Reactive Energy Management

Low Voltage components

Schneider Electric

Ensure reliability and safety on installations

Thanks to the know-how developed over the last 50 years, Schneider Electric is placed as the global specialist in Energy management providing a unique and comprehensive portfolio. Schneider Electric helps you to make the most of your energy with innovative, reliable and safe solutions with:

Quality and reliability

- Continuity of service thanks to the high performance and long life expectancy of capacitors,
- 100% tested in manufacturing plant at Bangalore,
- Designed and engineered with the highest international standards.

Safety

- Tested safety features integrated on each phase.
- Over-pressure detection system for safe disconnection at the end of life
- All the materials and components are non PCB pollutants

Efficiency and productivity

- Product development include innovation in ergonomics and easiness of installation and connection,
- Specially designed components to save time on installation and maintenance,
- All the components and solutions are available through a network of distributors and partners in more than 100 countries.

Your requirements….

Optimize Energy consumption:

- By reducing electricity bills,
- By reducing power losses,
- By reducing CO_2 emissions.

Increase the power availability:

- Compensate for voltage sags detrimental to process operation,
- Avoid nuisance tripping and supply interruptions.

Improve your business performance:

- Optimize the installation size,
- Reduce harmonic distortion to avoid the premature ageing of equipment and destruction of sensitive components

Our solutions….

Reactive energy management

In electrical networks, reactive energy is responsible for increased line currents, for a given active energy transmitted to loads.

The main consequences are:

- Necessary over sizing of transmission and distribution networks by the Utilities,
- Increased voltage drops and sags along the distribution lines,
- Additional power losses.

This is resulting in increased electricity bills for industrial customers because of:

- Penalties applied by most Utilities to reactive energy,
- Increased overall kVA demand,
- Increased energy consumption within the installations.

Reactive energy management aims to optimize your electrical installation by reducing energy consumption, and improve power availability. CO2 emissions are also globally reduced.

Utility power bills are typically reduced by 5 to 10%.

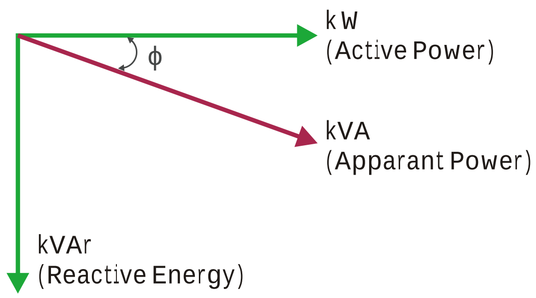
Improve electrical networks and reduce energy cost.

Contents

Principle of reactive energy management

Introduction

All electrical loads which operate by means of magnetic fields/electromagnatic field effects, such as motors, transformers, fluorescent lighting etc., Basically consume two types of power. Namely;
Active Power and Reactive Power



- Active Power (kW) : It is the power used by the loads to meet the functional output requirements.

- Reactive Power(kVAr) : It is the power used by the load to meet its magnetic field requirements as also the requirements of magnetic losses.

  The reactive power is always 90^{0} out of phase with respect to the active power.

  The unit normally used to express the reactive power is VAr (in practical usage kVAr)

The apparent power S (in kVA) is the vector sum of active and reactive power.

Effects of Reactive Power

It is now obvious that both active and reactive power(energy) are necessary inputs in all electrical systems. However the flow of reactive power has certain negative aspects which result in increased cost of electrical systems and also drop in the efficiency of system operations.

The increased flow of reactive power results in the following adverse conditions:

- Overloading of Transformers
- Higher kVA demand on the system
- Higher voltage drop throughout the system
- Increased I^2R losses leading to additional heating and loss of energy
- Increase in the rating of switch gear, cables and other protective devices

Power Factor

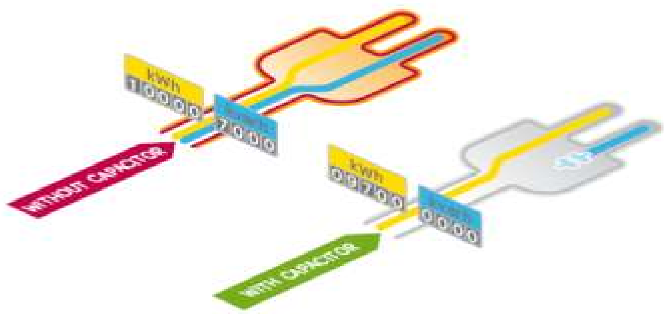
The power factor is the Cosine of the angle between Active power and Apparent power.

- Power Factor (Cos ϕ) = $\dfrac{\text{Active power (kW)}}{\text{Apparent power(kVA)}}$

- $(kVA)^2 = (kW)^2 + (kVAr)^2$ or $kVA = \sqrt{kW^2 + kVAr^2}$

- $kW = kVA \times \cos\phi$

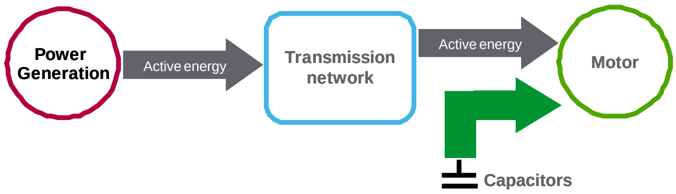
- $\tan\phi = \dfrac{kVAr}{kW}$



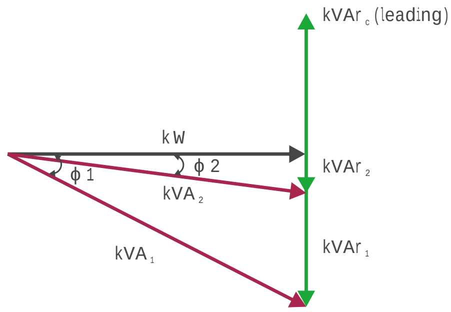
Power Factor Correction

Capacitors are most cost effective and reliable static devices which can generate and supply reactive power(energy). Capacitors consume virtually negligible active power and able to produce reactive power locally, thus enabling Power Factor Correction in locations such as

- Power capacitors
- Automatic power factor correction systems
- Detuned harmonic filter



The vector diagram given aside summarize the concept of power factor correction/improvement by reactive power compensation with capacitors.



$Cos\ \phi_1$= Initial power factor

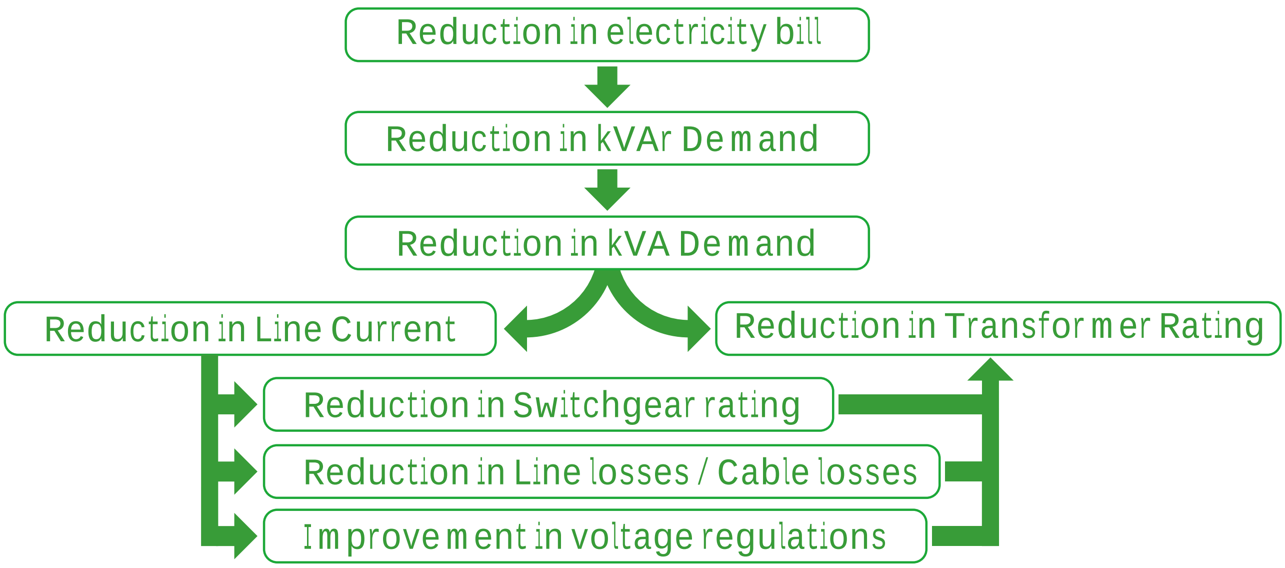
$Cos\ \phi_2$= Target power factor

$= kVA_2 < kVA_1$

Benefits of reactive energy management

By providing proper Reactive Energy Management system, the adverse effects of flow of reactive energy can be minimized.

Following table provides some of the benefits of Reactive Energy Management:



Savings on the electricity bill

- Eliminating penalties on reactive energy and decreasing kVA demand,
- Reducing power losses generated in the transformers and conductors of the installation.

Example:
Loss reduction in a 630 kVA transformer
PW = 6,500 W with an initial Power Factor = 0.7.
With power factor correction, we obtain a final Power Factor = 0.98
The losses become: 3,316 W, i.e. a reduction of 49%.

Increasing available power:

A high power factor optimizes an electrical installation by allowing a better usage of the components.

The power available at the secondary of an MV/LV transformer can therefore be increased by fitting power factor correction equipment at the low voltage side.

The opposite table shows the increased available power at the transformer output by improvement of Power Factor from 0.7 to 1.

Power factor	Additional available power
0.7	0%
0.8	+14%
0.85	+21%
0.90	+28%
0.95	+36%
1.00	+43%

Example
Calculation for Reduction in kVA Demand
Load KW = 500 KW
Initial PF (cosφ) = 0.75
Target PF (cosφ) = 0.98
Cos = KW/kVA
kVA = KW/ Cos
kVA1 = 500 KW/ 0.75 = 667 kVA (Before PF compensation)
kVA2 = 500 KW/ 0.98 = 510 kVA (After PF compensation)
Saving in kVA = 666- 510 = 157 kVA reduction
= 23.7 % reduction

Reduction in line current

Installing power factor correction equipment allows the conductors cross-section to be reduced, since less current is absorbed by the compensated installation for the same active power.

The opposite table shows the multiplying factor for the conductor cross-section according to the different values of power factor.

Power factor	Cable cross-section multiplying factor
1	1
0.80	1.25
0.60	1.67
0.40	2.50

Example
Calculation for Reduction in Line Current

$$I_1 = \frac{kVA \times 1000}{\sqrt{3} \times V} = \frac{667 \times 1000}{\sqrt{3} \times 440}$$

= 875 Amps (Before PF compensation)

$$I_2 = \frac{510 \times 1000}{\sqrt{3} \times 440}$$

= 669 Amps (After PF compensation)
Savings in Line current = 875 – 669 = 206 Amps reduction.

Improvement in voltage regulation

Installing capacitors allows the voltage drops to be reduced upstream of the point where the power factor correction device is connected.

$$\frac{\Delta V}{V} = \frac{Q}{S}$$

ΔV = Voltage Improvement
V = System Voltage Without Capacitors
Q = Capacitors Rating in MVAr
S = System Fault Level In MVA

Example:
For a 150 kVAr, 440V capacitor & System fault level of 15 MVA.

$$\frac{\Delta V}{V} = \frac{Q}{S}$$

$$\Delta V = \frac{440 \times 0.15}{15}$$

$$= 4.4 \text{ volts}$$

Mode of compensation

The selection of the Power Factor Correction equipment can follow a 3-step process:

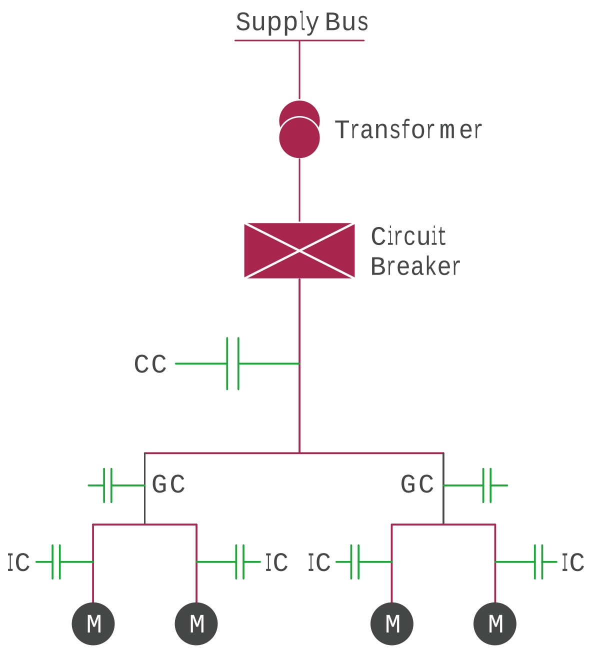
- Central compensation
- Group compensation
- Individual compensation

Central compensation
The capacitor bank is connected at the main incomer of the installation (such as Secondary side of Transformer) to be compensated in order to provide reactive energy for the whole installation. This configuration is convenient to achieve desired power factor Upstream (such as Metering point). The PF, Distribution losses and voltage profile remains unaltered at downstream of the network.

Central Compensation for complete installation – Fixed compensation / Semi-Automatic / Automatic power factor correction / Dynamic compensation for highly fluctuating loads
Refer single line diagram

Group Compensation
The capacitor banks are de-centralised and are connected at feeder level supplying different Load Centres. This configuration is convenient for a wide installation, with load centres distributed across the network.
Refer single line diagram

Individual Compensation
The capacitor bank is connected right at the terminals of inductive loads (especially for large motors). This configuration is well adapted when the load power is significant compared to the subscribed power. This is technical ideal configuration, as the reactive energy compensated at the load end.
Individual motor compensation
Refer single line diagram



CC=Central Compensation
GC=Group Compensation
IC = Individual Compensation
M = Motor Load

Types of compensation

Broadly, there are two types of compensation:

- Fixed compensation.
- Variable compensation.
  - APFC panels – Contactor / Thyristor based
  - ePFC – Electronic VAr compensator with IGBT.

Fixed compensation

This arrangement uses one or more capacitors to provide a constant level of compensation. Control may be

- Manual: by circuit-breaker or load-break switch,
- Semi-automatic: by contactor,
- Direct connection to an appliance and switched with it.

These capacitors are applied:

- At the terminals of inductive loads (mainly motors), at bus bars connecting numerous small motors and inductive appliances for which individual compensation would be too costly,
- In cases where the load factor is reasonably constant.

Variable compensation

The primary reason for Variable compensation is the variation of loads in the network. In many applications the process are not constant through out the day, hence the reactive energy required vary as per the load profile, to eliminate the risk of leading power factor and to optimize the kVA demand, the variable compensation techniques are used.

Variable compensation can be contactor based, thyristor based or Electronic based.

Calculation of kVAr required

For Industrial / Distribution Networks

In electrical installations, the operating load KW and its average power factor (PF) can be ascertained from electricity bill. Alternatively it can be easily evaluated by formula

- Average PF = KWh/kVAh
- Operating load KW = kVA demand x Average PF
- The average PF is considered as the initial PF and final PF can be suitably assumed as required .in such cases required Capacitor kVAr can be calculated as shown in example.

Operating Load = KW, Average PF = KWh/ kVAh
Operating Load KW = kVA demand X Average PF
kVA = KW / PF
The average PF is considered as initial PF and the final PF can be suitably assumed as target PF.

Capacitor kVAr can be calculated as sited above table
Initial PF 0.85, Target PF 0.98
kVAr = KW X Multiplying factor from Table
= 800 x 0.417
= 334 kVAr required.

INITIAL PF	TARGET PF									
	0.9	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99
0.4	1.807	1.836	1.865	1.896	1.928	1.963	2.000	2.041	2.088	2.149
0.42	1.676	1.705	1.735	1.766	1.798	1.832	1.869	1.910	1.958	2.018
0.44	1.557	1.585	1.615	1.646	1.678	1.712	1.749	1.790	1.838	1.898
0.46	1.446	1.475	1.504	1.535	1.567	1.602	1.639	1.680	1.727	1.788
0.48	1.343	1.372	1.402	1.432	1.465	1.499	1.536	1.577	1.625	1.685
0.5	1.248	1.276	1.306	1.337	1.369	1.403	1.440	1.481	1.529	1.590
0.52	1.158	1.187	1.217	1.247	1.280	1.314	1.351	1.392	1.440	1.500
0.54	1.074	1.103	1.133	1.163	1.196	1.230	1.267	1.308	1.356	1.416
0.56	0.995	1.024	1.053	1.084	1.116	1.151	1.188	1.229	1.276	1.337
0.58	0.920	0.949	0.979	1.009	1.042	1.076	1.113	1.154	1.201	1.262
0.6	0.849	0.878	0.907	0.938	0.970	1.005	1.042	1.083	1.130	1.191
0.62	0.781	0.810	0.839	0.870	0.903	0.937	0.974	1.015	1.062	1.123
0.64	0.716	0.745	0.775	0.805	0.838	0.872	0.909	0.950	0.998	1.058
0.66	0.654	0.683	0.712	0.743	0.775	0.810	0.847	0.888	0.935	0.996
0.68	0.594	0.623	0.652	0.683	0.715	0.750	0.787	0.828	0.875	0.936
0.7	0.536	0.565	0.594	0.625	0.657	0.692	0.729	0.770	0.817	0.878
0.72	0.480	0.508	0.538	0.569	0.601	0.635	0.672	0.713	0.761	0.821
0.74	0.425	0.453	0.483	0.514	0.546	0.580	0.617	0.658	0.706	0.766
0.75	0.398	0.426	0.456	0.487	0.519	0.553	0.590	0.631	0.679	0.739
0.76	0.371	0.400	0.429	0.460	0.492	0.526	0.563	0.605	0.652	0.713
0.78	0.318	0.347	0.376	0.407	0.439	0.474	0.511	0.552	0.599	0.660
0.8	0.266	0.294	0.324	0.355	0.387	0.421	0.458	0.499	0.547	0.608
0.82	0.214	0.242	0.272	0.303	0.335	0.369	0.406	0.447	0.495	0.556
0.84	0.162	0.190	0.220	0.251	0.283	0.317	0.354	0.395	0.443	0.503
0.85	0.135	0.164	0.194	0.225	0.257	0.291	0.328	0.369	0.417	0.477
0.86	0.109	0.138	0.167	0.198	0.230	0.265	0.302	0.343	0.390	0.451
0.87	0.082	0.111	0.141	0.172	0.204	0.238	0.275	0.316	0.364	0.424
0.88	0.055	0.084	0.114	0.145	0.177	0.211	0.248	0.289	0.337	0.397
0.89	0.028	0.057	0.086	0.117	0.149	0.184	0.221	0.262	0.309	0.370
0.9	0.000	0.029	0.058	0.089	0.121	0.156	0.193	0.234	0.281	0.342
0.91		0.000	0.030	0.060	0.093	0.127	0.164	0.205	0.253	0.313
0.92			0.000	0.031	0.063	0.097	0.134	0.175	0.223	0.284
0.93				0.000	0.032	0.067	0.104	0.145	0.192	0.253
0.94					0.000	0.034	0.071	0.112	0.160	0.220
0.95						0.000	0.037	0.078	0.126	0.186

kVAr for 3 Phase Motors

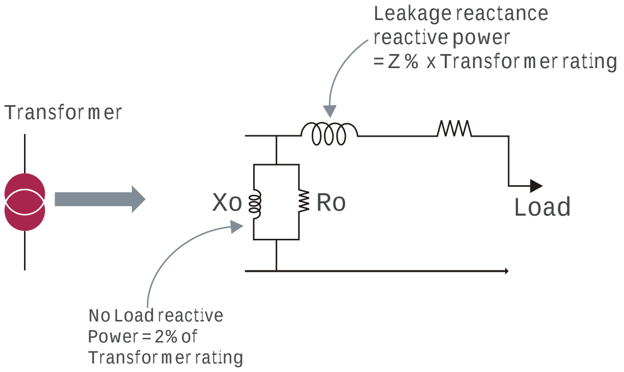
The Recommended kVAr ratings of power capacitors, which are to be used directly with 3 phase AC induction motors

Motor Rating in HP	Capacitor rating in kVAr when motor speed (RPM) is				
	3000 rpm	1500 rpm	1000 rpm	750 rpm	500 rpm
2.5	1	1	1.5	2	2.5
5	2	2	2.5	3.5	4
7.5	2.5	3	3.5	4.5	5.5
10	3	4	4.5	5.5	6.5
15	4	5	6	7.5	9
20	5	6	7	9	12
25	6	7	9	10.5	14.5
30	7	8	10	12	17
40	9	10	13	15	21
50	11	12.5	16	18	25
60	13	14.5	18	20	28
70	15	16.5	20	22	31
80	17	19	22	24	34
90	19	21	24	26	37
100	21	23	26	28	40
110	23	25	28	30	43
120	25	27	30	32	46
130	27	29	32	34	49
140	29	31	34	36	52
145	30	32	35	37	54
150	31	33	36	38	55
155	32	34	37	39	56
160	33	35	38	40	57
165	34	36	39	41	59
170	35	37	40	42	60
175	36	38	41	43	61
180	37	39	42	44	62
185	38	40	43	45	63
190	38	40	43	45	65
200	40	42	45	47	67
250	45	50	55	60	70

Transformer No – Load Compensation

The transformer works on the principle of Mutual Induction. The transformers will consume reactive power for magnetizing purpose.

Following equivalent circuit of transformer provides the details of reactive power demand inside the transformer:



Three Phase Distribution Transformer

kVA rating of Transformer	kVAr required for No-Load compensation
Up to and including 2000 KVA	2% of KVA rating

Single Phase Arc welding machine/Transformer

kVA rating of Transformer	kVAr required for compensation
6kVA	7.5 kVAr, Single phase 440v
9kVA	10 kVAr, Single phase 440v
10kVA	10 kVAr, Single phase 440v

Influence of harmonics in electrical installations

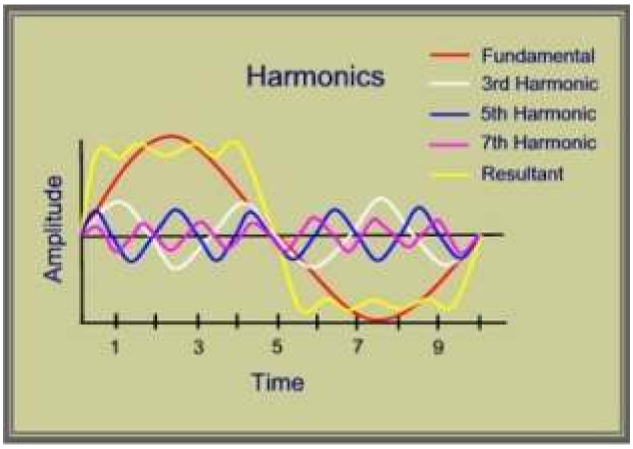
Definition of Harmonics

Harmonics are sinusoidal current whose frequency is Integral multiple of Fundamental (or Power) frequency.

Harmonic currents are caused due to wave chopping techniques used in non-linear loads.

The flow of harmonic currents through system impedances in turn creates voltage harmonics; the presence of voltage harmonics will alter the incoming Sinusoidal voltage waveform.

A Harmonic loads generating devices are VFD's, UPS, DC Drives, Battery Charger, Weldingloads, Electric Furnace, etc.



Effects of Harmonics

Equipment	Nature of ill effect.
Motor	Over heating, production of non-uniform torque increased vibration.
Transformer	Over heating and insulation failure, Noise.
Switchgear and cables	Neutral link failure, Increased losses due to skin effect and over heating of cables.
Capacitors	Life reduces drastically due to harmonic overloading.
Protective Relays	Mal-operation.
Power electronic equipment	Mis-firing of thyristors and failure of semiconductor devices.
Control and instrumentation electronic equipment	Erratic operation followed by nuisance tripping and breakdown.
Communication equipment / PC's	Interference and noise.
Neutral Cable	Higher Neutral current with 150 Hz frequency, Neutral over heating and /or open neutral condition.
Telecommunication equipment	Telephonic Interference, Mal-function of the sensitive electronics used, Failure of Telecom hardware.

Effect on Capacitors

Capacitors are in particular highly sensitive to the presence of Harmonics due to the fact the capacitive reactance, namely Xc is inversely proportional to the frequency of the harmonics present. As a result of this, the likely hood of amplification of Harmonic currents is very high when the natural resonance frequency of the capacitor and the network combined happens to be close to any of the harmonic frequencies present .

If the harmonic power is substantial ie.. greater than 10% (or) so, this situation could result in severe over voltages and overloads which will lead to premature failure of capacitors and the equipments.

Solution for Harmonic Rich Environment

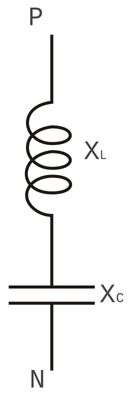
Capacitors are particularly sensitive to harmonics. Depending on the magnitude of harmonics in the network, different configurations shall be adopted.

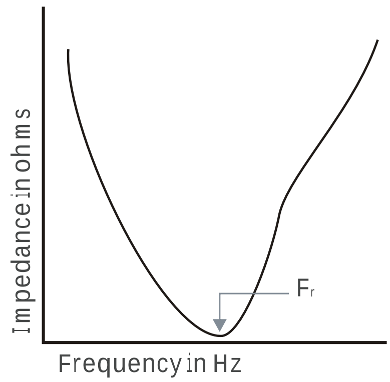
- Detuned Filter
- Broad band Filter
- Tuned Filter
- Active Filter

Detuned Filter

Detuned filters are the most preferred since they are cost effective solutions which work on the principle of avoiding resonance by achieving an inductive impedance at relevant harmonic frequencies. The tuning frequency is generally lower than 90% of the lowest harmonic frequency whose amplitude insignificant and which operate in a stable manner under various network configurations and operating conditions.

Detuned harmonic filter systems consist of Reactor (L) in series with a capacitor (C) as shown in figure.





Such a filter has a unique self series resonance at which reactance of reactor equals capacitance reactance of reactor.

$$Fr = \frac{1}{(2\pi\sqrt{Lc})}$$

Broadband filters

If an installation requires to mitigate the harmonic distortion without affecting the existing power factor or capacitors, specially designed broadband filters are recommended. The broadband filters will be connected in series with the non-linear load, hence the harmonic current generated by the non linear loads will be arrested at the point of generation.

Tuned filters

when non-linear loads are predominant, requesting harmonic mitigation. A special design is generally necessary, based on on- site measurements and computer simulations of the network.

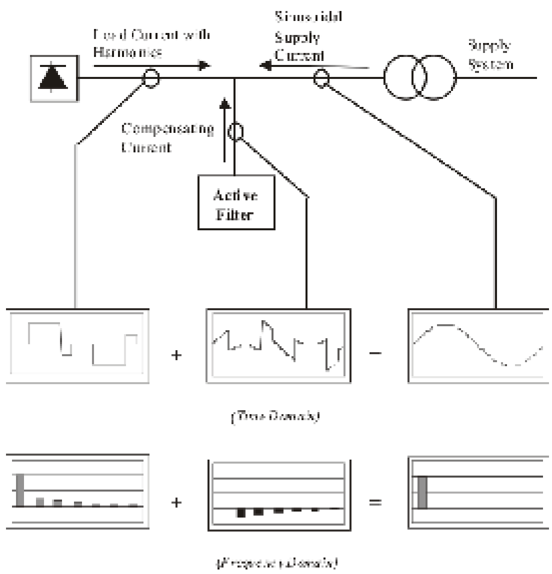
Active Filters

There are few instances where the passive filters cannot be used. Or example, if a wide spectrum of harmonics has to be filtered, the passive based solution may not be effective and impose significant limitations.

The Active harmonic filter can measure and filter the harmonics generated by non linear loads in real time mode.

Active filter works on a principle of generating harmonic current out of phase with the harmonic current existing in the network. The Active filter comprises of active elements such as IGBT's, DC Link capacitors, microprocessor based controller with DSP logic etc.

Following diagram shows the schematic of Active filter:



Since the harmonics are caused by non-linear loads, an indicator for the magnitude of harmonics is the ratio of the total power of non-linear loads to the supply transformer rating.

$$\%\ \text{non-linear load ratio} = \frac{\text{Total power of non-linear loads (kVA)}}{\text{Installed transformer rating (kVA)}} \times 100$$

Example:
Installed transformer rating = 650 kVA
Power of non-linear loads = 150 kVA
NNL = (150/650) x 100 = 23%

Capacitor selection

Capacitors must be selected depending on the working conditions expected during their lifetime.

Solution	Description	Recommended use for	Max. condition	Life expectancy (hours)
S Duty	Standard Duty capacitor	Non-Linear loads less then	NLL ≤ 10%	Up to 100000
		Over-current	1.5 I_N	
		Ambient temperature	55°C (class D)	
		Switching frequency/year	5000	
H Duty	Heavy Duty capacitor	Non-Linear loads up to	NLL ≤ 20%	Up to 130000
		Over-current	1.8 I_N	
		Ambient temperature	55°C (class D)	
		Switching frequency/year	7000	
GH Duty	Gas filled Heavy Duty capacitor	Non-Linear loads up to	NLL ≤ 20%	Up to 130000
		Over-current	1.8 I_N	
		Ambient temperature	55°C (class D)	
		Switching frequency/year	7000	
APP SH Duty	Super Heavy Duty capacitor	Non-Linear loads up to	NLL ≤ 20%	Up to 140000
		Over-current	2 I_N	
		Ambient temperature	55°C(class D)	
		Switching frequency/year	8000	
Energy (MD-XL)	Capacitor for special conditions	Non-Linear loads up to	NLL ≤ 25%	Up to 160000
		Over-current	2.5 I_N	
		Ambient temperature	70°C	
		Switching frequency/year	10000	
Harmonic Hduty	Heavy Duty, harmonic Rated capacitor + Detuned reactor	Filter Application + Non-Linear loads up to	NLL ≤30%	Up to 130000
		Over-current	1.8 I_N	
		Ambient temperature	55°C (class D)	
		Switching frequency/year	7000	
Harmonic APP SH Duty	Super Heavy Duty Harmonic rated capacitor + Detuned reactor	Filter Application + Non-Linear loads up to	NLL ≤35%	Up to 140000
		Over-current	2.0 I_N	
		Ambient temperature	55°C	
		Switching frequency/year	7000	
Harmonic Energy (MD-XL)	Energy, Harmonic rated capacitor + Detuned reactor	Filter Application + Non-Linear loads up to	NLL ≤40%	Up to 160000
		Over-current	2.5 I_N	
		Ambient temperature	70°C	
		Switching frequency/year	10000	

Above 25 % below 40% of non linear loads	Use capacitor + detuned harmonic Filter
Above 40% below 60% of non linear loads	System Study is required

Selection of Capacitor Rated voltage

Capacitors must be selected according to the service voltage of the network on which they will operate. The rated voltage (U_N) of the capacitors is then assimilated to the service voltage of the network. As a significant difference may exist between the service voltage and the actual supply voltage, the capacitors have been designed so that they can operate continuously with a supply voltage equal to 1.1 x U_N.

The rated current (I_N) of a capacitor is the current flowing through the capacitor when the rated voltage UN is applied at its terminals, supposing a purely sinusoidal voltage and the exact value of reactive power (kVAr) generated.

Considering possible voltage fluctuations, harmonic distortion and capacitance tolerances, the capacitors are designed to operate continuously at a higher current than the rated current. Different factors are proposed depending on the construction technology.

Life expectancy is given considering standard operating conditions: rated voltage, rated current, 25°C ambient temperature.

CAUTION: the life expectancy will be reduced if capacitors are used at the maximum level of the mentioned working conditions.

Capacitor operating conditions

The operating conditions have a great influence on the life expectancy of capacitors. For this reason, different categories of capacitors, with different withstand levels, must be selected according to operating conditions.

Capacitors must be selected in function of the following parameters:

- Ambient Temperature (°C),
- Expected over-current, related to voltage disturbances, including maximum sustained over voltage,
- Maximum number of switching operations/year,
- Requested life expectancy.

Different ranges with different levels of ruggedness are proposed:

- "SDuty": Standard duty capacitors for Steady load operating conditions,

- "HDuty": Heavy duty capacitors for fluctuating operating load conditions, particularly voltage disturbances,

- "Energy" (MD-XL): Specially designed capacitors, for frequent fluctuating load operating conditions, particularly high temperature.

Capacitor technology & Types

MPP type

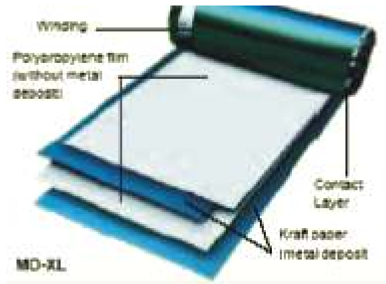
Capacitors comprise of a polypropylene Film as the dielectric vacuum coated with a special metal layer which acts as the electrode of the capacitor. The MPP film is wound in to cylindrical windings. The technology of windings is manufactured on very sophisticated Automatic machines. The capacitor elements so produced are then subjected to several processes including end connection spraying vacuum thermal treatment, assembly into the required containers followed by an elaborate vacuum impregnation process.

Varplus heavy duty/Varplus GH Capacitors are designed to withstand overload conditions which are beyond those specified in the IS and IEC standards. This is necessary because in some applications over voltages and over currents due to system parameters and harmonic presence can cause the overloading of capacitors..

Heavy duty capacitors are designed to carry 180% over current as against 130%.

Varplus Energy

Capacitors comprise of Low loss polypropylene Film combined with dual side metallised paper in the dielectric structure. The Metallization serves of paper ensures a high quality impregnation .The polypropylene film and metallised paper are wound together in cylindrical windings.

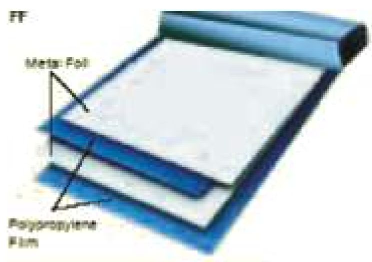


Energy capacitors are designed for very long life operation under over load conditions which are much beyond those specified in the IS and IEC standards. This is necessary because in some applications over voltages and over currents due to system parameters and harmonic presence can cause the overloading of capacitors..

Energy capacitors designed to carry 250% over current as against 130% specified in the standards.

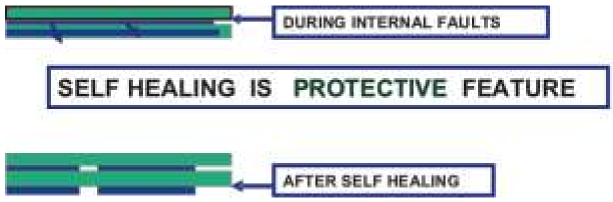
APP type / Film Foil

APP Capacitors are manufactured by using Hazy polypropylene film. This is placed between two layers of metal foil and windings.



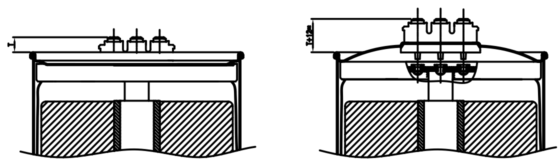
Self - Healing Technology

The capacitors such as MPP standard duty , Gasfilled, heavy duty and energy type capacitors are manufactured by using the material having self healing property. In the event of dielectric break down, the metal layer around the breakdown channel are evaporated by the temperature of electric arc that forms between the electrodes. Insulation
Area is formed which is resistive and voltage proof for all capacitor. The capacitor remains functional during and after the breakdown.



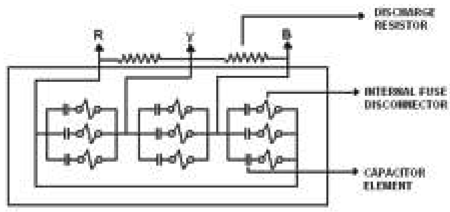
Protection /safety

SH type capacitors pressure sensitive disconnect or (PSD) make the capacitor explosion proof in the event of service faults against overvoltage and short circuits



Non – Self healing technology

App capacitors are non –self healing .They are provided with internal fuses for the isolation of faulty element when an element when an element break down occurs. The capacitor remains functional.



Types

A comprehensive range that offers 2 different construction technologies to fulfill your needs....

Can type

Box type

VarplusCan Capacitor

A safe, reliable and high performance solution for power factor correction in commercial, industrial and semi-industrial applications. Suitable for fixed or, automatic PFC, real time compensation, detuned and tuned filters.

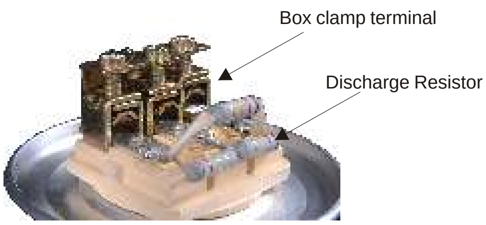
VarplusCan capacitors are designed and engineered to deliver a long working life with low losses.

Construction

Internally constructed with three single phase capacitor elements delta connected and assembled in an optimized design. Each capacitor element is manufactured with a unique polypropylene film as the dielectric which enables the feature of "self-healing".

The active capacitor elements are encapsulated in a specially formulated thermoset resin In case of Heavy duty & semi liquid resin in case of standard duty. Which ensures better mechanical stability and heat transfer from inside the capacitor.

Their unique finger-proof termination assembly which is fully integrated with discharge resistors allows capacitor a proper access to tightening and ensures a cable termination without any loose connections. Once, tightened, their special design guarantees that the tightening torque is always maintained.



Replace with good one

Main Characteristics

Easy installation & maintenance

- Heavy edge metallisation / wave cut edge to ensure high inrush current capabilities
- Optimized design to have a low weight, compactness and
- Reliability to insure an easy installation
- Unique termination system that allows a maintained tightening
- Single point for fixing and earthing

Safety

- Twin protection: Self-healing + Pressure Sensitive Disconnector
- Finger proof CLAMPTITE terminals to reduce risk of accidental
- contact and to ensure firm termination
- Special resistivity and metallization profile for higher thermal efficiency, lower temperature rise and enhanced life expectancy Special resistivity and metallization profile for higher thermal efficiency, lower temperature rise and enhanced life expectancy

50 kVAr

Availability

- Available on request in single phase design for special applications
- Available in small kVAr rating within all the network voltages 50Hz/60Hz

Typical Applications:

- PFC equipment assembly

VarplusCan Standard Duty Capacitors (SDuty)

- Non-Linear loads less then 10%
- Over-current - $1.5 I_N$
- Ambient temperature - 55°C
- Switching frequency up to 5000 /year
- Voltage range - 415 / 440 V (Other Voltage on request)
- kVAr range: 1 to 30 (40 & 50 kVAr on request)

VarplusCan Heavy Duty Capacitors (HDuty)

- Non-Linear loads upto 20%
- Over-current - $1.8 I_N$
- Ambient temperature - 55°C
- Switching frequency up to 7000 /year
- Voltage range - 415 / 440 / 480 / 525 V
  (660 / 690 / 800 V on request)
- kVAr range: 1 to 30 (40 & 50 kVAr on request)

Varplus Can Gas Filled Heavy Duty Capacitos (GHDuty)

- Non-Linear loads upto 20%
- Over-current - $1.8 I_N$
- Ambient temperature (up to 55°C)
- Switching frequency up to 7000 /year
- Voltage range - 415 / 440 / 480 / 525 V
  (660 / 690 / 800 V on request)
- kVAr range: 5 to 30 (40 & 50 kVAr on request)

VarplusCan Energy Capacitors (MD-XL)

- Non-linear loads upto 25%
- Over-current - $2.5 I_N$
- Ambient temperature conditions up to 70°C
- Frequent switching operation up to 10000/year
- Voltage range - 415 / 440 V (480 / 525 V on request)
- kVAr range: 5 to 15

Technical Details

	VarplusCan Standard Duty Capacitors (SDuty)	VarplusCan Heavy Duty Capacitors (HDuty)	VarplusCan Gas Filled Heavy Duty Capacitors (GH Duty)	VarplusCan Energy (MD-XL)
Standards	IS 13340-1993/IS13341 -1992, IEC 60831-1/-2	IS 13340-1993/IS13341 -1992, IEC 60831-1/-2	IS 13340-1993/ IS 13341 -1992,IEC 60831-1/-2	IS 13340-1993 /13341 -1992, IEC 60831-1/-2
Rated Voltage	415 /440V (other voltage on request)			
Frequency	50 Hz			
Power range	From 1 kvar to 30 kvar (other kvar on request)		From 5 kvar to 30 kvar	From 5 kvar to 15 kvar
Losses(Dielectrical)	< 0,2 watt/kvar			
Losses (Total)	< 0,5 watt/kvar			< 0,45 watt/kvar
Peak inrush current	Up to 200 x I_N	Up to 250 x I_N	Up to 250 x I_N	Up to 350 x I_N
Over voltage	1.1 U_N continuous			
Over current	1.5 x I_N	1.8 x I_N	1.8 x I_N	2.5 x I_N
Mean life expectancy	Up to 100,000 Hours	Up to 130,000 Hours	Up to 130,000 Hours	Up to 160,000 Hours
Capacitance tolerance	-5%, +10%			
Voltage test Between terminals	2.15x U_N (AC), 2 sec			
Between earth & terminals	< 660V, 3000V (AC) 10 sec & >660V, 6000V (AC), 10sec			
Discharge resistors	Fitted: standard discharge time 60 seconds			
Safety	Self healing + pressure sensitive disconnector + discharge device			
Protection	IP30 (IP54 on request)			
Casing	Extruded aluminum can			
Dielectric	Metallised Polypropylene film with Zn/Al alloy	Metallised Polypropylenefilm with Zn/Al alloy, special resistivity & profile, special edge (wave cut)	Metallised Polypropylenefilm with Zn/Al alloy, special resistivity & profile, special edge (wave cut)	Double metallized paper + Polypropylene film
Impregnation	Non - PCB, Bio degradable resin	Non - PCB, Dry resin	Non - SF6 Inert gas ,dry	Non-PCB, oil
Environmental conditions				
Ambient temperature	-25 to Max 55°C/Class D			-25 to Max 70°C
Humidity	95%			
Altitude	4000 m above sea level			
Installation features				
Mounting	Indoor, vertical position	Indoor, any position	Indoor, any position	Indoor, vertical position
Connection	Three phase delta connection (Single phase on request)			
Fixing and earthing	Threaded M12 stud at bottom			
Terminals	CLAMPTITE - Three phase terminal with electric shock protection (finger proof), designed for up to 16sq.mm cable termination, Double fasten with cable in lower kVAr.			

Capacitor ordering reference nos.

Rated KVAr	Rated Current (Amps)	Rated capacitance µF (x 3)	Dimension (mm) Dia	Height	Net Weight (kg)	Ordering reference no	Reference Drawing no.
VarplusCan Standard Duty Capacitors (SDuty)							
1	1.3	5.5	63	90	0.4	MEH_VCSDY_010A44_3	Drawing A (page 21)
2	2.6	11	63	115	0.5	MEH_VCSDY_020A44_3	
3	3.9	16.4	50	195	0.5	MEH_VCSDY_030A44_3	
4	5.2	21.9	50	195	0.6	MEH_VCSDY_040A44_3	
5	6.6	33	50	195	0.7	MEH_VCSDY_050A44_3	
7.5	9.8	50	63	195	0.9	MEH_VCSDY_075A44_3	
10	13.1	55	70	195	1.0	MEH_VCSDY_100A44_3	
12.5	12.5	69	75	278	1.2	MEH_VCSDY_125A44_3	Drawing B (page 21)
15	19.7	82	75	278	1.3	MEH_VCSDY_150A44_3	
20	26.2	110	90	278	2.1	MEH_VCSDY_200A44_3	Drawing C (page 21)
25	32.8	137	90	278	2.2	MEH_VCSDY_250A44_3	
30	39.4	164	90	278	2.3	MEH_VCSDY_300A44_3	
40	52.4	220	116	278	3.8	MEH_VCSDY_400A44_3	Drawing E (page 21)
50	65.6	274	136	278	4.9	MEH_VCSDY_500A44_3	
Note: 40 & 50 kVAr on request							
VarplusCan Heavy Duty capacitors (HDuty)							
1	1.3	5.5	63	90	0.5	MEH_VCHDY_010A44_3	Drawing A (page 21)
2	2.6	11	50	195	0.6	MEH_VCHDY_020A44_3	
3	3.9	16.4	50	195	0.6	MEH_VCHDY_030A44_3	
4	5.2	21.9	50	195	0.7	MEH_VCHDY_040A44_3	
5	6.6	33	63	195	0.8	MEH_VCHDY_050A44_3	
7.5	9.8	50	63	195	1	MEH_VCHDY_075A44_3	
10	13.1	55	75	203	1.1	MEH_VCHDY_100A44_3	Drawing B (page 21)
12.5	12.5	69	90	212	1.5	MEH_VCHDY_125A44_3	Drawing C (page 21)
15	19.7	82	90	212	1.6	MEH_VCHDY_150A44_3	
20	26.2	110	116	212	2.4	MEH_VCHDY_200A44_3	Drawing D (page 21)
25	32.8	137	116	212	2.5	MEH_VCHDY_250A44_3	
30	39.4	164	136	212	3.1	MEH_VCHDY_300A44_3	
40	52.4	220	136	278	3.4	MEH_VCHDY_400A44_3	Drawing E (page 21)
50	65.6	274	136	278	4.6	MEH_VCHDY_500A44_3	
Note: 40 & 50 kvar on request							
Varplus Can Gas Filled Heavy Duty capacitor (GH Duty)							
5	6.6	33	63	195	0.9	MEH_VCGSF_050A44_3	Drawing A (page 21)
7.5	9.8	50	63	195	1	MEH_VCGSF_075A44_3	
10	13.1	55	75	203	1.1	MEH_VCGSF_100A44_3	Drawing B (page 21)
12.5	12.5	69	90	212	1.5	MEH_VCGSF_125A44_3	Drawing C (page 21)
15	19.7	82	90	212	1.6	MEH_VCGSF_150A44_3	
20	26.2	110	116	212	2.4	MEH_VCGSF_200A44_3	Drawing D (page 21)
25	32.8	137	116	212	2.5	MEH_VCGSF_250A44_3	
30	39.4	164	136	212	3.1	MEH_VCGSF_300A44_3	
40	52.4	220	136	278	3.4	MEH_VCGSF_400A44_3	Drawing E (page 21)
50	65.6	274	136	278	4.6	MEH_VCGSF_500A44_3	
Note: 40 & 50 kVAr on request							
VarplusCan Energy (MD-XL)							
5	6.6	33	75	203	1.2	MEH_VCENY_050A44_3	Drawing B (page 21)
7.5	9.8	50	90	212	1.4	MEH_VCENY_075A44_3	
10	13.1	55	90	278	2.3	MEH_VCENY_100A44_3	Drawing C (page 21)
12.5	12.5	69	90	278	2.6	MEH_VCENY_125A44_3	
15	19.7	82	116	278	3.3	MEH_VCENY_150A44_3	Drawing D (page 21)

VarplusBox Capacitor

Varplus Box capacitors deliver reliable performance in the most of the fixed applications, in Fixed & Automatic PFC systems, in networks with frequently switched loads and harmonic disturbances.

Construction

The design is specially adapted for mechanical stability. The enclosure is designed to ensure reliable operation of the capacitors in hot and humid conditions, without the need of any additional ventilation louvers.

Special attention is paid to equalization of temperatures within the capacitor enclosures for better overall performance.

Main Characteristics

High performance:

- Heavy edge metallization/wave cut edge to ensure high inrush current capabilities
- Mechanically well suited for "stand alone" installations
- Special resistivity and profile metallization for enhanced life

Safety

- Its unique safety feature electrically disconnects the capacitors safely at the end of their useful life.
- The disconnectors are installed on each phase which makes the capacitors very safe in addition to the protective steel enclosure

Flexibility

- These capacitors can be easily mounted inside panels or in a stand-alone configuration
- Suitable for flexible bank configuration

Advanced Features

- Metal box
- High power ratings up to 100kVAr
- Easy repair and maintenance
- Up to 70°C temperature
- Peak inrush current withstand up to 400 x I_N

Typical Applications:

- Stand alone PFC equipment
- Direct connection to a machine, in harsh environment conditions

VarplusBox Standard Duty Capacitors (SDuty)


- Non-Linear loads less then 10%
- Over-current - 1.5 I_N
- Ambient temperature - 55°C
- Switching frequency up to 5000 /year
- Voltage range - 415 / 440 V (Other Voltage on request)
- kVAr range: 1 to 100 (40, 50, 75 and 100 kVAr on request)

Varplus Box Heavy Duty Capacitors (HDuty)

- Non-Linear loads upto 20%
- Over-current -1.8 I_N
- Ambient temperature - 55°C
- Switching frequency up to 7000 /year
- Voltage range - 415 / 440 / 480 / 525 V (660 / 690 / 800 V on request)
- kVAr range: 5 to 100 (40, 50, 75 and 100 kVAr on request)

Varplus Box Energy Capacitors (MD-XL)

- Non-linear loads upto 25%
- Over-current - 2.5 I_N
- Ambient temperature conditions up to 70°C
- Frequent switching operation up to 10000/year
- Voltage range - 415 / 440 / 480 / 525 V (660 / 690 / 800 V on request)
- kVAr range: 5 to 100 (40, 50, 75 and 100 kVAr on request)

Varplus Box APP Super heavy duty Capacitors (SHDuty)

- Non-linear loads upto 20%
- Over-current - 2.0 I_N
- Ambient temperature conditions up to 70°C
- Frequent switching operation up to 10000/year
- Voltage range - 415 / 440 / 480 / 525 V (660 / 690 / 800 V on request)
- kVAr range: 5 to 100 (40, 50, 75 and 100 kVAr on request)

Technical Details

	VarplusBox Standard Duty Capacitors (SDuty)	VarplusBox Heavy Duty Capacitors (HDuty)	Varplus Box Energy Capacitors (MD-XL)	Varplus Box APP Super Heavy Duty Capacitors (SHDuty)
Standards	13340-1993, IS 13341 -1992, IEC 60831-1/-2	IS 13340-1993, IS 13341 -1992, IEC 60831-1/-2	IS 13340-1993, IS 13341 -1992, IEC 60831-1/-2	IS 13585-1994, IEC 60834-1/-2
Rated Voltage	415 /440V (other voltage on request)			
Frequency	50 Hz			
Power range	From 1 to 100 kVAr	From 5 to 100 kVAr	From 5 to 100 kVAr	From 5 to 100 kVAr
Losses(Dielectrical)	< 0,2 watt/kvar			
Losses (Total)	< 0,5 watt/kVAr			
Peak inrush current	Up to 150 x I_N	Up to 250 x I_N	Up to 400 x I_N	Up to 350 x I_N
Over voltage	1.1 U_N continuous			
Over current	1.5 x I_N	1.8 x I_N	2.5 x I_N	2.0 x I_N
Mean life expectancy	Up to 100,000 Hours	Up to 130,000 Hours	Up to 160,000 Hours	Up to 140,000 Hours
Capacitance tolerance	-5%, +10%			
Voltage test				
Between terminals	2.15x U_N (AC), 2 sec			
Between earth & terminals	< 660V, 3000V (AC) 10 sec & >660V, 6000V (AC), 10sec			
Discharge resistors	Fitted: standard discharge time 60 seconds			
Safety	Self healing + pressure sensitive disconnector for every phase + discharge device			
Protection	IP20 (IP54 on request)			
Casing	Sheet steel enclosure			
Dielectric	Metallised Polypropylene film with Zn/Al alloy, flat metallization	Metallised Polypropylene film with Zn/Al alloy, special resistivity & profile, special edge (wave cut)	Double metallized paper + Polypropylene film	Aluminum foil + PP film
Impregnation	Non - PCB, Bio degradable PUR resin	Non - PCB, Dry Resin	Non-PCB, oil	Non-PCB, oil
Environmental conditions				
Ambient temperature	-25 to Max 55°C/Class D			
Humidity	95%			
Altitude	4000 m above sea level			
Installation features				
Mounting	Indoor, vertical position			
Connection	Three phase (delta connection)			
Fixing and earthing	Mounting cleats			
Terminals	Bushing terminals designed for large cable termination and direct bus bar mounting for banking			

Capacitor ordering reference nos.

Rated KVAr	Rated Current (Amps)	Rated capacitance µF (x 3)	Dimension (mm) W1	W2	D	H	Net Weight (kg)	Ordering reference no.	Reference Drawing nos.
VarplusBox Standard Duty Capacitors (SDuty)									
1	1.3	7	115	95	55	117	0.55	MEH_VBSDY_010A44_3	Drawing 10 (Pg-30)
2	2.6	13	115	95	55	148	0.65	MEH_VBSDY_020A44_3	
3	3.9	20	144	125	55	121	0.75	MEH_VBSDY_030A44_3	
4	5.2	27	144	125	55	152	0.95	MEH_VBSDY_040A44_3	
5	6.6	33	144	125	55	152	0.95	MEH_VBSDY_050A44_3	
6	7.9	40	144	125	55	162	1.1	MEH_VBSDY_060A44_3	
7.5	10	50	263	243	97	243	3	MEH_VBSDY_075A44_3	Drawing 1 (Pg-30)
10	13	55	263	243	97	243	3.5	MEH_VBSDY_100A44_3	
12.5	16	69	263	243	97	260	3.6	MEH_VBSDY_125A44_3	
15	20	82	263	243	97	355	4.7	MEH_VBSDY_150A44_3	
20	26	110	263	243	97	355	4.8	MEH_VBSDY_200A44_3	
25	33	137	263	243	97	355	5.1	MEH_VBSDY_250A44_3	
30	39	164	309	289	153	455	7.7	MEH_VBSDY_300A44_3	Drawing 2 (Pg-30)
40	52	219	309	289	153	455	7.8	MEH_VBSDY_400A44_3	
50	66	274	309	289	153	455	8	MEH_VBSDY_500A44_3	
75	98	411	435	280	270	455	21.3	MEH_VBSDY_750A44_3	Drawing 4 (Pg-30)
100	131	548	545	390	270	455	27	MEH_VBSDY_X00A44_3	Drawing 5 (Pg-30)
Varplus Box Heavy Duty Capacitors (HDuty)									
5	6.6	33	263	243	97	243	0.95	MEH_VBHDY_050A44_3	Drawing 1 (Pg-30)
7.5	10	50	263	243	97	243	3	MEH_VBHDY_075A44_3	
10	13	55	263	243	97	355	3.5	MEH_VBHDY_100A44_3	
12.5	16	69	263	243	97	355	3.6	MEH_VBHDY_125A44_3	
15	20	82	263	243	97	355	4.7	MEH_VBHDY_150A44_3	
20	26	110	309	289	153	355	4.8	MEH_VBHDY_200A44_3	
25	33	137	309	289	153	355	5.1	MEH_VBHDY_250A44_3	
30	39	164	309	289	224	497	7.7	MEH_VBHDY_300A44_3	Drawing 2 (Pg-30)
40	52	219	309	289	224	497	7.8	MEH_VBHDY_400A44_3	
50	66	274	309	289	224	497	8	MEH_VBHDY_500A44_3	
75	98	411	625	460	315	455	21.3	MEH_VBHDY_750A44_3	Drawing 4 (Pg-30)
100	131	548	795	630	315	455	27	MEH_VBHDY_X00A44_3	Drawing 5 (Pg-30)
Varplus Box Energy Capacitors (MD-XL)									
5	6.6	33	263	243	97	243	3.5	MEH_VBENY_050A44_3	Drawing 1 (Pg-30)
7.5	10	50	263	243	97	341	4.7	MEH_VBENY_075A44_3	
10	13	55	263	243	97	341	5	MEH_VBENY_100A44_3	
12.5	16	69	263	243	97	355	5.4	MEH_VBENY_125A44_3	
15	20	82	309	289	153	355	8	MEH_VBENY_150A44_3	
20	26	110	309	289	153	355	8.7	MEH_VBENY_200A44_3	
25	33	137	309	289	153	355	9.4	MEH_VBENY_250A44_3	
30	39	164	309	289	224	497	11.3	MEH_VBENY_300A44_3	Drawing 2 (Pg-30)
40	52	219	309	289	224	497	12.2	MEH_VBENY_400A44_3	
50	66	274	309	289	224	497	13	MEH_VBENY_500A44_3	
75	98	411	625	460	315	455	38	MEH_VBENY_750A44_3	Drawing 4 (Pg-30)
100	131	548	795	630	315	455	50	MEH_VBENY_X00A44_3	Drawing 5 (Pg-30)
Varplus Box APP Super Heavy Duty Capacitors (SHDuty)									
5	6.6	33	260	250	123	165	5.3	MEH_VBAPP_050A44_3	Drawing 11 (Pg-30)
7.5	10	50	260	250	123	185	6.4	MEH_VBAPP_075A44_3	
10	13	55	260	250	123	210	7.4	MEH_VBAPP_100A44_3	
12.5	16	69	260	250	123	230	8.6	MEH_VBAPP_125A44_3	
15	20	82	260	250	123	250	9.6	MEH_VBAPP_150A44_3	
20	26	110	383	370	123	250	13.8	MEH_VBAPP_200A44_3	
25	33	137	383	370	123	277	15.8	MEH_VBAPP_250A44_3	
30	39	164	405	230	383	367	28.6	MEH_VBAPP_300A44_3	Drawing 12 (Pg-30)
40	52	219	405	230	383	367	37	MEH_VBAPP_400A44_3	
50	66	274	405	230	383	395	42	MEH_VBAPP_500A44_3	
75	98	411	560	385	383	395	59	MEH_VBAPP_750A44_3	Drawing 13 (Pg-30)
100	131	548	715	540	383	395	77.2	MEH_VBAPP_X00A44_3	Drawing 14 (Pg-30)

Harmonic Capacitors for Detuned Filter application

Reactors have to be associated to capacitor banks for Power Factor Correction in systems with significant non-linear loads, generating harmonics.

Capacitors and reactors are configured in a series resonant circuit, tuned so that the series resonant frequency is below the lowest harmonic frequency present in the system. For this reason, this configuration is usually called "Detuned Capacitor Bank", and the reactors referred as "Detuned Reactors".

The use of detuned reactors thus prevents harmonic resonance problems, avoids the risk of overloading the capacitors and contributes to reducing voltage harmonic distortion in the network.

The tuning frequency can be expressed by the relative impedance of the reactor (in %), or by the tuning order, or directly in Hz.

The most common values of relative impedance are 5.67, 7 and 14%. (14% is used with high level of 3rd harmonic voltages).

Tuning Factor P (%)	Tuning order (Fh/F1)	Tuning frequency @50Hz (Hz)	Tuning frequency @60Hz (Hz)
5.67	4.2	210	252
7	3.8	189	227
14	2.67	134	160

The selection of the tuning frequency of the reactor capacitor depends on multiple factors:

- Presence of zero-sequence harmonics (3, 9, ...),
- Need for reduction of the harmonic distortion level,
- Optimization of the capacitor and reactor components.
- Frequency of ripple control system if any.

To prevent disturbances of the remote control installation, the tuning frequency is to be selected at a lower value than the ripple control frequency.

In Detuned filter application the voltage across the capacitors is higher than the nominal system voltage. Therefore capacitors must be designed to withstand higher voltages.

The presence of series reactor will increase the voltage across the capacitor due to Ferranti effect. Hence, the capacitors used in De-tuned filter application should be designed for higher voltage.

The table provides the details of Capacitor voltage applicable for different tuning factors:

Tuning Factor P (%)	Bus Voltage	Capacitor Voltage
5.67	440	480
7	440	480
14	440	525

VarplusCan Harmonic Capacitors

- Harmonic capacitor is specifically designed to carry wide spectrum of harmonic and fundamental currents without overloading.
- It is designed for higher voltage capacitor to allow increased voltage due to introduction of series reactor.
- The kVAr of the capacitor is suitably designed to deliver the rated kVAr of the filter at the bus voltage.

VarplusCan Harmonic Heavy Duty

For use with detuned reactor
- Non-Linear loads upto 30%
- Switching frequency up to 7000 /year
- Significant Voltage range - 480 / 525 V

VarplusCan Harmonic Gas Filled heavy(GH) duty

For use with detuned reactor
- Non-Linear loads upto 30%
- Switching frequency up to 7000 /year
- Significant Voltage range - 480 / 525 V

Varplus Can Harmonic Energy (MD-XL)

For use with detuned reactor
- Non-Linear loads upto 30%
- Switching frequency up to 10000 /year
- Significant Voltage range - 480 / 525 V

Harmonic Capacitor ordering reference nos.

VarplusCan Harmonic Heavy Duty Capacitors (H Duty)

Network Voltage	Detuning Factor (%)	Detuned Reactor kVAr@440V	Capacitor Dimension (mm) Dia	Height	Harmonic Capacitor ordering reference No.	Reference Drawing Nos.
440V	5.67%	5	63	195	MEH_VCHH1_050A44_3	Drawing A
		7.5	63	195	MEH_VCHH1_075A44_3	
		10	75	203	MEH_VCHH1_100A44_3	Drawing B
		12.5	90	212	MEH_VCHH1_125A44_3	Drawing C
		15	90	212	MEH_VCHH1_150A44_3	
		20	116	212	MEH_VCHH1_200A44_3	Drawing D
		25	136	212	MEH_VCHH1_250A44_3	
		50	136	212	2XMEH_VCHH1_250A44_3	
		75	136	212	3XMEH_VCHH1_250A44_3	
		100	136	212	4XMEH_VCHH1_250A44_3	
440V	7%	5	63	195	MEH_VCHH1_050A44_3	Drawing A
		7.5	63	195	MEH_VCHH1_075A44_3	
		10	75	203	MEH_VCHH1_100A44_3	Drawing B
		12.5	90	212	MEH_VCHGH1_125A44_3	Drawing C
		15	90	212	MEH_VCHH1_150A44_3	
		20	116	212	MEH_VCHH1_200A44_3	Drawing D
		25	136	212	MEH_VCHH1_250A44_3	
		50	136	212	2XMEH_VCHH1_250A44_3	
		75	136	212	3XMEH_VCHH1_250A44_3	
		100	136	212	4XMEH_VCHH1_250A44_3	
440V	14%	5	63	195	MEH_VCHH2_050A44_3	Drawing A
		7.5	63	195	MEH_VCHH2_075A44_3	
		10	90	212	MEH_VCHH2_100A44_3	Drawing C
		12.5	90	212	MEH_VCHH2_125A44_3	
		15	116	212	MEH_VCHH2_150A44_3	Drawing D
		20	116	212	MEH_VCHH2_200A44_3	
		25	136	212	MEH_VCHH2_250A44_3	
		50	136	212	2XMEH_VCHH2_250A44_3	
		75	136	212	3XMEH_VCHH2_250A44_3	
		100	136	212	4XMEH_VCHH2_250A44_3	

VarplusCan Harmonic Gas Filled Heavy Duty Capacitors (GH Duty)

Network Voltage	Detuning Factor (%)	Detuned Reactor kVAr@440V	Capacitor Dimension Dia	Height	Harmonic Capacitor ordering reference No.	Reference Drawing Nos.
440V	5.67%	5	63	195	MEH_VCGH1_050A44_3	Drawing A
		7.5	63	195	MEH_VCGH1_075A44_3	
		10	75	203	MEH_VCGH1_100A44_3	Drawing B
		12.5	90	212	MEH_VCGH1_125A44_3	Drawing C
		15	90	212	MEH_VCGH1_150A44_3	
		20	116	212	MEH_VCGH1_200A44_3	Drawing D
		25	136	212	MEH_VCGH1_250A44_3	
		50	136	212	2XMEH_VCGH1_250A44_3	
		75	136	212	3XMEH_VCGH1_250A44_3	
		100	136	212	4XMEH_VCGH1_250A44_3	
440V	7%	5	63	195	MEH_VCGH1_050A44_3	Drawing A
		7.5	63	195	MEH_VCGH1_075A44_3	
		10	75	203	MEH_VCGH1_100A44_3	Drawing B
		12.5	90	212	MEH_VCGH1_125A44_3	Drawing C
		15	90	212	MEH_VCGH1_150A44_3	
		20	116	212	MEH_VCGH1_200A44_3	Drawing D
		25	136	212	MEH_VCGH1_250A44_3	
		50	136	212	2XMEH_VCGH1_250A44_3	
		75	136	212	3XMEH_VCGH1_250A44_3	
		100	136	212	4XMEH_VCGH1_250A44_3	
440V	14%	5	63	195	MEH_VCGH2_050A44_3	Drawing A
		7.5	63	195	MEH_VCGH2_075A44_3	
		10	90	212	MEH_VCGH2_100A44_3	Drawing C
		12.5	90	212	MEH_VCGH2_125A44_3	
		15	116	212	MEH_VCGH2_150A44_3	Drawing D
		20	116	212	MEH_VCGH2_200A44_3	
		25	136	212	MEH_VCGH2_250A44_3	
		50	136	212	2XMEH_VCGH2_250A44_3	
		75	136	212	3XMEH_VCGH2_250A44_3	
		100	136	212	4XMEH_VCGH2_250A44_3	

Varplus Can Harmonic Energy Capacitor (MD-XL)

Network Voltage	Detuning Factor (%)	Detuned Reactor kVAr@440V	Capacitor Dimension Dia	Capacitor Dimension Height	Harmonic Capacitor ordering reference No.	Reference Drawing Nos.
440V	5.67%	5	75	203	MEH_VCEH1_050A44_3	Drawing B
		7.5	75	278	MEH_VCEH1_075A44_3	
		10	90	278	MEH_VCEH1_100A44_3	Drawing C
		12.5	90	278	MEH_VCEH1_100A44_3	
		15	116	278	MEH_VCEH1_150A44_3	Drawing E
440V	7%	5	75	203	MEH_VCEH1_050A44_3	Drawing B
		7.5	75	278	MEH_VCEH1_075A44_3	
		10	90	278	MEH_VCEH1_100A44_3	Drawing C
		12.5	90	278	MEH_VCEH1_125A44_3	
		15	116	278	MEH_VCEH1_150A44_3	Drawing E
440V	14%	5	75	278	MEH_VCEH2_050A44_3	Drawing C
		7.5	75	278	MEH_VCEH2_075A44_3	
		10	90	278	MEH_VCEH2_100A44_3	
		12.5	116	278	MEH_VCEH2_125A44_3	Drawing E
		15	116	278	MEH_VCEH2_150A44_3	

VarplusBox Harmonic Capacitors

VarplusBox Harmonic Heavy Duty Capacitors (Hduty)

For use with detuned reactor

- Non-Linear loads upto 30%
- Switching frequency up to 7000 /year
- Significant Voltage range - 480 / 525 V

Varplus Box Harmonic Energy Capacitors (MD-XL)

For use with detuned reactor

- Non-Linear loads upto 40%
- Switching frequency up to 10000 /year
- Significant Voltage range - 480 / 525 V

VarplusBox Harmonic
APP Super Heavy Duty Capacitor (SHDuty)

For use with detuned reactor

- Non-Linear loads upto 35%
- Switching frequency up to 8000 /year
- Significant Voltage range - 480 / 525 V

Harmonic Capacitor ordering reference nos.

Varplus Box Harmonic Heavy Duty Capacitors (HDuty)

Network Voltage	Detuning Factor (%)	Detuned Reactor kVAr@440V	Capacitor Dimension (mm) W1	W2	D	H	Harmonic Capacitor ordering reference No.	Reference Drawing Nos.
440V	5.67%	5	263	243	97	260	MEH_VBHH1_050A44_3	Drawing 1
		7.5	263	243	97	341	MEH_VBHH1_075A44_3	
		10	263	243	97	355	MEH_VBHH1_100A44_3	
		12.5	263	243	97	355	MEH_VBHH1_125A44_3	
		15	309	289	153	355	MEH_VBHH1_150A44_3	Drawing 2
		20	309	289	153	355	MEH_VBHH1_200A44_3	
		25	309	289	153	355	MEH_VBHH1_250A44_3	
		50	309	289	153	355	2XMEH_VBHH1_250A44_3	
		75	309	289	153	355	3XMEH_VBHH1_250A44_3	
		100	309	289	153	355	4XMEH_VBHH1_250A44_3	
440V	7%	5	263	243	97	260	MEH_VBHH1_050A44_3	Drawing 1
		7.5	263	243	97	341	MEH_VBHH1_075A44_3	
		10	263	243	97	355	MEH_VBHH1_100A44_3	
		12.5	263	243	97	355	MEH_VBHH1_125A44_3	
		15	309	289	153	355	MEH_VBHH1_150A44_3	Drawing 2
		20	309	289	153	355	MEH_VBHH1_200A44_3	
		25	309	289	153	355	MEH_VBHH1_250A44_3	
		50	309	289	153	355	2XMEH_VBHH1_250A44_3	
		75	309	289	153	355	3XMEH_VBHH1_250A44_3	
		100	309	289	153	355	4XMEH_VBHH1_250A44_3	
440V	14%	5	263	243	97	260	MEH_VBHH2_050A44_3	Drawing 1
		7.5	263	243	97	341	MEH_VBHH2_075A44_3	
		10	263	243	97	355	MEH_VBHH2_100A44_3	
		12.5	309	289	97	355	MEH_VBHH2_125A44_3	Drawing 2
		15	309	289	153	355	MEH_VBHH2_150A44_3	
		20	309	289	153	355	MEH_VBHH2_200A44_3	
		25	309	289	153	355	MEH_VBHH2_250A44_3	
		50	309	289	224	497	MEH_VBHH2_500A44_3	
		75	309	289	153	355	3XMEH_VBHH2_250A44_3	
		100	309	289	153	355	4XMEH_VBHH2_250A44_3	

Varplus Box Harmonic Energy Capacitors (MD-XL)

Network Voltage	Detuning Factor (%)	Detuned Reactor kVAr@440V	Capacitor Dimension (mm) W1	W2	D	H	Harmonic Capacitor ordering reference No.	Reference Drawing Nos.
440V	5.67%	5	263	243	97	260	MEH_VBEH1_050A44_3	Drawing 1
		7.5	263	243	97	341	MEH_VBEH1_075A44_3	
		10	263	243	97	355	MEH_VBEH1_100A44_3	
		12.5	263	243	97	355	MEH_VBEH1_125A44_3	
		15	309	289	153	355	MEH_VBEH1_150A44_3	Drawing 2
		20	309	289	153	355	MEH_VBEH1_200A44_3	
		25	309	289	153	355	MEH_VBEH1_250A44_3	
		50	309	289	224	497	MEH_VBEH1_500A44_3	
		75	309	289	153	355	3XMEH_VBEH1_250A44_3	
		100	309	289	153	355	4XMEH_VBEH1_250A44_3	
440V	7%	5	263	243	97	260	MEH_VBEH1_050A44_3	Drawing 1
		7.5	263	243	97	341	MEH_VBEH1_075A44_3	
		10	263	243	97	355	MEH_VBEH1_100A44_3	
		12.5	263	243	97	355	MEH_VBEH1_125A44_3	
		15	309	289	153	355	MEH_VBEH1_150A44_3	Drawing 2
		20	309	289	153	355	MEH_VBEH1_200A44_3	
		25	309	289	153	355	MEH_VBEH1_250A44_3	
		50	309	289	224	497	MEH_VEHH1_500A44_3	
		75	309	289	153	355	3XMEH_VBEH1_250A44_3	
		100	309	289	153	355	4XMEH_VBEH1_250A44_3	
440V	14%	5	263	243	97	260	MEH_VBEH2_050A44_3	Drawing 1
		7.5	263	243	97	341	MEH_VBEH2_075A44_3	
		10	263	243	97	355	MEH_VBEH2_100A44_3	
		12.5	309	289	97	355	MEH_VBEH2_125A44_3	Drawing 2
		15	309	289	153	355	MEH_VBEH2_150A44_3	
		20	309	289	153	355	MEH_VBEH2_200A44_3	
		25	309	289	153	355	MEH_VBEH2_250A44_3	
		50	309	289	153	355	2XMEH_VBEH2_250A44_3	
		75	309	289	153	355	3XMEH_VBEH2_250A44_3	
		100	309	289	153	355	4XMEH_VBEH2_250A44_3	

VarplusBox Harmonic APP Super Heavy Duty Capacitor (SHDuty)

Network Voltage	Detuning Factor (%)	Detuned Reactor kVAr@440V	Capacitor Dimension (mm) W1	W2	D	H	Harmonic Capacitor ordering reference No.	Reference Drawing Nos.
440V	5.67%	5	383	370	123	160	MEH_VBAH1_050A44_3	Drawing 11
		7.5	383	370	123	170	MEH_VBAH1_075A44_3	
		10	383	370	123	190	MEH_VBAH1_100A44_3	
		12.5	383	370	123	205	MEH_VBAH1_125A44_3	
		15	383	370	123	220	MEH_VBAH1_150A44_3	
		20	383	370	123	255	MEH_VBAH1_200A44_3	
		25	383	370	123	285	MEH_VBAH1_250A44_3	
		50	383	370	123	285	2XMEH_VBAH1_250A44_3	
		75	383	370	123	285	3XMEH_VBAH1_250A44_3	
		100	383	370	123	285	4XMEH_VBAH1_250A44_3	
440V	7%	5	383	370	123	160	MEH_VBAH1_050A44_3	Drawing 11
		7.5	383	370	123	170	MEH_VBAH1_075A44_3	
		10	383	370	123	190	MEH_VBAH1_100A44_3	
		12.5	383	370	123	205	MEH_VBAH1_125A44_3	
		15	383	370	123	220	MEH_VBAH1_150A44_3	
		20	383	370	123	255	MEH_VBAH1_200A44_3	
		25	383	370	123	285	MEH_VBAH1_250A44_3	
		50	383	370	123	285	2XMEH_VBAH1_250A44_3	
		75	383	370	123	285	3XMEH_VBAH1_250A44_3	
		100	383	370	123	285	4XMEH_VBAH1_250A44_3	
440V	14%	5	383	370	123	170	MEH_VBAH2_050A44_3	Drawing 11
		7.5	383	370	123	180	MEH_VBAH2_075A44_3	
		10	383	370	123	210	MEH_VBAH2_100A44_3	
		12.5	383	370	123	230	MEH_VBAH2_125A44_3	
		15	383	370	123	255	MEH_VBAH2_150A44_3	
		20	383	370	123	295	MEH_VBAH2_200A44_3	
		25	383	370	123	335	MEH_VBAH2_250A44_3	
		50	383	370	123	335	2XMEH_VBAH2_250A44_3	
		75	383	370	123	335	3XMEH_VBAH2_250A44_3	
		100	383	370	123	335	4XMEH_VBAH2_250A44_3	

Detuned Reactors

The detuned reactors (DR) are designed to mitigate harmonics, improve power factor and avoid electrical resonance in low voltage electrical networks.

Technical Details

Standards	IEC 60076-6, IS 5553
Description	Three phase, dry, magnetic circuit, impregnated
Rated voltage	440V, 50Hz (Other voltages on request)
De-tuning order	5.67% (210 Hz), 7% (189 Hz), 14%(134Hz)
Insulation class	F / H
Inductance tolerance per phase	± 3 %
Harmonic Levels	$U_3 = 0.5\% \times U_n$ $U_5 = 6.0\% \times U_n$ $U_7 = 5.0\% \times U_n$ $U_{11} = 3.5\% \times U_n$ $U_{13} = 3.0\% \times U_n$
Fundamental Current (Max)	$I_1 = 1.06 \times In$ (rated capacitor current)
Duty cycle (Irms)	100%
Limit of Linearity	$L \geq 0.95 \times L_N$ upto $1.74 \times I_1$
Insulation level	1.1 kV
Dielectric test 50Hz between windings and windings/earth	4.3 kV, 1 min
Degree of protection	IP00
Thermal protection	Restored on terminal block 250 V AC, 2 A

Operating conditions

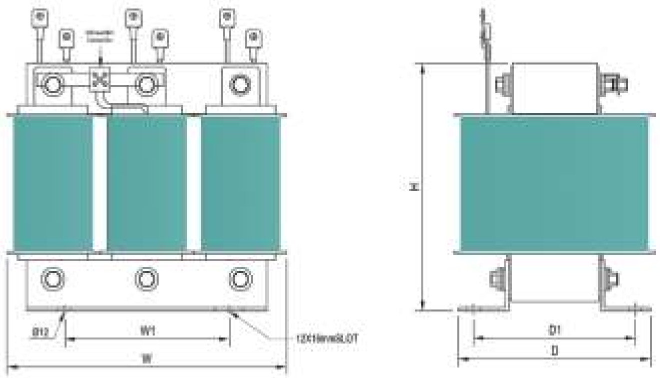
- Indoor application
- Storage temperature: - 40°C, + 60°C
- Relative humidity in operation: 20- 80%
- Saline mist withstand: 250 hours
- Operating temperature / Altitude:
  ≤1000 m:
  Min = 0°C, Max=55°C,
  highest average over 1 year= 40°C, 24 hours = 50°C ≤2000 m:
  Min = 0°C, Max = 50°C,
  highest average over 1 year= 35°C, 24hours = 45°C

Installation guidelines

- Forced ventilation required
- Vertical detuned reactor winding for better heat dissipation
- Electrical connection:
- to a screw terminal block for 6.25 and 12.5 kVAr detuned reactors
- to a drilled pad for 25, 50 and 100 kVAr detuned reactors
- As the detuned reactor is fitted with thermal protection, the normally closed dry contact must be used to disconnect the step in the event of overheating.

- As per IEC 61642 :1997 ,clause no 3.3 guide line

Typically, reactors cannot be added to existing capacitors to make a detuned filter as the installed capacitors may not be rated for the additional voltage and/or current caused by the added series reactor. Normally, a power factor correction installation having series reactors shall not be mixed with equipment with out series reactor. Care should also be taken when a detuned filter is extended by equipment having a different tuning frequency. In both cases problems can occur due to unequal sharing of harmonic load and possible overloading of one filter or part of it.



Detuned Reactor ordering reference nos.

Tuning factor (%)	kvar	Inductance (mH) x 3	I_N A	W (mm)	W1 (mm)	D (mm)	D1 (mm)	H (mm)	Weight (kg)	Reactor ordering reference no.
5.67% Fr= 210 Hz	5	7.4	18.4	203	145	110	86	142	7	MEH_VDR_050_05_A44
	7.5	4.94	12.5	203	145	110	86	142	7.8	MEH_VDR_075_05_A44
	10	3.7	16.7	203	145	110	86	142	9	MEH_VDR_100_05_A44
	12.5	2.96	20.9	234	145	110	86	203	10	MEH_VDR_125_05_A44
	15	2.47	25.1	234	145	110	86	203	10.5	MEH_VDR_150_05_A44
	20	1.85	33.4	234	145	130	106	183	13	MEH_VDR_200_05_A44
	25	1.48	41.8	234	145	130	106	183	15	MEH_VDR_250_05_A44
	50	0.741	83.6	350	220	150	126	243	35	MEH_VDR_500_05_A44
	75	0.494	125.4	410	220	215	191	248	84	MEH_VDR_750_05_A44
	100	0.37	167.2	410	220	215	191	248	85	MEH_VDR_X00_05_A44
7% Fr = 189Hz	5	9.28	7.4	203	145	110	86	142	7	MEH_VDR_050_07_A44
	7.5	6.19	11.2	203	145	110	86	142	8	MEH_VDR_075_07_A44
	10	4.64	14.9	203	145	110	86	142	8.5	MEH_VDR_100_07_A44
	12.5	3.71	18.6	234	145	110	86	203	9.8	MEH_VDR_125_07_A44
	15	3.09	22.3	234	145	110	86	203	10.5	MEH_VDR_150_07_A44
	20	2.32	29.7	234	145	130	106	183	14.9	MEH_VDR_200_07_A44
	25	1.86	37.2	234	145	130	106	183	15.5	MEH_VDR_250_07_A44
	50	0.928	74.4	234	145	180	156	203	30	MEH_VDR_500_07_A44
	75	0.618	111.5	350	220	167	143	222	43	MEH_VDR_750_07_A44
	100	0.464	148.7	350	220	172	148	222	48	MEH_VDR_X00_07_A44
14% Fr= 134 Hz	5	20.6	7	234	145	116	92	203	9.5	MEH_VDR_050_14_A44
	7.5	13.38	10.5	234	145	116	92	203	11	MEH_VDR_075_14_A44
	10	10.03	14	234	145	116	92	203	12	MEH_VDR_100_14_A44
	12.5	8.03	17.5	234	145	116	92	203	13	MEH_VDR_125_14_A44
	15	6.69	21	234	145	116	92	203	14.2	MEH_VDR_150_14_A44
	20	5.02	28	234	145	185	161	183	30	MEH_VDR_200_14_A44
	25	4.01	35	234	145	185	161	183	29	MEH_VDR_250_14_A44
	50	2.01	70.1	234	145	174	150	203	35	MEH_VDR_500_14_A44
	75	1.34	105.1	350	220	207	183	243	67	MEH_VDR_750_14_A44
	100	1	140.1	350	220	212	188	243	77	MEH_VDR_X00_14_A44

Other voltage Detuned reactor on request :625, 690 & 800V,

Power Factor Controller

Varlogic Series

The Varlogic controllers permanently monitor the reactive power of the installation and control the connection and disconnection of capacitor steps in order to obtain the targeted power factor

RT6

Advanced Features

- Analyses and provides information on network characteristics
- Controls the reactive power required to obtain the target power factor.
- Monitors and provides information on equipment status.
- Communicates on the Modbus network (Varlogic NRC12)

General characteristics

Output relays:

AC: 5A / 120V, 2A / 250V, 1A / 400V
DC: 0.3A / 110V, 0.6A / 60V, 2A / 24V

Protection Index

Front panel: IP41
Rear: IP20

NR6 / 12

Measuring current: 0 ... 5A

Installation guidelines

- Forced ventilation required
- Vertical detuned reactor winding for better heat dissipation
- Electrical connection:
  to a screw terminal block for 6.25 and 12.5 kVAr detuned reactors
  to a drilled pad for 25, 50 and 100 kVAr detuned reactors

As the detuned reactor is fitted with thermal protection, the normally closed dry contact must be used to disconnect the step in the event of overheating.

As per IEC 61642 :1997 ,clause no 3.3 guide line

Typically, reactors cannot be added to existing capacitors to make a detuned filter as the installed capacitors may not be rated for the additional voltage and/or current caused by the added series reactor.

NRC12

Normally, a power factor correction installation having series reactors shall not be mixed with equipment with out series reactor. Care should also be taken when a detuned filter is extended by equipment having a different tuning frequency. In both cases problems can occur due to unequal sharing of harmonic load and possible overloading of one filter or part of it.

Technical Characteristics

Features	RT6	NR-6/12	NRC12
Number of steps	6	12-Jun	12
Supply voltage (V AC) 50 / 60Hz	 185 ... 265 320 ... 460	88 ... 130 185 ... 265 320 ... 460	88 ... 130 185 ... 265 320 ... 460
Display ● 4 digit 7 segment LEDs ● 65 x 21 mm backlighted screen ● 55 x 28 mm backlighted screen	 • 	 • 	 •
Dimensions	143x143x67	155x158x70	155x158x80
Flush panel mounting 35 mm DIN rail mounting (EN 50022)	• 	• •	• •
Operating temperature	0°C – 55°C	0°C – 60°C	0°C – 60°C
Alarm contact			•
Internal temperature probe			•
Separate fan relay contact		•	•
Alarm history		5 last alarms	5 last alarms
Type of connection: ● phase-to-neutral ● phase-to-phase	 •	 • •	 • •
Current input: ● CT... 10000/5 A ● CT 25/5A ... 6000/5A ● CT 25/1A ... 6000/5A	 • 	 • 	 • •
Target cosϕ setting: ● 0.85 ind. ... 1 ● 0.85 ind. ...0.9 cap.	 • 	 •	 •
Possibility of a dual cosϕ target			•
Accuracy			
Response delay time:	10 ... 1800 sec.		
Reconnection delay time: ● 10 ... 1800 s ● 10 ... 600 s ● 10 ... 900 s	 • 	 • 	 •
Step configuration programming: ● Fixed ● Auto ● Disconnected			 •
4-quadrant operation for generator application			•
Alarms ● Over voltage ● Over compensation ● Under compensation ● Under current ● Faulty bank			

Ordering Reference Nos.

Type	No. of Stages	Ordering Reference no.
RT6	6	51207
NR6	6	52448
NR12	12	52449
NRC12	12	52450
RT8	8	
RT12	12	

Thyristor switch

When highly fluctuating loads are present in the system, such as lifts, crushers, welders, etc., Power Factor Correction requires a frequent and fast switching of capacitor banks.

With conventional switching devices such as contactors, this would lead to repetitive surge-current and over-voltage every time the capacitor bank is switched on. Frequent switching would allow enough time for the capacitor to discharge, which would create additional and unacceptable stress.

Thyristor modules are proposed for switching capacitors without transient inrush currents, normally associated with the electro mechanical contactor switching. An unlimited number of connections are made possible, without applying significant stress to the capacitors.

Main features

Rated voltage : 3 phase 440V AC 50 Hz
Capacitor ratings : 5 - 10 - 12.5 - 15 - 20 – 25 - 30 - 50 - 60 kVAr. Other ratings are available on request.
Control supply : 240 V ± 10% at 50 Hz, 7 VA. Other voltages are available on request.
Command input voltage : Separate terminals provided for 10-30V DC or 240 V AC or potential free contact.

Cooling fan will start running only when the command signal is made available to the switch. During idle conditions of the switch the fan will not run, thus avoiding power losses.

There is a fault indication for over current and over temperature.

There are six LED indications and one control push button, provided in the front facia of the module, to enable the user to observe the operating conditions of the switch and to reset /restart the switch after a fault condition is cleared.

Optional provision has been made to switch on a contactor to bypass the Thyristor switch, once the switching cycle is complete. This provision is made to avoid power losses whenever the switch is on.

Six terminals provided for through power wiring for convenience of panel-builder.

Horizontal or vertical mounting is possible.

Supply and Capacitor connections may be connected to either end.

Thyristor switch ordering reference nos.

Rated kVAr	Rated Current (Amps)	Dimension (mm) W	D	H	Net Weight (kg)	Thyristor switch ordering reference no.	Reference Drawing Nos.
5	6.6	145	265	228	6.1	MEH_VTS_050_440_3	Drawing
7.5	10	145	265	228	6.1	MEH_VTS_075_440_3	
10	13	145	265	228	6.1	MEH_VTS_100_440_3	
12.5	16	145	265	228	6.1	MEH_VTS_125_440_3	
15	20	145	265	228	6.1	MEH_VTS_150_440_3	
20	26	145	265	228	6.5	MEH_VTS_200_440_3	
25	33	145	265	228	6.5	MEH_VTS_250_440_3	
50	66	145	265	228	6.5	MEH_VTS_500_440_3	
60	79	145	265	228	6.5	MEH_VTS_600_440_3	

Contactors

Special contactors LC1 D•K are designed for switching 3-phase, single or multiple-step capacitor banks. They conform to standards IEC 60070 and 60831, NFC 54-100, VDE 0560, UL and CSA.

These contactors are fitted with a block of early make poles and damping resistors, limiting the value of the current on closing to 60 IN max. This current limitation increases the life of all the components of the installation, in particular that of the fuses and capacitors.

Ordering Reference Nos.

Voltage	kVAr	Contactor Ordering reference no.
440V 50 Hz	12.5	LC1DFK11**
	16.7	LC1DGK11**
	20	LC1DLK11**
	25	LC1DMK11**C
	33.3	LC1DPK12**C
	40	LC1DTK12**C
	60	LC1DWK12**C

*.Other voltages are available on request 400, 660, 690V contactor
** COIL Voltage cod

Voltage	110	220	415
LC1-DFK..... DMK50/60HZ	F7	M7	N7
LC1-DPK...... DWK50HZ	F5	M5	N5

Reference Number Structure

Capacitors

```
MEH_VBSDY_125A44_3
    1  2    3 4 5 6
```

1. Construction
   B= Box
   C= Can

2. Range
   SDY Duty
   HDY Duty
   HGY Duty
   ENY Energy
   APP SHD
   HH1 Harmonic HDuty 5.67 or 7%
   HH2 Harmonic HDuty 14%
   HE1 Harmonic Energy 5.67 or 7%
   HE2 Harmonic Energy 14%
3. kVAr range
   Example:
   125 = 12.5 kvar
   X00 = 100 kvar
4. Frequency
   A = 50Hz
   B = 60Hz
5. Voltage
   Example:
   44 = 440V

6. Number of phases
   1 = single phase
   3 = three-phase

Detuned reactors

```
MEH_VDR_250_05_A44
         1   2  3 4
```

1. kVAr
   Example:
   25 = 25 kvar
   X00= 100 kvar

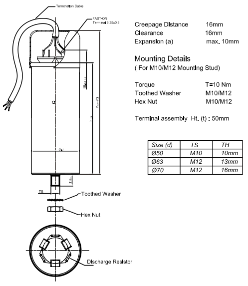
2. Tuning
   05 = 5%
   07 = 7%
   14 = 14%

3. Frequency
   A = 50Hz
   B = 60Hz

4. Voltage
   Example:
   44 = 440V

Mechanical characteristics

Drawing A - Three Phase, Cylindrical Capacitor

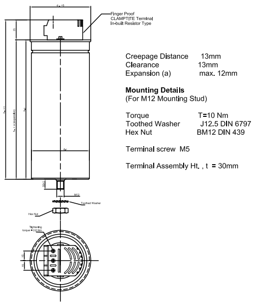


General details	
Creepage distance:	13 mm
Clearance:	13 mm
Expansion (a):	12 mm max.
Maximum Height:	h+t+a

Details for M12 Mounting stud	
Tightening torque:	10Nm
Toothed washer:	J12,5 DIN6797
Hex Nut:	BM12 DIN 439

Details for terminal block	
Screw type:	M5
Assembly Ht (t):	30mm
Tightening torque:	2,5 Nm

Drawing B - Three Phase, Cylindrical Capacitor

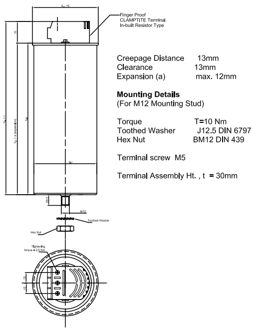


General details	
Creepage distance:	13 mm
Clearance:	13 mm
Expansion (a):	12 mm max.
Maximum Height:	h+t+a

Details for M12 Mounting stud	
Tightening torque:	10Nm
Toothed washer:	J12,5 DIN6797
Hex Nut:	BM12 DIN 439

Details for terminal block	
Screw type:	M5
Assembly Ht (t):	30mm
Tightening torque:	2,5 Nm

Drawing C - Three Phase, Cylindrical Capacitor

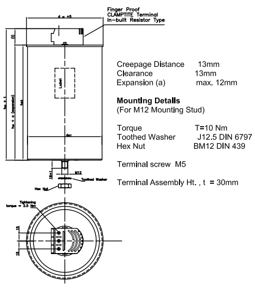


General details	
Creepage distance:	13 mm
Clearance:	13 mm
Expansion (a):	12 mm max.
Maximum Height:	h+t+a

Details for M12 Mounting stud	
Tightening torque:	10Nm
Toothed washer:	J12,5 DIN6797
Hex Nut:	BM12 DIN 439

Details for terminal block	
Screw type:	M5
Assembly Ht (t):	30mm
Tightening torque:	2,5 Nm

Drawing D - Three Phase, Cylindrical Capacitor

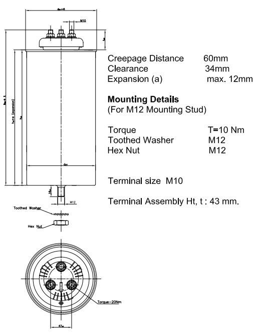


General details	
Creepage distance:	13 mm
Clearance:	13 mm
Expansion (a):	12 mm max.
Maximum Height:	h+t+a

Details for M12 Mounting stud	
Tightening torque:	10Nm
Toothed washer:	J12,5 DIN6797
Hex Nut:	BM12 DIN 439

Details for terminal block	
Screw type:	M5
Assembly Ht (t):	30mm
Tightening torque:	2,5 Nm

Drawing E - Three Phase, Cylindrical Capacitor



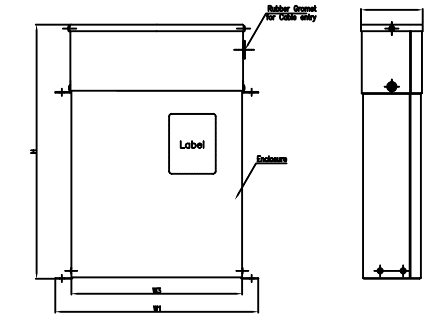
General details	
Creepage distance:	13 mm
Clearance:	13 mm
Expansion (a):	12 mm max.
Maximum Height:	h+t+a

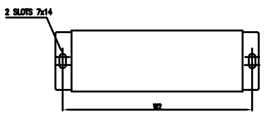
Details for M12 Mounting stud	
Tightening torque:	10Nm
Toothed washer:	J12,5 DIN6797
Hex Nut:	BM12 DIN 439

Details for terminal block	
Screw type:	M5
Assembly Ht (t):	30mm
Tightening torque:	2,5 Nm

Mechanical characteristics

Drawing 1 - Three Phase, Rectangular Capacitor



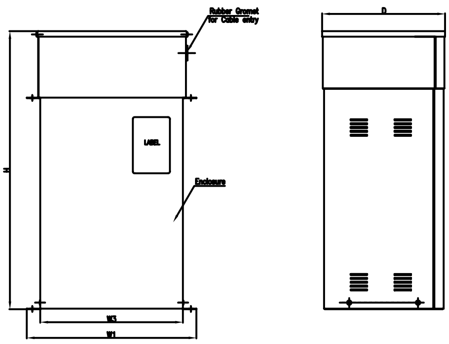


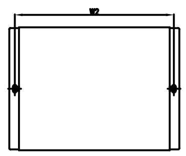
Creepage Distance : 30 mm

Clearance
Phase to Phase : 25 mm (min).
Phase to Earth : 19 mm (min).

Mounting Details
Mounting screw M6 , 2 Nos.

Drawing 2 - Three Phase, Rectangular Capacitor



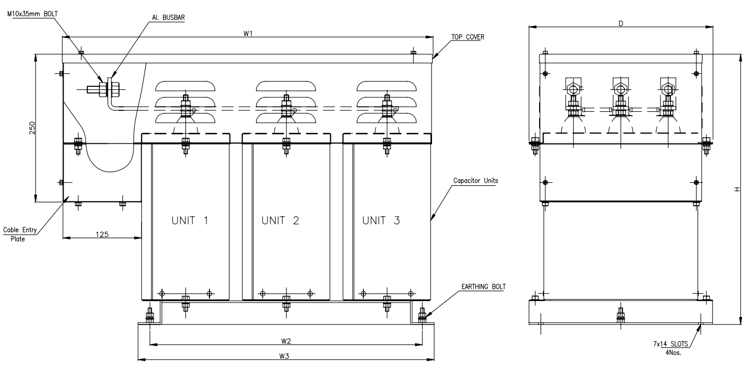


Creepage Distance : 30 mm

Clearance
Phase to Phase : 25 mm (min).
Phase to Earth : 19 mm (min).

Mounting Details
Mounting screw M6 , 2 Nos.

Drawing 2 - Three Phase, Rectangular Capacitor Bank

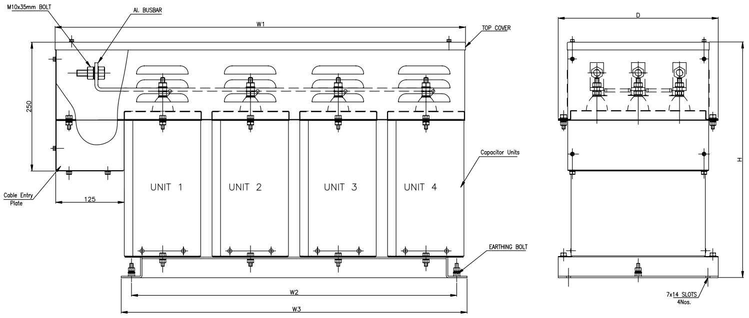


Creepage Distance : 30 mm

Clearance
Phase to Phase : 25 mm (min).
Phase to Earth : 19 mm (min).

Mounting Details
Mounting screw M6 , 4 Nos.

Drawing 5 - Three Phase, Rectangular Capacitor Bank (Four Unit)



Creepage Distance : 30 mm

Clearance
Phase to Phase : 25 mm (min).
Phase to Earth : 19 mm (min).

Mounting Details
Mounting screw M6 , 4 Nos.

Drawing 10 - Three Phase, Rectangular Capacitor