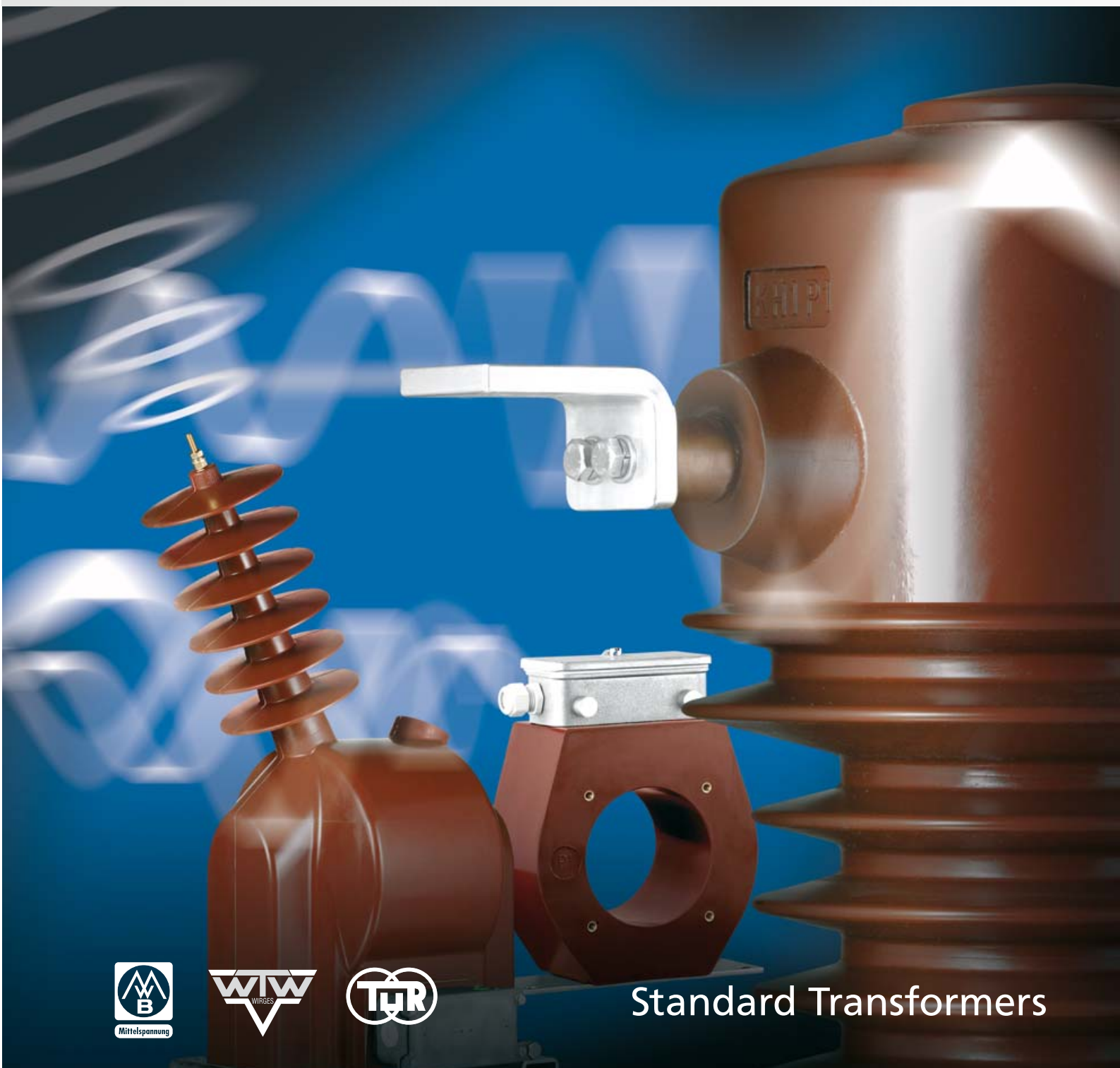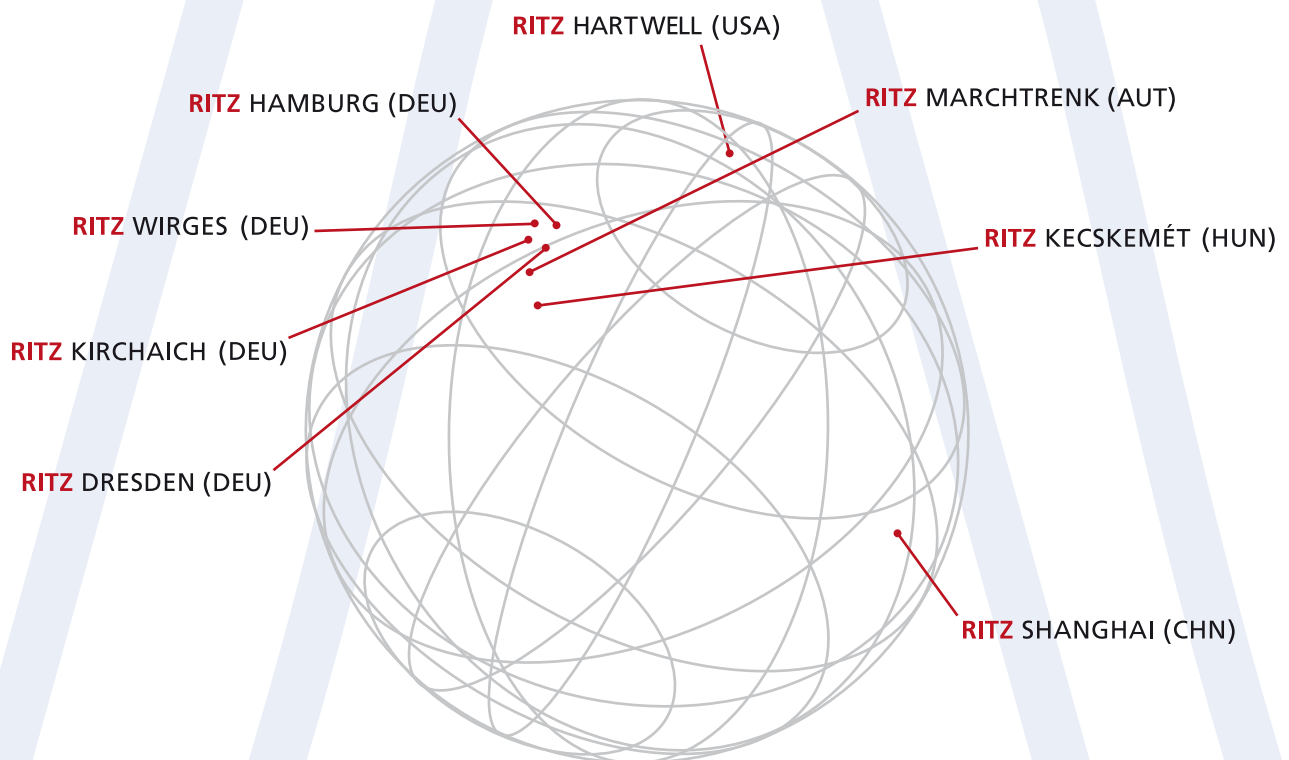
Standard Transformers

RITZ Instrument Transformers GmbH – Core competency

Under the trading name „RITZ Instrument Transformers GmbH" RITZ has been pooling its activities to gather new strengths since 01.08.2007.

The tradition and knowledge of the parent company „RITZ Messwandler Hamburg" and the subsidiary „RITZ Messwandler Dresden (TuR)" has been united with the companies "Wandler- und Transformatoren-Werk Wirges (WTW) and "Messwandlerbau Bamberg (MWB)" under this name. This merger unites a total of more than two hundred years of know-how in instrument transformers production.

In addition, RITZ has decided to concentrate on the core business of medium voltage and low voltage transformers in which the high voltage division is sold. The resources gained through this shall now be applied for additional innovations and quality standards in the medium and low voltage products. RITZ is therefore securing its position on the global market.

The overseas corporations of RITZ Instrument Transformer GmbH in Austria (Marchtrenk), Hungary (Kecskemét), China (Shanghai) and USA (Hartwell) strengthen the company's position on the international market.

RITZ HARTWELL (USA)

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RITZ KIRCHAICH (DEU)

RITZ DRESDEN (DEU)

RITZ SHANGHAI (CHN)

Contents

1.0. Medium Voltage Current and Voltage Transformers

1.1 General

Instrument transformers are transformers, which convert high currents or voltages into measurable and standardized currents or voltages, which are proportional and in-phase to the primary signal. They are intended to supply electrical measuring instruments, meters, relays or other electrical devices.

CT according to DIN-Design

PT according to DIN-Design

Current Transformer

A current transformer is designed to convert the primary rated current which flows through the primary winding.

The secondary winding must generally be short circuited at any time, otherwise dangerous high voltages can occur at the secondary terminals.

The secondary connected devices are connected in series.

Current Transformers can be equipped with one or more independent magnetic cores with equal or different characteristics for measuring, metering and/or protective purposes.

Voltage Transformer

Voltage transformers have only one iron core with attached secondary winding (s).

If an open delta circuit (da-dn) is necessary, an additional winding can be provided for single pole insulated transformers.

It is extremely dangerous to short circuit a voltage transformer.

For single pole insulated transformers the end of the primary winding is grounded as "N" inside of the secondary terminal box, and must not be removed during operation.

1.2 Design

Instrument transformers can be differentiated into different designs through their specification and application. The following basic designs exit:

• Supporting types according to DIN 42600 (only for indoor use) or designed according to customer requirement for indoor and outdoor application

• Bushing types for indoor and outdoor application

• Voltage transformers, single or double pole insulated, for indoor and outdoor application.

Support type current transformers for indoor applicationss

Single pole voltage transformer for indoor applications

High current bushing type current transformer

Outdoor voltage transformer with characteristic shields to extend the creepage distance

1.3 Current Transformer

Current transformers are transformers which convert high currents into measurable and standardized currents proportional and in-phase to the primary signal.

A current transformer can be equipped with one or more independent ferromagnetic cores made of silicon or nickel iron steel.

The secondary winding (W2) is symmetrically wound around the iron core. This causes a very intensive magnetic coupling of the primary to the secondary winding. The number of turns of the secondary winding depends on the ratio between the primary and the secondary rated current. The iron core(s) and the secondary winding must be grounded.

Depending on the primary rated current and the short time current (I_{th}), the primary winding (W1) consists of one solid winding (primary conductor) or a number of turns.

The primary winding is designed for the full rated current and has the same potential as the busbar.

The highest system voltage (phase to phase voltage) has to be considered for the design of the transformer with respect to its insulation between the primary and the secondary winding.

The windings W1 and W2 as well as the iron core(s), together with the secondary winding(s) are completely resin-embedded and casted in a single production step by using a pressure gelation casting process.

Rating Plate — Primary Conductor (W1) — Cast Resin

Terminal Box sealable

Earthing Terminal

Cable Bushing — Secondary Terminals — Core 1 W2 — Core 2 W2 — Bottom Plate
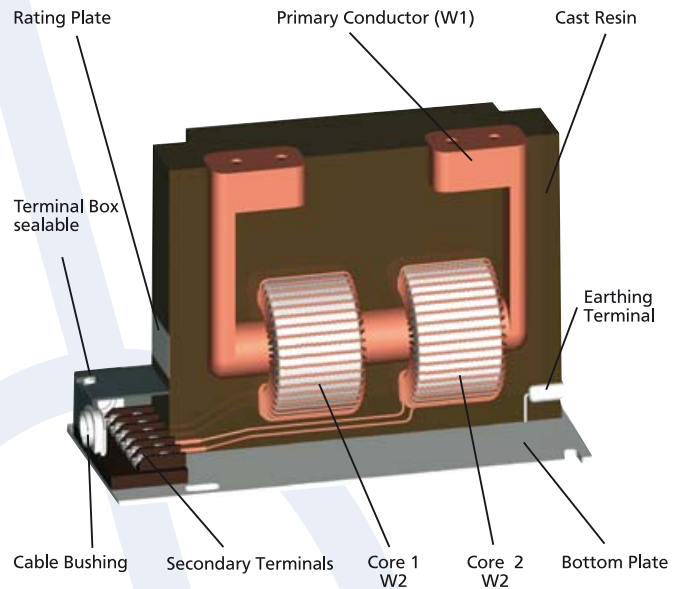
General design sample of a current transformer

The resin body is mounted on a metal plate. The secondary terminals are embedded in the resin body and protected by a plastic box. The cover of the box is removable and can be sealed. Each secondary terminal can be separately grounded inside the secondary terminal box. The grounding screw is connected to the bottom plate. The terminal box is equipped with two or three removable cable plugs, which makes wiring easy.

The ends of the primary winding are provided with flat terminals ("P1/P2"), made of copper or brass alloy, and located at the top of the resin body.

A M8 grounding screw is available on the bottom plate for grounding the current transformer. Grounding can take place directly on the frame of the switchgear or on a separate grounding bar.

1.3.1 Choice Limitations of the Rated Burden

Especially for small rated primary currents, and high rated short time thermal currents (I_{th}), the rated burden of a current transformer is limited due to the maximum permissible kAW-value (ampere turns). In this case, information should be requested from the manufacturer.

If the rated burden of a current transformer is calculated according to the formula

$$P_N = \frac{(AW)^2 \cdot Q_{Fe} \cdot K}{l_{Fe}} \ [VA]$$

AW   primary ampere turns
Q_{Fe} iron cross section (mm^2)
K   constant
l_{Fe} ferromagnetic circuit (cm)

it becomes evident that, if the ampere turns (AW) can be doubled, a burden which is four times higher can be achieved. Physically speaking, however, this is not always feasible, because the ampere turns are limited by the rated dynamic current (I_{dyn}). The reason for this is the force of the magnetic field intensity which, in case of a short circuit, attempts to mutually balance the individual primary windings. Furthermore, the maximum rated burden depends on the size of the resin body.

1.3.2 Definitions

1.3.2.1 Rated Primary and Secondary Current

The value of the primary and secondary current indicates the performance rating of the transformer. A common practice is to use a secondary rated current of 1 or 5 A. The primary rated current depends on the network and is defined by the end user.

Economically speaking, a secondary rated current of 1A should be chosen in order to keep the rated burden low, especially for long wiring distances.
$P_N = I^2 \cdot R + P_B$

1.3.2.2 Rated Continuous Thermal Current

This is the value of the current which can be permitted to flow continuously through the primary winding while the secondary winding is connected to the rated burden, without the rise in temperature exceeding the values specified.

It is common practice that the rated continuous thermal current is equal to the rated current but a higher current can also be defined.

1.3.2.3 Rated Short Time Thermal Current

The r.m.s value of the primary current is the value which a transformer will withstand for one or three seconds without suffering harmful effects, should the secondary wiring be short circuited.

1.3.2.4 Rated Dynamic Current

The peak value of the primary current is the value which a transformer will withstand, without being damaged electrically or mechanically by the resulting electromagnetic forces, should the secondary winding be short circuited.

1.3.2.5 Burden

Burden is the impedance of the secondary circuit and power factor in ohms. The burden is usually expressed as the apparent power in volt amperes (VA) at a specified power factor and at the rated secondary current.

1.3.2.6 Rated Burden

The value of the burden is based on the accuracy requirements of this specification.

1.3.2.7 Error Limits

The composite error for metering cores has to be higher than 10% to protect the connected metering devices in case of over currents. In the opposite the composite error for protection cores at the rated accuracy limit of the primary current should be smaller or equal 5% (5P) or 10% (10P) to secure a proper tripping of the connected protection devices.

1.3.2.8 Instrument Security Factor

In the event of a system fault when a current is flowing through the primary winding of a current transformer, the apparatus is offered the highest level of protection by the transformer when the security factor value (FS) of the rated instrument is small.

1.3.3 Metering Current Transformer

This is a current transformer intended to supply indication instruments, integrating meters and similar apparatus.

1.3.3.1 Accuracy Class

This is the limit of the permissible percentage of current error at the rated current. In general, the limits of current error are calculated for a range between 1% up to 120% of rated current.

Permissible limits for current error (F_i) and phase displacement (δ_i) according to IEC 60044-1

Accuracy Class	± percentage of current error at percentage of rated current					± phase displacement in minutes at percentage of rated current				
	1	5	20	100	120	1	5	20	100	120
Measuring Current Transformers										
0,1	-	0,4	0,2	0,1	0,1	-	15	8	5	5
0,2 S	0,75	0,35	0,2	0,2	0,2	30	15	10	10	10
0,2	-	0,75	0,35	0,2	0,2	-	30	15	10	10
0,5 S	1,5	0,75	0,5	0,5	0,5	90	45	30	30	30
0,5	-	1,5	0,75	0,5	0,5	-	90	45	30	30
1	-	3,0	1,5	1,0	1,0	-	180	90	60	60
Protective Current Transformers										
5 P	-	-	-	1	-	-	-	-	60	-
10 P	-	-	-	3	-	-	-	-	-	-

Instrument Transformer Error Limits for Accuracy Class 0.1

Instrument Transformer Error Limits for Accuracy Class 0.2s; 0.2

Instrument Transformer Error Limits for Accuracy Class 0.5s; 0.5

Instrument Transformer Error Limits for Accuracy Class 1
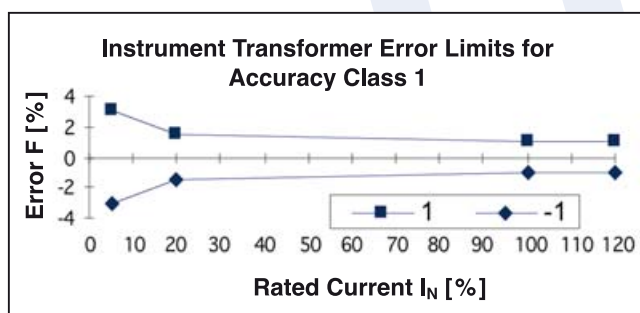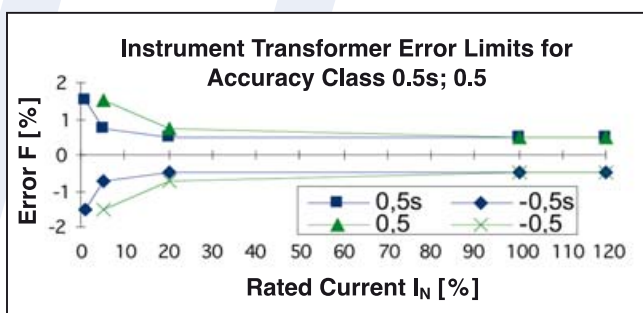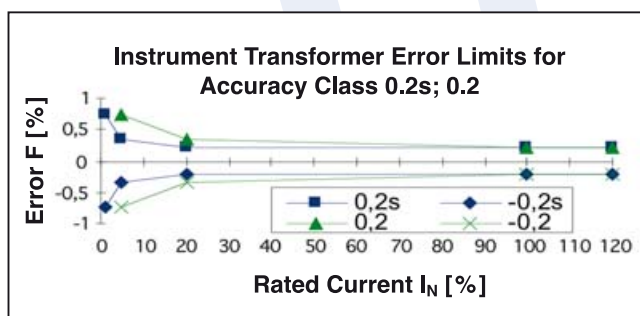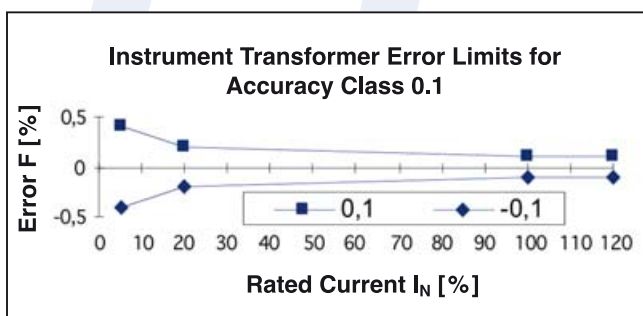
1.3.4 Protective Current Transformer

A current transformer intended to supply protective relays. Protective current transformers are marked with the letter "P".

1.3.4.1 Special Request

On request current transformers can be designed for higher extended current ratings than the standard value of 120%. Additional typical values are for example 150% and 200%. This means that accuracy is guaranteed at 150% or 200% of the rated primary current.

1.3.5 Reconnection of Current Transformer

In case of changeable ratios, for example extension of nominal rated current, it is possible to design the transformer with primary reconnection or secondary tapping.

1.3.5.1 Primary Reconnection

The primary reconnection can only be used for primary currents up to 2 x 600A and for current transformers which have a primary winding consisting of several primary turns. The ratio of the reconnection is always 1:2.

C1 – C2 low rated current   P1/C1 – P2/C2 high rated current
Circuit Diagram Primary Reconnection

For primary reconnection, the primary winding consists of two winding sections (P1-C2 & C1-P2) which can either be connected in series or parallel.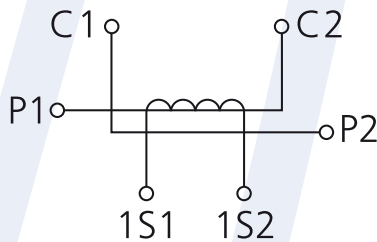 The changeover will be done at the primary side by using joint bars. In case of primary reconnection the rated burden, the accuracy, and the instrument security factor remains unchanged.

1.3.5.2 Secondary Tapping

For secondary tapping the secondary winding is wound on the iron core in two or more separate sections. The ends of these are connected to the secondary terminals. Changeover will be performed at the secondary side. In the case that the primary rated current should be changed to the lower current, the accuracy class between 0.2 and 3 will decrease at approximately the square value of the reduction in primary current. The ratings of the protective cores of class 5P or 10P decrease almost proportionally to the reduction of the primary current.
The values of the rated short time thermal current, as well as the dynamic current, remains the same at all ratios.
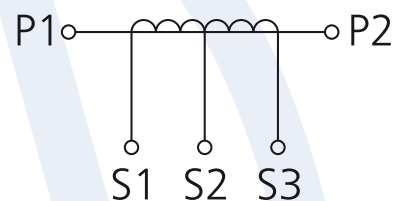
S1 – S3 high rated current   S1 – S2 low rated current
Circuit Diagram Secondary Tapping

1.3.6 Over Current Range

In the event of a system fault, the secondary rated current increases in proportion to the primary rated current up to the limit of the primary current.
The error limits will only be observed of the secondary burden is equal to the rated burden. If the burden is different to the rated burden, the instrument security factor will be changed.
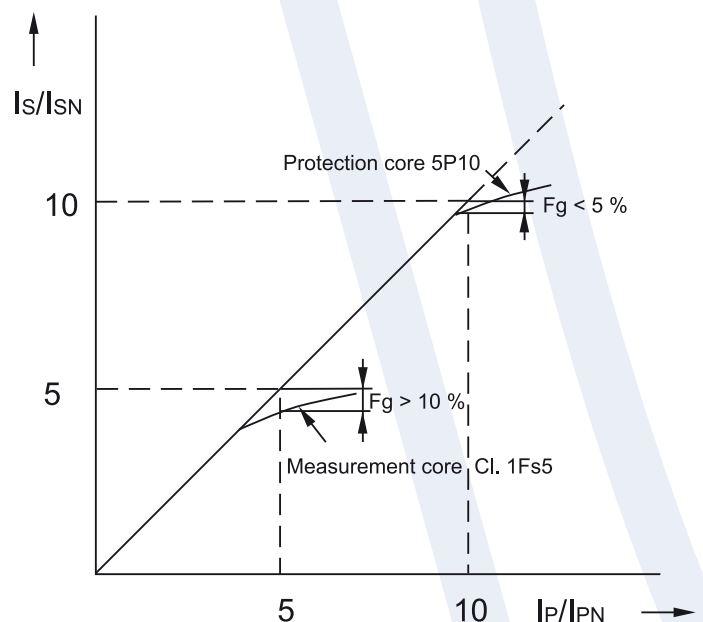
1.3.7 Service and Grounding

The secondary winding must generally be connected to a burden or be short circuited at all times; otherwise dangerous high voltages can occur in the secondary terminals. One end of the secondary winding as well as all other metal parts of the transformer must be grounded.
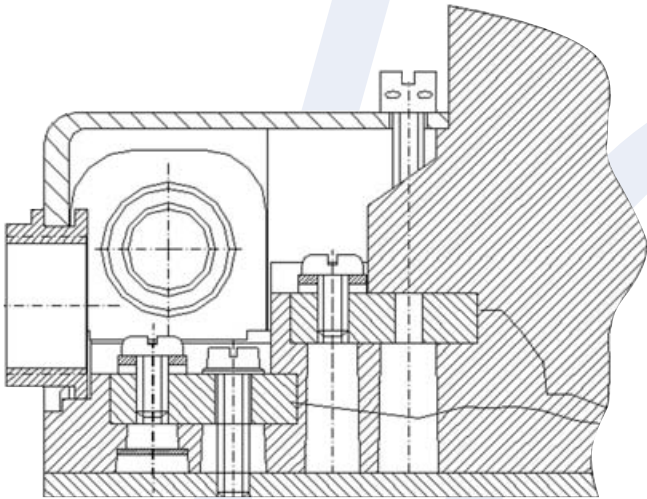
Secondary terminal with grounding screw of a current transformer type ASS.

1.3.8 Capacitive Divider

With reference to the guidelines of the modern switch gear it is required, and it is common practice with respect to safe handling of the switch gear, that the doors and all coverings can only be opened after the panel is de-energized. This will be achieved by using a voltage indicator which is mounted in the front door of the panel.

The voltage indicator consists of a capacitive divider splitting the voltage U between phase and ground into two voltages, namely U1 and U2. An indicating device, which is connected between the terminal CK inside of the secondary terminal box and earth.

Indication range
Smaller than $0,1 \times U_N$ no indication
Equal or greater than $0,4 \times U_N$ safe indication

All supporting type current transformers can be equipped with a capacitive divider.

The capacitive divider is embedded in the resin body. The capacity C_{2W} is connected to the terminal CK inside of the secondary terminal box. A surge arrester is connected between the terminals CK and earth and is intended to limit the output voltage.
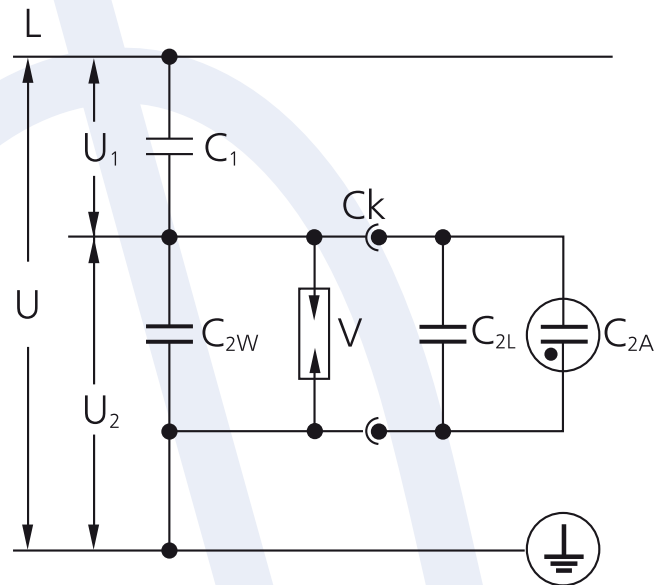
Circuit diagram capacitive divider

C_{2A}	voltage indicator
C_1	upper capacity
C_{2W}	lower capacity
C_{2L}	lead capacity
Ck	terminal
L	high voltage
U	line to ground voltage
U_1	partial voltage at C_1
U_2	partial voltage at C_2 ($C_{2W} + C_{2L} + C_{2A}$)
V	surge arrester

1.4 Voltage Transformer

Voltage transformers are transformers which convert high voltages into measurable and standardized voltages proportional and in-phase to the primary signal.
Voltage transformers have only one magnetic iron core with attached secondary winding (s).
Voltage transformers can be provided either as single pole or double pole insulated designs. An additional winding can be provided for single pole insulated transformers (da-dn) if necessary for an open delta circuit.
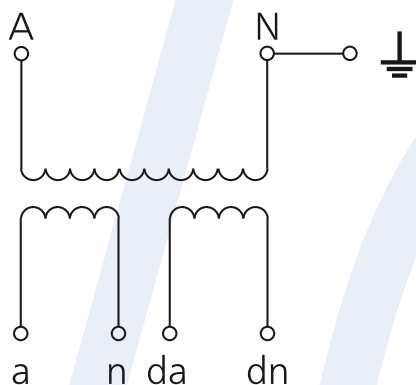
Schematic single pole insulated voltage transformer with an open delta winding
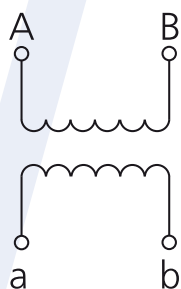
Schematic double pole insulated voltage transformer

It is extremely dangerous to short circuit a voltage transformer.

The end of the primary winding in single pole insulated transformers is grounded as „N" inside of the secondary terminal box, and must not be removed during operation.

1.4.1 V-Connection of Two Double Pole Insulated Voltage Transformers

When using two double pole insulated transformers connected in „V-connection", it must be strictly observed that the secondary winding(s) of only one of the two transformers is grounded. This is in order to avoid a short circuit between these two transformers.
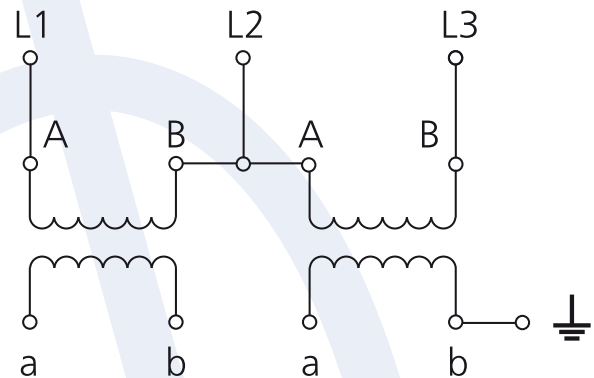
Schematic V-connection

1.4.2 General Design

Voltage transformers have only one magnetic iron core. For single pole insulated voltage transformers the secondary winding(s) are attached directly to the grounded iron core. In single pole insulated transformers the secondary winding(s) are directly attached to the grounded iron core. In double pole insulated voltage transformers the insulation between primary and secondary winding(s) has to be designed for one half of the phase to ground voltage.
The secondary windings are designed to withstand a test voltage of 3 kV against each other.
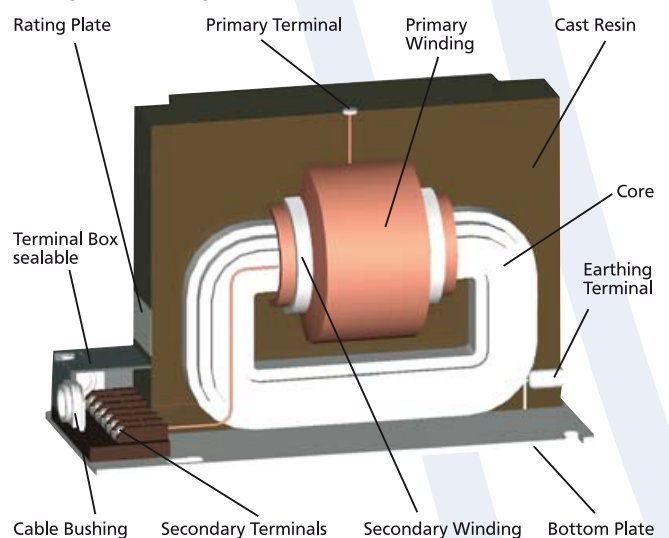
General design sample of a single pole voltage transformer

The high voltage winding as well as the secondary winding(s) are completely embedded in resin and casted in a single production step by using a pressure gelation casting process.

The resin body is mounted on a metal plate. The secondary terminals are embedded in the resin body and protected by a plastic box. The cover of the box is removable and can be sealed. Each secondary terminal can be separately grounded inside the secondary terminal box. The grounding screw is connected to the bottom plate. The terminal box is equipped with two or three removable cable plugs, which makes wiring easier.

The end(s) of the primary winding are provided with inserts (M10) made of copper or brass alloy, and located at the top of the resin body.

A M8 grounding screw is available on the bottom plate for grounding the voltage transformer. Grounding can take place directly on the frame of the switchgear or on a separate grounding bar.

1.4.3 Definitions

1.4.3.1 Highest Voltage for Equipment
The highest r.m.s. phase to phase voltage for which a transformer is designed with respect to its insulation.

1.4.3.2 Rated Primary and Secondary Voltage
The value of the primary and secondary voltage, which appears in the designation of the transformer, and on which its performance is based. The values are indicated in the transformer rating plate.

1.4.3.3 Rated Transformation Ratio
The ratio of the rated primary voltage to the rated secondary voltage.

1.4.3.4 Limits of Voltage Error and Phase Displacement
The voltage error (F_u) and phase displacement (δu) at the rated frequency shall not exceed the values given in the following table at any voltage between 80% and 120% of rated voltage, and with burdens between 25% and 100% of the rated burden and a power factor of 0.8.

accuracy class	± voltage error (%)	± phase displacement (minutes)
0,2	0,2	10
0,5	0,5	20
1	1	40

1.4.3.5 Rated Output
The value of the apparent power (in VA at a specified power factor), which the transformer is intended to supply to the secondary circuit at the rated secondary voltage, and with rated burden connected to it.

1.4.3.6 Rated Burden
The apparent resistance of the connected burden including the wiring on which the accuracy requirements are based.

1.4.3.7 Thermal Limiting Output
The value of the apparent power with reference to the rated voltage, which can be taken from a secondary winding at the applied rated primary voltage, without exceeding the limitations of the rise in temperature.

1.4.3.8 Rated Thermal Limiting Output of the Residual Voltage Winding

The thermal limiting output of the residual winding shall be specified in volt ampere (VA) in relation to the secondary voltage with the unit power factor. The preferred values are given in the IEC-Standard.

Since the residual windings are connected in an open delta circuit, these windings are only loaded under fault conditions. Therefore, a maximum duration of 8 hours for example, can be chosen.

1.4.3.9 Rated Voltage Factor

The rated voltage factor is determined by the maximum operating voltage depending on the system grounding conditions. In single pole insulated transformers, it is common practice to use a rated voltage factor of 1,9 x the rated voltage for a load duration of 8 hours. The rated factor is defined as $1,2 \cdot U_N$ for all other types.

1.4.3.10 Reconnection of Voltage Transformer

Due to dielectric reasons the reconnection of a voltage transformer is only possible by secondary tapping.
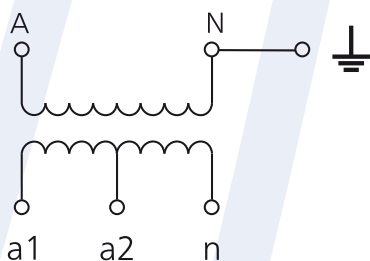
The ends of the winding are connected to the secondary terminals. Changeover will be performed at the secondary side. In the case that the primary rated voltage is to be changed to the lower voltage, the accuracy class remains unchanged. The rated burden decreases at approximately the square value of the reduction in the primary voltage.

1.4.4 Service and Grounding

Contrary to current transformers, voltage transformers must never be short circuited to the secondary side. The "N" terminal is grounded to the bottom plate in the secondary terminal box and may never be removed when in service.

Each secondary terminal can be grounded inside the secondary terminal box.
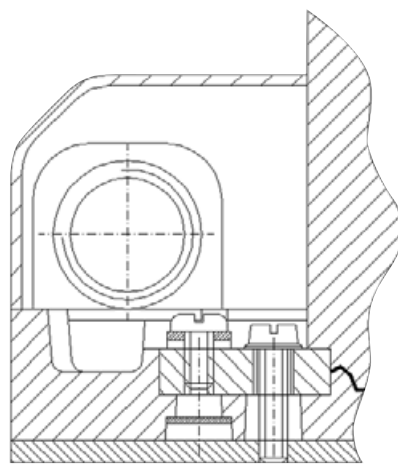
Secondary part with earthing terminal of the voltage transformer types VES/VEN

1.4.5 Ferroresonances

In electrical installations ferroresonances can occur if the following criteria are present:
• Use of single pole insulated voltage transformer
• The network is ungrounded (insulated neutral starpoint)
• Voltage surges caused by prior switching operations

In such a case an oscillating circuit between the earth capacity (C_e) and the transformer inductance (L_w) will occur, which will lead to a very intensive voltage increase and subsequently, saturation of the iron core of the transformer. Overheating of the iron core as well as the materials used inside the primary winding is the consequence. The high temperature leads to the destruction of the resin matrix. Flashover of the high voltage to the grounded iron core and the secondary winding will occur. The resulting pressure increase inside the resin body leads to bursting of the resin body.

To avoid such damage the transformers can be equipped with a residual winding connected in an open delta circuit and equipped with a dumping device (resistor, reactor or a combination of the two). The design of this device depends on the thermal limiting output of the residual winding.
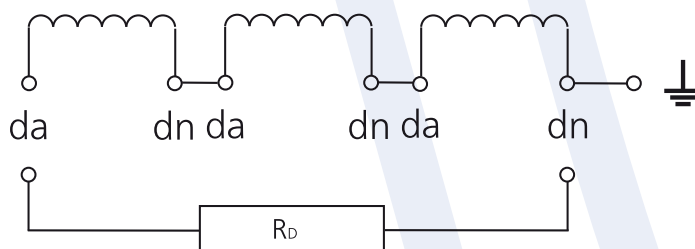
Attention: To avoid a secondary short circuit it must be strictly observed that the open delta circuit is only grounded once.

1.5 Service Conditions

All current and voltage transformers are designed in accordance with the conditions described in the international standards.

The transformers are classified in two categories as given in the following table.

Transformers for indoor applications
• Lowest temperature   - 5°C
• Highest temperature   + 40°C
• Relative humidity/24 hours   95%
• Relative humidity/months   90%

Transformers for outdoor applications

• Lowest temperature   -25/-40°C
• Highest temperature   + 40°C
• Relative humidity   100%

1.5.1 Altitude

For an installation at an altitude higher than 1000 meters the arcing distance under the standardized reference atmospheric conditions shall be determined by multiplying the withstand voltages required at the service location by a factor „K_a" in accordance with the following table.
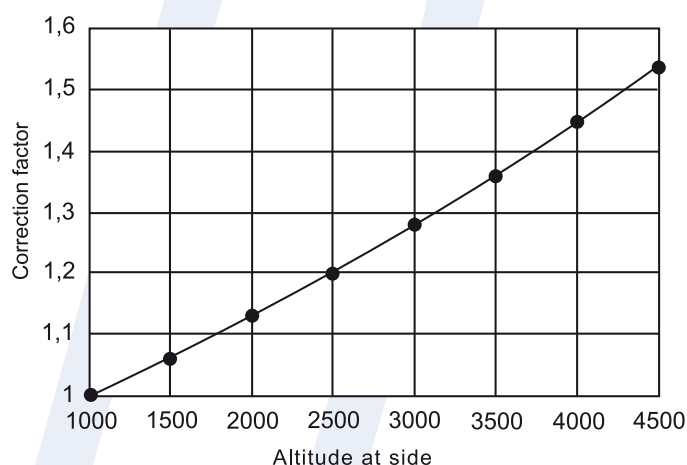
Altitude correction factor

Formula

$$U_k \geq U \cdot K_a$$

U   BIL under atmospheric reference
U_k BIL under service location
K_a altitude correction factor according to the above graph

Example:
For a BIL of 75 kV (1,2/50 μs) at 2500 meters above sea level a corrected value of 90 kV must be chosen. (75 kV · 1,2 = 90 kV)

1.6 Test Voltages and Insulation Levels for Instrument Transformers

In order to guarantee safe operation of an instrument transformer throughout its designed lifetime, the following test must be carried out during type tests and routine tests.

• Rated lightning impulse withstand voltage test (type test)
• Power frequency withstand voltage test on primary and secondary windings (routine test)
• Partial discharge test (routine test)
• Determination of errors (routine test)

Highest voltage for equipment [kV]	Power frequency voltage [kV]	Lightning impulse voltage [kV]
7,2	20	60
12	28	75
17,5	38	95
24	50	125
36	70	170

1.7 Insulation Class

Most of the instrument transformers are designed for the insulation class „E" as described in the IEC-standard, whereby the absolute maximum temperature is 115 °C.
The maximum temperature increase must not exceed 75° K at an ambient temperature of 40 °C.

1.8 Partial Discharge Test

In spite of a safety view of the dielectric of an instrument transformer, a partial discharge test has to be carried out. Such a test is required for all transformers with a rated voltage higher than 3.6 kV. The max. permissible levels are listed in the following table.

Instrument Transformer Type	Test Voltage 1 Minute	Partial Discharge Level (pC)
Current Transformer	$1,2 \cdot U_m$	50
Single Pole Votage Transformer	$1,2 \cdot U_m/\sqrt{3}$	20
Double Pole Voltage Transformer	$1,2 \cdot U_m$	20

1.9 Standards

Current and voltage transformers are generally designed in accordance with the following standards:

• IEC 60044-1 "current transformers"
• IEC 60044-2 "inductive voltage transformers"
• ANSI/IEEE-standard
• All other relevant worldwide standards

Handling after Receipt:
All transformers are suitably packed for transportation.
The packaging should be inspected immediately upon receipt for any damages caused in during transportation.
Should any external damage(s) be found or any signs of improper handling are present, please notify
Ritz Instrument Transformers GmbH immediately.

Safety Advice
Hazardous voltage occurs in this electrical equipment during operation. Violation of the service instructions can result in property damage, severe personal injury or even death.
Only qualified personnel should work on or around this equipment, and only after becoming thoroughly familiar with warnings, safety notices, and maintenance procedures.

The successful and safe operation of this equipment depends on proper handling, installation, operation, and maintenance.

2.0 Products

	Design	U$_m$ (kV)	Type	Page
Current Transformer for Indoor Applications				
	Support Type Current Transformer Indoor Block Type Narrow Type DIN 42600, Part 8, available as Size 1, 2, 3	12 | 17,5 | 24 | 36	ASS 12 | 17,5 | 24 | 36	18
	Support Type Current Transformer Indoor Block Type Small Type DIN 42600, Part 4	3,6 | 7,2 | 12	GSW 12/0	19
	Support Type Current Transformer Indoor Block Type Large Type DIN 42600, Part 5	12 | 17,5 | 24 | 36	ASN 12 | 17,5 | 24 | 36	20
	Current Transformer Indoor Head Type	52 | 72,5	GI 52 | 72,5	21
	High Current Tranformer Indoor	12 | 17,5 | 24	GSSO 12 | 17,5 | 24	22
	Bushing Type Current Transformer Indoor	12 | 17,5 | 24 | 36	GDS 12 | 17,5 | 24 | 36	23
Current Transformer for Outdoor Applications				
	Support Type Current Transformer Outdoor Compact Type	12 | 17,5 | 24 | 36	GIFK 12 | 17,5 | 24 | 36	24
	Support Type Current Transformer Outdoor Standard Type	12 | 17,5 | 24 | 36	GIFS 12 | 17,5 | 24 | 36	25
	Head Type Outdoor GOST certificate available	12 | 17,5 | 24 | 36 52 | 72,5	GIF 10 | 17,5 | 20 | 30 | 36 52 | 72,5	26

	Design	U$_m$ (kV)	Type	Page
Voltage Transformer Single Pole				
Indoor				
	Indoor Single Pole Narrow Type DIN 42600, Part 9	12 | 17,5 | 24	VES 12 | 17,5 | 24	27
	Indoor Single Pole Small Type DIN 42600, Part 7	3,6 | 7,2 | 12	GSE 12/0	28
	Indoor Single Pole Large Type DIN 42600, Part 3 VEN 52 not according DIN	12 | 17,5 | 24 | 36 52	VEN 12 | 17,5 | 24 | 36 VEN 52	29
Outdoor				
	Outdoor Single Pole GOST Certificate available	12 | 17,5 | 24 | 36 | 40,5	VEF 12 | 17,5 | 24 | 36	30
	Outdoor Single Pole Head Type	52 | 72,5	VEF 52 | 72,5	31
Voltage Transformer Double Pole				
Indoor				
	Indoor Double Pole Narrow Type DIN 42600, Part 9	12 | 17,5 | 24	VZS 12 | 17,5 | 24	32
	Indoor Double Pole Small Type DIN 42600, Part 7	3,6 | 7,2 | 12	GSZ 12/0	33
	Indoor Double Pole Large Type DIN 42600, Part 3	12 | 24 | 36	VZN 12 | 17,5 | 24 | 36	34
Outdoor				
	Outdoor Double Pole GOST Certificate available	12 | 17,5 | 24 | 36	VZF 12 | 17,5 | 24 | 36	35

ASS

2.1 Current Transformer Indoor up to 52 kV

2.1.1 Support Type Current Transformer Indoor Block Type
ASS 12 | 17,5 | 24 | 36
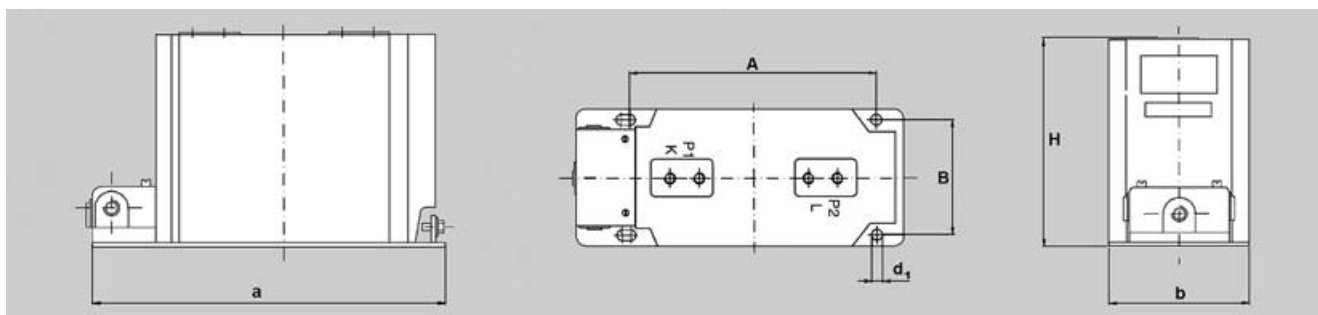
TYPE ASS	Dimensions mm			
	ASS 12	ASS 17,5	ASS 24	ASS 36
A	270	270	280	300
B	125	125	150	225
a	360	360	355	403
b	148	148	178	249
d_1	12	12	14	14
H	220	220	280	390
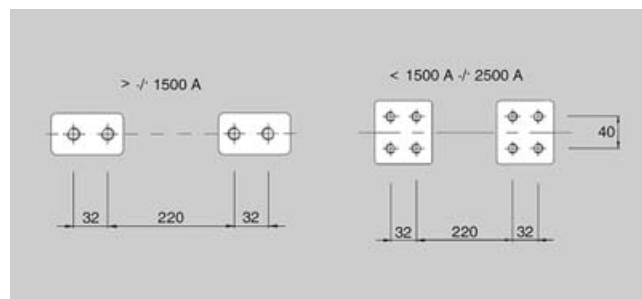
TYPE ASS					
		ASS 12	ASS 17,5	ASS 24	ASS 36
U_m	kV	12	17,5	24	36
Test voltages	kV	28 | 75	38 | 95	50 | 125	70|170
Rated Primary Current – I_{PN}	A	up to 2500	up to 2500	up to 2500	up to 2500
Rated Secondery Current – I_{SN}	A	1 | 5	1 | 5	1 | 5	1 | 5
Rated Short Time Thermal Current – I_{th}		up to 1000 x I_{PN} | max. 100 kA			
Rated Peak Current – I_{dyn}		2,5 x I_{th}			
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burden			
Frequency	Hz	50|60			
Weight	kg	20	20	28	70

Subject to Technical Changes

2.1.2 Support Type Current Transformer Indoor Block Type
GSW 12/0 3,6 | 7,2 | 12

DIN - Bottom plate
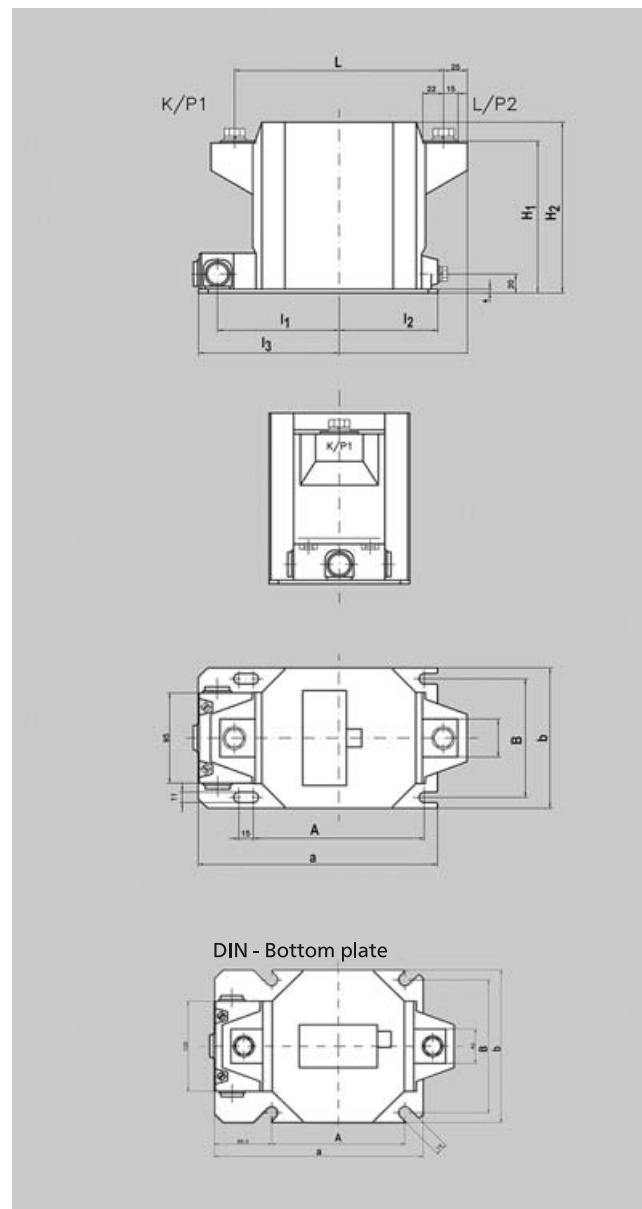
TYPE GSW 12/0	Dimensions mm			
Size	1	2	3	DIN
A	135	180	220	155
B	125	125	125	155
a	238	283	323	279
b	148	148	148	178
H_1	160	160	160	160
H_2	180	180	180	180
L	175	220	260	220
l_1	105	128	148	124
l_2	82	105	125	100
l_3	125	148	168	144

TYPE GSW 12/0					
Size		1	2	3	DIN
U_m	kV	12	12	12	12
Test voltages	kV	28 | 75	28 | 75	28 | 75	28 | 75
Rated Primary Current – I_{PN}	A	5 up to 800	5 up to 800	5 up to 800	5 up to 800
Rated Secondery Current – I_{SN}	A	1 | 5	1 | 5	1 | 5	
Rated Short Time Thermal Current – I_{th}		up to 600 x I_{PN} | max. 60 kA			
Rated Peak Current – I_{dyn}		2,5 x I_{th}			
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burden			
Frequency	Hz	50|60			
Weight	kg	6	7	8	8

Subject to Technical Changes

ASN

2.1.3 Support Type Current Transformer Indoor Block Type
ASN 12 | 17,5 | 24 | 36
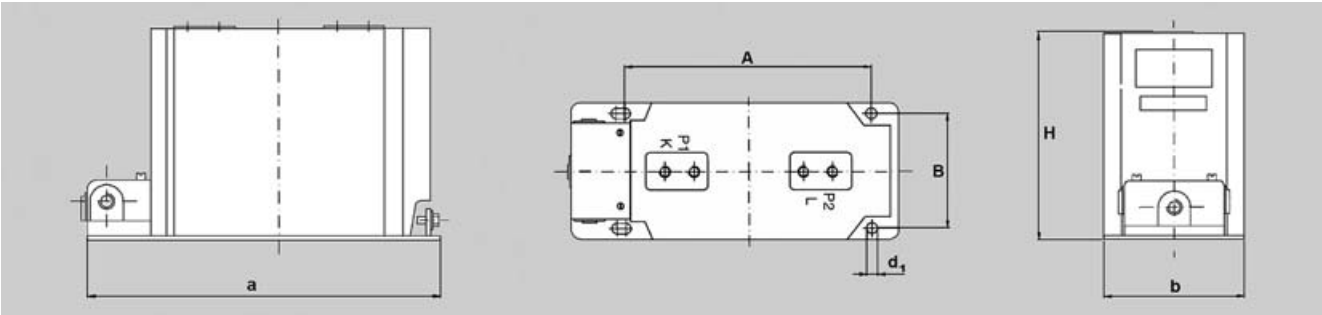
TYPE ASN	Dimensions mm			
	ASN 12	ASN 17,5	ASN 24	ASN 36
A	225	225	250	300
B	175	175	200	225
a	330	330	330	403
b	198	198	198	249
d_1	11	11	14	14
H	240	240	300	390
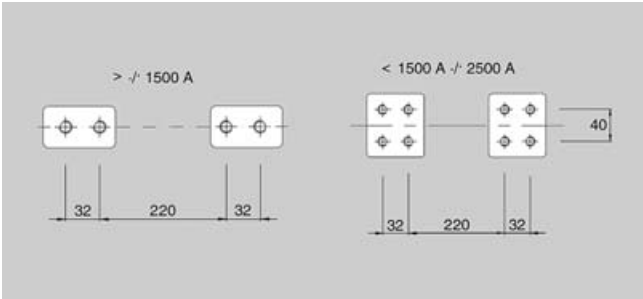
TYPE ASN					
		ASN 12	ASN 17,5	ASN 24	ASN 36
U_m	kV	12	17,5	24	36
Test voltages	kV	28	75	38	95	50	125	70	170
Rated Primary Current – I_{PN}	A	up to 1250	up to 1250	up to 1250	up to 1250
Rated Secondery Current – I_{SN}	A	1	5	1	5	1	5	1	5
Rated Short Time Thermal Current – I_{th}		up to 1000 x I_{PN}	max. 100 kA			
Rated Peak Current – I_{dyn}		2,5 x I_{th}				
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burden				
Frequency	Hz	50	60				
Weight	kg	24	24	38	70

Subject to Technical Changes

2.1.4 Current Transformer Indoor Head Type
GI 52 | 72,5
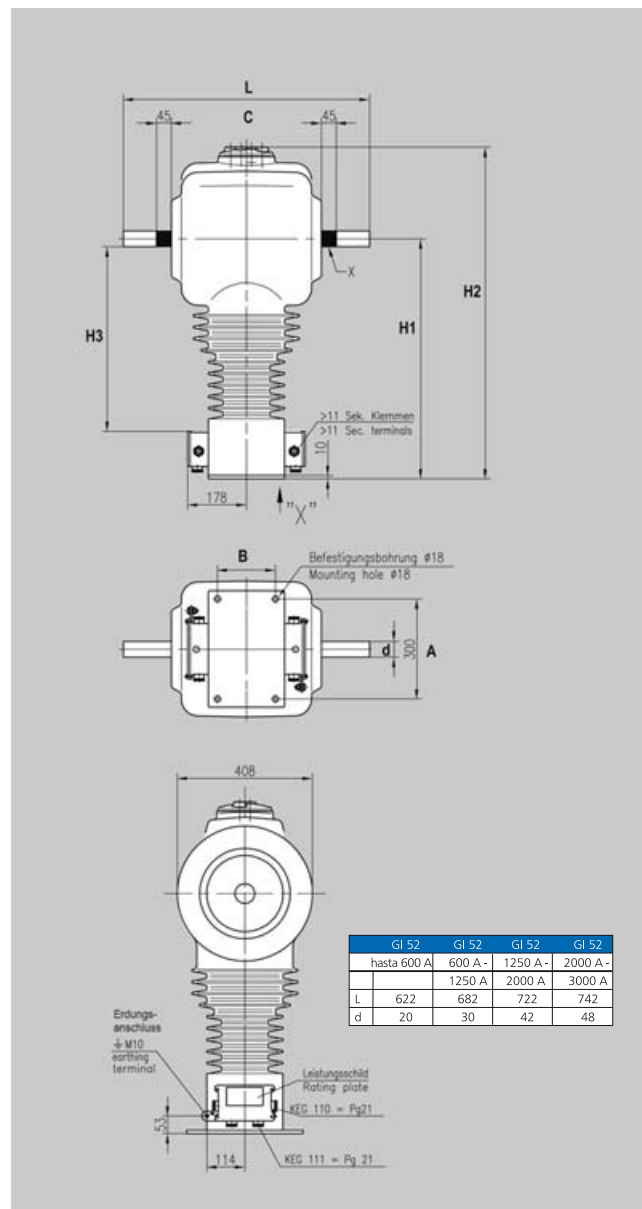
TYPE GI Dimensions mm		
	GI 52	GI 72,5
A	175	175
B	300	300
a	230	500
b	350	500
C	452	520
H_1	725	1015
H_2	1002	1322
H_3	557,5	850

	GI 52	GI 52	GI 52	GI 52
	hasta 600 A	600 A - 1250 A	1250 A - 2000 A	2000 A - 3000 A
L	622	682	722	742
d	20	30	42	48

TYPE GI			
		GI 52	GI 72,5
U_m	kV	52	72,5
Test voltages	kV	95 | 250	140 | 325
Rated Primary Current – I_{PN}	A	up to 3000	
Rated Secondery Current – I_{SN}	A	1 | 5	
Rated Short Time Thermal Current – I_{th}		up to 1000 x I_{PN} | max. 100 kA	
Rated Peak Current – I_{dyn}		2,5 x I_{th}	
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burden	
Frequency	Hz	50|60	
Weight	kg	147	

Subject to Technical Changes

GSSO

2.1.5 High Current Transformer Indoor
GSSO 12 | 17,5 | 24

TYPE GSSO	Dimensions mm		
Size	0	3	4
A	135	155	305
B	155	155	155
a	207	269	419
b	180	180	180
l_1	150	300^{+2}	450^{+3}
l_2	105	145	220
l_3	82	102	177
l_4	125	167	242

Design	d
1	102
2	130
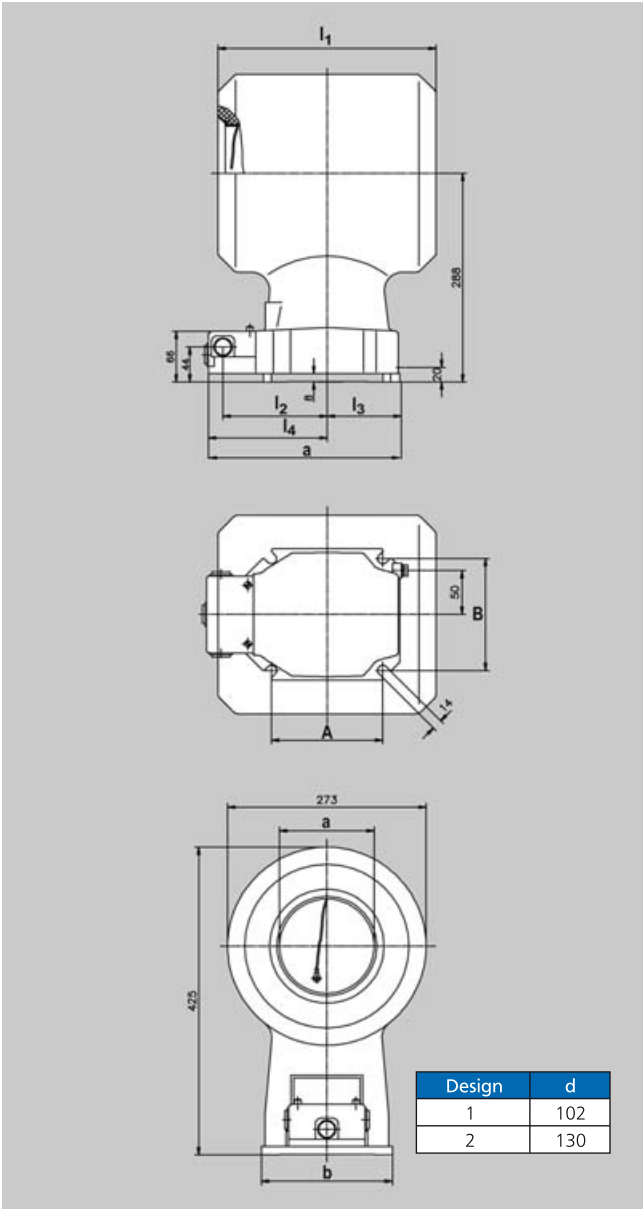
TYPE GSSO				
		0	3	4
U_m	kV	12 | 24	12 | 24	12 | 24
Test voltages	kV	50 | 125	50 | 125	50 | 125
Rated Primary Current – I_{PN}	A	100 up to 4000		
Rated Secondery Current – I_{SN}	A	1 | 5	1 | 5	1 | 5
Rated Short Time Thermal Current – I_{th}		up to 1000 x I_{PN} | max. 200 kA		
Rated Peak Current – I_{dyn}		2,5 x I_{th}		
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burden		
Frequency	Hz	50|60		
Weight	kg	21	34	70

Subject to Technical Changes

2.1.6 Bushing Type Current Transformer Indoor
GDS 12 | 17,5 | 24 | 36
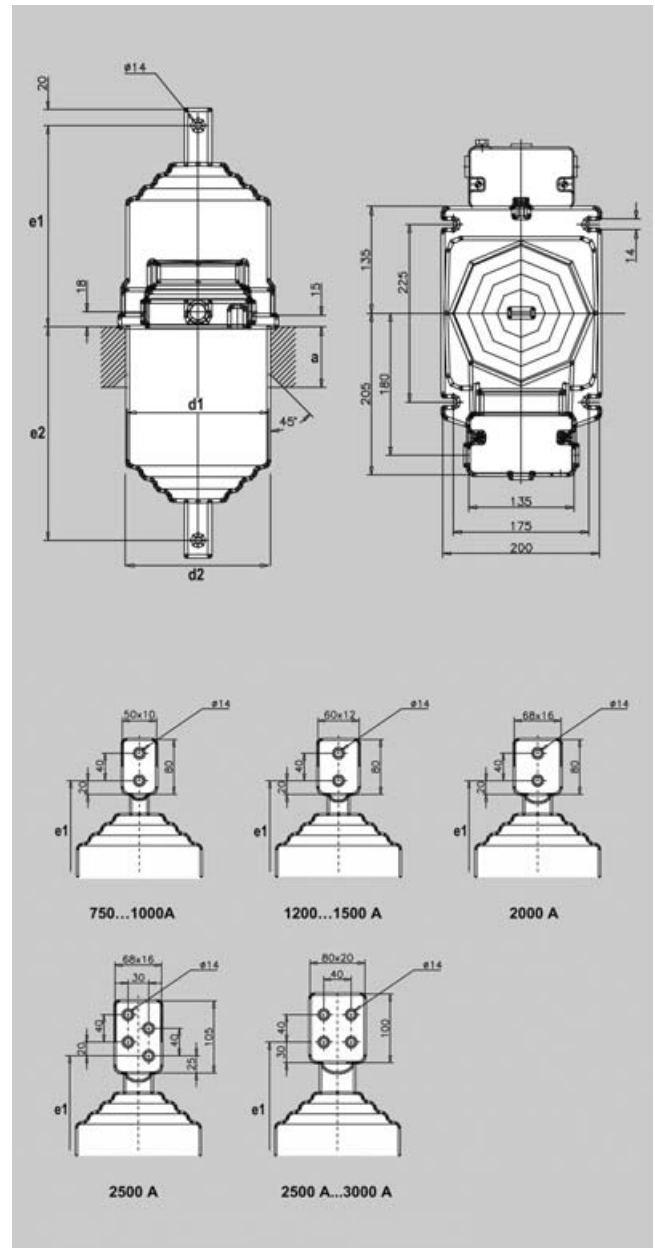
TYPE GDS	Dimensions mm							
		GDS 12				GDS 24		GDS 36
Size		0	1	2	3	1	2	1
a		50	60	115	195	60	140	60
d_1		180						
d_2		185						
e_1	1500 A	190	190	255	315	255	315	315
	2000 A	195	195	260	320	260	320	320
	2500 A	215	215	280	340	280	340	340
e_2	1500 A	150	210	270	330	270	330	330
	2000 A	155	215	275	335	275	335	335
	2500 A	175	235	295	355	295	355	355
Weight [kg]		12-18	16-22	28-32	34-40	28-32	35-40	35-40

TYPE GDS					
		GDS 12	GDS 17,5	GDS 24	GDS 36
U_m	kV	12	17,5	24	36
Test voltages	kV	28 | 75	38 | 95	50 | 125	70 | 170
Rated Primary Current – I_{PN}	A	s 150 A up to 2500 A | 3000 A available on request			
Rated Secondery Current – I_{SN}	A	1 | 5	1 | 5	1 | 5	1 | 5
Rated Short Time Thermal Current – I_{th}		up to 1000 x I_{PN} | max. 100 kA			
Rated peak Current – I_{dyn}		2,5 x I_{th}			
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burden			
Frequency	Hz	50 | 60			

Subject to Technical Changes

GIFK

2.2 Current Transformer Outdoor up to 52 kV

2.2.1 Support Type Current Transformer Outdoor Compact Type
GIFK   12 | 17,5 | 24 | 36
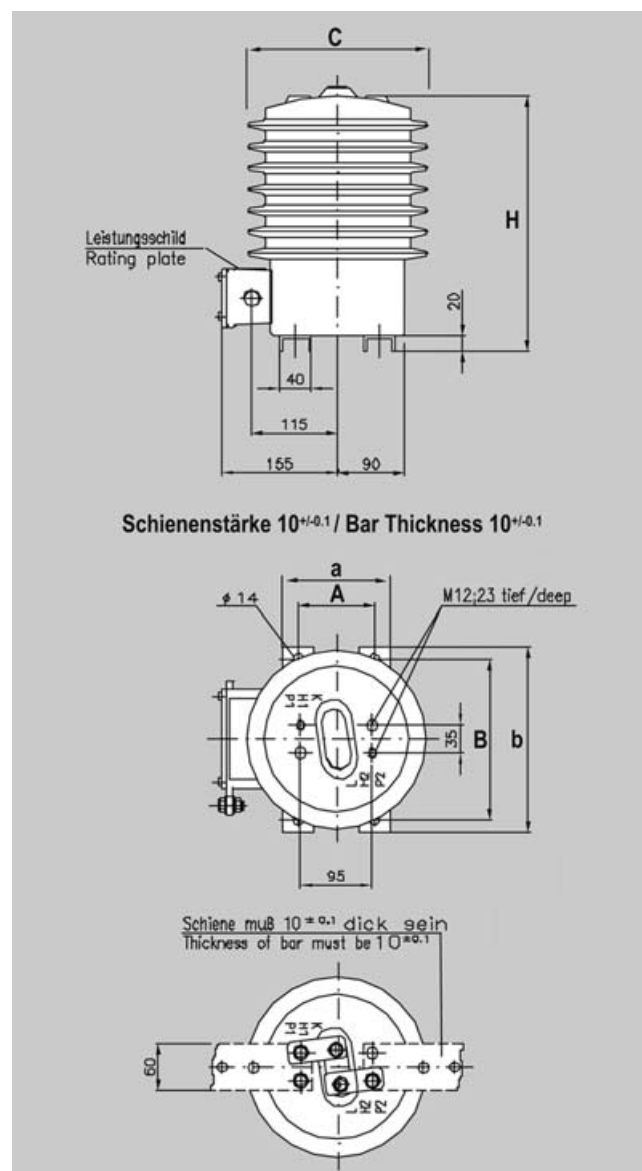
TYPE GIFK	Dimensions mm	
	GIFK 12 | 17,5 | 24	GIFK 36
A	100	100
B	200	200
a	140	140
b	240	240
C	235	235
H	335	419

TYPE GIFK					
		GIFK 12	GIFK 17,5	GIFK 24	GIFK 36
U_m	kV	12	17,5	24	36
Test voltages	kV	28|75	38|95	50|125	70|170
Rated Primary Current – I_{PN}	A	up to 1250			
Rated Secondery Current – I_{SN}	A	1 | 5	1 | 5	1 | 5	1 | 5
Rated Short Time Thermal Current – I_{th}		up to 1000 x I_{PN} | max. 63 kA			
Rated peak Current – I_{dyn}		2,5 x I_{th}, max. 100 kA			
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burden			
Frequency	Hz	50 | 60			
Creepage Distance	mm	486	486	486	650
Weight	kg	22	22	22	30

Subject to Technical Changes

2.2.2 Support Type Current Transformer Outdoor Standard Type
GIFS   12 | 17,5 | 24 | 36

Prim.–Umschaltbar/Prim.–reconnection 1:2   ÷2×300A
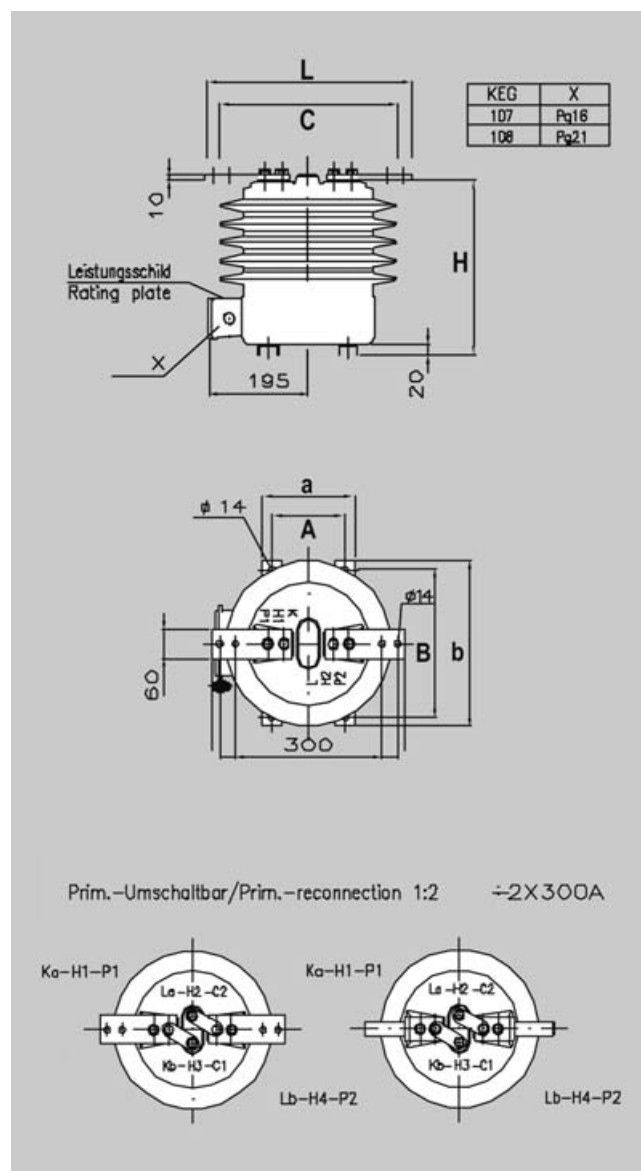
TYPE GIFS Dimensions mm		
	GIFS 12	17,5	24	GIFS 36
A	150	150
B	300	300
a	190	190
b	335	335
C	335	335
H	355	439

TYPE GIFS		GIFS 12	GIFS 17,5	GIFS 24	GIFS 36
U_m	kV	12	17,5	24	36
Test voltages	kV	28|75	38|95	50|125	70|170
Rated Primary Current – I_{PN}	A	up to 1250			
Rated Secondery Current – I_{SN}	A	1 | 5	1 | 5	1 | 5	1 | 5
Rated Short Time Thermal Current – I_{th}		up to 1000 x I_{PN} | max. 63 kA			
Rated peak Current – I_{dyn}		2,5 x I_{th}, max. 100 kA			
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burden			
Frequency	Hz	50|60			
Creepage Distance	mm	575	575	575	926
Weight	kg	40	40	40	55

Subject to Technical Changes

GIF

2.2.3 Current Transformer Outdoor Head Type
GIF   10 | 17,5 | 20 | 30 | 36 | 52 | 72,5
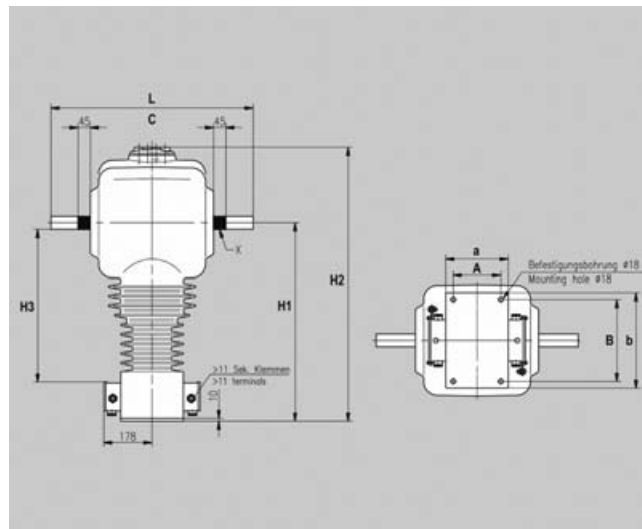
TYPE GIF Dimensions mm		GIF 10	17,5	GIF 20	GIF 30	GIF 36	GIF 52	GIF 72,5
A		175	175	175	175	175	175
B		300	300	300	300	300	300
a		230	230	230	230	500	500
b		350	350	350	350	500	500
C		380	430	430	452	520	520
H_1		437	527	527	725	910	1015
H_2		592[1]	707	707[1]	1002	1217	1322
H_3		268	358	358	557,5	745	850
L	up to 600 A	550	600	600	622	750	750
	600 A up to 1250 A	610	660	660	682	750	750
	1250 A up to 2000 A	650	700	700	722	790	790
	2000 A up to 3000 A	670	720	720	742	810	810

| TYPE GIF		GIF 10	GIF 17,5	GIF 20	GIF 30	GIF 36	GIF 52	GIF 72,5
U_m	kV	12	17,5	24	36	36	52	72,5
Test voltages	kV	28|75	38|95	50|125	70|170	70|170[2]	95|250	140| 325
Rated Primary Current – I_{PN}	A	up to 3000						
Rated Secondery Current – I_{SN}	A	1 | 5	1 | 5	1 | 5	1 | 5	1 | 5	1 | 5	1 | 5
Rated Short Time Thermal Current – I_{th}		up to 1000 x I_{PN} | max. 63 kA						
Rated Peak Current – I_{dyn}		2,5 x I_{th}, max. 100 kA						
Core(s), Number of Cores		Must be determined on the basis of the requirements accuracy class, over-current value, burdens						
Frequency	Hz	50|60						
Creepage Distance	mm	665	665	800	800	1290	1823	2150
Weight	kg	65	65	100	115	147	180	255

[2] Increased BIL possible 70/200
Subject to Technical Changes

2.3 Voltage Transformer Single Pole 52 kV

### 2.3.1 Voltage Transformer Indoor
VES 12 | 17,5 | 24
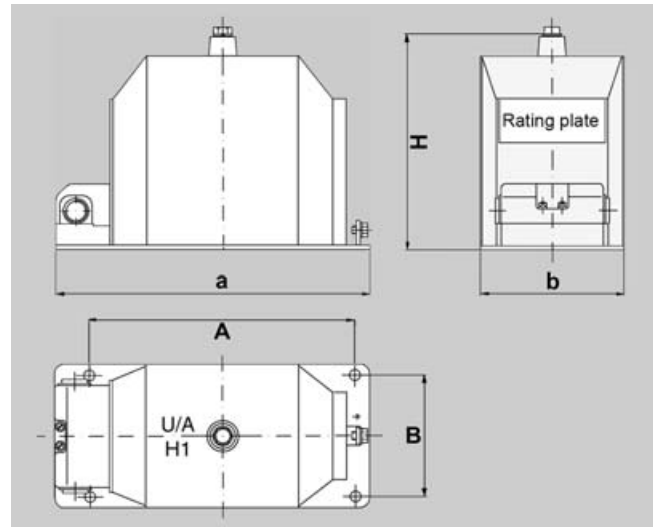
TYPE VES	Dimensions mm		
	VES 12	VES 17,5	VES 24
A	270	270	280
B	125	125	150
a	320	320	354
b	148	148	178
H	220	220	280

TYPE VES					
			VES 12	VES 17,5	VES 24
U_m		kV	12	17,5	24
Test voltages		kV	28|28 | 75	38 | 38 | 95	50 | 50 | 125
Rated Primary Voltage – U_{PN}		V	$10000/\sqrt{3}$ $11000/\sqrt{3}$	$13800/\sqrt{3}$ $15000/\sqrt{3}$	$20000/\sqrt{3}$ $22000/\sqrt{3}$
Rated Secondery Voltage – U_{SN}		V	$100/\sqrt{3}$ | $110/\sqrt{3}$		
Rated Secondary Voltage for the Earthing Corens		V	100/3 | 110/3		
Rated Output in Accuracy Class (IEC)	0,2	VA	20	20	20
	0,5	VA	50	50	50
	1,0	VA	100	100	100
Thermal Limit Current		A	6	9	9
Thermal Limit Current at 1,9 x U_n / 8h		A	6	6	6
Frequency		Hz	50|60		
Weight		kg	19	19	27

Subject to Technical Changes

2.3.2 Voltage Transformer Indoor
GSE 12/0   3,6 | 7,2 | 12

DIN - Bottom plate
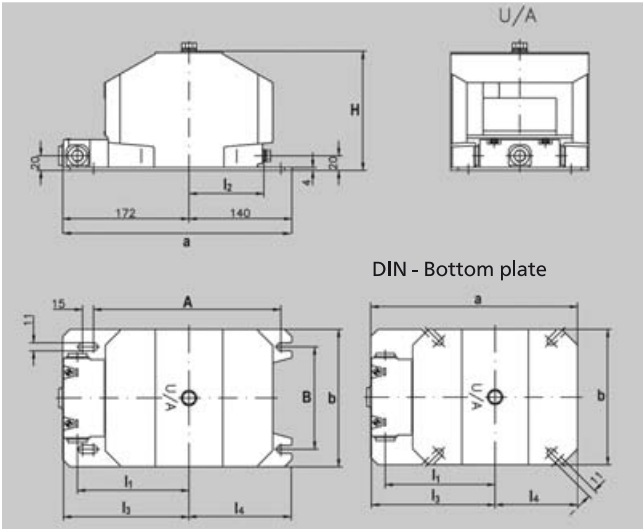
TYPE GSE	Dimensions mm	
	GSE 12/0	GSE 12/0 DIN
A	260	155
B	140	155
a	312	286
b	188	188
H	160	160
l_1	152	152
l_2	102	102
l_3	171	171
l_4	140	100

TYPE GSE			
			GSE 12	0
U_m		kV	12
Test voltages		kV	28	75
Rated Primary Voltage – U_{PN}		V	3000/√3	5000/√3 6000/√3	10000/√3
Rated Secondery Voltage – U_{SN}		V	100/√3	110/√3
Rated Secondary Voltage for the Earthing Core(en)		V	100/3	110/3
Rated Output in Accuracy Class (IEC)	0,2	VA	30
	0,5	VA	90
	1,0	VA	180
Thermal Limit Current		A	7
Thermal Limit Current at 1,9 x U_n / 8h		A	6
Frequency		Hz	50|60
Weight		kg	18

Subject to Technical Changes

2.3.3 Voltage Transformer Indoor
VEN   12 | 17,5 | 24 | 36 | 52

TYPE VEN	Dimensions mm				
	VEN 12	VEN 17,5	VEN 24	VEN 36	VEN 52
A	225	225	250	300	300
B	175	175	200	225	225
a	355	355	355	400	400
b	200	200	230	250	280
H	240	240	273	321	522

VEN up to 36 kV

VEN up to 52 kV
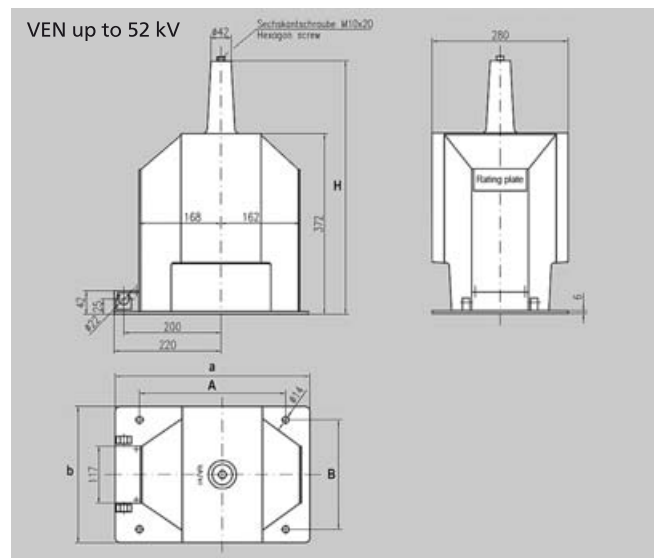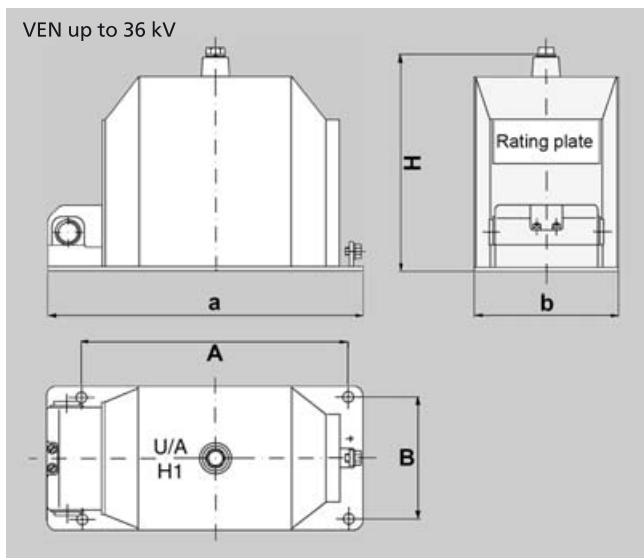
TYPE VEN							
			VEN 12	VEN 17,5	VEN 24	VEN 36	VEN 52
U_m		kV	12	17,5	24	36	52
Test voltages		kV	28|75	38 | 95	50 | 125	70 | 170	95 | 250
Rated Primary Voltage – U_{PN}		V	10000/√3 11000/√3	13800/√3 15000/√3	20000/√3 22000/√3	30000/√3 33000/√3	45000/√3 50000/√3
Rated Secondery Voltage – U_{SN}		V	100/√3 | 110/√3				
Rated Secondary Voltage for the Earthing Core(en)		V	100/3 | 110/3				
Rated Output in Accuracy Class (IEC)	0,2	VA	30	30	30	30	45
	0,5	VA	100	100	100	100	100
	1,0	VA	200	200	200	200	200
Thermal Limit Current		A	10	10	10	10	10
Thermal Limit Current at 1,9 x U_n / 8h		A	9	9	9	9	9
Frequency		Hz	50|60				
Weight		kg	24	24	32,5	50	75

Subject to Technical Changes

2.3.4 Voltage Transformer Outdoor
VEF   12 | 17,5 | 24 | 36
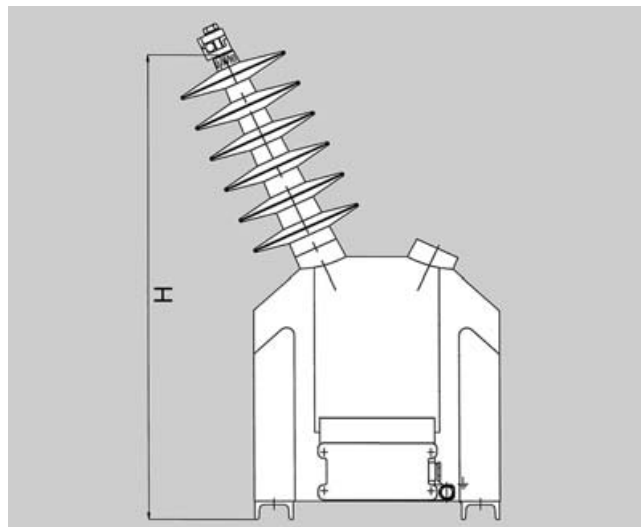
TYPE VEF Dimensions mm				
	VEF 12	VEF 17,5	VEF 24	VEF 36
A	270	270	270	270
B	160	160	160	200
a	310	310	310	320
b	185	185	185	240
H	380	490	490	622
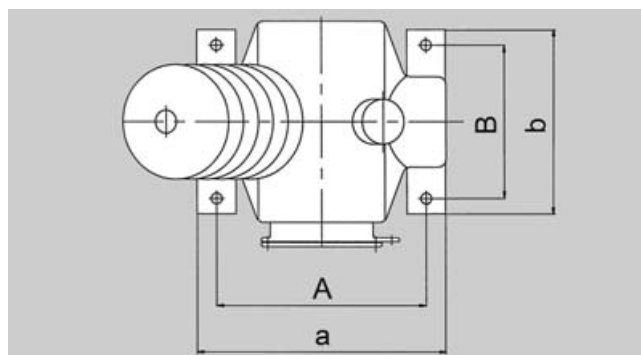
TYPE VEF						
			VEF 12	VEF 17,5	VEF 24	VEF 36
U_m		kV	12	17,5	24	36
Test voltages		kV	28|75	38|95	50|125	70|170
Rated Primary Voltage – U_{PN}		V	10000/√3 11000/√3	13800/√3 15000/√3	20000/√3 22000/√3	30000/√3 33000/√3
Rated Secondery Voltage – U_{SN}		V	100/√3 | 110/√3			
Rated Secondary Voltage for the Earthing Core(en)		V	100/3 | 110/3			
Rated Output in Accuracy Class (IEC)	0,2	VA	40	40	40	50
	0,5	VA	100	100	100	100
	1,0	VA	200	200	200	200
Thermal Limit Current		A	6	9	9	10
Thermal Limit Current at 1,9 x U_n / 8h		A	6	6	6	10
Frequency		Hz	50|60			
Creepage Distance		mm	400	745	745	950
Weight		kg	33,5	35,5	35,5	51

Subject to Technical Changes

2.3.5 Voltage Transformer Outdoor Head Type
VEF   52 | 72,5
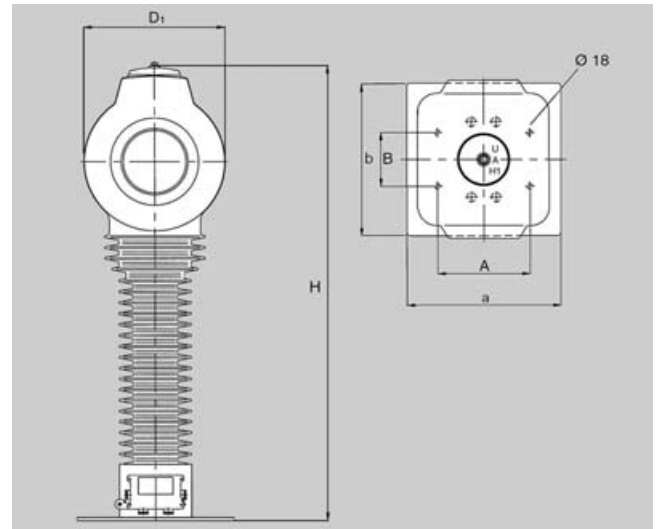
TYPE VEF Dimensions mm		
	VEF 52	VEF 72,5
A	300	300
B	175	175
a	500	500
b	500	500
D₁	450	450
H	1217	1322

TYPE VEF				
			VEF 52	VEF 72,5
U_m		kV	52	72,5
Test voltages		kV	95 | 250	140 | 325
Rated Primary Voltage – U_{PN}		V	45000/√3 50000/√3	60000/√3 66000/√3
Rated Secondery Voltage – U_{SN}		V	100/√3 | 110/√3	
Rated Secondary Voltage for the Earthing Core(en)		V	100/3 | 110/3	
Rated Output in Accuracy Class (IEC)	0,2	VA	80	60
	0,5	VA	200	160
	1,0	VA	400	320
Thermal Limit Current		A	12	12
Thermal Limit Current at 1,9 x U_n / 8h		A	9	9
Frequency		Hz	50|60	
Creepage Distance		mm	1910	2350
Weight		kg	170	200

Subject to Technical Changes

VZS

2.4 Voltage Transformer Double Pole up to 36 kV

2.4.1 Voltage Transformer Indoor
VZS   12 | 17,5 | 24
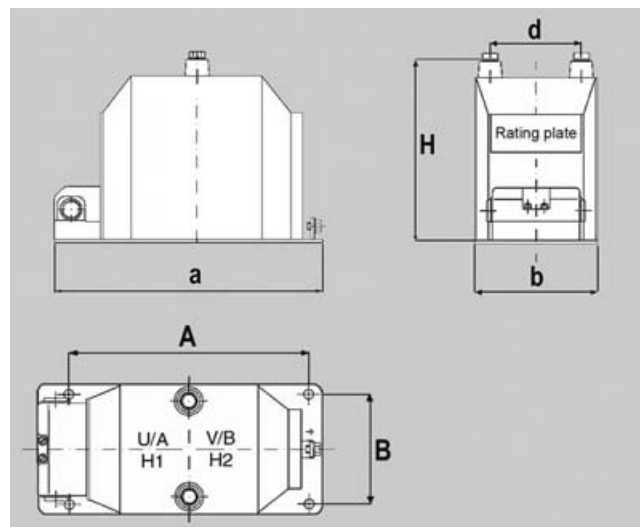
TYPE VZS	Dimensions mm		
	VZS 12	VZS 17,5	VZS 24
A	270	280	280
B	125	150	150
a	320	354	354
b	148	178	178
C	100	165	165
d	110	130	130
H	220	230	280

TYPE VZS					
			VZS 12	VZS 17,5	VZS 24
U_m		kV	12	17,5	24
Test voltages		kV	28|28|75	38|38|95	50|50|125
Rated Primary Voltage – U_{PN}		V	10000 11000	13800 15000	20000 22000
Rated Secondery Voltage – U_{SN}		V	100 | 110		
Rated Secondary Voltage Class (IEC)	0,2	VA	20	20	20
	0,5	VA	50	50	50
	1,0	VA	100	100	100
Thermal Limit Current		A	4	4	4
Frequency		Hz	50|60		
Weight		kg	19	27	27

Subject to Technical Changes

2.4.2 Voltage Transformer Indoor
GSZ 12/0   3,6 | 7,2 | 12

DIN - Bottom plate
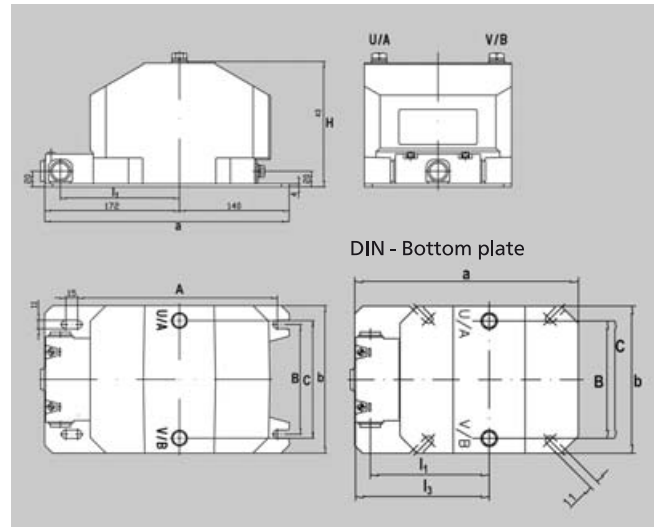
TYPE GSZ Dimensions mm		
	GSZ 12/0	GSZ 12/0 DIN
A	255	155
B	140	150
a	312	286
b	188	188
C	150	150
H	160	160
l_1	152	152
l_2	102	100
l_3	171	171
l_4	140	100

TYPE GSZ			
			GSZ 12
U_m		kV	12
Test voltages		kV	28 | 28 | 75
Rated Primary Voltage – U_{PN}		V	3000 | 5000 | 6000 | 10000
Rated Secondery Voltage – U_{SN}		V	100 | 110
Rated Secondary Voltage Class (IEC)	0,2	VA	30
	0,5	VA	90
	1,0	VA	180
Thermal Limit Current		A	4 (400 VA) for a – n
Frequency		Hz	50|60
Weight		kg	18

Subject to Technical Changes

2.4.3 Voltage Transformer Indoor
VZN   12 | 17,5 | 24 | 36

TYPE VZN Dimensions mm			
	VZN 12	VZN 17,5	VZN 24	VZN 36
A	225	225	250	300
B	175	175	200	225
a	355	355	355	400
b	200	200	230	349
d	150	150	210	320
H	240	240	273	390
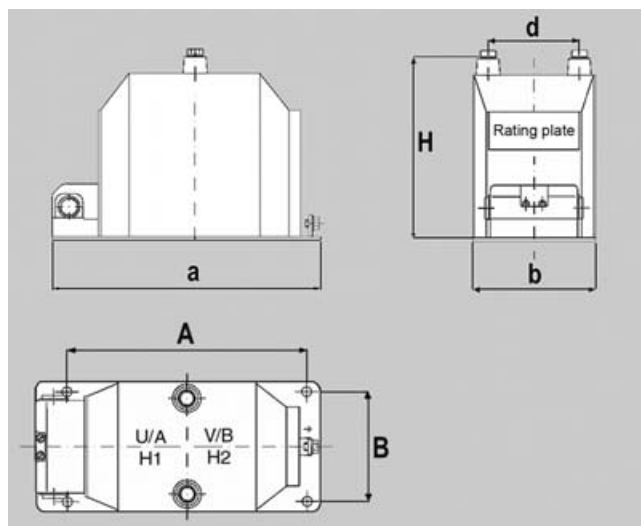
TYPE VZN						
			VZN 12	VZN 17,5	VZN 24	VZN 36
U_m		kV	12	17,5	24	36
Test voltages		kV	28|28|75	38|38|95	50|50|125	70|70|170
Rated Primary Voltage – U_{PN}		V	10000 11000	13800 15000	20000 22000	30000 33000
Rated Secondery Voltage – U_{SN}		V	100 | 110			
Rated Secondary Voltage Class (IEC)	0,2	VA	30	30	30	30
	0,5	VA	100	100	100	100
	1,0	VA	200	200	200	200
Thermal Limit Current		A	6	6	6	6
Frequency		Hz	50|60			
Weight		kg	26	26	32,5	70

Subject to Technical Changes

2.4.4 Voltage Transformer Outdoor
VZF   12 | 17,5 | 24 | 36
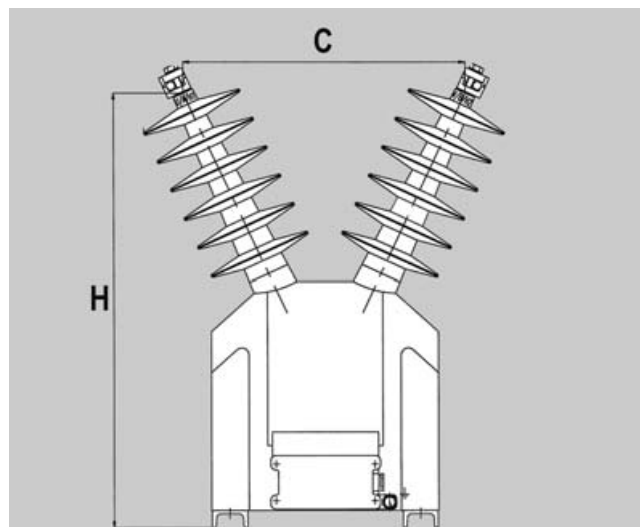
TYPE VZF	Dimensions mm			
	VZF 12	VZF 17,5	VZF 24	VZF 36
A	270	270	270	270
B	160	160	160	200
a	310	310	310	320
b	185	185	185	240
C	190	320	320	400
H	380	490	490	622
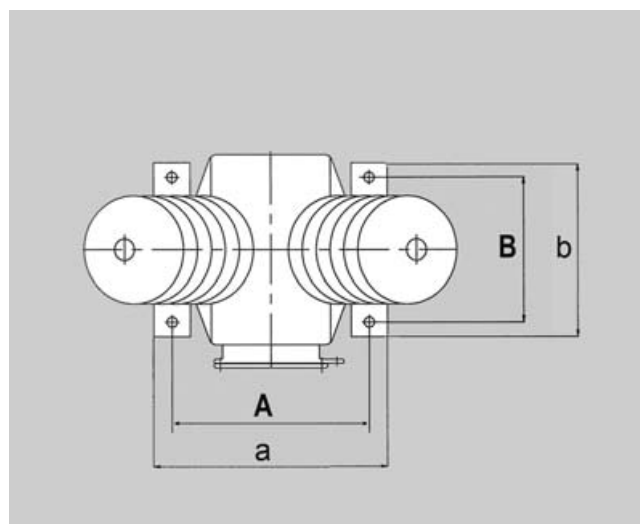
TYPE VZF						
			VZF 12	VZF 17,5	VZF 24	VZF 36
U_m		kV	12	17,5	24	36
Test voltages		kV	28|28|75	38|38|95	50|50|125	70|70|170
Rated Primary Voltage – U_{PN}		V	10000 11000	13800 15000	20000 22000	30000 33000
Rated Secondery Voltage – U_{SN}		V	100 | 110			
Rated Output in Accuracy Class (IEC)	0,2	VA	40	40	40	50
	0,5	VA	100	100	100	100
	1,0	VA	200	200	200	200
Thermal Limit Current		A	6	6	6	9
Frequency		Hz	50|60			
Creepage Distance		mm	400	745	745	900
Weight		kg	34	37	37	57

Subject to Technical Changes

Low Voltage Instrument Transformers

Low-Voltage Instrument Transformers up to 1.2 kV
c.t.s for measuring and protection purposes

- Wound primary c.t.
- Summation c.t.
- C.t.s for switch fuses
- Multi-range c.t.
- Window type c.t.s for high currents
- Split core types for earth fault protection
- Auxiliary c.t.
- Window type c.t.
- Tube type c.t.
- Split-core c.t.
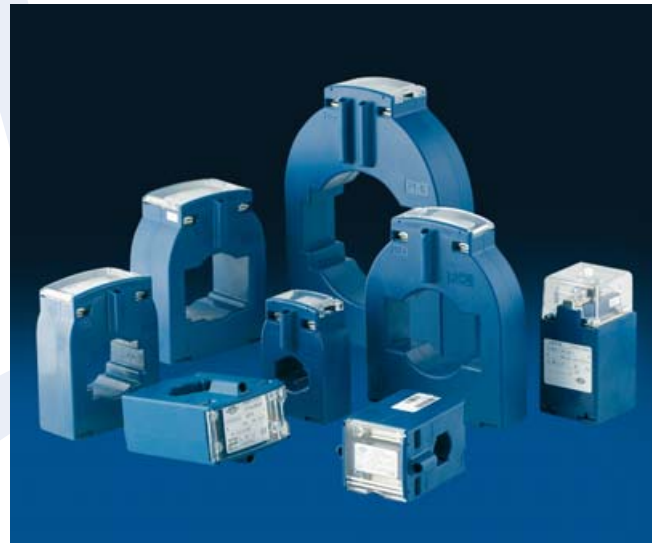
# SIS Cast Resin Bus Bar Systems up to 72,5 kV & 7000 A

The Alternative to Parallel-Connected Cables

System Specific Benefits
- Compact design
- Reduced requirements for the installation space
- Small bending radii
- 3-dimensional geometric shape is possible
- Natural cooling due to effectual conductor design
- High opererational reliability due to factory routine test of each bus bar
- No maintenance

Safety Benefits
- Touch Safe
- Fully insulated and capacitive graded system
- High thermal and dynamic short circuit current withstand capabilities
- Excluded phase to phase short-circuits
- No toxic fumes in case of fire - self extinguishing

Bus Bar Fixing

Section A-B
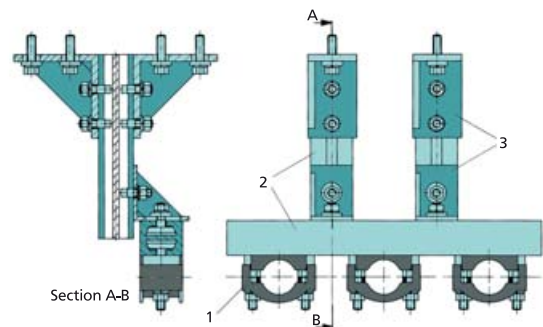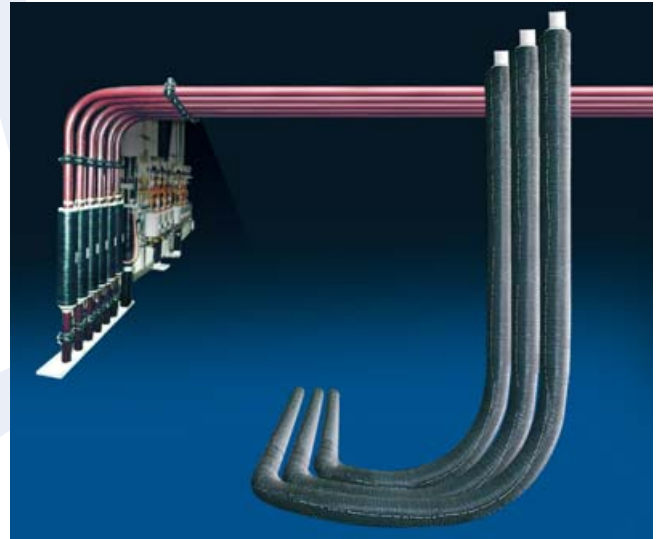
1. Plastic fixing clamps
2. Aluminium
3. Aluminium fixing angles
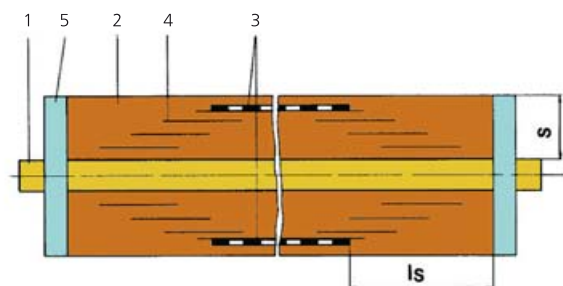
Bus Bar Design Principle

1. Conductor
2. Epoxy-impregnated paper wrapping
3. Earth layer
4. Capacitive grading
5. End ring – Metal ring

Cast Resin Insulated Power Transformers up to 36 kV and 20 MVA

Cast Resin Power Transformers 50 kVA up to 20 MVA
RITZ produces transformers in Glass Fibre reinforced Vacuum Technology (GVT) for ratings up to 20 MVA and for a maximum system voltage of 36 kV voltage class

Applications
- Power Distribution
- Rectifier Drives
- Oil Platforms / Vessels
- Injection Systems
- Grounding Systems
- Traction Power Systems (Streetcar, Tram, Metro, Railway)
- Generator Excitation
- Transmitter Systems
- Laboratory Systems

Customer oriented package solutions
- Transformer Installation
- Disposal of existing oil and PCB transformers
- Start-up

Glass Fibre reinforced Vacuum Technology (GVT) is used for High Voltage coils and optionally for Low Voltage coils in order to guarantee the highest possible quality and reliability to avoid cracks or voids during manufacturing and service.

Characteristics
- Impulse voltage proof
- Partial discharge free
- Short circuit proof
- Highest mechanical strength
- Cooling channels in HV&LV coils
- Pre-galvanised steel frame

RITZ transformers are designed according to the required international specifications like DIN/VDE or IEC.
Further more they fulfil all climatic, environmental and fire protection requirements:
- Enviromental class E2
- Climate class C2
- Fire protection class F1
- Basic impulse level List 2

The requirements of the environmental protection is taken into account for design of the RITZ cast resin transformers.

Special Transformers
- Injection transformers for ripple control applications
- Reactors for ripple control applications
- High current transformers
- Earthing transformers
- Medium frequency transformers
- Filter and blocking reactors
- Smoothing and interphase reactors

Electronic Instrument Transformers and Sensores

Electronic Instrument Transformers and Sensor

Voltage-Sensoric
- Voltage up to 90 kV
- Accuracy of 0,2 %
- Frequency from 0 to 10 kHz

Current-Sensoric
- Current up to 24000 A
- Accuracy of 0,01 %
- Frequency from 0 to 10 kHz

Applications
- Power Engineering
- Rail Transportation Power Supply
- Electrochemistry
- Environment Engineering
- Research

- Grid Analyse
- Protection Technology
- Switchgear Systems
- Automobile Industry

Block-Type Multi Sensor

The sensor provides signals for current and voltage measurement as well as voltage reference for electronic protection relays.

Current measurement
- Using a Rogowski coil

Voltage measurement
- Using an ohmic voltage divider

Voltage reference
- Using a coupling electrode

Cast Resin Parts

We develop and formulate casting resin molding materials for electrical applications in the low and medium voltage range and for electronics. We sketch and produce casting resin-isolated devices and shaped parts for application in electrical energy engineering for example special bushings, fuse housings etc.

We look forward to our cooperation with you.