VISHAY INTERTECHNOLOGY, INC.

www.vishay.com

SURGE SUPPRESSOR CAPACITORS
VISHAY ESTA

DATA BOOK

VSE-DB0104-1603

ABOUT VISHAY INTERTECHNOLOGY, INC.

GLOBAL INDUSTRY LEADER

Vishay Intertechnology was founded in 1962 by Dr. Felix Zandman, with a loan from his cousin Alfred P. Slaner. The Company was named after Dr. Zandman's ancestral village in Lithuania, in memory of family members who perished in the Holocaust. The Company's initial product portfolio consisted of foil resistors and foil resistance strain gages. In 1985, having grown from a start-up into the world's leading manufacturer of these products, the Company began a series of strategic acquisitions to become a broad-line manufacturer of electronic components. Today, Vishay Intertechnology is one of the world's largest manufacturers of discrete semiconductors and passive electronic components.

As Vishay Intertechnology grew through innovations and acquisitions, its resistive foil technology products became non-core businesses. In 2010, Vishay Intertechnology spun off these non-core businesses into an independent company listed on the New York Stock Exchange: Vishay Precision Group (NYSE: VPG).

DIVERSE MARKETS

Vishay Intertechnology supports customers in virtually every major market sector. Vishay components are used every day in designs around the world, for applications in industrial, communications, transportation, consumer, medical, and defense products. Vishay has manufacturing plants in the Americas, Asia, Europe, and Israel, as well as sales offices worldwide. Its innovations in technology, successful acquisition strategy, superior product quality, and "one-stop shop" service to customers have made the Company a global industry leader.

STRATEGIC ACQUISITIONS

2014	Capella Microsystems Holy Stone Polytech
2013	MCB Industrie
2012	HiRel Systems
2011	Huntington Electric: Resistor businesses
2008	KEMET: Wet tantalum capacitor business
2007	International Rectifier: PCS business
2002	BCcomponents Beyschlag
2001	General Semiconductor Infineon: Infrared components business Mallory (NACC) Tansitor
2000	Cera-Mite Electro-Films Spectrol
1998	Siliconix Telefunken
1994	Vitramon
1993	Roederstein
1992	Sprague
1988	Sfernice
1987	Draloric
1985	Dale

SOLUTIONS FOR GROWTH

Vishay is very well positioned to provide components for new macroeconomic growth drivers such as connectivity, mobility, and, sustainability. Through its R&D, engineering, quality programs, and sales initiatives, it generates a steady stream of innovative components to enable designers to create new generations of end products.

In tablets, smartphones, and wearables, Vishay components support power management, wireless connectivity, display interface, and touch screen controls, provide protection from the electrostatic discharge (ESD) that can cause component and system failure, and perform other functions. Vishay components are also found in wireless charging devices, mobile payment systems and other near-field communications systems, servers, network devices, base stations, solid-state drives, telematics systems, and other products and systems in our increasingly interconnected world.

In the area of mobility, to take just one example, Vishay components support a wide range of functions in electric power steering, including electromagnetic interference (EMI) filtering, quiescent current switch-off, three-phase motor switching, current sensing, and voltage division. Vishay components also are used in transmission control units, exhaust systems, start-stop systems, climate controls, braking and safety, lighting, infotainment, proximity and gesture recognition, and more. In hybrid vehicles, Vishay components are used in main inverters, high-voltage bus systems, and energy recuperation. Power capacitors, inductors, and high-power resistors are used to move high-speed trains, buses, intralogistic devices, aircraft, ships, and other carriers in modern infrastructure.

In the area of sustainability, Vishay components are used in the main inverters, power filters, and pitch and system controls of wind turbines. Components in wind turbine systems include high-power semiconductor modules, high-voltage MOSFETs, power ICs, diodes and rectifiers, optical isolators, shunt resistors, crowbar resistors, inductors, and power capacitors. Vishay components are used in solar panels and inverters, and for on-panel power conversion. They are used in smart meters and smart grids, power transmission and distribution systems, power grid quality stabilization, oil and gas exploration equipment, energy harvesting, and more.

A WORLD OF SOLUTIONS

Surge Suppressor Capacitors
Vishay ESTA

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Surge Suppressor Capacitors

APPLICATIONS

RC surge suppressors are designed to protect the windings of electrical machines and transformers against steep fronted and high voltage impulses which occur as a result of atmospheric discharges.

To reduce power-frequency voltages which are transferred capacitively to the secondary or tertiary side of the transformers in the event of an earth fault occurring on the primary side.

CONSTRUCTION

The RC surge suppressors can have either indoor or outdoor bushings. Their active parts are flat-type winding elements with two electrodes which are insulated from each other. The winding elements are incorporated into the capacitor casing. Both air and moisture are extracted under vacuum and at high temperature and all cavities are filled with an impregnant. The capacitor casings are either of aluminum or of stainless steel and are given two coatings of paint.

Capacitors for rated voltages of up to 24 kV form the basic units.

Those for 7.2 kV have two bushings. Capacitors for 12 kV and above have one bushing and the second pole is connected to the casing.

Capacitors to be used in systems with voltage higher than 24 kV are mounted on base insulators, with a maximum of two capacitors connected in series on the same insulator.

STANDARD SPECIFICATIONS

The capacitors are designed and tested related to VDE 0560, Part 3. The rated voltage U_N of capacitors to be connected between phases and earth are given in the same specifications.

In systems with an insulated neutral or earthed through arc-suppression coils, the rated voltage is U_{N1} equal to phase-to-phase voltage $U_{r,}$ whereas in systems with an effectively earthed neutral, the rated voltage U_{N2} is equal to $U_r/\sqrt{3}$.

According to VDE 0111, paragraph 6, a system is effectively earthed if, in the event of a simple earth fault, the voltage of the healthy phases cannot exceed 80 % of the system (phase-to-phase) voltage. Not all the transformer neutral points of the system need to be earthed to achieve this.

In cases of doubt, it is recommended to choose capacitors whose rated voltage is equal to the system voltage.

CURRENT-CARRYING CAPACITY

RC surge suppressors installed in systems with an insulated neutral or earthed through arc-suppressions coils and in systems with a rigidly earthed neutral can be loaded continuously at 120 % rated voltage and used at frequencies of up to 60 Hz.

All the surge suppressors meet the insulation requirements for equipment rated at 1 kV and above (VDE 0111/12.66).

TECHNICAL DATA

Dielectric	All film polypropylene
Impregnant	Non PCB
Rated voltage	7.2 kV to 36 kV
Rated capacitance	0.05 µF to 0.8 µF
Temperature class	-25 °C to +50 °C
Installation	Indoor or outdoor

CAPACITANCE VALUES TO VDE 0675

U_N	kV	7.2	12	17.5	24	36
C_N	µF	0.5	0.3	0.3	0.3	0.15

Other values of capacitance, voltage, or temperature class are available upon request.

MODE OF OPERATION

Protection Against Steep-Fronted Voltage Impulses

Electrical machines connected to overhead lines without cables or transformers being interposed should be protected by capacitors (VDE 0675 - Guidelines for Surge Suppression Equipment). These surge suppressors are connected inter-turn faults.

Because of their energy storing capability, surge suppressors reduce the front steepness of voltage impulses (see Fig. 1).

This flattering effect also avoids any damaging impulse reflections on the equipment connected.

Moreover, the magnitude of the overvoltage is also reduced since the impulse entering the winding has a finite “virtual time to half value on the tail”.

The capacitances stated in the above table have been calculated so that the front steepness of voltage impulse entering the winding is reduced to a maximum of 10 % winding test voltage per µs.

This value is based on the assumption that the original front steepness of the impulse is very great and that voltage peaks are in the range of more than 50 % flashover voltage impulse for the overhead line insulators. The voltage across the surge suppressor and the time until - because of the flattering effect - the voltage becomes a maximum at the terminal can be seen from Fig. 2.

Both the voltage and time apply to an impulse with a very steep front and a tail which decreases as an exponential function.

The charts are based on the expression given below.

$$T_0 = 1.44 \text{ x } T_r$$

where T_0 = time constant of the exponential decrease of the incoming impulse

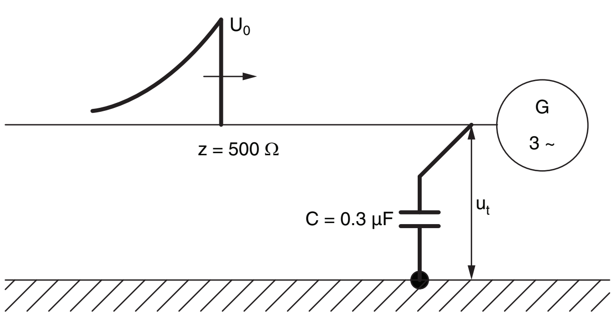
T_r = virtual time to half value on the incoming impulses (60 µs approx.)

$$U_0 = \hat{U}_0 \text{ x } e - t/T_O$$

where U_0 = incoming impulse on base of time

$\hat{U}_0$ = peak value of incoming impulse

T = time in s



$$T_C = C \text{ x } Z$$

where T_C = time constant of particular system section

C = capacitance of the protective capacitor

Z = surge impedance of the overhead line (500 Ω approx.)

$$\frac{u_t}{\hat{U}_0} = \frac{2}{1 - (T_C/T_0)} \text{ x } e - \left(\frac{t}{T_0 - e} - \frac{t}{T_C}\right)$$

where u_t = voltage curve on a base at the line terminal

$$\frac{t_m}{T_0} = \frac{2}{1 - (T_C/T_0)} \text{ x } \ln\frac{T_C}{T_0}$$

where t_m = time until voltage u_t becomes a maximum at the line terminal

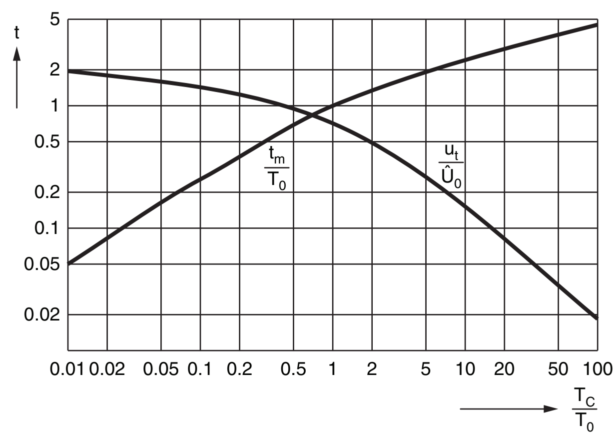


Fig. 2 - Reduction of voltage impulse by a protective capacitor at a line terminal

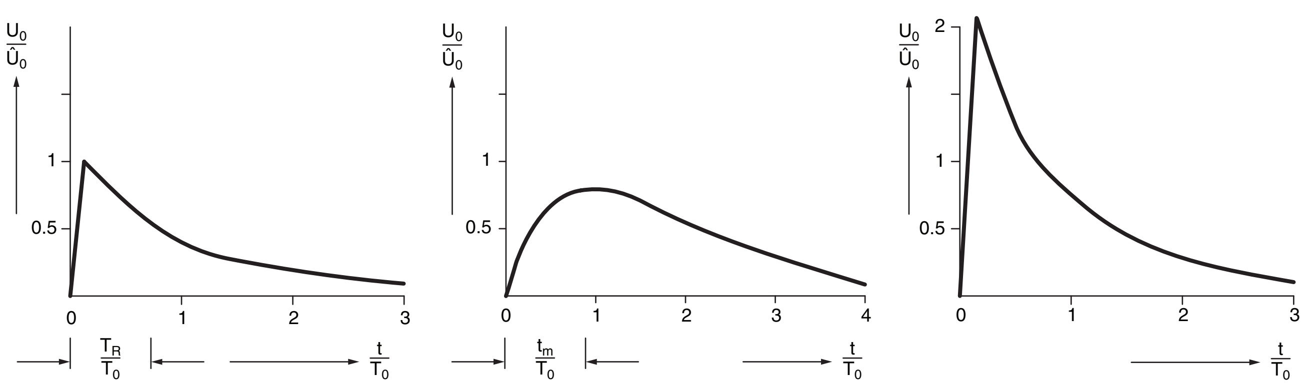


Fig. 1

Surge arresters used in conjunction with surge suppressor capacitors operates at a lower instantaneous value of the voltage than without such capacitors. This is because of the reduced front steepness of the impulse and the consequently lessened effect of “delayed ignition”.

The obvious advantage is that the machine windings, which in most cases have weaker insulation than overhead lines, are better protected.

The machine arresters must, therefore, be designed for lower impulse and power-frequency sparkover voltages than the usual arresters.

On the other hand, since they are now likely to operate in the event of internal overvoltages as well, they must have a correspondingly higher discharge capacity.

In case of electrical equipment connected to overhead lines through cables, the capacitance of the surge suppressor capacitance can be reduced by roughly the amount corresponding to the operating of the cables.

The inductance’s and capacitance’s of the machines or transformers connected have little influence on the size of the protective capacitance’s required, and inquires need therefore only be made if he zone ahead of the equipment to be protected is subject to special conditions.

EXAMPLE

Reduction of the voltage impulse on an overhead line by a surge protection capacitor.

Surge impedance Z of the overhead line: 500 Ω
Capacitance C of the protective capacitors: 0.3 μF
Time constant T_C = C x Z = 0.3 x 500 = 150 μs

Virtual time to half value on the tail, T_r, of the incoming impulse: 50 μs

Thus:

$$T_0 = 1.44 \times T_r = 1.44 \times 50 = 72\ \mu s$$

$$T_C/T_0 = 150/72 = 2.08$$

From the chart:

$$\hat{u}_t/\hat{U}_0 = 0.5 \text{ and } t_m/T_0 = 1.4$$

where $\hat{u}_t$ = voltage curve on a base at the line terminal

It can thus be seen that an incoming impulse with at peak ($\hat{U}_0$) of 1000 kV and a virtual time on half value on the tail (T_r) of 50 μs is reduced to a peak ($\hat{U}_t$) of 500 kV by the capacitor. Moreover, the voltage impulse u_t at the terminal does not attain its maximum until time T_m = 1.4 x 72 = 100 μs.

This shows that the steepness of the incoming impulse has been reduced considerably.

PROTECTION AGAINST POWER-FREQUENCY VOLTAGES TRANSFERRED CAPACITIVELY

In the case of unloaded generator transformer with a high transformation ratio (e.g. 110 kV on the higher voltage side), unduly high power-frequency voltages may be transferred capacitively to the lower-voltage side (U_{2C}) if an earth fault occurs on the higher-voltage side. For a single-phase earth fault, this can be expressed as follows:

$$U_{2C} = \frac{C_1}{C_1 + C_2} U_0$$

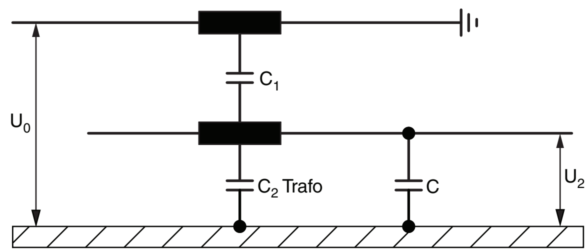


Fig. 3

U_0 = voltage to earth on the higher voltages side

C_1 = capacitance between higher and lower windings of one transformer phase (1 nF to 10 nF)

C_2 = resulting capacitance of a lower voltage phase including that of the transformer lower-side to earth (1 nF to 10 nF), the capacitance of the protective capacitor and possibly that of a cable connecting the transformer with the generator and also the capacitance of the latter

In systems operated with a free neutral or earthed through an arc-suppression coil, the voltage to earth is equal to the phase-neutral voltage, i.e.

$$U_0 = U_Y$$

Whereas in rigidly earthed systems and under the most favourable conditions:

$$U_0 = \frac{2}{3} U_Y$$

Moreover, the lower-side systems voltage U_{2b} is superimposed on C_{2C}. The maximum phase-to-earth voltage U_2' can thus be expressed as follows:

$$U_2' \sim U_{2C}' + \frac{U_{2b}}{\sqrt{3}}$$

Capacitors of low rating. E.g. of 0.075 µF and 0.15 µF, are best used for reducing power-frequency voltages transferred capacitively. It does not matter if their capacitances are higher than those calculated since the protection afforded by these capacitors is higher because of their greater energy storing capability.

CONNECTION

The surge suppressor capacitors can be connected at the shortest possible distance from the equipment to be protected.

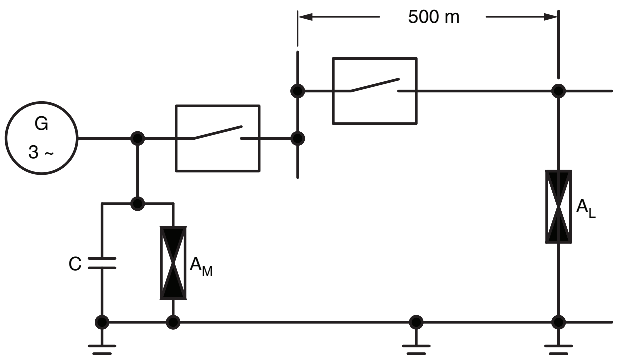


Fig. 4 - Surge suppression scheme for a generator which feeds an overhead line direct

C = surge suppressor

A_L = surge arrester on the overhead line

A_M = generator arrester

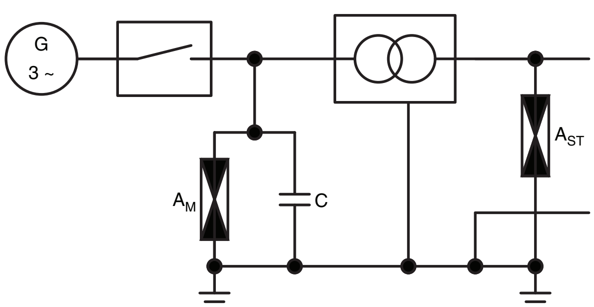
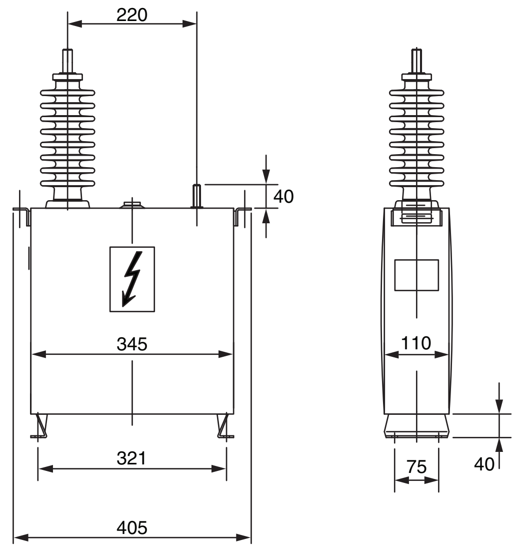
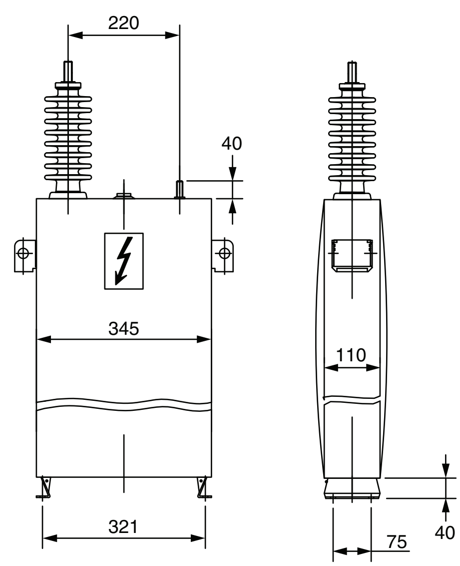


Fig. 5 - Surge suppression scheme for a generator which feeds an overhead line through a transformer. Capacitors afford protection against power-frequency voltages transferred capacitively.

A_{ST} = station arrester

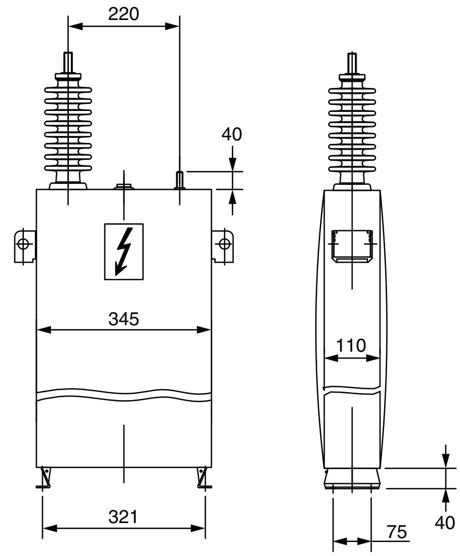
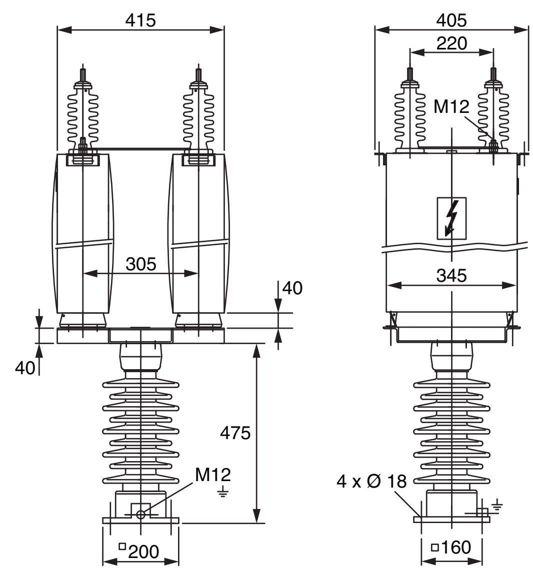
Single Phase Types

<table>
<tr><th colspan="6">SURGE SUPPRESSOR CAPACITORS</th></tr>
<tr><th>TYPE</th><th>U_N
kV</th><th>C_N
µF</th><th>U_E
kV/1 min</th><th>IMPULSE
kV_P</th><th>DRAWING</th></tr>
<tr><td>Phaso 12/0.1 µF</td><td rowspan="7">12</td><td>0.1</td><td rowspan="7">28</td><td rowspan="7">75</td><td rowspan="7">
</td></tr>
<tr><td>Phaso 12/0.15 µF</td><td>0.15</td></tr>
<tr><td>Phaso 12/0.2 µF</td><td>0.2</td></tr>
<tr><td>Phaso 12/0.25 µF</td><td>0.25</td></tr>
<tr><td>Phaso 12/0.3 µF</td><td>0.3</td></tr>
<tr><td>Phaso 12/0.4 µF</td><td>0.4</td></tr>
<tr><td>Phaso 12/0.5 µF</td><td>0.5</td></tr>
<tr><td>Phafso 17.5/0.1 µF</td><td rowspan="7">17.5</td><td>0.1</td><td rowspan="7">38</td><td rowspan="7">95</td><td rowspan="7">
</td></tr>
<tr><td>Phafso 17.5/0.15 µF</td><td>0.15</td></tr>
<tr><td>Phafso 17.5/0.2 µF</td><td>0.2</td></tr>
<tr><td>Phafso 17.5/0.25 µF</td><td>0.25</td></tr>
<tr><td>Phafso 17.5/0.3 µF</td><td>0.3</td></tr>
<tr><td>Phafso 17.5/0.4 µF</td><td>0.4</td></tr>
<tr><td>Phafso 17.5/0.5 µF</td><td>0.5</td></tr>
</table>

Note

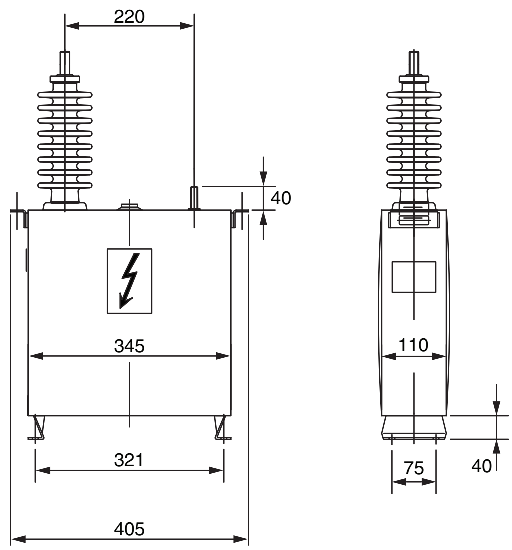
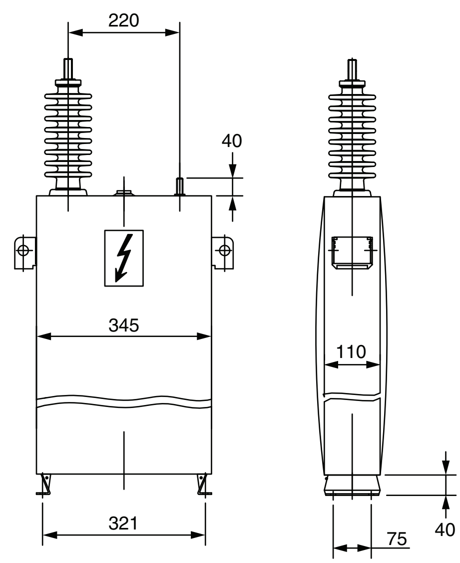
- Dimensions are depending on the losses of the capacitor

SURGE SUPPRESSOR CAPACITORS

TYPE	U_N kV	C_N µF	U_E kV/1 min	IMPULSE kV_P	DRAWING
Phafso 24/0.1 µF		0.1			
Phafso 24/0.15 µF		0.15			
Phafso 24/0.2 µF		0.2			
Phafso 24/0.25 µF	24	0.25	50	125	
Phafso 24/0.3 µF		0.3			
Phafso 24/0.4 µF		0.4			
Phafso 24/0.5 µF		0.5			
US/36/0.1 µF		0.1			
US/36/0.15 µF		0.15			
US/36/0.2 µF	36	0.2	70	170	
US/36/0.25 µF		0.25			
US/36/0.3 µF		0.3			

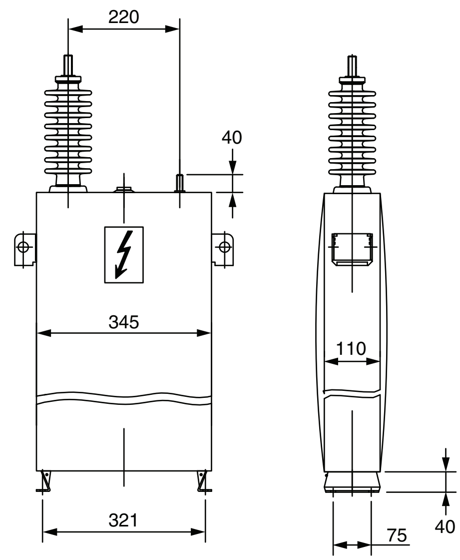
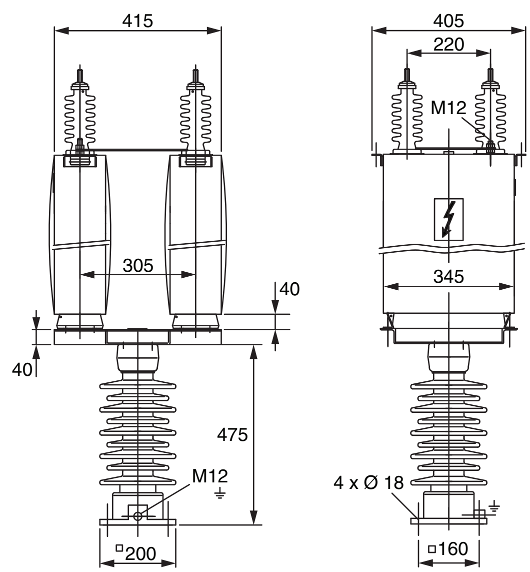
Note

- Dimensions are depending on the losses of the capacitor

RC-SURGE SUPPRESSOR CAPACITORS						
TYPE	**U_N kV**	**C_N µF**	**U_E kV/1 min**	**IMPULSE kV_P**	**R Ω**	**DRAWING**
Phaso 12/0.1 µF / ...		0.1				
Phaso 12/0.15 µF / ...		0.15				
Phaso 12/0.2 µF / ...		0.2				
Phaso 12/0.25 µF / ...	12	0.25	28	75	10 to 50	
Phaso 12/0.3 µF / ...		0.3				
Phaso 12/0.4 µF / ...		0.4				
Phaso 12/0.5 µF / ...		0.5				
Phafso 17.5/0.1 µF / ...		0.1				
Phafso 17.5/0.15 µF / ...		0.15				
Phafso 17.5/0.2 µF / ...		0.2				
Phafso 17.5/0.25 µF / ...	17.5	0.25	38	95	10 to 50	
Phafso 17.5/0.3 µF / ...		0.3				
Phafso 17.5/0.4 µF / ...		0.4				
Phafso 17.5/0.5 µF / ...		0.5				

Notes
- Dimensions are depending on the losses of the capacitor
- Earth fault protection (T < 1 min)

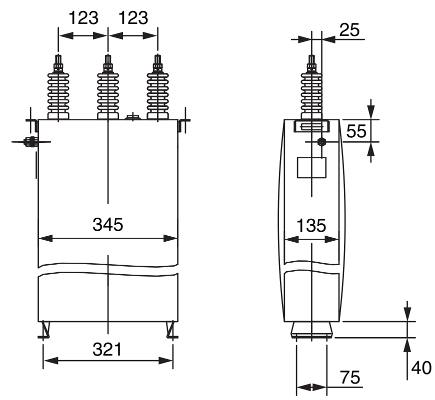
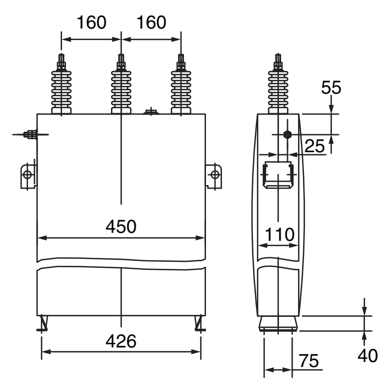
RC-SURGE SUPPRESSOR CAPACITORS WITH BUILT IN DAMPING RESISTOR

TYPE	U_N kV	C_N µF	U_E kV/1 min	IMPULSE kV_P	R Ω	DRAWING
Phafso 24/0.1 µF / ...		0.1				
Phafso 24/0.15 µF / ...		0.15				
Phafso 24/0.2 µF / ...		0.2				
Phafso 24/0.25 µF / ...	24	0.25	50	125	10 to 50	
Phafso 24/0.3 µF / ...		0.3				
Phafso 24/0.4 µF / ...		0.4				
Phafso 24/0.5 µF / ...		0.5				
RC/36/0.1 µF / ...		0.1				
RC/36/0.15 µF / ...		0.15				
RC/36/0.2 µF / ...	36	0.2	70	170	10 to 50	
RC/36/0.25 µF / ...		0.25				
RC/36/0.3 µF / ...		0.3				

Notes

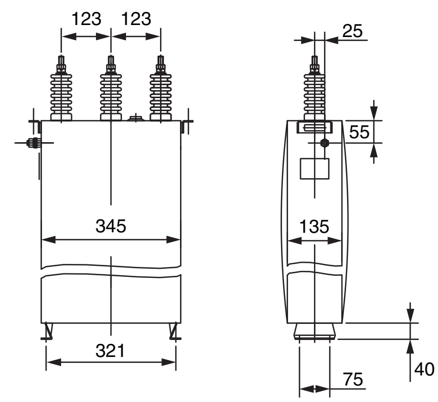
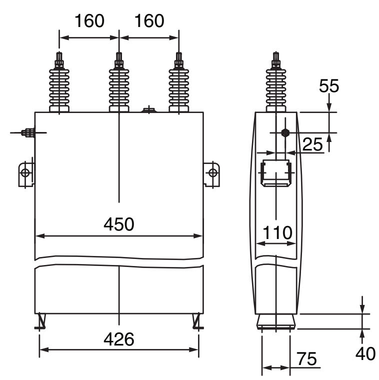
- Surge suppressor 36 kV consists of: 2 x capacitors unit connected in series
  1 x mounting plate
  1 x post insulator 36 kV (70 kV/200 kV_P)
- Dimensions are depending on the losses of the capacitor
- Earth fault protection (T < 1 min)

Three Phase Types

SURGE SUPPRESSOR CAPACITORS					
TYPE	U_N kV	C_N µF	U_E kV/1 min	IMPULSE kV_P	DRAWING
Phaso 7.2/3 x 0.25 µF	7.2	3 x 0.25	20	60	
Phaso 7.2/3 x 0.3 µF		3 x 0.3			
Phaso 7.2/3 x 0.4 µF		3 x 0.4			
Phaso 7.2/3 x 0.5 µF		3 x 0.5			
Phaso 7.2/3 x 0.6 µF		3 x 0.6			
Phaso 7.2/3 x 0.8 µF		3 x 0.8			
Phaso 12/3 x 0.1 µF	12	3 x 0.1	28	75	
Phaso 12/3 x 0.15 µF		3 x 0.15			
Phaso 12/3 x 0.2 µF		3 x 0.2			
Phaso 12/3 x 0.25 µF		3 x 0.25			
Phaso 12/3 x 0.3 µF		3 x 0.3			
Phaso 12/3 x 0.4 µF		3 x 0.4			
Phaso 12/3 x 0.5 µF		3 x 0.5			

Note

- Dimensions are depending on the losses of the capacitor

RC SURGE SUPPRESSOR CAPACITORS WITH BUILT IN DAMPING RESISTOR						
TYPE	**U_N kV**	**C_N µF**	**U_E kV/1 min**	**IMPULSE kV_P**	**R Ω**	**DRAWING**
Phaso 7.2/3 x 0.25 µF / ...	7.2	3 x 0.25	20	60	10 to 50	
Phaso 7.2/3 x 0.3 µF / ...		3 x 0.3				
Phaso 7.2/3 x 0.4 µF / ...		3 x 0.4				
Phaso 7.2/3 x 0.5 µF / ...		3 x 0.5				
Phaso 7.2/3 x 0.6 µF / ...		3 x 0.6				
Phaso 7.2/3 x 0.8 µF / ...		3 x 0.8				
Phaso 12/3 x 0.1 µF / ...	12	3 x 0.1	28	75	10 to 50	
Phaso 12/3 x 0.15 µF / ...		3 x 0.15				
Phaso 12/3 x 0.2 µF / ...		3 x 0.2				
Phaso 12/3 x 0.25 µF / ...		3 x 0.25				
Phaso 12/3 x 0.3 µF / ...		3 x 0.3				
Phaso 12/3 x 0.4 µF / ...		3 x 0.4				
Phaso 12/3 x 0.5 µF / ...		3 x 0.5				

Notes

- Dimensions are depending on the losses of the capacitor
- Earth fault protection (T < 1 min)

Zinc Oxide RC-Surge Suppressor (ZORC) for HV-Motor and Transformers M-Type and Panel Mounting P-Type

DESCRIPTION

ZORCs are RC surge suppressors with included varistors. The technology for the design of the ZORCs is the same as for all other capacitors in this catalog.

ZORCs will protect transformers and motors from insulation failures. As all surge transients will be removed at source by the ZORCs. The lifetime of transformers and motors will be increased for many years.

ZORCs will be inside the curves defined by IEEE and CIGRE for motor impulse withstand levels. To reach a comprehensive insulation coordination, independent what switching device or switching curve is used (air, vacuum, gas or oil).

ZORCs help to reduce costs of down time losses of transformers and motors and for replacements.

ZORCs will reduce significant the expenses for maintenance and insulation failures of motors and transformers, which user accept as normal.

ZORCs will eliminate connected with vacuum and other switchgears, all multiple striking (re- and pre-) transients.

So ZORCs prevents high frequency currents at zero in the contact gap of the switch.

APPLICATION

ZORCs are optimized to be mounted inside the motor or transformer terminal boxes to be connected to each phase and earth.

ZORCs will protect vacuum and other switchgears.

ZORCs connection diagrams in HV motor circuits:

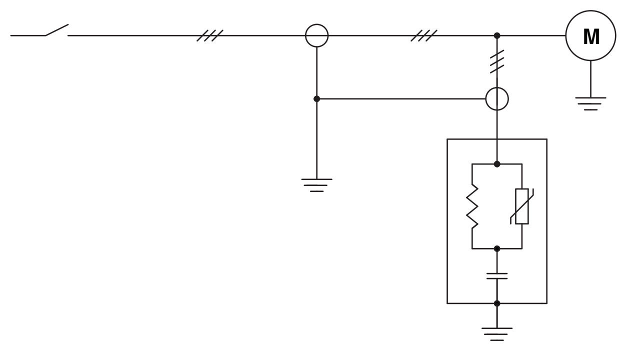


Fig. 1 - ZORC type M connected to motor terminals

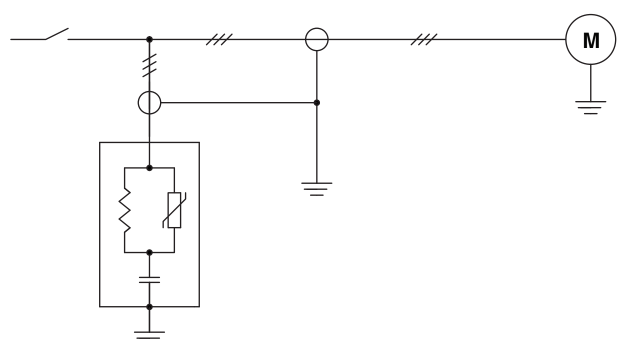
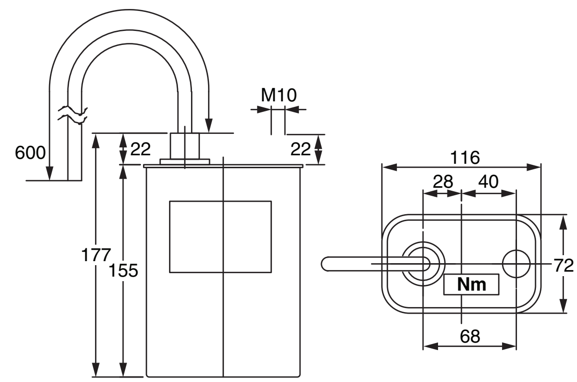
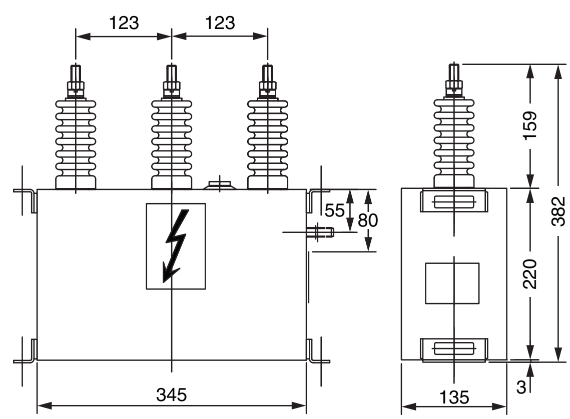
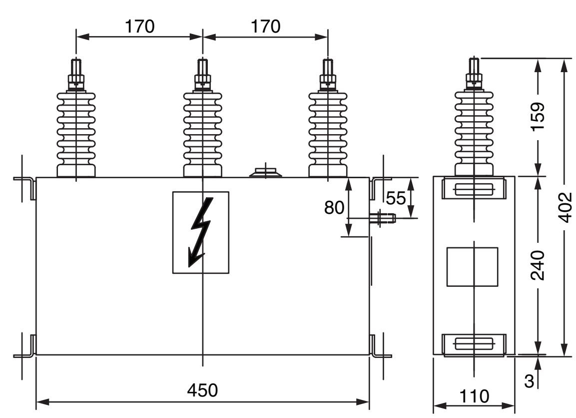


Fig. 2 - ZORC type P connected in switchgear panel

<table>
<tr><th colspan="6">ZORC</th></tr>
<tr><th>TYPE</th><th>U_N
kV</th><th>C_N
µF</th><th>PH</th><th>DIMENSION
mm</th><th>DRAWING</th></tr>
<tr><td>Zoaso 3.3/0.1 µF / M</td><td>3.3</td><td rowspan="2">0.1</td><td rowspan="2">1</td><td rowspan="2">116 x 72 x 155</td><td rowspan="2">
</td></tr>
<tr><td>Zoaso 6.6/0.1 µF / M</td><td>6.6</td></tr>
<tr><td>Zoaso 3.3/3 x 0.2 µF / P</td><td rowspan="2">3.3</td><td rowspan="4">3 x 0.2</td><td rowspan="4">3</td><td rowspan="4">345 x 135 x 220</td><td rowspan="4">
</td></tr>
<tr><td>Zoaso 3.3/3 x 0.2 µF / M</td></tr>
<tr><td>Zoaso 6.6/3 x 0.2 µF / P</td><td rowspan="2">6.6</td></tr>
<tr><td>Zoaso 6.6/3 x 0.2 µF / M</td></tr>
<tr><td>Zoaso 11/3 x 0.2 µF / P</td><td rowspan="2">11</td><td rowspan="2">3 x 0.2</td><td rowspan="2">3</td><td rowspan="2">450 x 110 x 240</td><td rowspan="2">
</td></tr>
<tr><td>Zoaso 11/3 x 0.2 µF / M</td></tr>
</table>

Note

- Application:
  M = motor
  P = panel

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MOSFETs
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- Automotive-Grade MOSFETs

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- Power Management and Power Control ICs
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Diodes Segment

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- Schottky Rectifiers
- Ultra-Fast Recovery Rectifiers
- Standard and Fast Recovery Rectifiers
- High-Power Rectifiers / Diodes
- Bridge Rectifiers

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- Schottky and Switching Diodes
- Zener Diodes
- RF PIN Diodes

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- ESD Protection Diodes (including arrays)

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- Fast Thyristors

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- Punch-Through Trench

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- Custom Modules

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- Linear
- Phototriac
- High-Speed
- IGBT and MOSFET Driver

Solid-State Relays

LEDs and 7-Segment Displays

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- Hall Effect Position Sensors
- Precision Magnetic Encoders

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- PTC Thermistors
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- Planar Devices
- Transformers
- Custom Magnetics

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- Molded Chip Polymer Tantalum Capacitors
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