

ZORC[®] Surge Suppressor

Operating Manual



SUPPLIER & SERVICES IN THE MIDDLE EAST
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High Frequency Transient Surge Suppressors

For protection of medium and low voltage motors, transformers and generators

Introduction

Every year huge losses are incurred by end-users because of insulation failures of medium voltage (3kV – 40kV) motors, and dry-type transformers.

The costs of insulation failure include:

- Costs of removing failed equipment from service, and for re-installation after repair
- Cost of transportation to and from the site
- Direct repair costs
- Costs of downtime and lost production (or disruption to production)

Owing to the nature and duty normally associated with medium voltage motors and dry-type transformers, the indirect costs are often significantly higher than the direct repair costs.

ZORC[®] is a unique high frequency transient overvoltage surge suppressor for the protection of motors, transformers and generators from steep wave-front, short rise-time, high magnitude, spikes, surges and other transient overvoltage, generated by switching and other sources.

The protective characteristics of ZORC[®] provide comprehensive insulation co-ordination with both the CIGRÉ and IEEE motor impulse voltage withstands characteristics at all practical surge magnitudes and rise-times. ZORC[®] eliminates multiple pre-striking and re-striking (re-ignition) transients associated with vacuum and other switchgear.

Suitable for both switchgear panel and machine terminal box mounting, ZORC[®] provides an easy-to-apply, compact and low cost solution to the extremely expensive problem of motor, transformer and generator insulation failures.



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Steep Wave-Front Surges

A steep fronted surge comprises a step-change in voltage or current (without reference to earth), with rise-times in the order of 0.1 – 0.2 μ s.

Steep wave-front travelling waves are injected into a cable during the process of switching of motors, transformers and generators, when a pre-strike or re-strike occurs across the closing or opening contact gap of the switch.

Because the motor, transformer or generator load surge impedance is invariably high with respect to the cable surge impedance, the steep wave-fronts are reflected and refracted at the load terminals.

Refraction causes the magnitude of steep voltage wave-fronts to almost double when the wave-front impinges on the load terminals.

During switching, reflection of pre-strike or re-strike current wave-fronts cause high frequency current zeros in the contact gap of the switch. Arc extinction occurs in switchgear capable of interrupting at the high frequency current zeros, and subsequent re-strikes result in the generation of multiple pre-striking transients.

Thus, refraction and reflection of steep wave-fronts, caused by a mismatch of the cable and load surge impedances, is central to the generation of the severe multiple pre-striking and multiple-escalating re-striking switching transients associated with vacuum and other switchgear. (Fig. 1 and 2)

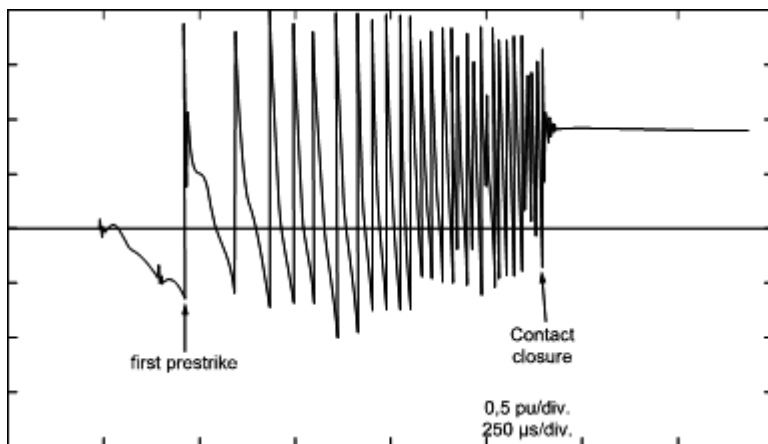


Fig.1 Multiple pre-striking during routine motor Switch-on. Without ZORC[®] surge suppressor fitted

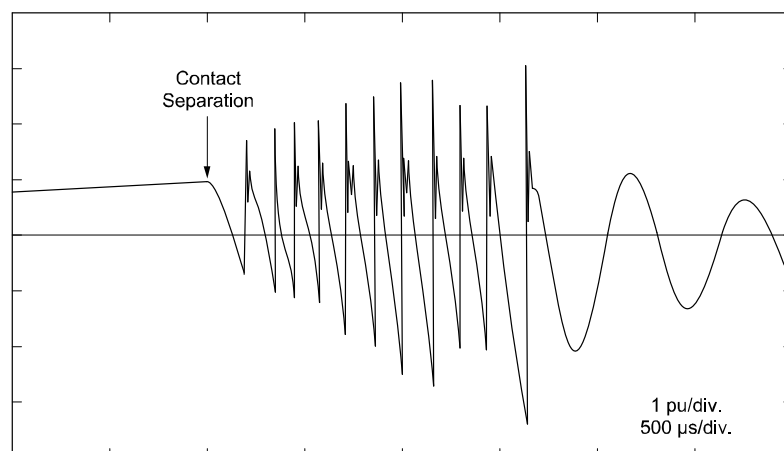


Fig.2 Multiple re-striking (re-ignition) during interruption of a motor starting current i.e. stalled tripping (without a ZORC[®] surge suppressor fitted)

Other switching transients can also occur, such as current chopping and virtual current chopping transients. The former is normally not severe because the voltage transient generated is not steep fronted, and the normal chopping currents of medium voltage switchgear are not high. The latter is extremely severe and cannot be tolerated by motors and dry-type transformers in any circumstances.

Steep wave-front surges on medium voltage power systems may also result from direct lightning strikes, from flashover across insulators or from induced surges caused by lightning and other atmospheric discharges.
Other Switching Transients

Steep wave-front surges may also be generated by arcing earth faults on unearthed, reactance, or capacitance earthed power systems.

Motor insulation impulse withstand levels

The ability of motors and dry-type transformers to withstand steep wave front switching, lightning and other transient overvoltage phenomena is the lowest of all equipment generally connected to a three-phase power system.

The surge withstand ability of motors and dry-type transformers decreases with decreasing impulse wave-front rise-times (i.e. with steeper wave-fronts) because a steep wave-front surge does not distribute itself evenly over the motor/transformer winding, but stresses the line-end coils more. The steeper the surge wave front, the more the stressing of the inter-turn insulation of the line-end coils. (Fig. 3)

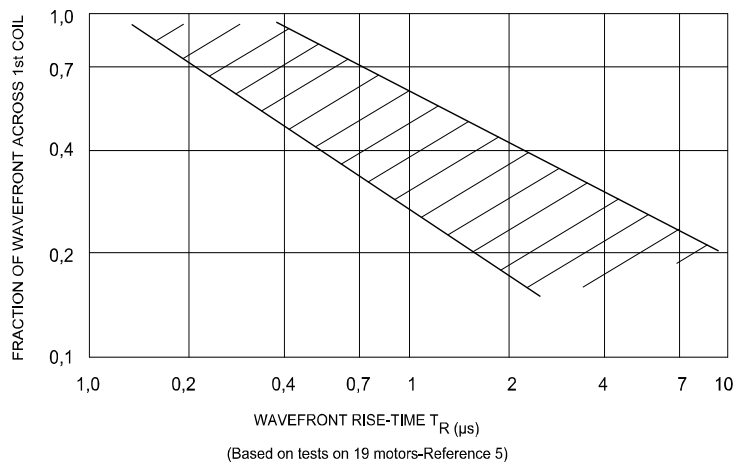


Fig.3 Percentage of voltage wave-front appearing across line-end coil as a function of rise-time

This contrasts with the protective characteristics of power surge arresters, which exhibit an increasing (or at best, a constant) spark-over/residual voltage characteristic for steeper impulse wave-fronts i.e., it is impossible for power surge arresters to provide adequate insulation co-ordination at all practical impulse magnitudes and rise-times.

In addition, power surge arresters provide protection with respect to earth, or between phases, whereas steep wave-front surges are step changes in voltage without reference to earth (often crossing earth potential) which stress the inter-turn insulation of the line-end coils of motors and dry-type transformers. (See Fig. 1 and 2).

In service, there is an inevitable and unpredictable degradation of motor and transformer insulation as a result of the effects of temperature, vibration, shrinkage of insulation (resulting in loosening of a coil within a slot and subsequent chafing), environmental and atmospheric conditions, the number, magnitude and rise-times of transient over-voltage applied to the motor, etc.

There are no international standards which lay down requirements regarding medium voltage motor insulation impulse withstand levels, either at the point of manufacture or over the intended service life of the motor.

However, the CIGR  Working Group 13.02 and the IEEE working group on the impulse strength of AC rotating machines, give some guidance as to what can be expected in practice. The IEEE curve takes the effects of ageing into account. (Fig. 4)

Cigr : Withstand level given by 5 manufacturers

IEEE: Recommended withstand value taking into account ageing.

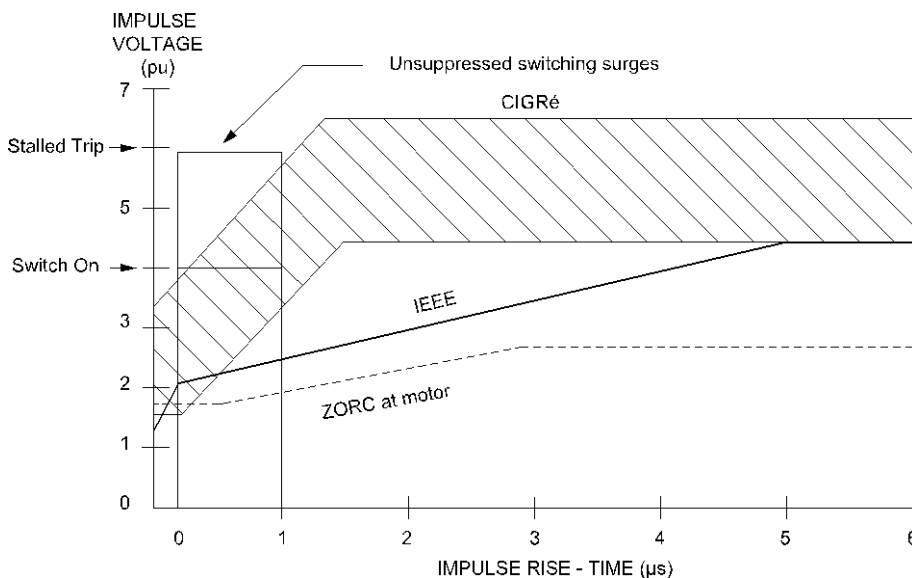


Fig.4 Impulses withstand levels of medium voltage motors. Showing unsuppressed switching surge magnitudes and rise-times, and insulation co-ordination provided by ZORC[®]

It is well documented that routine motor switch-on operations can result in surges of up to 4pu with rise times of 0.1 - 1ms, and stalled tripping operations can result in surges of 5 - 6pu with rise times of 0.1 - 1ms. These surges are significantly higher than the motor withstand levels given by the IEEE and CIGR  curves. (Fig. 4)

Note: $1\text{pu} = \sqrt{2} / \sqrt{3} \times V_{L-L}$

How ZORC[®] works

The ZORC[®] surge suppressor is a unique voltage and frequency dependent cable-terminating network comprising of capacitors, resistors and Zinc Oxide (ZnO) non-linear arresters. (Fig. 5)

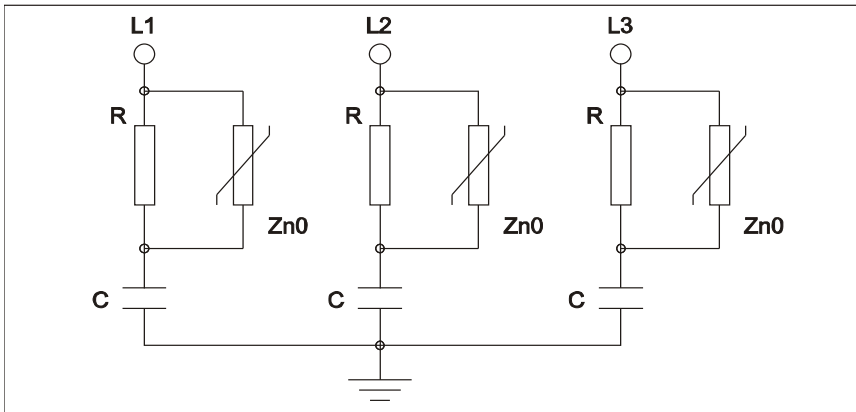


Fig.5 ZORC[®] circuit and technique

Under normal mains frequency conditions the impedance of the capacitive elements is very high, effectively "disconnecting" the resistive components from the system and minimising heat dissipation and stressing of these elements.

Under high frequency transient conditions the impedance of the capacitive elements is low with respect to the resistive elements, effectively "inserting" the resistive components in the power system as a cable-terminating network.

For cable terminating resistors having a value of $Z_c \leq R \leq 3 Z_c$ (where Z_c is the cable surge impedance) voltage refraction and reflection of steep wave fronts is minimised, voltage doubling is avoided, and high frequency re-strike current zeros in the switch are eliminated.

This eliminates multiple pre-striking and re-striking transients associated with vacuum and other switchgear. (Fig 6 & 7).

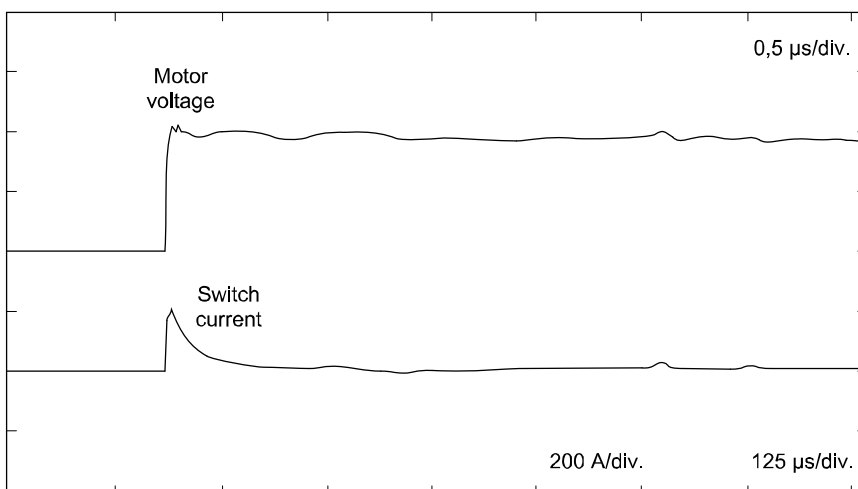


Fig.6 Clean switch-on of motor with ZORC surge suppressor fitted, showing elimination of multiple pre-striking

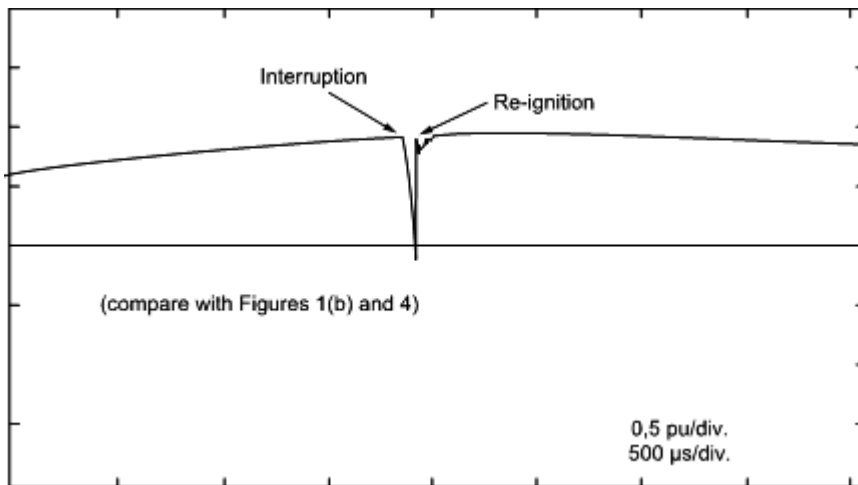


Fig.7 Single re-strike during interruption of a motor starting current with a ZORC surge suppressor fitted, showing elimination of multiple escalating re-striking

Under high magnitude steep wave-front conditions, the ZnO arresters (having a knee-point voltage of 1 – 2 pu) “trigger”, providing a very low resistance in series with the capacitive elements. Therefore, a suitably low absolute limit is provided to the magnitude of a steep wave-front at the load terminals, and that portion of a steep wave-front which exceeds this limit is sloped to a value within the IEEE recommended motor insulation withstand levels.

The cable surge impedance Z_c is independent of cable length, and does not vary widely for different cable types and sizes. Therefore, a resistance value of 30 ohms for the ZORC[®] suppressor, satisfying the condition $Z_c \leq R \leq 3 Z_c$, is suitable for virtually all installations, and is independent of cable length, motor size and voltage.

The value of the capacitive elements is optimised to minimise the heat dissipation and stressing of the resistive elements under normal mains frequency conditions while still performing its function as a “frequency dependent switch” and as a “wave sloping capacitor” under high frequency transient conditions.

With the ZORC[®] circuit, ZnO gapless non-linear arresters, with a clamping voltage low enough to protect the inter-turn insulation of the line-end coils, i.e. less than 2pu, (where $1pu = \sqrt{2} / \sqrt{3} \times V_{L-L}$), can be used, because the voltage across the non-linear elements is negligible under normal mains frequency operating conditions.



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User benefits provided by ZORC[®]

- ZORC[®] halves the magnitude of steep wave-front surges impinging on the load terminals by providing a matched cable terminating impedance under transient conditions thereby eliminating refraction of steep wave-front surges (i.e. eliminates voltage doubling effects).
- ZORC[®] eliminates multiple pre-striking and re-striking transients associated with vacuum and other switchgear, by eliminating reflections of the pre-strike and re-strike current wave-fronts, and thus preventing high frequency current zeros in contact gap of the switch.
- ZORC[®] provides a suitably low absolute limit to the magnitude of steep wave-fronted surges that may impinge on the load terminals, and slopes that portion of the steep wave front that exceeds this limit.
- ZORC[®] provides comprehensive insulation co-ordination, at all practical steep wave-front surge magnitudes and rise-times, within the motor impulse withstand levels recommended by the IEEE and CIGRĚ curves.
- ZORC[®] protects new motors and dry-type transformers throughout their service life by reducing the magnitude, rise-time and frequency of occurrence of steep wave fronts impinging on the load terminals.
- ZORC[®] extends the life of motor and dry-type transformer insulation if retrofitted to existing motors in service.
- ZORC[®] saves money by eliminating losses incurred as a result of insulation failures of motors and dry-type transformers, in terms of both direct repair costs as well as costs of down-time leading to lost or disrupted production.

ZORC[®] Product Features

Compact

ZORC[®] is compact enough to be fitted within most motor, transformer or generator terminal enclosures or switchgear panels.

Low cost

ZORC[®] offers an unparalleled price / performance ratio.

Easy to apply

ZORC[®] Surge Suppressors may be selected from a catalogue with no detailed engineering required.

Mounting options

ZORC[®] versions are available for both machine mounting (M-type) and panel mounting (P-type).

Single phase and three phase versions

ZORC[®] suppressors are available as both single phase and three phase versions. Single-phase versions are suitable for installing in phase segregated terminal enclosures.

Hazardous environment application

As an option ZORC[®] Surge Suppressors may be ordered certified for use in potentially flammable atmospheres (Class 1 Division 2 locations, ExN non sparking), temperature classes T1 to T5, to SABS 970-1971 (amended).

Easy to install

ZORC[®] suppressors may be mounted in any orientation, and convenient mounting brackets or clamps are provided.

Well proven

Many thousands of ZORC[®] Surge Suppressors have been installed over the past 25 years on motors, generators and transformers, solving the pressing problem of insulation failures and attendant repair and downtime costs.

Voltage range

ZORC[®] models are available to suit various voltages from 400V up to 40kV

Applications

ZORC[®] suppressors have been installed in large quantities in the following industries:

- Chemical
- Petrochemical
- Underground mining (gold, platinum, coal, other)
- Surface mining (coal, copper, uranium, iron ore, other)
- Metal beneficiation (steel, stainless steel, gold, platinum, copper and uranium refineries)
- Power generation (generators, power station auxiliaries)
- Pumping (water pumping stations, oil pipelines)

ZORC[®] suppressors are typically applied in the following specific applications on motors, generators, and dry and oil immersed transformers and associated switchgear:

- Fans
- Pumps
- Compressors
- Mills
- Crushers
- Refrigeration machines
- Motor-generator sets
- Mine winders
- Conveyors
- Underground and surface mini-substations and mobile substations
- Generators
- Power station auxiliaries
- Induction & arc furnaces
- Dry type transformers

Available Types

Standard ZORC[®] - medium voltage

Medium voltage ZORC[®] units are available in voltages ranging from 2.2kV to 40kV. Both machine and panel mount versions are available as follows:

- Machine mount from 2.2kV to 40kV
- Panel mount from 2.2kV to 12.5kV
- Single phase only from 15kV to 40kV
- Single and three phase from 2.2kV to 13.8kV

Note: The prefix 'M' indicates a machine mounted ZORC[®] while a prefix 'P' indicates a panel mounted ZORC[®].

Compact ZORC[®] - medium voltage

- M3C-3kV for use on 3.3kV 3 phase 50/60Hz systems
- M3C-6kV for use on 6.6kV 3 phase 50/60Hz systems

The compact ZORC[®] is a 3 phase design fitted with 1 meter long voltage silicone rubber flexible leads. This facilitates easy installation into a motor/transformer terminal box and is directly connected to the motor/transformer terminals, thus reducing the required clearance associated with the conventional porcelain bushings.

LVZ ZORC[®] - low voltage

The low voltage ZORC[®] has four standard models:

- LVZ400 for use on 380 / 400V 3 phase 50Hz systems
- LVZ550 for use on 525 / 550V 3 phase 50Hz systems
- LVZ690 for use on 660 / 690V 3 phase 50Hz systems
- LVZ1100 for use on 1000 / 1100V 3 phase 50Hz systems

Note: ZORC[®] RC Surge Suppressors are also available as customised designs for 22kV to 40kV 3-phase 50/60Hz systems, generally for dry-type transformer and oil immersed transformer protection applications. Certain other system voltages are available on request. Enquire from Powertech System Integrators for further details.

Installation

ZORC[®] surge suppressors may be installed in any orientation (including upside down) on the machine side of the associated medium voltage motor/generator/transformer switch in the following positions (in order of preference from a surge protection point-of-view):

- In the motor/generator/transformer terminal box, connect from each phase to earth
- Cabled to the motor/generator/transformer terminal box via a 3-core cable (25mm² minimum), plus earth conductor (in accordance with local regulations)
- In line with the motor/generator/transformer supply cable, shunt connected from each phase to earth
- In the associated motor/generator/transformer switch panel, connected from each phase to earth

Convenient mounting brackets or clamps are provided.

Connections

In the case of ZORC[®] surge suppressors with porcelain bushings, care should be taken to use flexible connections to the bushings to avoid vibration or shock being transmitted to the bushings in service and during transportation (when pre-wired). In addition, care should be taken not to over tighten the nuts on the bushing and earth studs (maximum 20Nm). Use a spanner to hold the bottom nut while tightening the top nut.

Flexible Leads

In the case of ZORC[®] surge suppressors with flexible insulated connection leads (M1-3KV, M1-6KV, M3C-3KV & M3C-6KV), the leads can be cut to length to suit the application but should not be extended. These compact single-phase motor/ transformer-mounting units must be directly connected to the machine terminals.

Earth / Ground

Be sure to earth the ZORC[®] suppressor earth stud to the machine earth or switchgear panel earth bar, and ensure the machine is earthed back to the system earth via the machine's cable earth conductor, in accordance with local regulations.

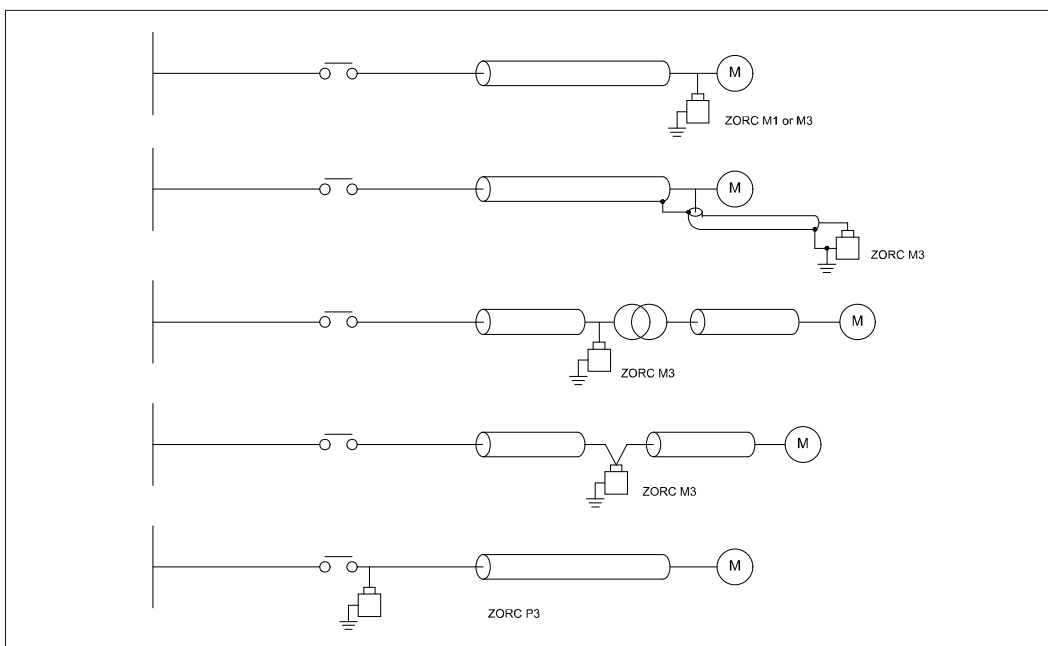


Fig.8 Preferred connections of ZORC[®] surge suppressors

Instructions for Safe Use

Purpose of this Document

Keep these instructions available for personnel responsible for proper installation, maintenance, operation and testing.

These instructions are a guide to the safe use of ZORC[®]. They do not supplant or take the place of any applicable national and or local safety codes or requirements of local authorities or insurance underwriters.

Apparatus covered by this instruction literature should be operated and serviced only by competent personnel familiar with good safety practice. These instructions are written for such personnel and are not intended as a substitute for proper training and experience in safety procedures for this type of equipment.

All possible contingencies which may arise during installation, operation or maintenance and all details and variations of this equipment do not purport to be covered by these instructions. If further information is required by the purchaser regarding their particular installation, operation or maintenance of their equipment, Powertech System Integrators should be contacted.

Manufactured Standards

The ZORC[®] product is manufactured in South Africa to the SABS ISO9001 quality control system, including the capacitor unit within the ZORC[®]. All the internal and external insulation levels and testing requirements comply fully with IEC-871-1 for shunt capacitors with 660V rating and upwards.

The ZORC[®] product is not specifically catered for under the, NEMA, EEI-NEMA, and ANSI Standards, but we must state that the manufacture of the ZORC[®] device is constructed under the general guidelines for capacitors that are in accordance with IEC 60871-1: 2005, ANSI, IEEE 18, NEMA CP-1, VDE 0560 part 410 and CIGRÉ 13.02 standards.

Warning

Before the ZORC[®] is energised make a final check that the line voltage to be connected to the unit is within the rated voltage of the ZORC[®]. At the same time also inspect for any physical damage that may have been caused during transportation or installation handling.

When the apparatus is energised, bushings and insulating materials will be connected to high voltages. Keep a safe distance from energised parts as severe personal injury or death could result.

For the safety of personnel, this apparatus should be remotely isolated from High Voltage circuits before performing maintenance, inspections, and servicing. All components should be electrically disconnected by means of a visible break, and should be securely grounded when not in service. Also refer to "Shock Hazard" listed in this document.

Receiving

When unpacked, carefully inspect the unit for damage and check the nameplate to be sure the desired rating has been received.

File a claim immediately with the carrier for any damaged sustained in transit and notify PTSI.

Handling

ZORC[®] should not be lifted by the bushings as this may cause damage resulting in a bushing oil leak or cause personal injury.

Safety

Follow your company's safety procedures.

Read these instructions carefully before attempting to install, operate, or maintain this device. Failure to follow these instructions could cause severe personal injury, death, or property damage.

Insulation Medium

The ZORC[®] is a Faradol 810 oil filled device and the necessary MSDS information should be noted.

Explosion Hazard

When a ZORC[®] is subject to conditions outside of the design parameters and fails, it may rupture.

This possibility must be considered when considering a location for the ZORC[®] in relation to other equipment.

In extreme cases explosion is also a possibility and personnel should be protected during tests.

Fire Hazard

Since this product contains a combustible liquid (OSHA Class III-B), the location of the ZORC[®] should be chosen with consideration given to the possibility of fire and its containment in the event of ZORC[®] failure and in case of rupture.

See National Electric Code for location limitations.

Shock Hazard

ZORC[®] units do not contain discharge resistors. For safe handling the following should be considered:

- Before inspecting or working on the ZORC[®] the power must be removed from the ZORC[®] by means of a visible disconnect
- After disconnecting the power the ZORC[®] will generally retain a charge that must be removed before handling

The charge may be removed as follows:

- After disconnecting the ZORC[®] from the power source wait at least 5 minutes, then short and ground the ZORC[®] equipment using an insulated grounding stick. Shorting should be terminal-to-terminal and terminal to case
- The resistance of the grounding stick, in ohms, should be approximately equal to the maximum peak voltage that may have been applied to the ZORC[®]
- The resistor should have a peak voltage capability greater than the maximum peak voltage that may be applied to the ZORC[®] and energy absorbing capability greater than the energy stored in the ZORC[®]
- After discharging, a shorting connection should be installed between the terminals and removed just prior to re-connection and re-energisation

Installation

The installation conditions considerations for a ZORC[®] are as follows:

- Select the correct ZORC[®] for the operating voltage
- The ZORC[®] should be preceded by a surge arrester if lightning can occur or be induced in the electrical system
- The ZORC[®] should be properly bolted down
- The ZORC[®] should be protected from excessive dust, moisture or vermin

Rating

When installing ZORC[®] check the nameplate of each unit to see that it has the proper rating for the circuit. The ZORC[®] will operate with a 10% voltage variance.

The line connections harmonic content should be less than 8% Total Voltage Harmonic distortion.

Ambient Temperature

Standard operating / energising ambient temperatures range for a Faradol 810 impregnated ZORC[®] is -40°C to +40°C. Higher ambient temperatures will shorten the life span of a ZORC[®].

NOTE: 46°C is the ambient temperature limit of the ZORC[®] as measured at the ZORC[®]. For some applications such as mounting in enclosures, ambient temperatures at the ZORC[®] units will exceed ambient temperature around equipment.

Position the ZORC[®] to minimise heating from other equipment and provide free flow of air around the ZORC[®]. For operation at temperatures above 46°C, consult PTSI.

Energising a ZORC[®] with an internal temperature less of than -40°C may damage the ZORC[®] and possibly cause failure. ZORC[®] should therefore not be energised with internal temperature lower than -40°C.

If the internal temperature of the ZORC[®] drops to less than -40°C, the unit must be brought to a minimum internal temperature of -20°C, before energisation.

Vibration

The ZORC[®] should be installed on a stable surface, i.e. no vibration is allowed.

Vibration could cause mechanical stresses on the oil seals at the base of the bushings used on the ZORC[®] resulting in unwanted oil leakage.

Caution should be taken when positioning the ZORC[®] in machinery such as a crusher where the vibration component is higher than normal. Mounting in the motor terminal box when the motor can transfer vibration through to the ZORC[®] is not advisable.

Electrical Connections

When aluminium wire is used an oxidation preventative should be used especially in a salt or corrosive atmosphere. Use 2.5 mm² flexible direct connections to the bushings or the compact unit. These should be less than one 1.5m long. Do not extend the flexible leads under any circumstances.

Electrical Clearance

When installing ZORC[®], care should be taken to obtain the necessary spacing and electrical clearances for safe operation.

Earth / Grounding

The earth should be to the machine quality earth or to the cable shielding as appropriate and not less than 16mm² to 25mm². Braided copper is preferred although other types may be used. Using a smaller size could result in local damage and possible failure of the ZORC[®] when the discharge goes to ground via the mounting bracket. This is possible when there is a bad earth or lack of capacity of installed earth cabling.

Method for Terminating Cables at the Bushings

When the ZORC[®] is fitted with bushings and connecting stud, two nuts are fitted to each terminal. It is advised that the lower nut is held by using a second spanner while tightening the top nut. This will remove the stress from the bushing mounting and ceramic insulator.

A maximum torque of 20 Nm is recommended. Anything in excess of this value may result in bushing damage and or personal injury.

Stress on Bushings and Terminals

Connections to the ZORC[®] must not create stress on the bushings.
Use flexible connections between the ZORC[®] and rigid / fixed system connections.

Additional Considerations

External Fusing

The use of fusing is not a specific requirement but may be applied at the discretion of the user. With a ZORC[®] installation, a fuse failure will lead to loss of protection if the failure goes unnoticed. Different fault conditions make it difficult to grade fuses to protect under fault and ZORC[®] failure.

Lightning Protection

The ZORC[®] is not a lightning protection device. It is designed to shunt the breaker switching spikes. It is strongly advised that additional lightning protection be employed in high lightning incidence areas.

Maintenance

The ZORC[®] is maintenance-free requiring only periodic cleaning of bushings in contaminated areas.

Equipment should be inspected periodically for failure or leaks. This check can be made after de-energising and following the necessary safety procedures detailed elsewhere in this document.

The use of hoses in the vicinity of an 'open' ZORC[®] installation must be avoided. Testing can be carried out once a year.

Inspection

- Inspect the ZORC[®] for dirty, broken or chipped bushings.
- Physical damage to the casing.
- Earth cable and terminal cable. The casing earth and terminal cable should not be corroded.
- Inspect casing for any bulging. (Needs to be removed from service immediately).
- Inspect very carefully for oil leaks, especially as a result of hair-line cracks on the bushing. (Needs to be removed from service immediately).

Guideline for Life Expectancy for ZORC units in service

With the variable operating and environmental conditions that can affect the operating life of the ZORC[®] we can only give a guideline for life expectancy of the unit.

In an ideal environment where the ZORC[®] is installed correctly, the internal capacitor is the most vulnerable component in the ZORC[®].

Certain conditions that the ZORC[®] unit might be exposed to, such as very high ambient and internal temperatures, could accelerate the degradation of the internal capacitor. For this reason the expected life span of the ZORC[®] has been conservatively set at 20 years.

The life expectancy on standard capacitor banks is typically set at approximately 30 to 40 years.

Testing

Manufacturing Tests

Each ZORC[®] surge suppressor is routine tested prior to dispatch as follows:

Factory Test and AC Over-Potential Test:

Type	Test 1			Test 2		
	Voltage between L1 & L2	Voltage between L1 & L2	Voltage between L1 & L2	Voltage between L1 & earth	Voltage between L2 & earth	Voltage between L3 & earth
ZORC [®] rated voltage						
M3/P3 – 3.3kV	14kV DC	14kV DC	14kV DC	3.3kV AC	3.3kV AC	3.3kV AC
M3/P3 – 6.6kV	28kV DC	28kV DC	28kV DC	6.6kV AC	6.6kV AC	6.6kV AC
M3/P3 – 11kV	47kV DC	47kV DC	47kV DC	11kV AC	11kV AC	11kV AC
M3C – 3.3kV	14kV AC	14kV AC	14kV AC	3.3kV AC	3.3kV AC	3.3kV AC
M3C – 6.6kV	28kV AC	28kV AC	28kV AC	6.6kV AC	6.6kV AC	6.6kV AC

TEST 1: Capacitance to be within 10% of nameplate rating when measure before and after test. Apply test voltage between L1 & L2, L1 & L3, and L2 & L3 phases, each for 10 seconds.

TEST 2: Bridge L1, L2 & L3, and then apply test voltage between bridged connections and earth for 10 seconds.

Note: These are factory ZORC[®] tests and should not be used as site testing. (Refer below).

Field Tests

In general, ZORC[®] surge suppressors should not require re-testing prior to putting into service and, in any case, if testing is a prerequisite before applying power the ZORC[®] should be tested separately from the associated motor/generator/ transformer/switchgear.

The following field tests can be carried out to check a ZORC[®] surge suppressor, giving a 95% certainty of product integrity:

- Check for obvious physical damage (broken bushing, leaking impregnate, bulging tank, tracking on bushings, etc.)
- Measure the capacitance from each phase to earth and check that it is within 10% of nominal (0.1 or 0.2 μ F as stamped on the ZORC[®] rating plate). Use a hand-held capacitance meter or apply a known low voltage (e.g. 230V AC) between each phase and earth, measure the phase currents and calculate the capacitance.
- With the ZORC[®] line connections bonded together and using a DC cable test set, test between line and earth for 10 seconds. Confirm there are no dielectric breakdowns or audible discharges.
- Apply recommended lower voltages for field-tests as below:
 - 7.5kV for 3kV ZORC[®].
 - 15kV for 6.6kV ZORC[®].
 - 20kV for 11kV ZORC[®].

Disposal

The impregnating liquid used in this ZORC[®] is Faradol 810, a biodegradable material. Incineration or other disposal should be in accordance with federal, state, and / or local regulations.

CAUTION: Avoid liquid contact with the skin and eyes and exposure to fumes in an unventilated area.

Publication references

Refer Publication 1 EPCC Report:

Guide for the Application of Switching Surge Suppressor to Medium Voltage Motors, presented jointly by the South African Institute of Electrical Engineers and the Electric Power Co-coordinating Committee, at a seminar held on 19 August 1992.

Refer Publication 2 Yelland, CP:

New Developments in the Protection of Medium Voltage AC Motors from Steep Fronted Surges, SAIEE Industrial Power System Disturbances Symposium Proceedings, September 1983.

Refer Publication 3 Pretorius, RE:

Optimised Surge Suppression of High Voltage Vacuum Contractor Controlled Motors, IEE International Conference on Sources and Effects of Power System Disturbances, London, May 1982.

Refer Publication 4 Pretorius, RE:

The generation of travelling waves in cable connected motor circuits and the effects thereupon of RC surge suppression circuits, CSIR Special Report ELEK 90, December 1980.

Refer Publication 5 Nailen, RE:

Transient surges and motor protection. Ind. and Com. Power System Tech. Conference, Seattle, 1979.



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