TREFFER

Power Factor improvement solution

In Medium Voltage

Treffer Power

TREFFER™

22 year in PQS

One Source for Power Quality Solution

MV-APFC

Medium Voltage Automatic Power Factor Correction Panel

Global Export

Technical aspect

Why does the power factor need to be corrected?

Reactive power compensation is essential for the correct technical and economical management of an MV electric system. Its benefits are:

Technical optimisation

- Helping to control voltage throughout the transmission and distribution system
- Discharging power lines and power transformers
- Reducing level of system losses

Economic optimisation

- Reduced billable reactive energy costs (surcharges by country and tariff)
- Reduced hidden economic cost from the Joule effect in transport lines
- Enables a better use ratio (kW/kVA) for installations.

When and where to compensate at MV?

Basically MV must be compensated when working with:

Generation, transport and distribution systems

The usual points where power factor correction is carried out are the feeder lines of power generating plants (wind farms, hydroelectric installations, etc.), receiver or distribution substations, and distribution hubs.

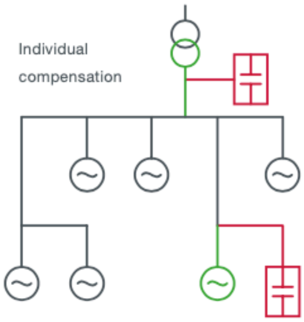
Industrial installations with MV distribution and consumption

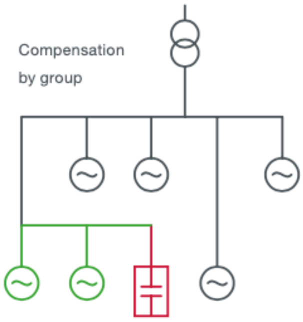
As a general rule, installations that distribute and consume energy at MV are eligible to be compensated, such as pumping centres desalination plants, paper factories, cement factories, the petrochemical industry, steel mills, etc.

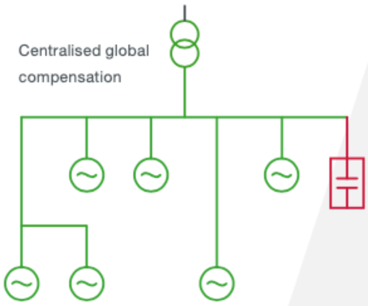
Industrial installations with MV distribution and LV consumption

Normally LV compensation is carried out when dealing with small amounts of power and with a rapid demand fluctuation level in comparison with MV. However, if there is a large number of transformer substations and high reactive energy consumption but little load fluctuation, power factor correction at MV should be proposed.

Technical aspect







How should I compensate?

Reactive compensation may be carried out at any point of an installation. A different strategy must be followed for each method and position to obtain power factor improvement.

Individual compensation
Direct compensation to the machine being compensated is the optimum technical solution for directly reducing reactive consumption in the load. This is commonly used for pumps, motors and transformers.

Compensation by group
Compensation for load groups in installations that have a sectored and extensive distribution. This serves as an ancillary support for a global centralised compensation system for increasing the load capacity of the line supplying the group of compensated loads.

Centralised global compensation
Compensation connected to the installation's main feeder, normally used for reducing electricity billing due to reactive energy surcharges.

Individual compensation of power transformers and asynchronous motors

One of the main applications of MV compensation is the individual compensation of power transformers and asynchronous motors.

Power transformers
Two components must be taken into account when determining the reactive power of a transformer: non-load consumption (magnetising current) and load consumption.

$$Q_T = S_N \cdot \left(\frac{I_0(\%)}{100}\right) + \left(\frac{u_{cc}(\%)}{100}\right) \cdot \left(\frac{S}{S_N}\right)^2 \cdot S_N$$

The fixed part depends on the transformer's magnetising current, which usually accounts for 0.5 to 2% of the transformer's rated power. The variable part depends on the load ratio being consumed (S/S_N) and the short-circuit voltage (V_{cc}%). Actually 5% to 7% compensation of nominal power for industrial-use transformers is recommended and up to 10% for energy distribution line transformers.

Asynchronous motors
Special care must be taken when opting to directly compensate asynchronous motors, with or without an operation or disconnection element. This aspect is relevant for avoiding the possibility of damaging the motor or the installation from an excitation effect. It is recommended to avoid compensation of over 90% of the motor's idle current in order to prevent autoexcitation of the motor due to capacitor discharge in its direction. The value of the power to be compensated can be estimated as follows:

Preventing the autoexcitation phenomenon.

$$Q_M \leq 0{,}9 \cdot I_0 \cdot U_N \cdot \sqrt{3}$$

$$Q_M \leq 2 \cdot P_N \cdot (1 - \cos\varphi_i)$$

Where Q_M is the reactive power to be compensated (kvar), I_0 the motor's idle current (A), U_N the rated voltage (U), P_N the nominal power of the motor (kW) and $\cos\varphi$ is the initial cosine phi of the motor.

This way makes it difficult to compensate more than one cosine phi greater than 0.95, so individual compensation is carried out by using a disconnection element at the same time as the motor is disconnected in order to avoid the autoexcitation phenomenon.

Technical aspect

Controlling the voltage level in the lines

One of the critical points during electrical energy distribution is maintaining the voltages at the different points of the distribution lines. This applies to ring networks in the different distribution centres and radial networks at line terminals. There are two methods available for controlling voltage at the MV distribution line terminals, which depend on the configuration of the distribution lines:

- Control at the line origin, generally for lines with a radial configuration.
- Control at the network points in a ring or at the terminal of a MV line in radial configuration.

Voltage control at the line origin

To maintain a nominal voltage level at an unmeshed MV line terminal, distribution companies commonly regulate the voltage at the substation output at above its nominal value. This is done by compensating the reactive energy at its origin in order to compensate for the voltage drop in the line. The MV bus-bar capacitor connection is associated with the voltage increase at its connection point. In accordance with **Standard IEC 60871-1** the following equation can be used for calculating the voltage increase resulting from connecting capacitors to an MV network:

$$\Delta U(\%) = \frac{Q_{bat}}{S_{cc}} \cdot 100$$

$\Delta U(\%)$: Reported percentage voltage drop at U_N
Q_{bat}: Power of the capacitor bank in kvar
S_{dc}: Short-circuit power at the installation point of the capacitors, in kVA

In anticipation of possible load fluctuations, the capacitors that will be connected to the substation output or transformer substation are usually fractioned in steps. The power, type of unit and fractioning level usually depend on the criteria of each distribution company. It should be noted that fractioning the total power in different steps enables voltage levels for different network load states to be improved, thereby avoiding overvoltages that would be produced by over-compensation.

Voltage control at the line termination

The voltage in MV lines with various branches that have a significant length (several km) cannot be regulated at all of the distribution points by placing capacitors at the beginning of the line. In these cases capacitors are usually installed in distribution hubs where voltage regulation is needed. The voltage drop at the end of a line or section can be calculated with the equation:

$$\Delta U(\%) = 100 \cdot \frac{P \cdot L}{U_N^2} \cdot (R_L + X_L \cdot \tan\varphi)$$

$\Delta U(\%)$: Reported percentage voltage drop at U_N
P: Transported active power
R_L & X_L: resistance and ractive impedance by length (km)
L: length of the line (km)
U_N: Rated voltage of the network

Reduction of losses in MV lines

The reduction of losses in distribution installations and transport is an important factor in the economic assessment of an installation, given that these losses are a hidden economic loss. The Joule effect losses on a line can be summarised as:

$$\Delta P = R_L \cdot \left| \frac{2 \cdot Q_L \cdot Q_{bat} - Q_{bat}^2}{U_2} \right| \cdot L$$

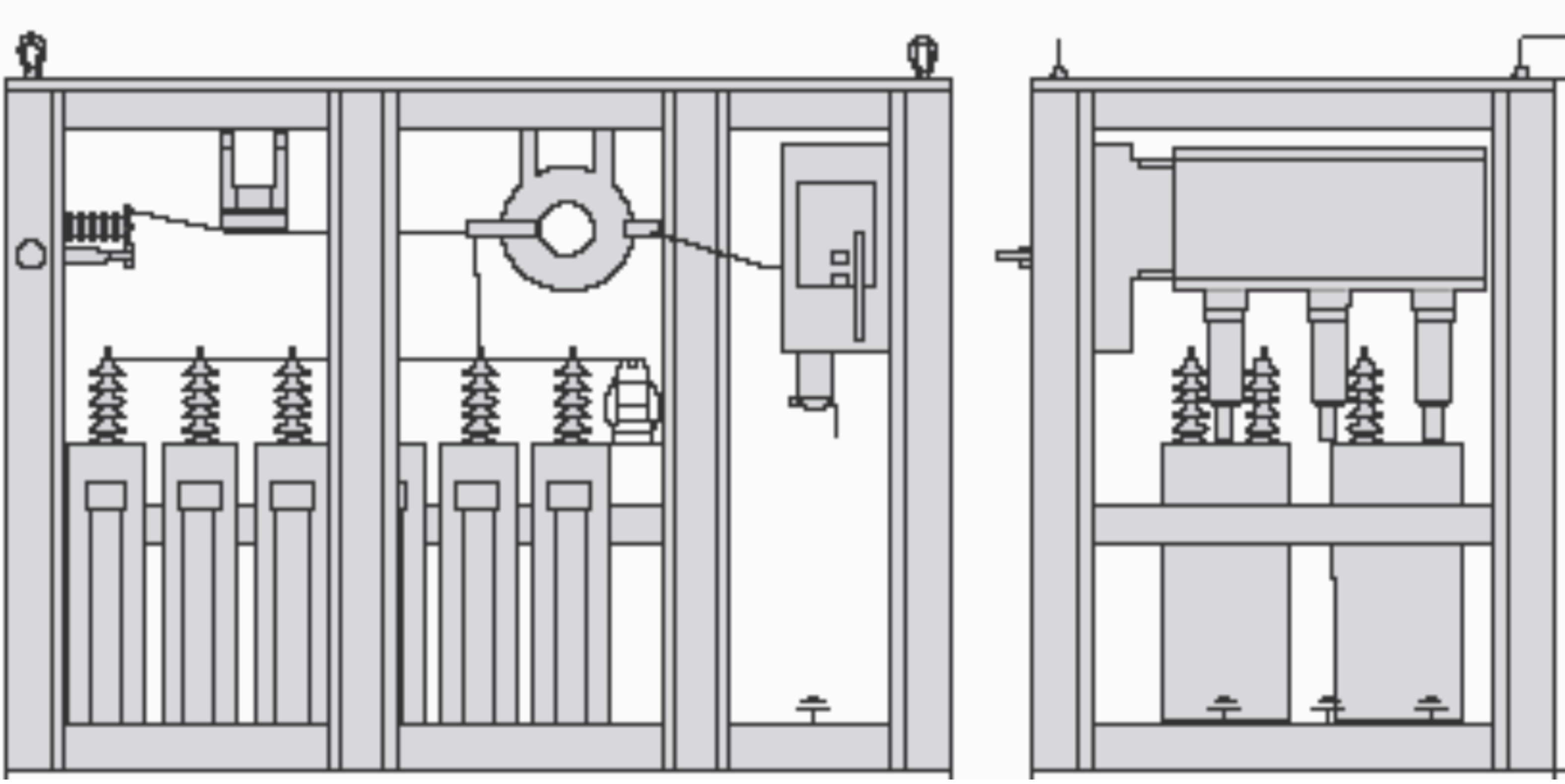
Where R_L is the resistance per unit of length and L is the length.

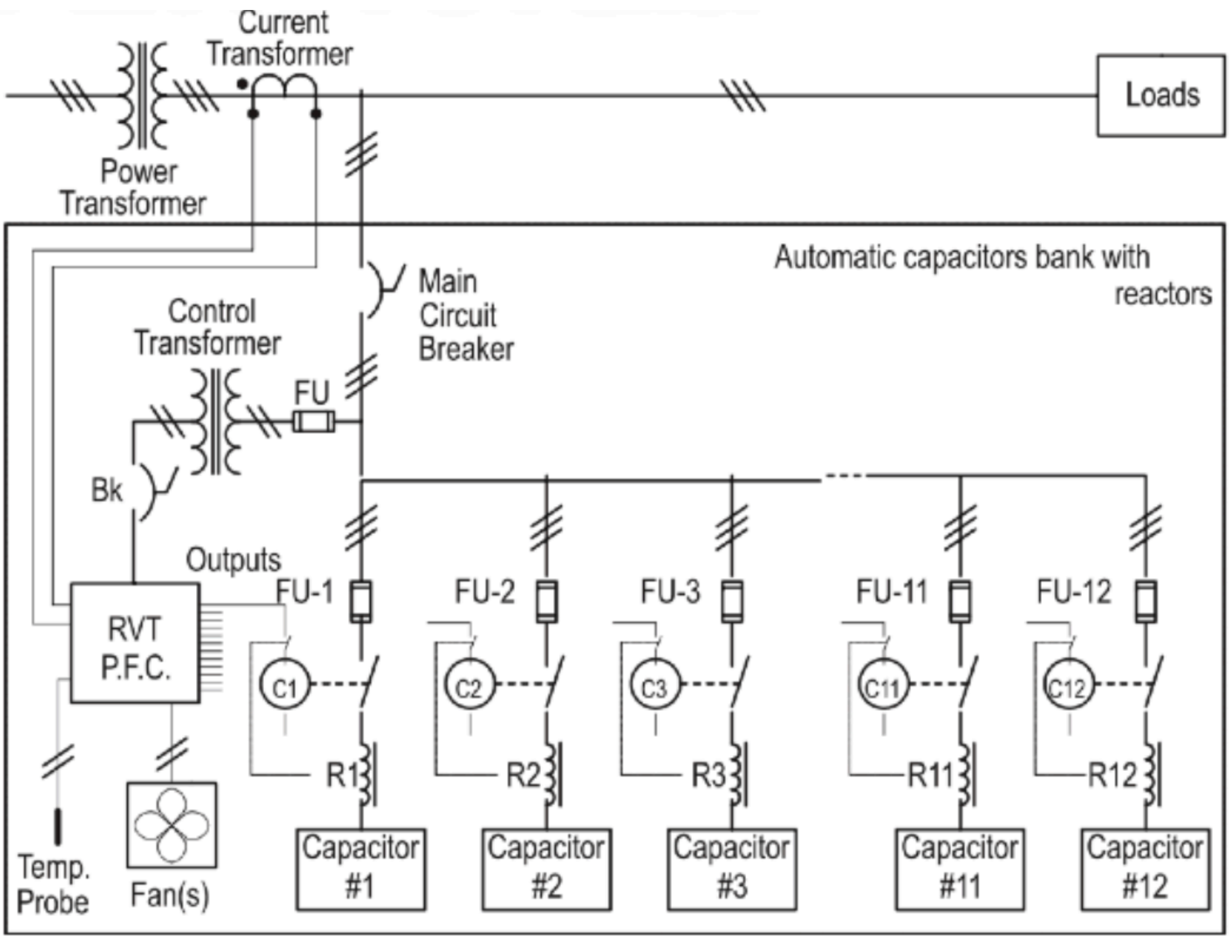
The decrease in losses as a result of reactive compensation can be calculated as follows:

$$P\,(\text{kW}) = 3 \cdot R_L \cdot I^2 \cdot L$$

With Q_L being the load's reactive power and Q_{bat} the power of the compensation capacitor bank.

Schematic View of MV APFC Panel





Major Components of MV APFC Panel

MV Capacitor

MV Reactor

Off-load Isolator

MV Vacuum contactor

MV HRC Fuse

APFC controller

RVT/NCT

MV Capacitor unit

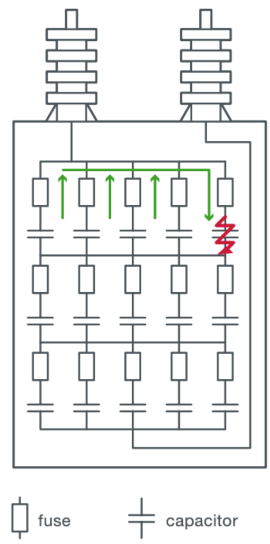
TREFFER range of MV capacitors comprises a complete series of single and three phase capacitors in full compliance with **International Standard IEC 60871**. The design and production of the capacitors is carried out with the guarantee and reliability of the finest raw materials and sufficient flexibility to provide a personalised solution for each application.

High reliable unit

"all capacitors undergo strict Quality control checks"

TREFFER has a department made up of R+D experts who form a highly experienced team that cares for and ensures that the entire design and production process provides the highest guarantee of quality and reliability. Quality management is not only applied internally but also during each step of the supply chain. This means that our specialised suppliers rigorously assess the quality of the materials and their production processes. Before being supplied to the client, all capacitors undergo individual trials in strict compliance with the **International IEC Standard** and all of the data is logged for the resulting documentation and testing certificates.

Capacitor protection with an internal fuse



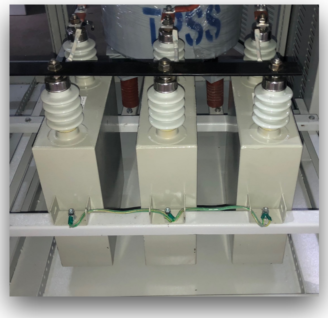
Example of a capacitor with an internal fuse

Modern high-voltage capacitors are subject to very high insulation requirements. A capacitor comprises several capacitor units or capacitor elements. Thus, the purpose of suitable internal protection for capacitors is to disconnect a defective unit before dangerous consequences occur, thus reducing any possible secondary effects of the fault.

Standard IEC 60871-4 is applicable to internal fuses that are designed to isolate faulty capacitor elements in order to enable operation of the remaining parts of the capacitor units and the battery to which the unit is connected. These fuses are not a substitute for a switching unit such as a circuit breaker or for external protection of the capacitor bank. In the event of a defect in a basic capacitor element, the sound elements will be discharged in parallel with the faulty element. The discharge will immediately melt the internal fuse of the damaged unit.

MV Capacitor

Table of general technical features for TREFFER Medium Voltage capacitors



Nominal power	10-600 KVAr
Rated voltage	1- 36 KV
Frequency	50/60 Hz
Insulation level	See table of insulation levels
Maximum overvoltage	See table of overvoltage levels, as per **IEC**
Overcurrent	$1.3 \cdot I_N$
Capacity tolerance	-5%…+10%
Total losses	< 0.15 W / kvar
Statistical mean lifetime	>130,000 hours (normal conditions)
Nominal power	75 V-10 minutes (optional 50 V-5 minutes)
Rated voltage	Maximum 200 x I_N
Ambient temperature category	-40°C/"C" (optional class D) (table 3)
Ventilation	Natural
Protection degree	IP 00
Humidity	Maximum 95%
Maximum service altitude	1000 m above sea level (consult other conditions)
Assembly position	Vertical / Horizontal
Assembly attachments	Lateral supports and leg anchors
Container	Stainless steel for internal or external use
Dielectric	All polypropylene film
Saturant	PCB free, biodegradable
Internal safety device	Internal fuses
External safety device	Pressure switch (optional)
Terminals	Porcelain
Terminal tightening torque	10 Nm
Colour	RAL 7035

Insulation level (BIL)

These are the insulation levels that must be met in accordance with **Standard IEC 60871-1** and **IEC 60071-1**. These voltage levels depend on the highest voltage level of the unit or on external factors such as altitude or saline environments.

Highest voltage of the unit	Assigned short term voltage	Voltage assigned with ray-type impulse
7.2 kV	20 kV	60 kVpeak
12 kV	28 kV	75 kVpeak
17.5 kV	38 kV	95 kVpeak
24 kV	50 kV	125 kVpeak
36 kV	70 kV	170 kVpeak

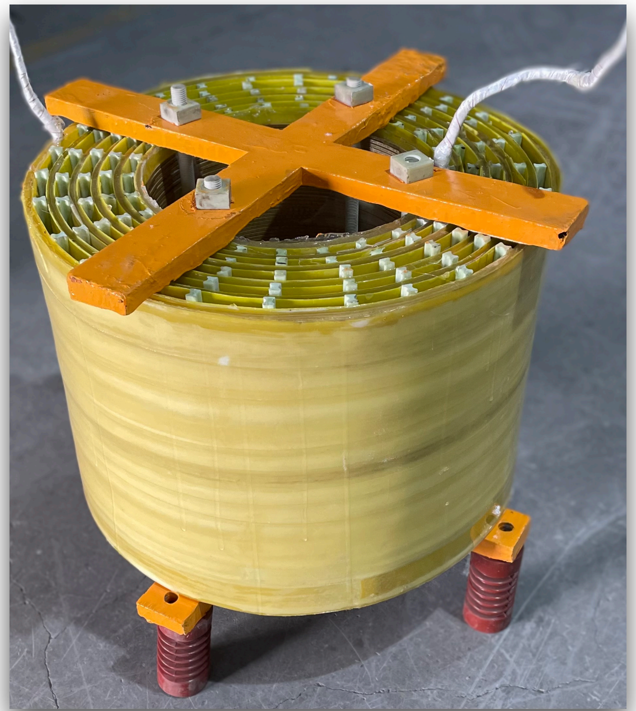
Overvoltage levels

Admissible sporadic, non-continuous overvoltage levels in accordance with **Standard IEC 60871-1**.

Voltage	Maximum duration	Observations
U_N	Permanent	Maximum mean value during capacitor energization period
$1.1 \times U_N$	12 hrs per 24 hr period	Network voltage regulation and fluctuation
$1.15 \times U_N$	30 minutes per 24 hr period	Network voltage regulation and fluctuation
$1.20 \times U_N$	5 minutes	

MV Reactor

Air core Reactor



Treffer reactor windings consist of numerous aluminium or copper conductors connected in parallel. These conductors can be insulated single wires, insulated cables or aluminium profiles separated by fibreglass spacers. The cost-effective solution to be selected, in terms of dimensions and conductor type to be used in each design, depends on the required ratings for the equipment. For encapsulated design, the conductors are mechanically immobilised and encapsulated by epoxy impregnated fibreglass filaments forming cylinders. Depending on the reactor ratings, one or more of these cylinders are connected in parallel between aluminium or copper spiders. The individual cylinders are separated by fibreglass spacers forming cooling ducts. F- 155°C & H-180°C Class

Air-core dry-type reactors provide a linear response of impedance versus current that is essential to numerous applications. they are mainly employed in electric power transmission and distribution systems as well as in electric power systems of electrical plants. they are installed to protect these systems and to increase their efficiency.

A wide range of both single and three phase reactors for manufacturing tuned harmonic filters, which can be manufactured for different voltages from 1 kV up to 36 kV, and any tuning frequency: 5.67%, 6%, 7%, 14%, etc.

The reactors are made from low-loss plate metal and a copper coil or aluminium band, depending on the model. Once assembled they are impregnated using a sophisticated vacuum system that guarantees minimum loss, greater mechanical consistency, increased insulation and low noise emissions.

MV Reactor

Iron core Reactor

A wide range of both single and three phase reactors for manufacturing tuned harmonic filters, which can be manufactured for different voltages from 1 kV up to 36 kV, and any tuning frequency: 5.67%, 6%, 7%, 14%, etc.

The reactors are made from low-loss plate metal and a copper coil or aluminium band, depending on the model. Once assembled they are impregnated using a sophisticated vacuum system that guarantees minimum loss, greater mechanical consistency, increased insulation and low noise emissions.

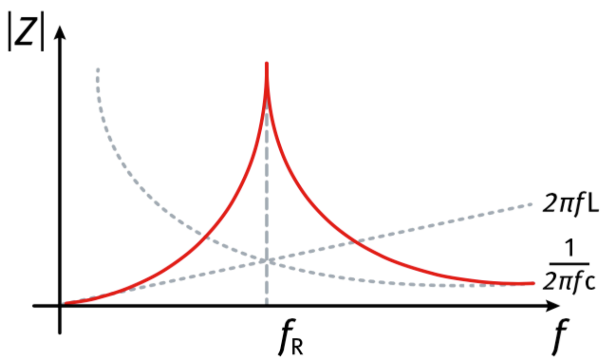
Capacitor bank resonance

Capacitor banks are units that do not intrinsically generate harmonics, although they can be affected by the injection of harmonic currents from non-linear loads, which together can produce a parallel resonance between the capacitor bank and the installation's power transformer, resulting in a maximum impedance at a frequency called resonance.

A resonance frequency occurs in industrial installations when the impedance values of the transformer coincide (X_T) with the capacitor's (X_C):

$$f_R = f \cdot \sqrt{\frac{X_C}{X_T}} = f \cdot \sqrt{\frac{S_{CC}}{Q}}$$

Where S_{DC} is the short-circuit power of the transformer in kVA, and Q the capacitor bank's power in kvar.



This increase in impedance does not remain static at a single frequency but will shift depending on the resonance conditions at each moment. If the power Q of the capacitor bank decreases, the resonance frequency of the installation increases and, inversely,
if the power Q of the capacitor bank increases, the installation's resonance frequency decreases, becoming more dangerous as it approaches the frequencies where considerable current values are injected, resulting in:

— Voltage wave quality deterioration (THDU% increase)
— Reduced useful life of the capacitors or their destruction — Capacitors bank or installation protections trip.

MV Reactor

Table of general technical features for TREFFER Medium Voltage Reactor

Model	FRK
Rated Output	0.5KVAr - 800KVAr
Rated Voltage	1KV to 33KV
Insulation level	See table of insulation level
Frequency	50/60 Hz
Overcurrent	1.3 X In
Inductance tolerance	-0+15%
Rated frequency	50/60 Hz
Insulation class	F/H class
Series Impedance in %	0.2%, 1%,2%, 6% , 7% ,14%
Winding Material	Copper / Aluminium
Dielectric material	Epoxy resin
Maximum overvoltage	As per IEC table
In & Out terminal	AL /Cu
Max AC current	Up to 1250 A
Resonate frequency	133 HZ, 189 Hz, 204 Hz, up to 550Hz
BIL	Up to 250KV
Std IEC	60076-6
Type	Indoor/Out door

Off-load isolator

The salient feature of ABS Load Break Switch is its ability to permit load connections even under a short circuit condition without danger of the operating personnel.tl complies with IEC,

VDE and ISI standards. A high speed (snap action) make and break ensures a fast switching action and the very special design of arc chutes having excellent extinguishing properties for both high and low currents, suitability or mounting in morizontal or vertical plane etc. prove the versatility of these switches.

Due to the compact design of individual cubicles, and the feasibility of mounting the switches in different directions, economy in space is achieved, with ample scope for future extension.

The triple pole Load Break Switch can be used for switching of Transformer feeders, overhead lines, Capacitor Banks, Cable feeders and Ring Mains. For Protection against short circuits H.T. Fuses can be offered with the switch.

SHUNT TRIP COIL

Shunt trip coil release being offered for spring charged version Load Break Switches, are meant for remote tripping mainly and can be offered for different aux. voltages (indicated below) and the coils are of short time rated.

110V A.C 50 Hz 220V AC. 50 Hz /110V D.C 220V D.C

* **AUXILIARY CONTACTS**

This can be fitted on to the switch or isolator with a combination of 2n/0 +2n/c or 3n/0 +3n/c 1+ wiping contact.This can be supplied as a factory assembled accessory with or without interlock with the main drive mechanism. The earthing switch can be mounted either on incoming or outgoing side or at the bottom of the fuse base.

Rated Voltage : 1.1KV to 36KV

Rated Current : 200A to 1000A

SC / Sec : 10KA to 40 KA /3 Sec

Pole : 3/4

Frequency : 50/60 Hz

Type : Indoor

MV Vacuum Contactor

The medium voltage V-Contact contactor are apparatus suitable for operating in alternating current and are normally used to control users requiring a high number of hourly operations.
The V-Contact VSC contactor introduces the drive with permanent magnets, already widely used, experimented and appreciated in medium voltage circuit breakers, into the worldwide panorama of medium voltage contactor.
The experience acquired by ABB in the field of medium voltage circuit breakers fitted with drives with “MABS” permanent magnets, has made it possible to develop an optimised version of the actuator (bistable MAC drive) for medium voltage contactor.
The drive with permanent magnets is activated by means of an electronic multi-voltage feeder. The feeders differ according to the integrated functions and to the auxiliary power supply voltage.
Each feeder is able to take any voltage value within its own operating band.
The withdrawable versions are foreseen for use with UniGear ZS1 and UniSec WBC switch gears, PowerCube units and CBE1 enclosures. For use with the CBE11 enclosures, please contact ABB. All the contactors mentioned above are available, on request, in one of the two following versions. • **SCO** (Single Command Operated): closing takes

place by supplying auxiliary power to the special input of the multi-voltage feeder. On the other hand, opening takes place when the auxiliary power is either voluntarily cut off (by means of a command) or involuntarily (due to lack of auxiliary power in the installation).

- **DCO** (Double Command Operated): closing takes place by supplying the input of the closing command of the apparatus in an impulsive way. On the other hand, opening takes place when the input of the opening command of the contactor is supplied in an impulsive way.

- **Rated Voltage** : 3.3KV/6.6KV/12KV
- **Rated current** : 200A/400A/630A
- **Capacitor switching current** : 100A/200A
- **For more Details referee mfg data sheet**

MV HRC Fuse

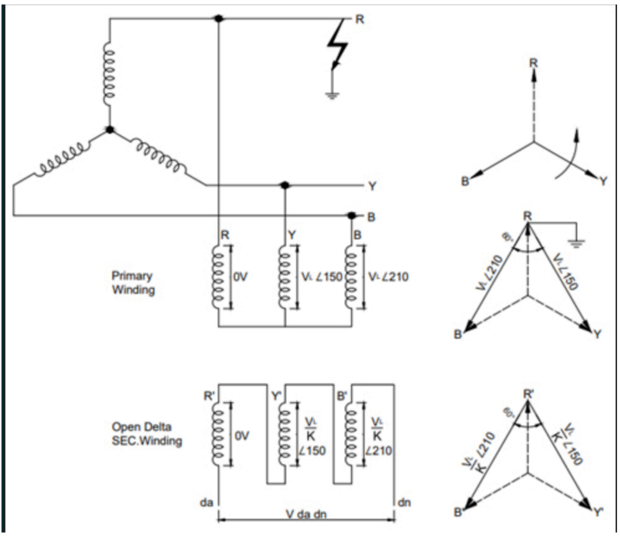
Current limiting HV fuse links split into three internationally recognised types: **back-up** (or **partial range**) fuse links, which will interrupt any current from their rated breaking capacity down to a minimum breaking current specified by the manufacturer; and **general purpose** fuse links, which will interrupt all currents from rated breaking capacity down to a current that will melt the elements within one hour. A third type is the full range fuse. This term applies to fuse links that can interrupt any current below the rated breaking capacity that melts the fuse elements satisfactorily

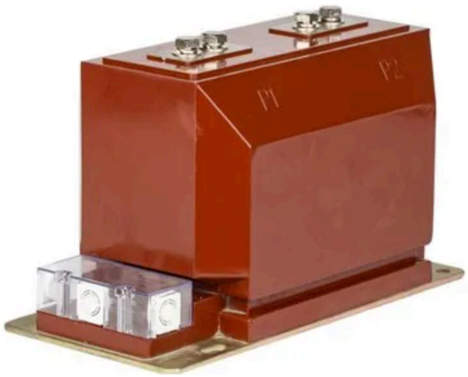
Voltage Rating : 1.1KV/3.3KV/6.6KV/12KV
Current Ratings : 1 A to 200 A
SC : 20 to 40 KA
Standards. : IEC 60282-1

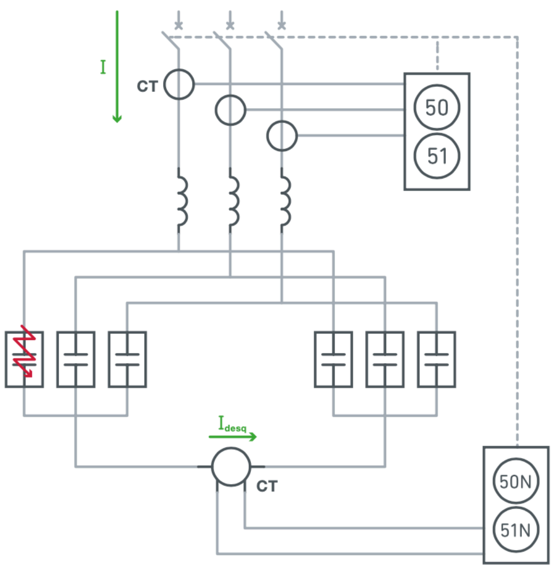
Protection Equipment - RVT / NCT

A residual voltage transformer (RVT) is a device that measures the residual voltage in an electrical system to detect and diagnose faults. RVTs are used in a variety of applications, including:

- Detecting unbalanced voltage: RVTs can detect unbalanced voltage in three-phase systems.
- Detecting earth faults: RVTs can detect earth faults and phase unbalances.
- Monitoring neutral voltage: RVTs can monitor the neutral voltage in systems with neutral grounding.
- Discharging capacitors: RVTs can discharge capacitors in three-phase capacitor banks
- **Rated voltage** : 3.3KV/6.6KV/12KV
- **Burden** : 30 VA ~ 100 VA







Unbalance protection (double star)
When an element suffers a fault, the capacity of the group where this element is installed decreases. This capacity variation results in an impedance increase for this group and at the same time a variation in the voltage distribution in the capacitor. The group of elements where the anomaly occurs suffers an over voltage.
The unbalance protection parameters in the double star are: — The voltage in a capacitor cannot exceed 110% of its rated voltage.
If the number of faulty elements in a unit is so high that there is a danger of provoking a chain reaction of faults, the battery must be disconnected even if the voltage has not exceeded 110% of its rated value in any of the capacitors in the bank. Normally, the battery should be disconnected when the voltage in the working elements exceeds 140% of its nominal value.
Generally, the second parameter is the one that determines the battery's trip current level. Unbalance protection is based on the current measurement that is detected between equipotential points, such as the two neutrals of the double stars. If the impedance varies in one of the branches, it will give rise to an unbalance that provokes the circulation of a current between the neutrals of the two stars. To operate correctly the transformer must be at least of accuracy class 1.

- **Rated voltage** : 3.3KV/6.6KV/12KV
- **Burden** : 30 VA ~ 100 VA
- **Class** : 5P10

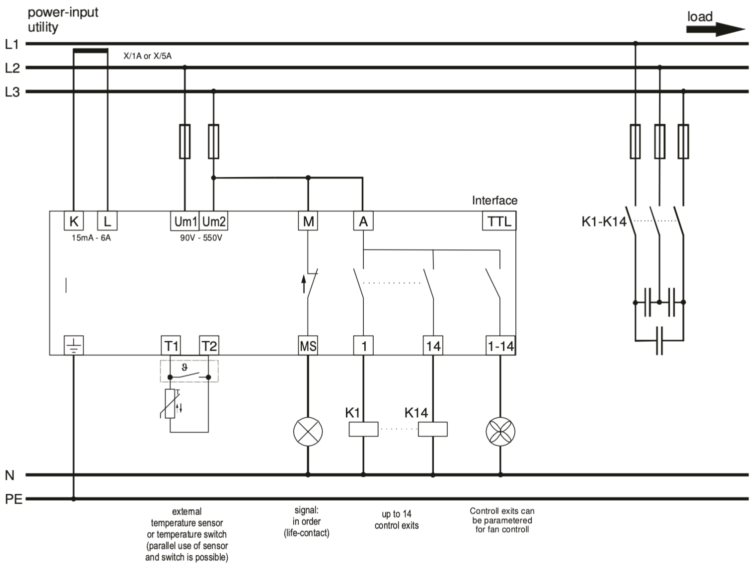
APFC Controller (Power factor regulator)

APFC is an automatic power factor control panel which is used to improve the power factor, whenever required, by switching ON and OFF the required capacitor bank units automatically.

APFC Panel has microcontroller based programmable controller which switches the capacitor banks of suitable capacity automatically in multiple stages by directly reading the reactive load (RKVA) which works in the principle of VAR sensing tends to maintain the PF to 0.99 Lag.

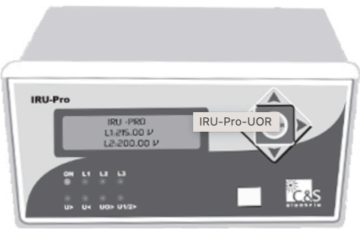
power factor controllers measure the voltage and current of the load continuously, calculating their values through mathematical algorithms in order to obtain TRUE RMS values. Calculated in this way, the power factor considers the harmonic content of the current and voltage, resulting in more accurate measurements

PFR-X-R

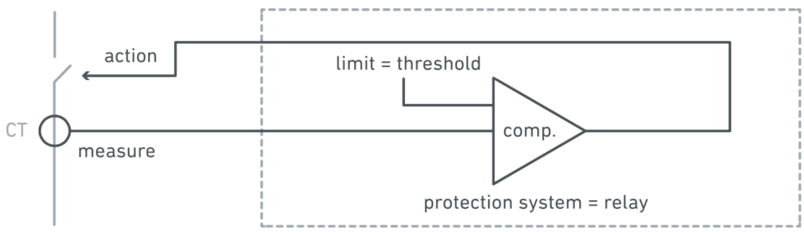


- **No of steps** — 6,12.
- **Auxiliary voltage** - 110/230V
- **Load Side Voltage** - 85 ~ 550 V
- **Current Ratio secondary** - 1/5A

Protection Relay



The protection systems that give the order to the switch to actuate are called protection relays. For them to function, an external power supply and signal input for the measurement sensors are required in accordance with the required protection.



Basic diagram of an electric protection chain

The level of protection that a relay can provide is indicated by an international ANSI protection code. The relevant protection levels for MV capacitor banks are:

- **50** — **Instant overcurrent relay. *Short-circuit***
- **51** — **Timed current relay. *Overcurrent***
- **50N / 51N** — **Timed, instant neutral current relay. *Double star imbalance***
- **27** — **Minimum voltage relay**
- **59** — **Maximum voltage relay**

Additional Components (Optional)

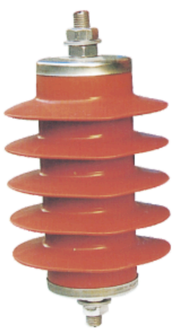
Current Transformer

CT will be installed in main comer or individual capacitor bank step feeder to measure capacitor bank current or protection in case of unbalance current /Earth fault
Rated voltage : 1.1KV/3.3/6.6/12KV ,
Rated Current : -/5A. -/1A

Voltage Transformer

PT will be installed in main comer or individual capacitor bank step feeder to measure capacitor bank voltage or protection in case of unbalance voltage /over voltage/under Voltage

Surge Arrestor



M.V. Surge Arresters are used to protect capacitor bank and other equipments in station against the damage by atmospheric (especially lightning effects) and operational conditions.Metal oxides surge arresters without gaps are designed to prevent probable damages in the case of typical surges in energy systems while it has no negative effect on energy systems in normal operation voltage. This special feature of gapless arresters originating from non-linear characteristics of metal-oxide varistors between voltage and current scales. The non-linear feature is much higher compared to SiC surge arresters.
Rated voltage : 1.1KV/3.3/6.6/12KV
MOCV : 2.2KV to 36KV

Ventilation

In Capacitor & Reactor installed in environmental conditions where natural convention cooling is insufficient, an auxiliary thermostat-controlled forced air system is essential for evacuating the internal heat of the reactor

Fan size : 6”,8”,10”
RPM : 2450 to 2600
CFM : 230 to 560

MV APFC Panel - Technical Data

Panel Design	All Components will be mounted in MS steel encloser with Powder coated
Frequency	50/60 Hz
Nominal Voltage	3.3/6.6/12/33KV
Rated KVAr	150KVAr ~ 12000KVAr
Rated frequency	50/60 Hz
Protection Class	IP 32/42/54/55
Switching Device	Vacuum contactor / VCB
MV Capacitor	APP Type
MV Reactor	Air Core / Iron Core
Incomer Isolator	Off/On Load - with/without Earth switch
Back up protection	HRC fuse link / Capacitor internal fuse
APFC Controller	Microprocessor based relay 5/6/8/12 stpes
Ambient temprature	- 5°F to 50°F
Config	Single / Multi
Application	Detuned/Tuned/PF Improvement
IEC STD	600871/60076

MV APFC Panel - Type Test. Report

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CPRI

TEST REPORT

Test Report Number : CPRIBLREATD22T0224 Date: 23 June 2022

TEST RESULTS

Condition of Sample on the Receipt : Good
Serial Number of sample tested : TPSS-22-000074

Sl. No.	PARTICULARS: TESTS CONDUCTED	PARTICULARS: REFERENCE CLAUSE	OBSERVATIONS
1.0	IP 5X Category 2 Test, as per IEC 60529: Edition 2.2, 2013-08 Standard.	Clause No. 13.4 Protection against Ingress of solid foreign objects – Dust Protection Test.	No entry of dust observed inside "HT APFC panel" enclosure.
2.0	IP X5 Test as per IEC 60529: Edition 2.2, 2013-08 Standard.	Clause No. 14.2.5, 14.3 Protection against harmful ingress of water – Hose jet of water using nozzle of dia. 6.30 mm, water flow rate 12.5 l/min ± 5% and 3m distance.	Traces of water observed on bottom plate of rear side door no. 2 of "HT APFC panel" enclosure.
3.0	Electrical Tests Conducted		After IP 55 Test
3.1	Insulation resistance test at 5kV DC is applied for one minute between the connected terminals and body of the "HT APFC panel " enclosure		273 MΩ
3.2	Power frequency voltage withstand test at 67kV AC is applied for one minute between the connected terminals and body of the "HT APFC panel " enclosure		Withstood

Conclusion: The sample tested complies with the requirement of Clause (s) 13.4, 14.2.5 and 14.3 of IEC 60529: Edition 2.2, 2013-08 for the test (s) conducted.

(D. Venkatesh)
Test Engineer

CENTRAL POWER RESEARCH INSTITUTE

CPRI

TEST REPORT

Test Report Number	:	CPRIBLREATD22T0224 Date: 23 June 2022
Name and Address of the Customer	:	M/s. Treffer Power system solution Pvt. Ltd., Gat No. 1538, dehu Alandi Road, Chikhali, Tal-Haveli, Pune – 412114.
Name and Address of the Manufacturer	:	M/s. Treffer Power system solution Pvt. Ltd., Gat No. 1538, dehu Alandi Road, Chikhali, Tal-Haveli, Pune – 412114.
Particulars of sample tested	:	HT APFC Panel
Type	:	Outdoor
Description of test sample	:	Refer Sheet 2 of 5
Serial Number	:	TPSS-22-000074
Number of samples tested	:	One
Date(s) of Test(s)	:	22 June 2022 and 23 June 2022
CPRI Sample code Number(s).	:	PCDMISC22RS0037
Particulars of tests conducted	:	IP 55 Category 2 Test
Test in accordance with Standard/Specification	:	IEC 60529: Edition 2.2, 2013-08
Sampling Plan	:	Not Applicable
Customer's Requirement	:	Nil
Deviations if any	:	Nil
Name of the witnessing persons		
Customers representative	:	Mr. Umesh Prakash Shelar
Other than customer's representatives	:	Ms. Aarti Verma, Sr.Manager – (E) , HPPTCL Ms. Ishita Vashista, A E (E) , HPPTCL
Test subcontracted with address of the laboratory	:	None
Documents constituting this report (in words)		
Number of Sheets	:	Five
Number of Oscillogram(s)	:	Nil
Number of Graph(s)	:	Nil
Number of Photograph(s)	:	Six
Number of Test Circuit Diagram(s)	:	Nil
Number of Drawing(s)	:	Four

(D. Venkatesh)
Test Engineer

(Dr. P. Chandra Sekhar)
Head of Division
Reviewed and Authorized by

CENTRAL POWER RESEARCH INSTITUTE

CPRI

TEST REPORT

Test Report Number: CPRIBLRPCDMISC22T0160 Date: 20 September 2022

TEST RESULTS

Serial Number of the sample tested: TPSS-22-000074-01

c) Measured value of temperature by the sensors at various locations at the end of 7 hours of Temperature rise test: are as follows(continued)

Position of sensor	Measured Temperature (Absolute)	Observed Temperature rise
B-phase-capacitor-1	32.4°C	4.3°C
B-phase-capacitor-2	34.2°C	6.1°C
B-phase-capacitor-3	34.0°C	5.9°C
Panel inside above B-phase reactor	29.8°C	1.7°C
Panel inside above Y-phase reactor	29.6°C	1.5°C
Panel inside above R-phase reactor	29.5°C	1.4°C
Panel door in front of B-phase reactor	30.3°C	2.2°C
Panel door in front of Y-phase reactor	30.0°C	1.9°C
Panel door in front of R-phase reactor	30.0°C	1.9°C

Position of sensor	Measured Temperature (Absolute)	Outside ambient temperature (Average)
Outside ambient at 1metre way from Panel -side-1	27.7°C	28.075 °C ≈ 28.1 °C
Outside ambient at 1metre way from Panel -side-2	28.3°C	
Outside ambient at 1metre way from Panel -side-3	28.3°C	
Outside ambient at 1metre way from Panel -side-4	28.0°C	

d) **Capacitance measurement before and after Temperature rise test (As per customer requirement):**

Measured values of capacitance before and after Temperature rise test are as follows.

Ambient temperature: 28°C Frequency: 50 Hz

Connection	Voltage applied	Measured Capacitance: Before Temperature rise test	Measured Capacitance: After Temperature rise test
R-phase to Ground	20.8kV ac	4.0397 μF	4.0417 μF
Y-phase to Ground	20.8kV ac	4.0387 μF	4.0412 μF
B-phase to Ground	20.8kV ac	4.0313 μF	4.0322 μF

(A. Sheik Mohamed)
Test Engineer

ELECTRICAL RESEARCH AND DEVELOPMENT ASSOCIATION
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TEST REPORT

ULR-TC538923100011675F SHEET 1 OF 5

NAME & ADDRESS OF CUSTOMER

TREFFER POWER SYSTEM SOLUTION PVT. LTD.
Gat No. 1538, Dehu Alandi Road,
Tal. Haveli, Chikhali, Pune-411062.

REPORT NO.: RP-2324-005028
DATE OF ISSUE: 17.05.2023

CUSTOMER REF. NO.:	**DATED:**
Letter	25.03.2023
DATE OF SAMPLE RECEIPT:	**DATE OF TESTING:**
17.02.2023	29.04.2023 to 12.05.2023

SAMPLE DESCRIPTION

36KV, 1800 KVAR HT APFC PANEL
Rated voltage (U_r): 36 kV
Rated normal current (I_r): 27.34 A
Rated frequency (f_r): 50 Hz, No. of phase: 3 + Earth
Rated insulation level:70kVrms/170kVp
Rated short-time withstand current (I_k): 25kArms
Rated peak withstand current (I_p): 62.5kA
Rated duration of short circuit (t_k): 3 Sec.
OFF-LOAD ISOLATOR DETAILS:
Rated Voltage: 36 kV, Rated Current: 630 A
Rated insulation level: 70kVrms/170kVp
No. of poles: 3, Type designation: Indoor
Make: Treffer Power System Solution Pvt. Ltd.
Rated short-time withstand current (Ik): 26.3kArms
Rated duration of short circuit (tk): 3 Sec.
Mathod of mounting: Vertical
Mathod of operation: Manual
Quantity (Tested): 1 No.

SAMPLE IDENTIFICATION

ERDA Sample Code No.: ERDA-00508127

Type Designation:
36KV, 1800 KVAR HT APFC PANEL

Drawing No.: As per SHEET 2 OF 5.

TEST DETAILS
Short time withstand current and peak withstand current tests [Cl. No. 6.6 (a)] (Test on main circuits)

TEST SPECIFICATIONS
As per customer's requirement, test procedure followed as per IS/IEC 62271-200:2003 (Reaffirmed 2013)

ENCLOSURES:
NUMBER OF OSCILLOGRAM : One
NUMBER OF PHOTOGRAPH : One
NUMBER OF TEST CIRCUIT DIAGRAM : One
NUMBER OF DRAWINGS : Eight

REMARKS: The sample (Main circuits) **conforms** to the requirements of short time withstand current and peak withstand current tests as specified by customer.

CHECKED BY

(Sandeep P. Soni)
APPROVED BY

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