

# Reactive Power Management Products





## About Us

Larsen & Toubro is a technology-driven company that infuses engineering with imagination. The Company offers a wide range of advanced solutions in the field of Engineering, Construction, Electrical & Automation, Machinery and Information Technology.

L&T Switchgear, a part of the Electrical & Automation business, is India's largest manufacturer of low voltage switchgear, with the scale, sophistication and range to meet global benchmarks. With over five decades of experience in this field, the Company today enjoys a leadership position in the Indian market with a growing international presence.

It offers a complete range of products including powergear, controlgear, industrial automation, building electricals & automation, reactive power management, energy meters, and protective relays. These products conform to Indian and International Standards.



Switchgear Factory, Mumbai



Switchgear Factory, Ahmednagar



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# Reactive Power Management Solutions



**Power Capacitors**



**Reactors**



**Thyristor Switching Modules**



**Capacitor Duty Contactors**



**MCBs**



**MCCBs**



**APFC Relays**



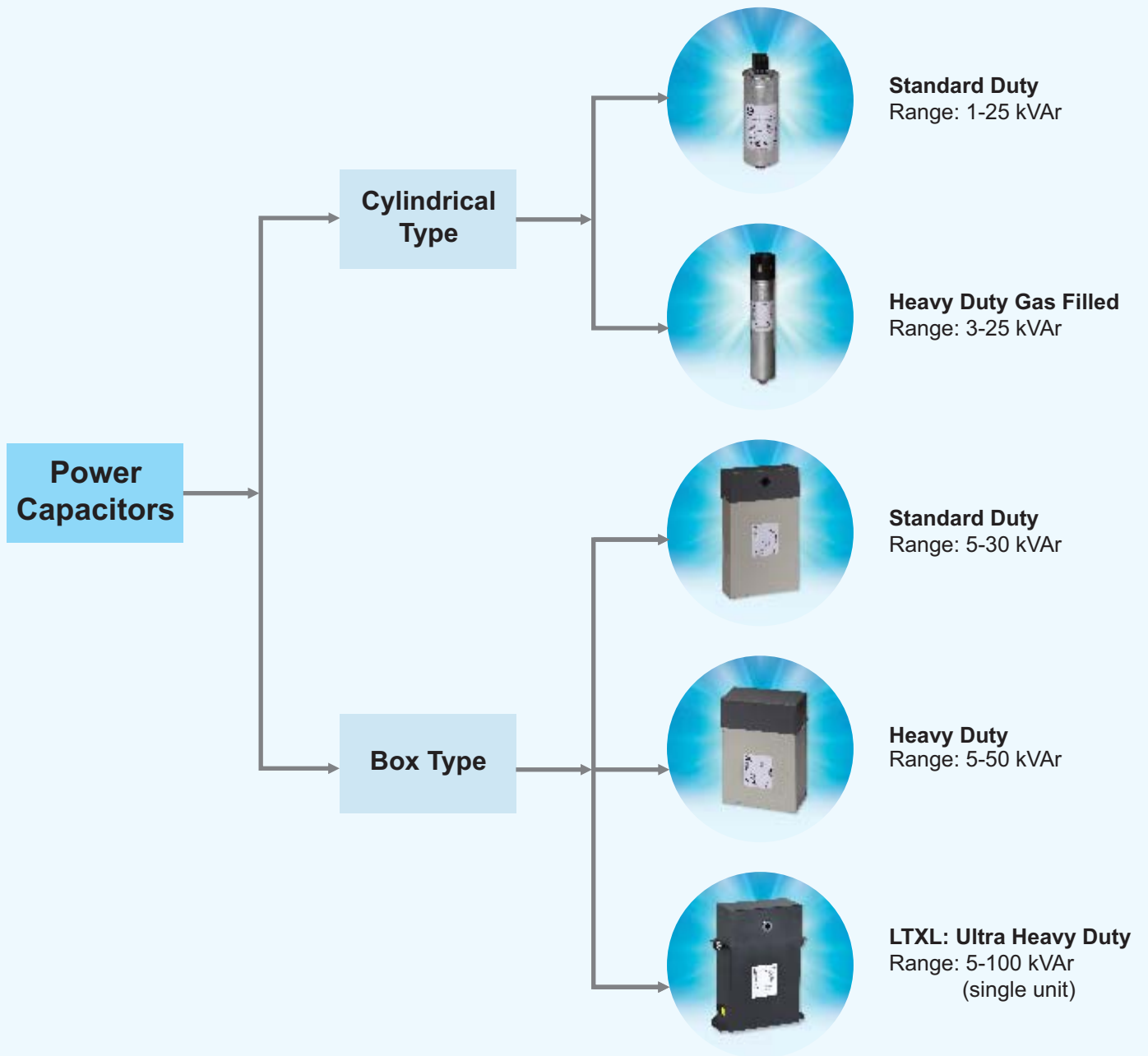
**Indicating Devices**



**Wires**



# Reactive Power Management Products



**Detuned Harmonics Filter Reactors**  
(5-100 kVAR)



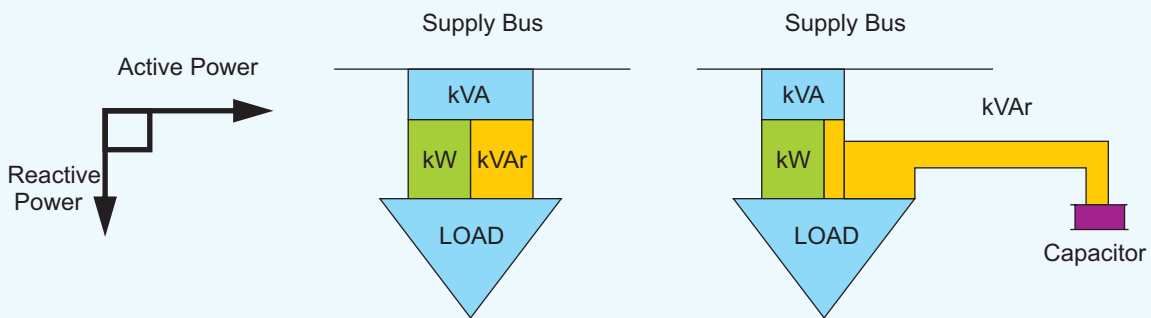
**Thyristor Switching Modules**  
(10-50 kVAR)



**APFC Panels**

# Principles of Power Factor Correction

A vast majority of electrical loads in low voltage industrial installations are inductive in nature. Typical examples are motors, transformers, drives & fluorescent lighting. Such loads consume both active and reactive power. The active power is used by the load to meet its real output requirements whereas reactive power is used by the load to meet its magnetic field requirements. The reactive power (inductive) is always 90° lagging with respect to active power as shown in figure 1. Figure 2 & 3 show the flow of kW, kVA and kVA in a network.



**Figure 1:**  
Phase relationship  
between Active and  
Reactive Power

**Figure 2:**  
Network without Capacitor

**Figure 3:**  
Network with Capacitor

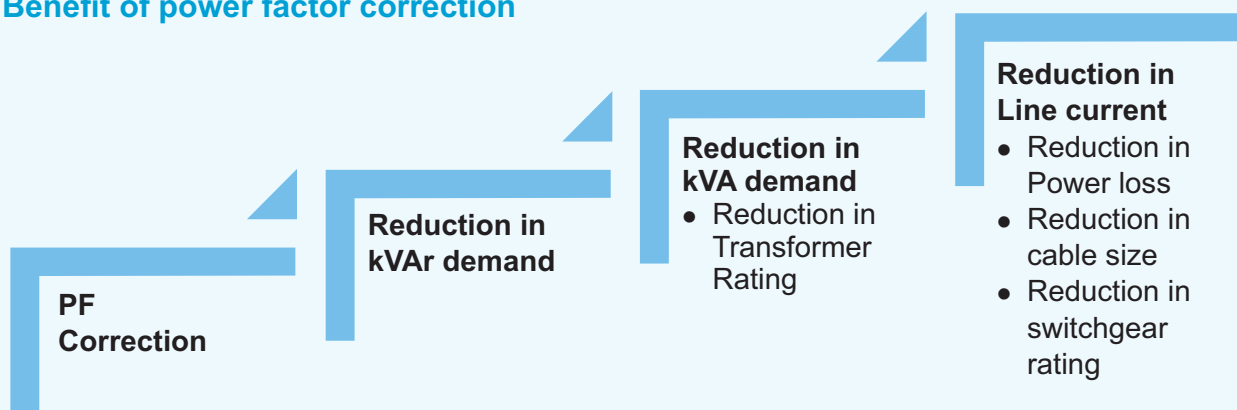
Flow of active and reactive power always takes place in electrical installations. This means that the supply system has to be capable of supplying both active and reactive power. The supply of reactive power from the system results in reduced installation efficiency due to:

- Increased current flow for a given load
- Higher voltage drops in the system
- Increase in losses of transformers, switchgear and cables
- Higher kVA demand from supply system as given in figure 2
- Higher electricity cost due to levy of penalties / loss of incentives

It is therefore necessary to reduce & manage the flow of reactive power to achieve higher efficiency of the electrical system and reduction in cost of electricity consumed.

The most cost effective method of reducing and managing reactive power is by power factor improvement through **Power Capacitors**. The concept of reduction in kVA demand from the system is shown in figure 3.

## Benefit of power factor correction



**PF  
Correction**

**Reduction in  
kVAr demand**

**Reduction in  
kVA demand**

- Reduction in  
Transformer  
Rating

**Reduction in  
Line current**

- Reduction in  
Power loss
- Reduction in  
cable size
- Reduction in  
switchgear  
rating

## Selection of Capacitor - 5 Step Approach

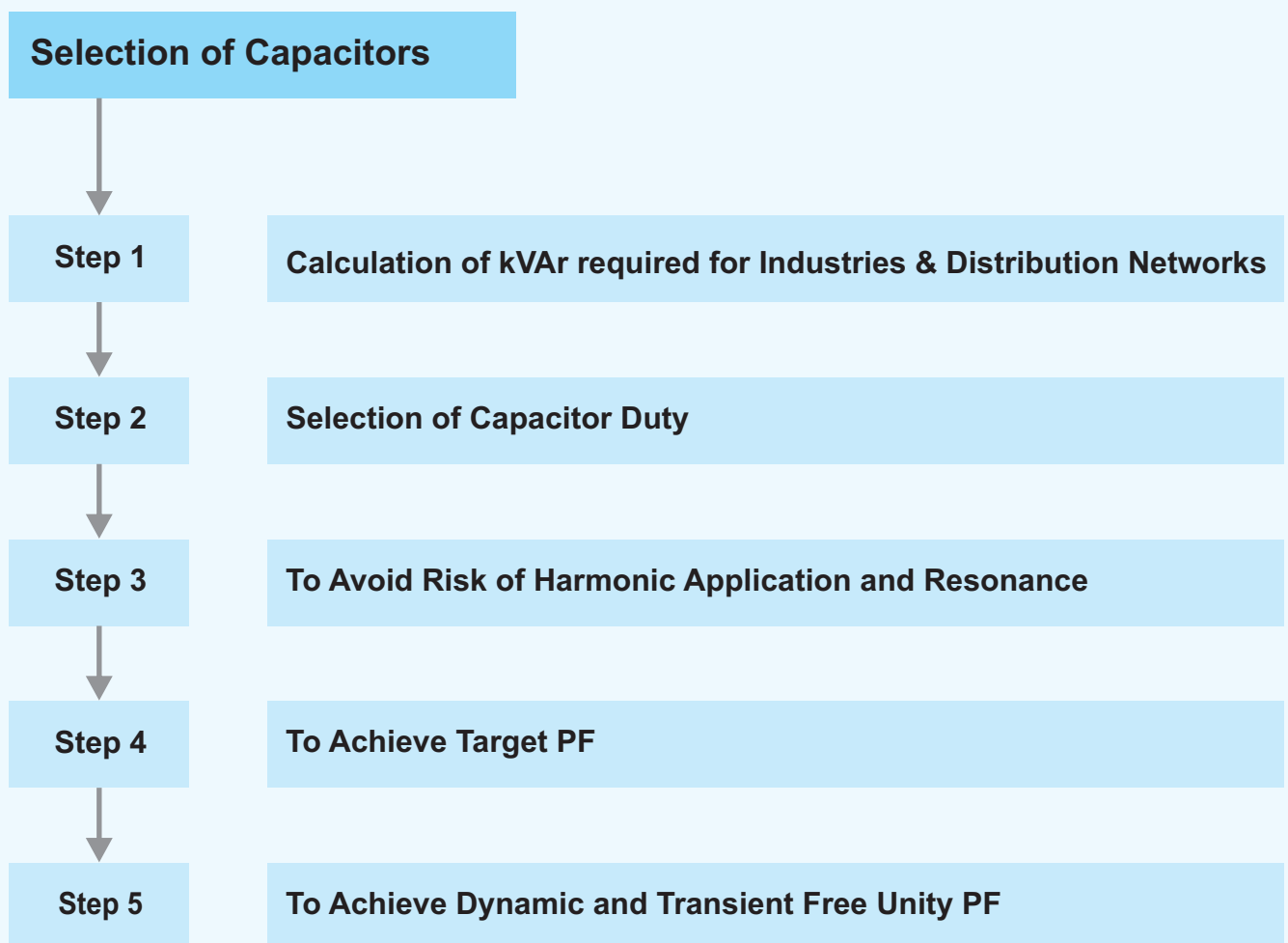
Power Factor Correction Capacitors have been used for many years as the most cost effective solution for PF improvement. Modern electrical networks are continuously evolving into more complex installations due to the increasing usage of non-linear loads, sophisticated control & automation, UPS systems, energy efficiency improvement devices etc.

This evolution is also accompanied by increased dependency on captive power generation as well as growing concerns about incoming supply power quality.

In this background, it is necessary to involve also the Power Factor Correction solution to a higher level so as to ensure sustainable achievement of high PF & acceptable harmonic distortion levels.

The selection of the correct type of PFC Capacitors & Filter reactors thus needs better understanding of the various issues involved.

This publication outlines a "5 Step" technology based approach, simplified for easier understanding to enable the correct selection of PFC Capacitors & Filter Reactors.





## Step 1: Calculation of kVAr required for Industries & Distribution Networks

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

$$\text{Average PF} = \text{kW/kVA}$$

$$\text{Operating load kW} = \text{kVA Demand} \times \text{Average PF}$$

The Average PF is considered as the initial PF and the final PF can be suitably assumed as target PF. In such cases required capacitor kVAr can be calculated as sited in below table.

Example: To calculate the required kVAr compensation for a 500 kW installation to improve the PF from 0.75 to 0.96

$$\text{kVAr} = \text{kW} \times \text{multiplying factor from table} = 500 \times 0.590 = 295 \text{ kVAr}$$

Note: Table is based on the following formula:  $\text{kVAr required} = \text{kW} (\tan\phi_1 - \tan\phi_2)$   
 where  $\phi_1 = \cos^{-1}(\text{PF}_1)$  and  $\phi_2 = \cos^{-1}(\text{PF}_2)$ .

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	0.38	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	0.600	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		0.029	0.058	0.089	0.121	0.156	0.193	0.234	0.281	0.342
0.91		0.030	0.060	0.093	0.127	0.164	0.205	0.253	0.313	0.313
0.92				0.031	0.063	0.097	0.134	0.175	0.223	0.284
0.93					0.032	0.067	0.104	0.145	0.192	0.253
0.94						0.034	0.071	0.112	0.160	0.220
0.95							0.037	0.078	0.126	0.186

## Step 2: Selection of Capacitor Duty

Selecting the type of Capacitor is the first decision to be made. Power Factor Correction Capacitors can be classified as follows:

- Standard Duty
- Heavy Duty
- LTXL: Ultra Heavy Duty

The criteria for this classification is based on the following:

- Operating life
- Permissible over voltage & over current coupled with the time duration
- Number of switching operations per year
- Peak inrush current withstand capability
- Operating ambient temperature

Duty	Over Current	Permissible Over Voltage @ rated Voltage 440V	Peak Inrush Currents	Ambient Temperature	Maximum switching operations/year
Standard Duty	1.5 x In	1.1 Un	200 x In	-25°C to 55°C	5000
Heavy Duty	1.8 x In	1.2 Un	300 x In	-25°C to 55°C	6000
LTXL: Ultra Heavy Duty	3 x In	1.3 Un	500 x In	-25°C to 70°C	20000

It is strongly recommended that the above table be followed as a guideline for selecting the appropriate capacitor for a given application. While choosing the type of duty it is also very important to identify the % age non-linear load in the system. The method of calculating the % age non-linear load is shown below:

### Calculation of Non - linear load:

Example:

$$\begin{aligned}
 \text{Installed transformer rating} &= 1000 \text{ kVA} \\
 \text{Non - linear loads} &= 100 \text{ kVA} \\
 \text{\% non - linear loads} &= (\text{non - linear loads} / \text{transformer rating}) \times 100 \\
 &= (100 / 1000) \times 100 \\
 &= 10\%
 \end{aligned}$$

Examples of non - linear load

UPS, Arc / induction furnace, Rectifiers, AC / DC Drives, Computer, CFL lamps, CNC machines, etc.

% Age Non - linear Load	Type of Duty
≥10%	Standard Duty
Upto 15%	Heavy Duty
Upto 25%	Ultra Heavy Duty
Above 25% to 30%	Use Capacitor + Reactor (detuned filters)
Above 30%	Hybrid filters (Active filter + detuned filters)*

\*For solutions contact L&T

### Step 3: To Avoid Risk of Harmonic Application and Resonance

To make a choice between the use of Capacitors or Capacitors + Filter reactors. This is important, because it is necessary to avoid the risk of “Resonance” as the phenomena of “Resonance” can lead to current and harmonic amplification which can cause wide spread damage to all Electrical & Electronic equipment in the installation including Capacitors. This can be avoided by installing capacitor + filter reactor.

**Caution:** It is safer to select a combination of “Capacitor + Filter reactor” so as to ensure that PF improvement is achieved in a reliable manner and the risk of resonance is avoided.

### Capacitor Technology & Construction Details

Capacitors are manufactured in three different types such as Standard duty, Heavy duty and Ultra Heavy duty. The Standard duty capacitors are manufactured using standard thickness of dielectric material with heavy edge metallization. Heavy duty capacitors are manufactured using thicker material and in lower width which increases current handling capacity as well as reduces temperature rise. Ultra Heavy duty capacitors are manufactured using thicker material, in lower width and have greater ability to handle in-rush current.

### Step 4: To Achieve Target PF

To estimate whether fixed compensation or automatic compensation is to be used. In order to achieve high power factor i.e., close to unity PF, the following guideline may be adopted to make a decision.

If the total kVAR required by the installation is less than 15% of the rating of the incoming supply transformers, then the use of fixed capacitors may be adopted at various points in the installation.

If the kVAR required by the installation is more than 15% of the rating of the incoming supply transformers, then automatic power factor correction solution needs to be adopted.

APFC panels with suitable kVAR outputs may be distributed and connected across various points within the installation.

**Note:** As in the case of selection of capacitors De-tuned filter APFC panels must be selected if non-linear loads exceed as per previous table.

### Step 5: To Achieve Dynamic and Transient Free Unity PF

To decide whether transient free PF correction is required. This is due to the fact that conventional switching techniques of capacitors involving electro-mechanical contactors will give rise to transient phenomena. This transient phenomena can interact with impedances present in the installation to create “Surges”. This occurrence of surges can cause serious damage to sensitive electronics and automation resulting in either their malfunction or permanent damage. The transient phenomenon is a sudden rise in voltage or current at the point of switching.

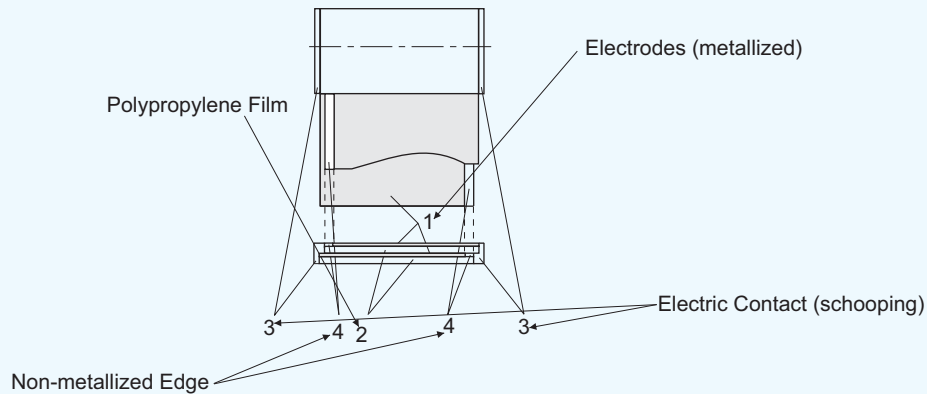
In this background, it is important to ensure that all the capacitors installed are switched in a transient free manner so as to ensure reliable performance of the installation.

In such a situation, it is necessary to specify the use of Thyristor switches for transient free switching of Capacitors.

**Note:** Thyristor switching can also be used for dynamic compensation which is needed if the fluctuation of loads is very high; such as lifts, welding load is very high; fast presses etc.

# Capacitor Technology

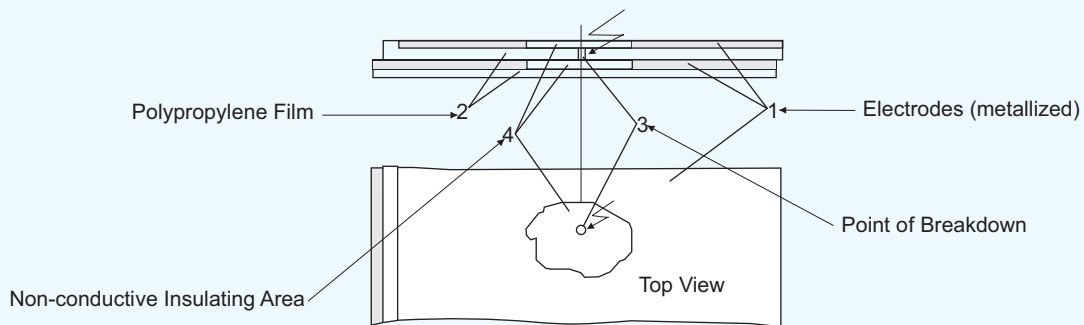
Capacitors are used in many diverse applications, and many different capacitor technologies are available. In low voltage applications, LT cylindrical capacitors which are made in accordance with metallized polypropylene technology have proved to be most appropriate and also the most cost effective. Depending on the nominal voltage of the capacitor, the thickness of the polypropylene film will differ.



**Design of LT Capacitor**

## Self - Healing

At the end of service life, or due to inadmissible electrical or thermal overload, an insulation breakdown may occur. A breakdown causes a small arc which evaporates the metal layer around the point of breakdown and re-establishes the insulation at the place of perforation. After electric breakdown, the capacitor can still be used. The decrease of Capacitance caused by a self-healing process is less than 100 pF. The self-healing process lasts for a few microseconds only and the energy necessary for healing can be measured only by means of sensitive instruments.



**Self - Healing Breakdown**

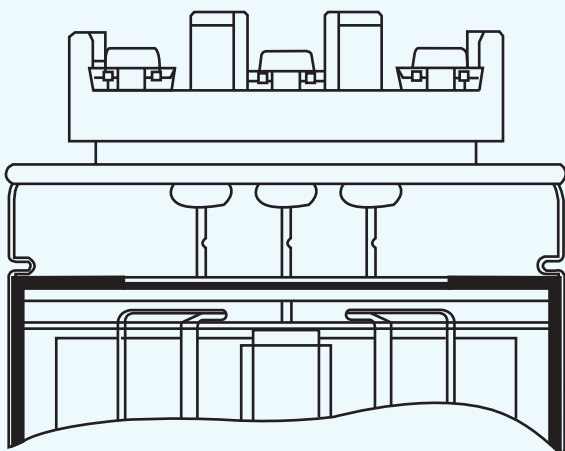
## Self - Healing Breakdown

For a self-healing dielectric, impregnation is basically not required. However, our LT-type capacitors are impregnated to eliminate environmental influences and to guarantee reliable, long-term operation. Vacuum impregnation eliminates air and moisture, improves “self-healing” and reduces thermal resistance.

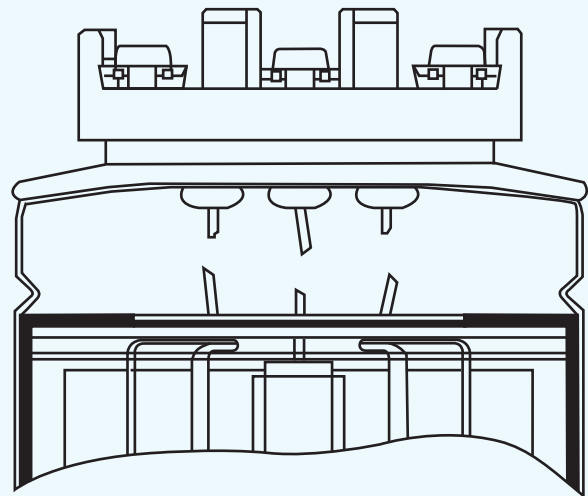
## Over pressure Tear - off Fuse

At the end of service life, due to inadmissible electrical or thermal overload, an over pressure builds up and causes an expansion of the cover. Expansion over a certain limit causes the tear-off of the internal fuses. The active capacitor elements are thus cut-off from the source of supply. The pressure within the casing separates the breaking point so rapidly that no harmful arc can occur.

### Operating Condition



### Torn - off Condition



## Box Type Capacitors

Technologically similar to cylindrical capacitors, box type capacitors consist a number of three phase cylindrical capacitor cells. The individual cells are wired together and mounted on a steel frame. The steel frame together with the cells is housed in a common sheet steel casing. The enclosure is powder coated and is designed to protect the capacitor cells from dust and moisture. Ease of mounting is ensured by 4 drillings at the bottom of the container.

This design ensures highest safety by:

- Self healing technology
- Over pressure tear - off fuse
- Robust steel container
- Massive connection studs

## Standard Duty Capacitors

L&T Standard Duty Capacitors are metalized polypropylene capacitors from 1kVAr to 25kVAr in cylindrical configuration and 1-50kVAr in box type configuration. These capacitors come with a stacked winding and are impregnated with a biodegradable soft resin. These capacitors are self healing type.



The Capacitors come with an over pressure disconnecter and finger proof terminals. They can be used to provide effective power factor correction in industrial and semi industrial applications.

### Technical Details

		Cylindrical	Box
<b>Range (kVAr)</b>		1 - 25	1 - 50
<b>Standards</b>		IEC 60831	IEC 60831
<b>Impregnation</b>		Resin	Resin
<b>Over Voltage withstand</b>	10%	12 h in 24 h	12 h in 24 h
	15%	30 m in 24 h	30 m in 24 h
	20%	5 m	5 m
	30%	1 m	1 m
<b>Over Current withstand</b>		1.5*In	1.5*In
<b>Inrush Current withstand</b>		200*In	200*In
<b>No of Operations/ year</b>		5000	5000
<b>Terminals</b>		Clamptite	Clamptite
<b>Ambient Temperature (°C)</b>		-25 / D	-25 / D
<b>Operating Losses Dielectric</b>		<0.2W / kVAr	<0.2W / kVAr
<b>Total Operating losses</b>		<0.45W / kVAr	<0.45W / kVAr

# Heavy Duty Capacitors

L&T Heavy Duty Capacitors are available from 3-25kVAr in cylindrical and from 5-50kVAr in box type construction. These capacitors have an inrush current withstand of 300 In and an overload withstand capacity of 1.8 In. These capacitors have all the features of standard capacitors like over pressure disconnecter and self healing.



The cylindrical Capacitors are subjected to an extended period of drying after which the casing is filled with an inert gas to prevent corrosion of the winding elements and inner electrical contacts. Compact design ensures space saving. Heavy Duty capacitors have a long life of 130000 hours.

## Technical Details

		Cylindrical	Box
<b>Range (kVAr)</b>		3 - 25	5 - 50
<b>Standards</b>		IEC 60831	IEC 60831
<b>Impregnation</b>		Inert Gas	Resin
<b>Voltage</b>		440, 480, 525, 690 V	440, 480, 525 V
<b>Over Voltage withstand</b>	<b>10%</b>	12 h in 24 h	12 h in 24 h
	<b>15%</b>	30 m in 24 h	30 m in 24 h
	<b>20%</b>	5 m	5 m
	<b>30%</b>	1 m	1 m
<b>Over Current withstand</b>		1.8*In	1.8*In
<b>Inrush current withstand</b>		250*In	300*In
<b>No. of Operations / year</b>		8000	8000
<b>Terminals</b>		Faston / Screw	Faston / Screw
<b>Ambient Temperature (°C)</b>		-40 / D	-25 / D
<b>Operating Losses Dielectric</b>		<0.2W / kVAr	<0.2W / kVAr
<b>Total Operating Losses</b>		<0.35W / kVAr	<0.35W / kVAr

# LTXL: Ultra Heavy Duty Capacitor

The LTXL range of capacitors are designed for Ultra heavy duty applications and can withstand heavy load fluctuations, high inrush current and harmonics.

## Applications

- Applications such as welding, steel rolling, etc., with heavy load fluctuations and high thermal loading
- Systems with high harmonic distortion levels (non linear load >15%)
- Systems with high dv / dt
- Tuned harmonic filter

## Features

- Long life expectancy (upto 300000 hrs)
- Maximum inrush current withstand capability (upto 500 times  $I_R$ )
- Low power loss (0.35 W/kVAr)
- Shock hazard protected terminals
- Internal fuse

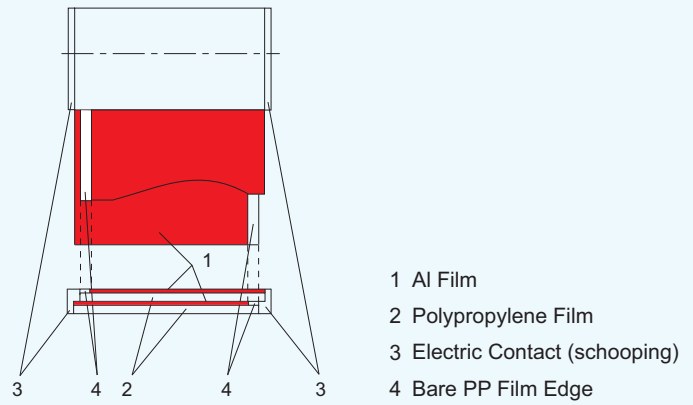


The life of a capacitor largely depends upon its operating temperature. LTXL box type capacitors use advanced APP technology. By employing thicker aluminum foil, thicker polypropylene film and special impregnates, LTXL box type capacitor is able to operate at lower temperatures and hence achieve a longer life. These capacitors are thus able to withstand stringent operating conditions. The higher surface area and special epoxy based coating also ensures better heat dissipation. The capacitor is designed to operate at ambient temperature up to 70°C.

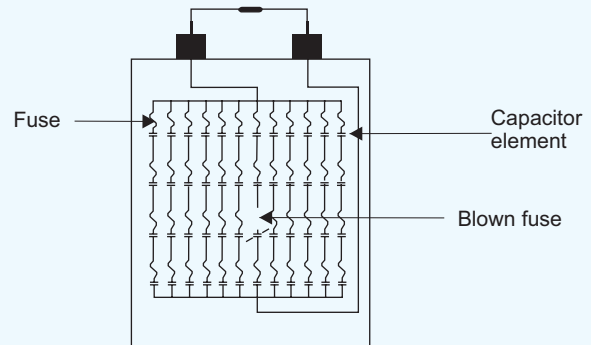


## Capacitor Technology

In LTXL box, two polypropylene films and two Al films are grouped together as shown in the figure below. The wave-cut and heavy edge metalized films are then rolled to form a capacitor element. Many such capacitor elements are pressed and stacked together and are internally connected in parallel. Depending upon the rating of the capacitor, the number of stacks differ. These stacks are placed inside a case and are vacuum impregnated with non-PCB, biodegradable impregnates.



**Design of LT Capacitor**



Each capacitor element is protected by an internal fuse as shown in the figure below. If there is an internal short circuit in any of the capacitor element, the fuse of that corresponding capacitor elements will blow.

## Technical Details

	LTXL Box
<b>Range</b>	5 - 100 kVAr
<b>Type</b>	Ultra Heavy Duty
<b>Standards</b>	IS 13585-1994, IEC 60931-2002
<b>Rated Frequency</b>	50 Hz, 60 Hz
<b>Rated Voltage</b>	415 / 440 V, 480 V, 525 V, 690 V, 850 V, 1000 V
<b>Over Voltage</b>	+10% (12h/24h), +15% (30m/24h), +20% (5m/24hrs), +30% (1m/24hrs)
<b>Over Current</b>	Upto $3 \times I_N$
<b>Peak Inrush Current</b>	Upto $500 \times I_N$
<b>Operating Losses (Dielectric)</b>	$< 0.2 \text{ W / kVAr}$
<b>Operating Losses (Total)</b>	$< 0.35 \text{ W / kVAr}$
<b>Tolerance on Capacitance</b>	-5 / +10% as per IS
<b>Degree of Protection</b>	IP52 with terminal cap
<b>Ambient Temperature</b>	-25°C to 70°C
<b>Cooling</b>	Natural or forced air cooling
<b>Permissible Relative Humidity</b>	Max 95%
<b>Maximum Operating Altitude</b>	4000m above sea level
<b>Mounting</b>	Upright
<b>Safety Features</b>	Internal Fuse
<b>Impregnation</b>	Non PCB, biodegradable oil
<b>Casing</b>	CRCA
<b>Dielectric Composition</b>	Biaxillay oriented polypropylene film with aluminum foil electrode
<b>Terminals</b>	Porcelain Bushing
<b>Discharge Resistors / Time</b>	Discharge Resistors fitted, Standard discharge time 60 seconds, Other discharge times on request
<b>Switching Operations (maximum)</b>	20000 switchings per year, 50000 switchings per year (with reactor)

## Reactors - Harmonic Filters

The increasing use of modern power electronic apparatus (drives, uninterruptible power supplies, etc) produces nonlinear current and thus influences and loads the network with harmonics (line pollution). The capacitance of the power capacitor forms a resonant circuit in conjunction with the feeding transformer. Experience shows that the self-resonant frequency of this circuit is typically between 250 and 500 Hz, i.e. in the region of the 5th and 7th harmonics. Such a resonance can lead to the following undesirable effects:

- Overloading of capacitors
- Overloading of transformers and transmission equipment
- Interference with metering and control systems, computers and electrical gear
- Resonance elevation, i.e. amplification of harmonics
- Voltage distortion

These resonance phenomena can be avoided by connecting capacitors in series with filter reactors in the PFC system. These so called “detuned” PFC systems are scaled in a way that the self-resonant frequency is below the lowest line harmonic and the detuned PFC system is purely inductive as seen by harmonics above this frequency. For the base line frequency (50 or 60 Hz usually), the detuned system on the other hand acts purely capacitive, thus correcting the reactive power.



### Technical Details

<b>Standards</b>	IEC 60289
<b>Rated Voltage (V)</b>	440, 690, 850, & 1000 V
<b>Rated Frequency (F)</b>	50
<b>Max Permissible Operating Voltage</b>	1.05 Un Continuously, 1.1 Un for 8 hours
<b>Max Permissible Operating Current</b>	1.06 In High Linearity, 1.8 In Continuously
<b>Duty Cycle</b>	100%
<b>Class of Protection</b>	I
<b>Ambient Temperature</b>	40°C
<b>Insulation Class</b>	Class F
<b>Protection</b>	Thermal Switch
<b>De-Tuning</b>	5.67%, 7% & 14%

## Thyristor Switching Modules

The usage of new technologies in modern industry has negative impacts on electric power quality of the main supply networks, e.g. frequent high load fluctuations and harmonic oscillation. Excessive currents, increased losses and flickering will not only influence the supply capacity but will also have a significant impact on the operation of sensitive electronic devices.

The solution is dynamic power factor correction system. With the thyristor module we provide the main component- "The Electronic Switch"- for dynamic power factor correction. The LT-TSM module series offers fast electronically controlled, self-observing thyristor switches for capacitive loads up to 200 kVAr, that are capable to switch PFC capacitors within a few milliseconds nearly without a limitation to the number of switchings during the capacitor lifetime. These switching modules are easy to install, have a fast reaction time of 5 msec and come with a built-in indications of operations, faults and activation.



### Technical Details

	LT TSM 10	LT TSM 25	LT TSM 50
Rated Voltage (V)	440 V		
Frequency (Hz)	50 / 60		
Rating (kVAr)	10	25	50
Losses PD (W)	35	75	150
LED display per Phase	2	2	2
Ambient Temperature (°C)	-10 to 55		
Signal Voltage Required	24 Vdc (20mA)		
Reaction Time (msec)	5		
Peak Inverse Voltage (PIV)	2.2 kV		

## Capacitor Duty Contactors - Type MO C

Switching of capacitors in Automatic Power Factor capacitor (APFC) panels are always challenging because of the inrush current. When capacitors are switched directly by using power contactors, the peak value of the inrush current may shoot above 200 times the rated current. This can harm power capacitors and other equipment in the panel. A simple solution to reduce the inrush current is by switching the capacitors through capacitor duty contactors. These special purpose contactors have auxiliary contacts that have series resistors of 4  $\Omega$ . These auxiliary contacts close before the main contacts, which reduce the inrush current to less than 20 times the rated current. The capacitor duty contactors have **de-latching technology**, in which, the auxiliary contacts will remain closed only for a few milliseconds. During breaking operation, the arcing occurs only at main contacts. This will ensure longer life of the contactor.



### Technical Specification

Type designation	Cat. Nos.		Rated operational current at 415 V, 50Hz (A)	Rating (kVAR)		Mechanical Life (in Millions)	Electrical Life (in Millions)	Max. operating frequency (operations / hr)
	1 NO	1 NC		230 VAC	415 VAC			
MO C8.5	CS96320	CS96337	12	5.0	8.5	10	0.2	240
MO C12.5	CS96321	CS96338	18	7.5	12.5	10	0.2	240
MO C15	CS90019	CS90020	21	8.5	15.0	10	0.2	240
MO C20	CS90021	CS90022	28	12.0	20.0	10	0.2	240
MO C25	CS96322	CS96339	35	14.5	25.0	10	0.2	240
MO C33.5	CS96323	CS96340	50	20.0	33.5	10	0.2	240
MO C50	CS96324	CS96341	70	30.0	50.0	10	0.2	240
MO C70	CS96325	CS96342	95	40.0	70.0	10	0.2	240
MO C80	CS96326	CS96343	110	45.0	80.0	10	0.2	240

# Power Factor Control and Monitoring Relays

- (8 & 14 Stages) Intelligent Power Factor Controller Relay

## Salient Features

- On line display of system PF
- Easy setting through - front panel push button
- Suitable for non-uniform banks
- LED indication for alarm code, no. of Banks selected, PF status-lead / lag / unity
- Auto / Manual mode
- Measurement sensitivity of 1%
- Automatic C/K correction
- Display of current, Voltage, kVAr, & Capacitor values



Model	RPM-8	RPM-14
Description	Automatic Power Factor Controller 8 stage	Automatic Power Factor Controller 14 stage
Design	Microcontroller based	Microcontroller based
Functions Available	Automatic PF control upto 8 stage	Automatic PF control upto 14 stage
Settings	Switching time 1-255 Sec. in step of 1 sec for same Bank switching Auto C/K selection PF control range 1% to 120% of rated current	Switching time 1-255 Sec. in step of 1 sec for same Bank switching Auto C/K selection PF control range 1% to 120% of rated current
Other Features	Can accept unequal banks Display of PF, V, I, kVAr LED indications for faults Alarm signal for CT reversal, under current, Under compensation, over compensation, over voltage, 1 A / 5 A field selectable	Can accept unequal banks Display of PF, V, I, kVAr LED indications for faults Alarm signal for CT reversal, under current, Under compensation, over compensation, over voltage, 1 A / 5 A field selectable
Burden on CT	0.3 VA	0.3 VA
Burden on PT	15 VA	15 VA
Operating temp	0°C to 60°C	0°C to 60°C
Weight	< 2kg	< 2kg
Output Contacts	8 N/O 1 N/O contact for alarm	14 N/O 1 N/O contact for alarm
Dim W x H x D in mm	144 x 144 x 100	144 x 144 x 100
Panel Cutout	138 x 138	138 x 138
Auxiliary supply	240 V AC	240 V AC

# etaSYS

## Standard Automatic Power Factor Correction Panels

Modern power networks cater to a wide variety of electrical and power electronics loads, which create a varying power demand on the supply system. In case of such varying loads, the power factor also varies as a function of the load requirements. It therefore becomes practically difficult to maintain consistent power factor by the use of fixed compensation i.e. fixed capacitors which shall need to be manually switched to suit the variations of the load. This will lead to situations where the installation can have a low power factor leading to higher demand charges and levy of power factor penalties.

In addition to not being able to achieve the desired power factor it is also possible that the use of fixed compensation can also result in leading power factor under certain load conditions. This is also unhealthy for the installation as it can result in over voltages, saturation of transformers, mal-operation of diesel generating sets, penalties by electricity supply authorities etc.

Consequently the use of fixed compensation has limitations in this context. It is therefore necessary to automatically vary, without manual intervention, the compensation to suit the load requirements. This is achieved by using an Automatic Power Factor Correction (APFC) system which can ensure consistently high power factor without any manual intervention. In addition, the occurrence of leading power factor will be prevented.

### APFC products are fully automatic in operation and can be used to achieve:

- Consistently high power factor under fluctuating load conditions
- Elimination of low power factor penalty levied by electrical supply authorities
- Reduced kVA demand charges
- Lower energy consumption in the installation by reducing losses
- Preventive leading power factor in an installation

### The basic operation is as follows:

- To continuously sense and monitor the load condition by the use of external CT (whose output is fed to the control relay)
- To automatically switch ON and OFF relevant capacitor steps on to ensure consistent power factor
- To ensure easy user interface for enabling reliable understanding of system operations carried out etc.
- To protect against any electrical faults in a manner that will ensure safe isolation of the power factor correction equipment

### Salient Features:

- Standard panel design with pre-selected switchgear and step sizes
- Allows user for easy panel selection
- The main incomer has fault interrupting capability > 50kA
- Aluminium busbar system suitable to withstand 50kA fault current
- Minimal joints in all the connections to ensure better reliability and low losses

## etaSYS Standard APFC Panel Range

Product	kVAr ratings	Description	Capacitors	Incomer	Branch Protection	Switching
etaSYS - MH	35 to 100 kVAr	Wall mountable	Heavy Duty Gas filled Capacitors	MCCB	MCCB	Auto + Manual
	100 to 500 kVAr	Free standing floor mountable	Heavy Duty Gas filled Capacitors	MCCB - upto 300 kVAr; ACB - 400 to 500 kVAr	MCCB	Auto + Manual
etaSYS - FH	35 to 100 kVAr	Wall mountable	Heavy Duty Gas filled Capacitors	MCCB	HRCF	Auto + Manual
	100 to 500 kVAr	Free standing floor mountable	Heavy Duty Gas filled Capacitors	MCCB - upto 300 kVAr; ACB - 400 to 500 kVAr	HRCF	Auto + Manual
etaSYS - MU	100 to 500 kVAr	Free standing floor mountable	LTXL - Ultra Heavy Duty Capacitors	MCCB - upto 300 kVAr; ACB - 400 to 500 kVAr	MCCB	Auto + Manual
etaSYS - FU	100 to 500 kVAr	Free standing floor mountable	LTXL - Ultra Heavy Duty Capacitors	MCCB - upto 300 kVAr; ACB - 400 to 500 kVAr	HRCF	Auto + Manual

## etaSYS Basic Design Specifications

<b>Power Range</b>	35 kVAr to 500 kVAr
<b>Rated System Voltage</b>	440 V / 415 V / 380 V / 400 V
<b>Rated Frequency</b>	50 Hz
<b>Short Circuit Rating</b>	> 36 kA
<b>Altitude</b>	1000 m
<b>Duty</b>	Continuous
<b>Ambient temperature</b>	-5°C to 45°C
<b>Power Supply</b>	Three phase, four line
<b>Relay current input signal</b>	-- / 5A, from CT on line
<b>Enclosures</b>	The load bearing structure is made of 2 mm sheet steel The front door and partition are made of 1.6 mm sheet steel The internal components are accessible on opening the front door Ingress protection - IP42
<b>Installation</b>	Indoor, wall mounted (upto 100 kVAr), floor mounted (100 kVAr and above) in a well-ventilated, non-dusty environment, cable entry from bottom
<b>Incomer</b>	3 Pole MCCBs upto 630 A, 3 Pole ACBs above 630 A
<b>Capacitors</b>	1. Heavy duty cylindrical gas filled capacitors 2. LTXL Ultra Heavy Duty Capacitors (see below table for step ratings).
<b>Contactors</b>	Three pole MPX Capacitor duty contactors of adequate ratings for respective steps
<b>Branch Protection</b>	1. MCCBs for providing short circuit protection and isolation 2. HRC Fuses of adequate ratings 3. High speed fuse / semiconductor fuse for thyristor switched APFC panels

## etaSYS - MH Standard APFC with a Combination of Heavy Duty Capacitors and MCCB

Cat. Nos.	Panel Rating (kVAr)	Step size (kVAr)	Steps	Switching Device	Type of Capacitor	Reactor	Branch protection	Main Incommer	Dimension (mm) (H x W x D)
LTAPMH0351B2	35	2x12.5 + 2x5	4	Contactora	MPPH	-	DU MCCB	dsine MCCB	1100 x 600 x 400
LTAPMH0501B2	50	2x12.5 + 2 x 10 + 1x5	5	Contactora	MPPH	-	DU MCCB	dsine MCCB	1100 x 600 x 400
LTAPMH0751B2	75	2x25 + 2 x 10 + 1x5	5	Contactora	MPPH	-	DU MCCB	dsine MCCB	1200 x 800 x 400
LTAPMH1001B2	100	50 + 25 + 15 + 5 + 5	5	Contactora	MPPH	-	DU MCCB	dsine MCCB	1500 x 1000 x 600
LTAPMH1002B2	100	50 + 25 + 15 + 5 + 5	5	Contactora	MPPH	7%	DU MCCB	dsine MCCB	1600 x 1000 x 800
LTAPMH1251B2	125	2x12.5 + 2x25 + 50	5	Contactora	MPPH	-	DU MCCB	dsine MCCB	1500 x 1000 x 600
LTAPMH1252B2	125	2x12.5 + 2x25 + 50	5	Contactora	MPPH	7%	DU MCCB	dsine MCCB	1600 x 1000 x 800
LTAPMH1501B2	150	2x12.5 + 3x25 + 50	6	Contactora	MPPH	-	DU MCCB	dsine MCCB	1800 x 1000 x 600
LTAPMH1502B2	150	2x12.5 + 3x25 + 50	6	Contactora	MPPH	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMH1751B2	175	2x12.5 + 2x25 + 2x50	6	Contactora	MPPH	-	DU MCCB	dsine MCCB	1800 x 1000 x 600
LTAPMH1752B2	175	2x12.5 + 2x25 + 2x50	6	Contactora	MPPH	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMH2001B2	200	2x12.5 + 25 + 3x50	6	Contactora	MPPH	-	DU MCCB	dsine MCCB	1800 x 1000 x 600
LTAPMH2002B2	200	2x12.5 + 1 x 25 + 3x50	6	Contactora	MPPH	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMH2251B2	225	2x12.5 + 4x50	6	Contactora	MPPH	-	DU MCCB	dsine MCCB	1800 x 1000 x 600
LTAPMH2252B2	225	2x12.5 + 4x50	6	Contactora	MPPH	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMH2501B2	250	2x25 + 4x50	6	Contactora	MPPH	-	DU MCCB	dsine MCCB	1800 x 1000 x 600
LTAPMH2502B2	250	2x25 + 4x50	6	Contactora	MPPH	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMH2751B2	275	1x100 + 3 x 50 + 2x12.5	6	Contactora	MPPH	-	DU MCCB	dsine MCCB	2100 x 1200 x 600
LTAPMH2752B2	275	1x100 + 3x50 + 2x12.5	6	Contactora	MPPH	7%	DU MCCB	dsine MCCB	2100 x 1200 x 800
LTAPMH3001B2	300	1x100 + 3x50 + 2x25	6	Contactora	MPPH	-	DU MCCB	dsine MCCB	2100 x 1200 x 600
LTAPMH3002B2	300	1x100 + 3x50 + 2x25	6	Contactora	MPPH	7%	DU MCCB	dsine MCCB	2100 x 1200 x 800
LTAPMH3501B2	350	1x100 + 3x50 + 4x25	8	Contactora	MPPH	-	DU MCCB	dsine MCCB	2100 x 1200 x 600
LTAPMH3502B2	350	1x100 + 3x50 + 4x25	8	Contactora	MPPH	7%	DU MCCB	dsine MCCB	2100 x 1400 x 800
LTAPMH4001B2	400	2x100 + 2x50 + 4x25	8	Contactora	MPPH	-	DU MCCB	ACB	2000 x 1600 x 800
LTAPMH4002B2	400	2x100 + 2x50 + 4x25	8	Contactora	MPPH	7%	DU MCCB	ACB	2000 x 1600 x 1200
LTAPMH4501B2	450	2x100 + 4x50 + 2x25	8	Contactora	MPPH	-	DU MCCB	ACB	2000 x 1600 x 800
LTAPMH4502B2	450	2x100 + 4x50 + 2x25	8	Contactora	MPPH	7%	DU MCCB	ACB	2000 x 1600 x 1200
LTAPMH5001B2	500	3x100 + 3x50 + 2x25	8	Contactora	MPPH	-	DU MCCB	ACB	2000 x 1600 x 800
LTAPMH5002B2	500	3x100 + 3x50 + 2x25	8	Contactora	MPPH	7%	DU MCCB	ACB	2000 x 1600 x 1200



## etaSYS - FH Standard APFC with a Combination of MCCB & HRCF

Cat. Nos.	Panel Rating (kVAr)	Step size (kVAr)	Steps	Switching Device	Type of Capacitor	Reactor	Branch protection	Main Incommer	Dimension (mm) (H x W x D)
LTAPFH0351B2	35	2x12.5 + 2x5	4	Contactora	MPPH	-	HRCF	dsine MCCB	1100 x 600 x 400
LTAPFH0501B2	50	2x12.5 + 2x10 + 1x5	5	Contactora	MPPH	-	HRCF	dsine MCCB	1100 x 600 x 400
LTAPFH0751B2	75	2x25 + 2x10 + 1x5	5	Contactora	MPPH	-	HRCF	dsine MCCB	1200 x 800 x 400
LTAPFH1001B2	100	50 + 25 + 15 + 5 + 5	5	Contactora	MPPH	-	HRCF	dsine MCCB	1500 x 1000 x 500
LTAPFH1002B2	100	50 + 25 + 15 + 5 + 5	5	Contactora	MPPH	7%	HRCF	dsine MCCB	1600 x 1000 x 800
LTAPFH1003B2	100	50 + 25 + 15 + 5 + 5	5	Thyristor	MPPH	7%	HSF	dsine MCCB	1800 x 1000 x 800
LTAPFH1251B2	125	2x12.5 + 2x25 + 50	5	Contactora	MPPH	-	HRCF	dsine MCCB	1500 x 1000 x 500
LTAPFH1252B2	125	2x12.5 + 2x25 + 50	5	Contactora	MPPH	7%	HRCF	dsine MCCB	1600 x 1000 x 800
LTAPFH1253B2	125	2x12.5 + 2x25 + 50	5	Thyristor	MPPH	7%	HSF	dsine MCCB	1800 x 1000 x 800
LTAPFH1501B2	150	2x12.5 + 3x25 + 50	6	Contactora	MPPH	-	HRCF	dsine MCCB	1800 x 1000 x 600
LTAPFH1502B2	150	2x12.5 + 3x25 + 50	6	Contactora	MPPH	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFH1503B2	150	2x12.5 + 3x25 + 50	6	Thyristor	MPPH	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFH1751B2	175	2x12.5 + 2x25 + 2x50	6	Contactora	MPPH	-	HRCF	dsine MCCB	1800 x 1000 x 600
LTAPFH1752B2	175	2x12.5 + 2x25 + 2x50	6	Contactora	MPPH	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFH1753B2	175	2x12.5 + 2x25 + 2x50	6	Thyristor	MPPH	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFH2001B2	200	2x12.5 + 25 + 3x50	6	Contactora	MPPH	-	HRCF	dsine MCCB	1800 x 1000 x 600
LTAPFH2002B2	200	2x12.5 + 1x25 + 3x50	6	Contactora	MPPH	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFH2003B2	200	2x12.5 + 1x25 + 3x50	6	Thyristor	MPPH	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFH2251B2	225	2x12.5 + 4x50	6	Contactora	MPPH	-	HRCF	dsine MCCB	1800 x 1000 x 600
LTAPFH2252B2	225	2x12.5 + 4x50	6	Contactora	MPPH	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFH2253B2	225	2x12.5 + 4 x 50	6	Thyristor	MPPH	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFH2501B2	250	2x25 + 4 x 50	6	Contactora	MPPH	-	HRCF	dsine MCCB	1800 x 1000 x 600
LTAPFH2502B2	250	2x25 + 4x50	6	Contactora	MPPH	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFH2503B2	250	2x25 + 4x50	6	Thyristor	MPPH	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFH2751B2	275	1x100 + 3x50 + 2x12.5	6	Contactora	MPPH	-	HRCF	dsine MCCB	2100 x 1200 x 600
LTAPFH2752B2	275	1x100 + 3x50 + 2x12.5	6	Contactora	MPPH	7%	HRCF	dsine MCCB	2100 x 1200 x 800
LTAPFH2753B2	275	1x100 + 3x50 + 2x12.5	6	Thyristor	MPPH	7%	HSF	dsine MCCB	2200 x 1200 x 800
LTAPFH3001B2	300	1x100 + 3x50 + 2x25	6	Contactora	MPPH	-	HRCF	dsine MCCB	2100 x 1200 x 600
LTAPFH3002B2	300	1x100 + 3x50 + 2x25	6	Contactora	MPPH	7%	HRCF	dsine MCCB	2100 x 1200 x 800
LTAPFH3003B2	300	1x100 + 3x50 + 2x25	6	Thyristor	MPPH	7%	HSF	dsine MCCB	2200 x 1200 x 800
LTAPFH3501B2	350	1x100 + 3x50 + 4x25	8	Contactora	MPPH	-	HRCF	dsine MCCB	2100 x 1200 x 600
LTAPFH3502B2	350	1x100 + 3x50 + 4x25	8	Contactora	MPPH	7%	HRCF	dsine MCCB	2100 x 1400 x 800
LTAPFH3503B2	350	1x100 + 3x50 + 4x25	8	Thyristor	MPPH	7%	HSF	dsine MCCB	2100 x 1600 x 800
LTAPFH4001B2	400	2x100 + 2x50 + 4x25	8	Contactora	MPPH	-	HRCF	dsine MCCB	2000 x 1600 x 800
LTAPFH4002B2	400	2x100 + 2x50 + 4x25	8	Contactora	MPPH	7%	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFH4003B2	400	2x100 + 2x50 + 4x25	8	Thyristor	MPPH	7%	HSF	dsine MCCB	2000 x 1600 x 1200
LTAPFH4501B2	450	2x100 + 4x50 + 2x25	8	Contactora	MPPH	-	HRCF	dsine MCCB	2000 x 1600 x 800
LTAPFH4502B2	450	2x100 + 4x50 + 2x25	8	Contactora	MPPH	7%	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFH4503B2	450	2x100 + 4x50 + 2x25	8	Thyristor	MPPH	7%	HSF	dsine MCCB	2000 x 1600 x 1200
LTAPFH5001B2	500	3x100 + 3x50 + 2x25	8	Contactora	MPPH	-	HRCF	dsine MCCB	2000 x 1600 x 800
LTAPFH5002B2	500	3x100 + 3x50 + 2x25	8	Contactora	MPPH	7%	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFH5003B2	500	3x100 + 3x50 + 2x25	8	Thyristor	MPPH	7%	HSF	dsine MCCB	2000 x 1600 x 1200

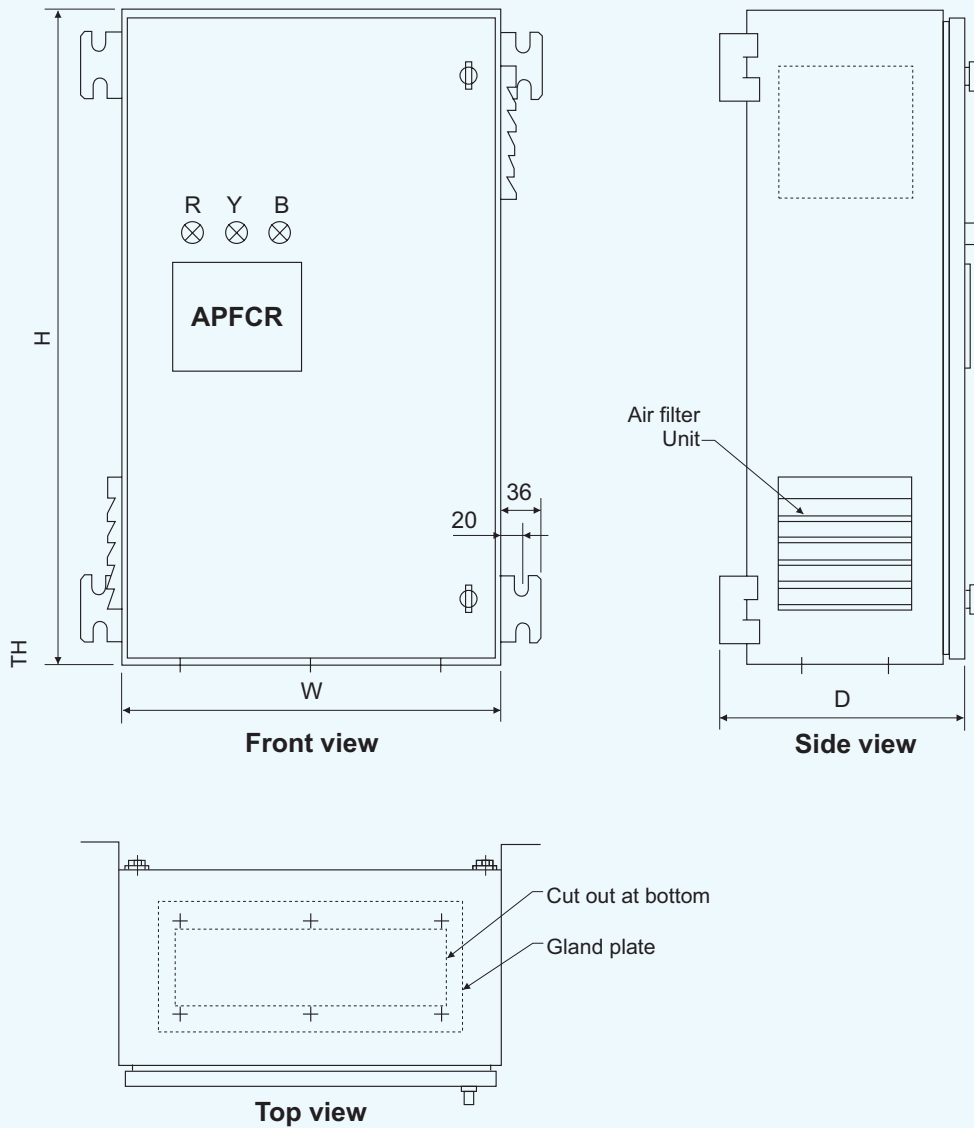
## etaSYS - MU Standard APFC with a Combination of LTXL & MCCB

Cat. Nos.	Panel Rating (kVAr)	Step size (kVAr)	Steps	Switching Device	Type of Capacitor	Reactor	Branch protection	Main Incommer	Dimension (mm) (H x W x D)
LTAPMU1001B2	100	50 + 25 + 15 + 5 + 5	5	Contactora	LTXL	-	DU MCCB	dsine MCCB	1500 x 1000 x 700
LTAPMU1002B2	100	50 + 25 + 15 + 5 + 5	5	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMU1251B2	125	2x12.5 + 2x25 + 50	5	Contactora	LTXL	-	DU MCCB	dsine MCCB	1500 x 1000 x 700
LTAPMU1252B2	125	2x12.5 + 2x25 + 50	5	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMU1501B2	150	2x12.5 + 3x25 + 50	6	Contactora	LTXL	-	DU MCCB	dsine MCCB	1800 x 1000 x 700
LTAPMU1502B2	150	2x12.5 + 3x25 + 50	6	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMU1751B2	175	2x12.5 + 2x25 + 2x50	6	Contactora	LTXL	-	DU MCCB	dsine MCCB	1800 x 1000 x 700
LTAPMU1752B2	175	2x12.5 + 2x25 + 2x50	6	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMU2001B2	200	2x12.5 + 25 + 3x50	6	Contactora	LTXL	-	DU MCCB	dsine MCCB	1800 x 1000 x 700
LTAPMU2002B2	200	2x12.5 + 1x25 + 3x50	6	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMU2251B2	225	2x12.5 + 4x50	6	Contactora	LTXL	-	DU MCCB	dsine MCCB	1800 x 1000 x 700
LTAPMU2252B2	225	2x12.5 + 4x50	6	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMU2501B2	250	2x25 + 4x50	6	Contactora	LTXL	-	DU MCCB	dsine MCCB	1800 x 1000 x 700
LTAPMU2502B2	250	2x25 + 4x50	6	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1000 x 800
LTAPMU2751B2	275	1x100 + 3x50 + 2x12.5	6	Contactora	LTXL	-	DU MCCB	dsine MCCB	2100 x 1200 x 700
LTAPMU2752B2	275	1x100 + 3x50 + 2x12.5	6	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1200 x 1200
LTAPMU3001B2	300	1x100 + 3x50 + 2x25	6	Contactora	LTXL	-	DU MCCB	dsine MCCB	2100 x 1200 x 700
LTAPMU3002B2	300	1x100 + 3x50 + 2x25	6	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1200 x 1200
LTAPMU3501B2	350	1x100 + 3x50 + 4x25	8	Contactora	LTXL	-	DU MCCB	dsine MCCB	2100 x 1200 x 700
LTAPMU3502B2	350	1x100 + 3x50 + 4x25	8	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2100 x 1400 x 1200
LTAPMU4001B2	400	2x100 + 2x50 + 4x25	8	Contactora	LTXL	-	DU MCCB	dsine MCCB	2000 x 1600 x 1200
LTAPMU4002B2	400	2x100 + 2x50 + 4x25	8	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2000 x 1800 x 1200
LTAPMU4501B2	450	2x100 + 4x50 + 2x25	8	Contactora	LTXL	-	DU MCCB	dsine MCCB	2000 x 1600 x 1200
LTAPMU4502B2	450	2x100 + 4x50 + 2x25	8	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2000 x 1800 x 1200
LTAPMU5001B2	500	3x100 + 3x50 + 2x25	8	Contactora	LTXL	-	DU MCCB	dsine MCCB	2000 x 1600 x 1200
LTAPMU5002B2	500	3x100 + 3x50 + 2x25	8	Contactora	LTXL	7%	DU MCCB	dsine MCCB	2000 x 1800 x 1200

## etaSYS - FU Standard APFC with a Combination of LTXL & HRCF

Cat. Nos.	Panel Rating (kVAr)	Step size (kVAr)	Steps	Switching Device	Type of Capacitor	Reactor	Branch protection	Main Incommer	Dimension (mm) (H x W x D)
LTAPFU1001B2	100	50 + 25 + 15 + 5 + 5	5	Contactora	LTXL	-	HRCF	dsine MCCB	1500 x 1000 x 700
LTAPFU1002B2	100	50 + 25 + 15 + 5 + 5	5	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFU1003B2	100	50 + 25 + 15 + 5 + 5	5	Thyristor	LTXL	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFU1251B2	125	2x12.5 + 2x25 + 50	5	Contactora	LTXL	-	HRCF	dsine MCCB	1500 x 1000 x 700
LTAPFU1252B2	125	2x12.5 + 2x25 + 50	5	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFU1253B2	125	2x12.5 + 2x25 + 50	5	Thyristor	LTXL	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFU1501B2	150	2x12.5 + 3x25 + 50	6	Contactora	LTXL	-	HRCF	dsine MCCB	1800 x 1000 x 700
LTAPFU1502B2	150	2x12.5 + 3x25 + 50	6	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFU1503B2	150	2x12.5 + 3x25 + 50	6	Thyristor	LTXL	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFU1751B2	175	2x12.5 + 2x25 + 2x50	6	Contactora	LTXL	-	HRCF	dsine MCCB	1800 x 1000 x 700
LTAPFU1752B2	175	2x12.5 + 2x25 + 2x50	6	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFU1753B2	175	2x12.5 + 2x25 + 2x50	6	Thyristor	LTXL	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFU2001B2	200	2x12.5 + 25 + 3x50	6	Contactora	LTXL	-	HRCF	dsine MCCB	1800 x 1000 x 700
LTAPFU2002B2	200	2x12.5 + 1x25 + 3x50	6	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFU2003B2	200	2x12.5 + 1x25 + 3x50	6	Thyristor	LTXL	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFU2251B2	225	2x12.5 + 4x50	6	Contactora	LTXL	-	HRCF	dsine MCCB	1800 x 1000 x 700
LTAPFU2252B2	225	2x12.5 + 4x50	6	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFU2253B2	225	2x12.5 + 4x50	6	Thyristor	LTXL	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFU2501B2	250	2x25 + 4x50	6	Contactora	LTXL	-	HRCF	dsine MCCB	1800 x 1000 x 700
LTAPFU2502B2	250	2x25 + 4x50	6	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1000 x 800
LTAPFU2503B2	250	2x25 + 4x50	6	Thyristor	LTXL	7%	HSF	dsine MCCB	2100 x 1000 x 800
LTAPFU2751B2	275	1x100 + 3x50 + 2x12.5	6	Contactora	LTXL	-	HRCF	dsine MCCB	2100 x 1200 x 700
LTAPFU2752B2	275	1x100 + 3x50 + 2x12.5	6	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1200 x 1200
LTAPFU2753B2	275	1x100 + 3x50 + 2x12.5	6	Thyristor	LTXL	7%	HSF	dsine MCCB	2200 x 1200 x 1200
LTAPFU3001B2	300	1x100 + 3x50 + 2x25	6	Contactora	LTXL	-	HRCF	dsine MCCB	2100 x 1200 x 700
LTAPFU3002B2	300	1x100 + 3x50 + 2x25	6	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1200 x 1200
LTAPFU3003B2	300	1x100 + 3x50 + 2x25	6	Thyristor	LTXL	7%	HSF	dsine MCCB	2200 x 1200 x 1200
LTAPFU3501B2	350	1x100 + 3x50 + 4x25	8	Contactora	LTXL	-	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFU3502B2	350	1x100 + 3x50 + 4x25	8	Contactora	LTXL	7%	HRCF	dsine MCCB	2100 x 1400 x 1200
LTAPFU3503B2	350	1x100 + 3x50 + 4x25	8	Thyristor	LTXL	7%	HSF	dsine MCCB	2100 x 1600 x 1200
LTAPFU4001B2	400	2x100 + 2x50 + 4x25	8	Contactora	LTXL	-	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFU4002B2	400	2x100 + 2x50 + 4x25	8	Contactora	LTXL	7%	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFU4003B2	400	2x100 + 2x50 + 4x25	8	Thyristor	LTXL	7%	HSF	dsine MCCB	2000 x 1800 x 1200
LTAPFU4501B2	450	2x100 + 4x50 + 2x25	8	Contactora	LTXL	-	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFU4502B2	450	2x100 + 4x50 + 2x25	8	Contactora	LTXL	7%	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFU4503B2	450	2x100 + 4x50 + 2x25	8	Thyristor	LTXL	7%	HSF	dsine MCCB	2000 x 1800 x 1200
LTAPFU5001B2	500	3x100 + 3x50 + 2x25	8	Contactora	LTXL	-	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFU5002B2	500	3x100 + 3x50 + 2x25	8	Contactora	LTXL	7%	HRCF	dsine MCCB	2000 x 1600 x 1200
LTAPFU5003B2	500	3x100 + 3x50 + 2x25	8	Thyristor	LTXL	7%	HSF	dsine MCCB	2000 x 1800 x 1200

## Overall Dimensions of APFC Panel



### Notes:

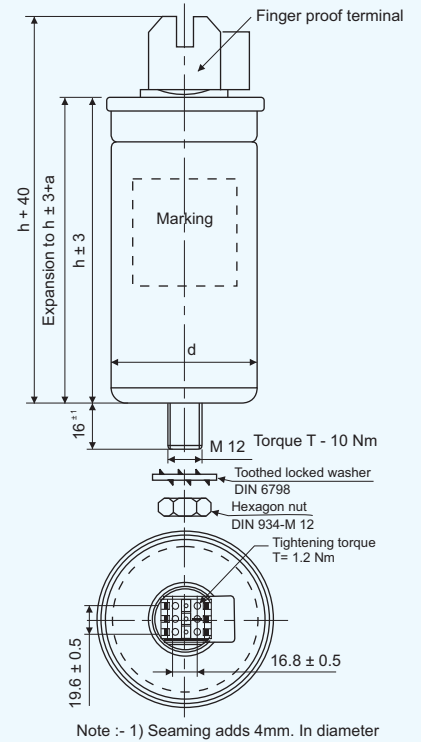
- Wall mounted : upto 100 kVr
- Floor mounted : above 100 kVr
- Recommended front access : 1000mm
- Recommended side clearance : 1000mm
- Paint shade : ral 7032 Powder coated
- Tolerance on dimensions :  $\pm 10$ mm
- Cable entry : bottom

# Dimensions

## Standard Duty Capacitors

### Cylindrical Type

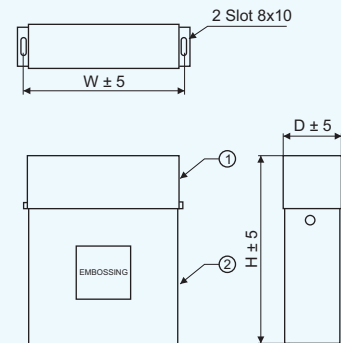
Sr. No.	Voltage	Power rating (kVA <sub>r</sub> )		Capacitance (uF)	Rated current (A)	Dimensions in (mm)		Cat. Nos.
		50 Hz	60 Hz			H	D	
1	440 V	1	1	16.44	1.31	130	45	LTCCF301B2
2	440 V	2	2	32.88	2.62	130	50	LTCCF302B2
3	440 V	3	4	49.32	3.94	165	50	LTCCF303B2
4	440 V	4	5	65.77	5.25	165	63.5	LTCCF304B2
5	440 V	5	6	82.21	6.56	225	63.5	LTCCF305B2
6	440 V	6	7	98.65	7.87	225	63.5	LTCCF306B2
7	440 V	7.5	9	123.31	9.84	195	75	LTCCD307B2
8	440 V	8.33	10	136.96	10.93	195	75	LTCCD308B2
9	440 V	10	12	164.42	13.12	195	85	LTCCD310B2
10	440 V	12.5	15	205.52	16.40	270	85	LTCCD312B2
10	440 V	15	18	246.62	19.68	270	85	LTCCD315B2
10	440 V	20	24	328.83	26.24	345	85	LTCCD320B2
10	440 V	25	30	411.04	32.80	345	90	LTCCD325B2



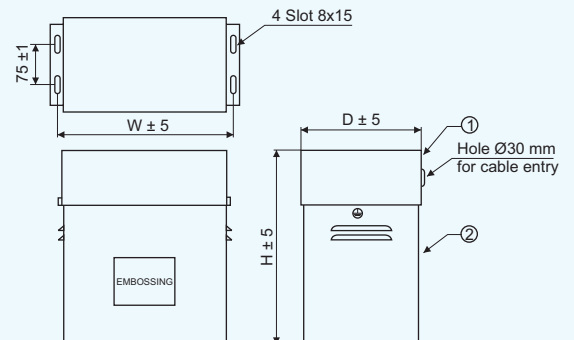
### Box Type

Sr. No.	Voltage	Power rating (kVA <sub>r</sub> )		Capacitance (uF)	Rated current (A)	Dimensions in (mm)			Cat. Nos.
		50 Hz	60 Hz			H	W	D	
1	440 V	1	1	16.44	1.31	125	140	40	LTBCF301B2
2	440 V	2	2	32.88	2.62	125	140	40	LTBCF302B2
3	440 V	3	4	49.32	3.94	145	170	50	LTBCF303B2
4	440 V	4	5	65.77	5.25	145	170	50	LTBCF304B2
5	440 V	5	6	82.21	6.56	175	170	50	LTBCF305B2
6	440 V	6	7	98.65	7.87	175	170	50	LTBCF306B2
7	440 V	7.5	9	123.31	9.84	300	240	80	LTBCD307B2
8	440 V	8.33	10	136.96	10.93	300	240	80	LTBCD308B2
9	440 V	10	12	164.42	13.12	300	240	80	LTBCD310B2
10	440 V	12.5	15	205.52	16.40	300	240	80	LTBCD312B2
11	440 V	15	18	246.62	19.68	300	240	80	LTBCD315B2
12	440 V	20	24	328.83	26.24	300	240	160	LTBCD320B2
13	440 V	25	30	411.04	32.80	300	240	160	LTBCD325B2
14	440 V	30	36	493.25	39.37	300	240	160	LTBCD330B2

#### kVA<sub>r</sub> to 15 kVA<sub>r</sub>

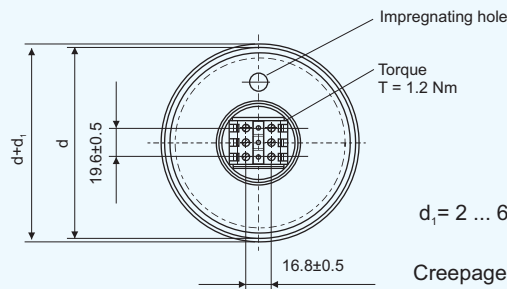
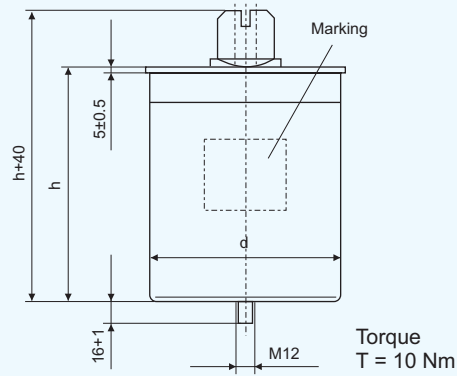


#### 20 kVA<sub>r</sub> to 30 kVA<sub>r</sub>



# Heavy Duty Capacitors

## Cylindrical Type

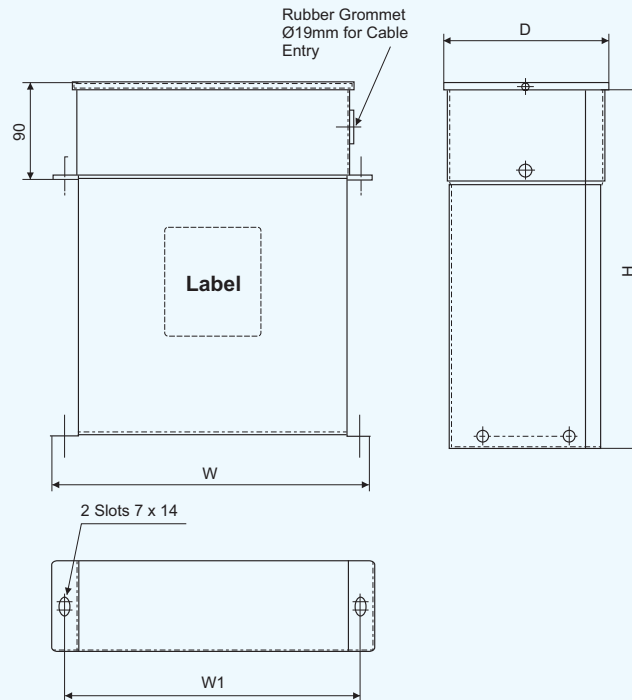


$d_1 = 2 \dots 6$  mm (depending on the capacitor type;  
for details please refer to the data sheet)  
Creepage distance 12.7 mm min. Clearance 9.6 mm min.

Sr. No.	Voltage	Power rating (kVAr)		Capacitance (uF)	Rated current (A)	Dimensions in (mm)		Cat. Nos.
		50 Hz	60 Hz			H	D	
1	440 V	5	6	82.21	6.56	190	64	LTCCN305B2
2	440 V	7.5	9	123.31	9.84	190	64	LTCCN307B2
3	440 V	8.33	10	136.96	10.93	190	64	LTCCN308B2
4	440 V	10	12	164.42	13.12	265	64	LTCCN310B2
5	440 V	12.5	15	205.52	16.40	265	64	LTCCN312B2
6	440 V	15	18	246.62	19.68	190	84.4	LTCCN315B2
7	440 V	20	24	328.83	26.24	265	84.4	LTCCN320B2
8	440 V	25	30	411.04	32.80	265	84.4	LTCCN325B2
9	480 V	5	6	69.08	6.01	190	64	LTCCN305C2
10	480 V	7.5	9	103.62	9.02	190	64	LTCCN307C2
11	480 V	8.33	10	115.08	10.02	190	64	LTCCN308C2
12	480 V	10	12	138.16	12.03	190	84	LTCCN310C2
13	480 V	12.5	15	172.69	15.04	190	84	LTCCN312C2
14	480 V	15	18	207.23	18.04	265	84	LTCCN315C2
15	480 V	20	24	276.31	24.06	265	84	LTCCN320C2
16	480 V	25	30	345.39	30.07	265	84	LTCCN325C2
17	480 V	30	36	414.47	36.09	230	116	LTCCN330C2
18	525 V	5	6	57.74	5.50	190	64	LTCCN305M2
19	525 V	7.5	9	86.61	8.25	190	64	LTCCN307M2
20	525 V	8.33	10	96.20	9.16	190	64	LTCCN308M2
21	525 V	10	12	115.49	11.00	265	65	LTCCN310M2
22	525 V	12.5	15	144.36	13.75	265	65	LTCCN312M2
23	525 V	15	18	173.23	16.50	265	65	LTCCN315M2
24	525 V	20	24	230.97	21.99	265	84	LTCCN320M2
25	525 V	25	30	288.72	27.49	265	84	LTCCN325M2
26	525 V	30	36	346.46	32.99	230	116	LTCCN330M2

# Heavy Duty Capacitors

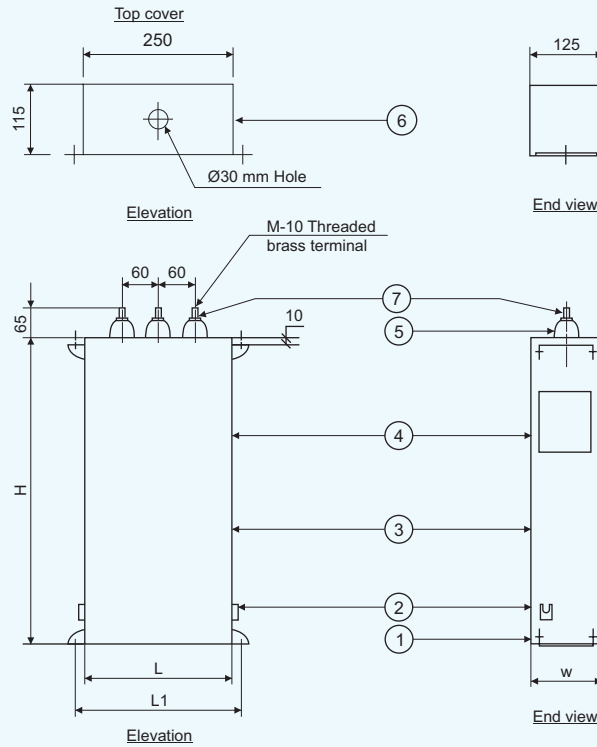
## Box Type



Sr. No.	Voltage	Power rating (kVA <sub>r</sub> )		Capacitance (µF)	Rated current (A)	Dimensions in (mm)			Cat. Nos.
		50 Hz	60 Hz			H	W	D	
1	440 V	5	6	82.21	6.56	240	205	60	LTBCH305B2
2	440 V	7.5	9	123.31	9.84	240	205	60	LTBCH307B2
3	440 V	8.33	10	136.96	10.93	325	263	80	LTBCH308B2
4	440 V	10	12	164.42	13.12	325	263	80	LTBCH310B2
5	440 V	12.5	15	205.52	16.40	325	263	80	LTBCH312B2
6	440 V	15	18	246.62	19.68	325	263	160	LTBCH315B2
7	440 V	20	24	328.83	26.24	325	263	160	LTBCH320B2
8	440 V	25	30	411.04	32.80	325	263	160	LTBCH325B2
9	440 V	30	36	493.25	39.37	325	263	160	LTBCH330B2
10	440 V	50	60	822.08	65.61	375	263	320	LTBCH350B2
11	480 V	5	6	69.08	6.01	240	205	60	LTBCH305C2
12	480 V	7.5	9	103.62	9.02	240	205	60	LTBCH307C2
13	480 V	10	12	138.16	12.03	325	263	80	LTBCH310C2
14	480 V	12.5	15	172.69	15.04	325	263	80	LTBCH312C2
15	480 V	15	18	207.23	18.04	325	263	160	LTBCH315C2
16	480 V	20	24	276.31	24.06	325	263	160	LTBCH320C2
17	480 V	25	30	345.39	30.07	325	263	160	LTBCH325C2
18	480 V	30	36	414.47	36.09	325	263	160	LTBCH330C2
11	525 V	5	6	57.74	5.50	240	205	60	LTBCH305M2
12	525 V	7.5	9	86.61	8.25	240	205	60	LTBCH307M2
13	525 V	10	12	115.49	11.00	325	263	80	LTBCH310M2
14	525 V	12.5	15	144.36	13.75	325	263	80	LTBCH312M2
15	525 V	15	18	173.23	16.50	325	263	160	LTBCH315M2
16	525 V	20	24	230.97	21.99	325	263	160	LTBCH320M2
17	525 V	25	30	288.72	27.49	325	263	160	LTBCH325M2
18	525 V	30	36	346.46	32.99	325	263	160	LTBCH330M2

# LTXL: Ultra Heavy Duty Capacitors

## Box Type

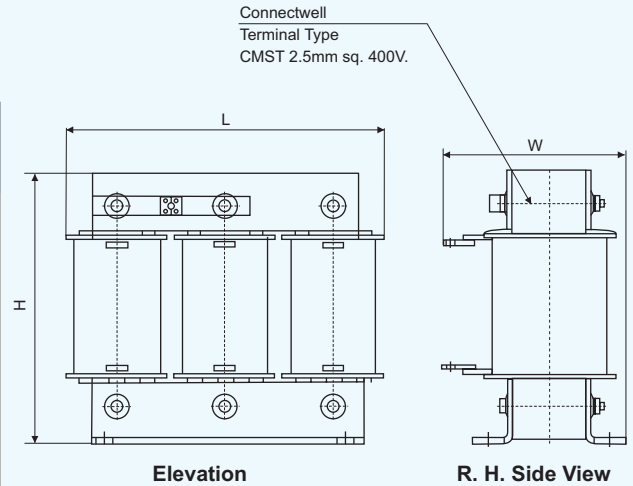


Sr. No.	Voltage	Power rating (kVAR)		Capacitance (uF)	Rated current (A)	Dimensions in (mm)				Cat. Nos.
		50 Hz	60 Hz			L	L1	W	H	
1	440 V	5	6	82.21	6.56	240	270	115	115	LTBCU305B2
2	440 V	7.5	9	123.31	9.84	240	270	115	150	LTBCU307B2
3	440 V	8.33	10	136.96	10.93	240	270	115	150	LTBCU308B2
4	440 V	10	12	164.42	13.12	240	270	115	175	LTBCU310B2
5	440 V	12.5	15	205.52	16.40	240	270	115	200	LTBCU312B2
6	440 V	15	18	246.62	19.68	240	270	115	225	LTBCU315B2
7	440 V	20	24	328.83	26.24	240	270	115	275	LTBCU320B2
8	440 V	25	30	411.04	32.80	240	270	115	325	LTBCU325B2
9	440 V	30	36	493.25	39.37	240	270	115	375	LTBCU330B2
10	440 V	50	60	822.08	65.61	240	270	115	575	LTBCU350B2
11	480 V	5	6	69.08	6.01	240	270	115	100	LTBCU305C2
12	480 V	7.5	9	103.62	9.02	240	270	115	150	LTBCU307C2
13	480 V	10	12	138.16	12.03	240	270	115	150	LTBCU310C2
14	480 V	12.5	15	172.69	15.04	240	270	115	175	LTBCU312C2
15	480 V	15	18	207.23	18.04	240	270	115	200	LTBCU315C2
16	480 V	20	24	276.31	24.06	240	270	115	250	LTBCU320C2
17	480 V	25	30	345.39	30.07	240	270	115	300	LTBCU325C2
18	480 V	30	36	414.47	36.09	240	270	115	325	LTBCU330C2
19	480 V	50	60	690.78	60.14	240	370	115	500	LTBCU350B2
20	525 V	5	6	57.74	5.50	340	370	115	100	LTBCU305M2
21	525 V	7.5	9	86.61	8.25	340	370	115	115	LTBCU307M2
22	525 V	8.33	10	96.20	9.16	340	370	115	125	LTBCU308M2
23	525 V	10	12	115.49	11.00	340	370	115	125	LTBCU310M2
24	525 V	12.5	15	144.36	13.75	340	370	115	150	LTBCU312M2
25	525 V	15	18	173.23	16.50	340	370	115	175	LTBCU315M2
26	525 V	20	24	230.97	21.99	340	370	115	200	LTBCU320M2
27	525 V	25	30	288.72	27.49	340	370	115	250	LTBCU325M2
28	525 V	30	36	346.46	32.99	340	370	115	275	LTBCU330M2
29	525 V	50	60	577.43	54.99	340	370	115	425	LTBCU350M2



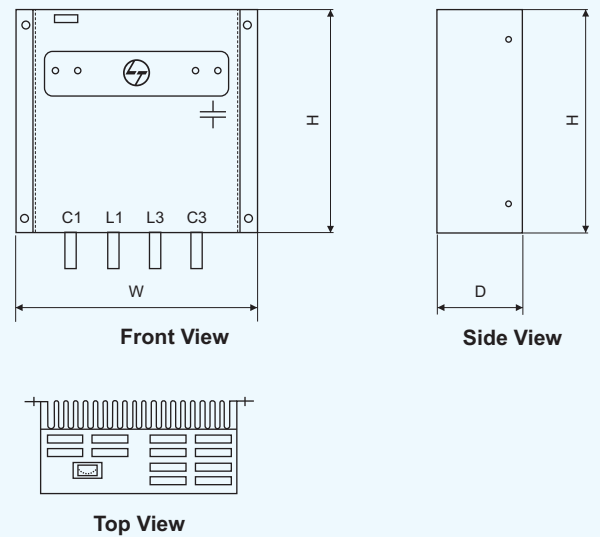
## 7% Detuned Copper Reactor (440 V)

kvar	Cat. Nos.	Rated current (A)	Inductance (mH)	L (mm)	W (±5 mm)	H (mm)
5	LTFR0705B2	7.5	9.28 mH	175	96	157
10	LTFR0710B2	14.9	4.64 mH	178	125	161
15	LTFR0715B2	22.4	3.1 mH	225	150	230
20	LTFR0720B2	29.8	2.33 mH	226	152	205
25	LTFR0725B2	37.2	1.86 mH	226	152	205
50	LTFR0750B2	74.5	0.93 mH	260	207	240
75	LTFR0775B2	122.2	0.62 mH	300	182	270
100	LTFR0700B2	148.9	0.46 mH	305	204	270



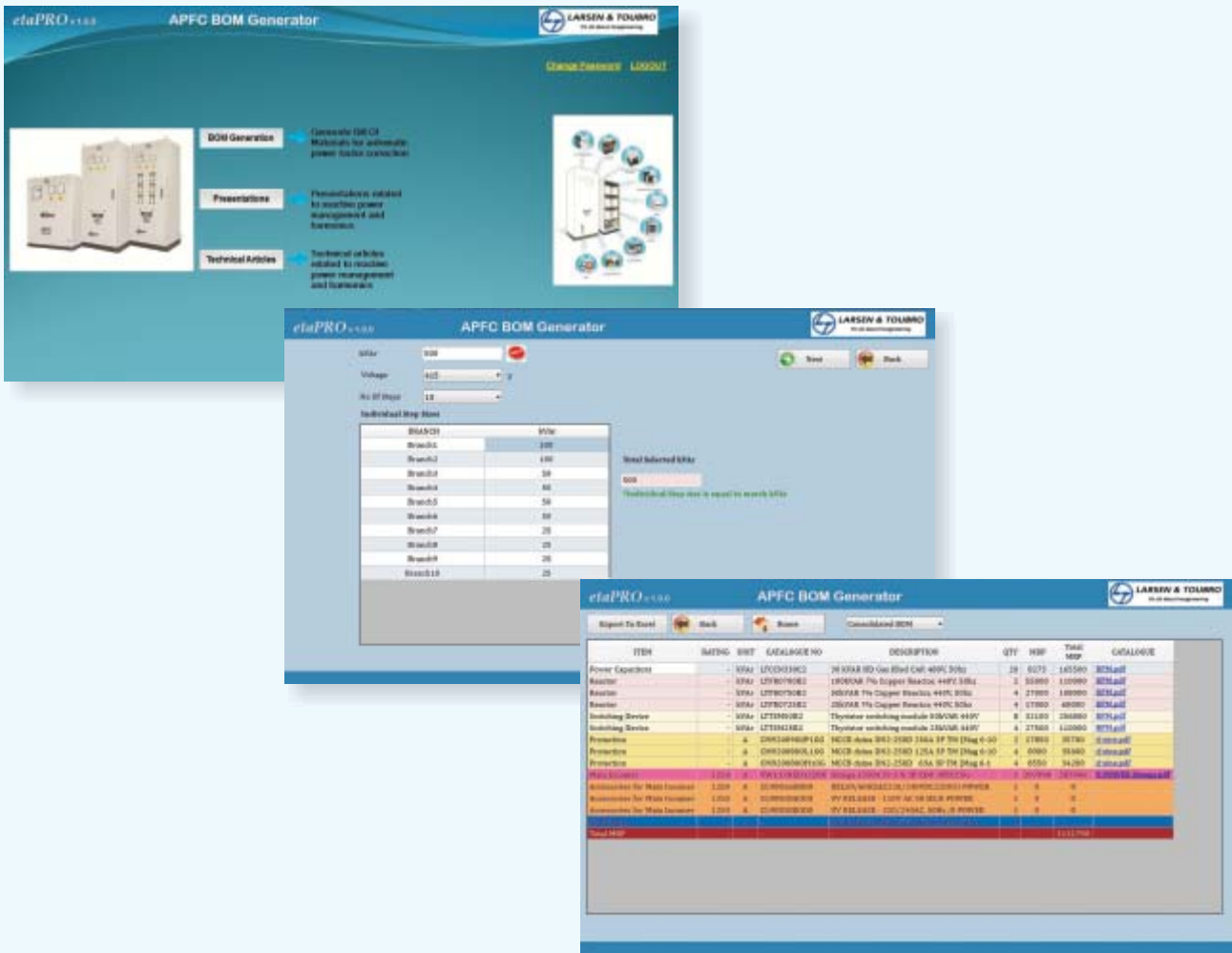
## Thyristor Switching Modules

Rating (kVAR)	Max. RMS Current (A)	Dimensions in (mm)			Cat. Nos.
		W	D	H	
10	20	153	75	153	LTTSM10B2
25	50	156	171	200	LTTSM25B2
50	100	156	171	200	LTTSM50B2



## Ordering Information of Capacitors

Cat. No.	L	T	C	C	S	3	2	5	B	2
	L&T Capacitors		Type		Duty	Phase	kVAR Rating		Voltage	
			C - Cyl		F, S - Standard	3P - 3			B - 440 V	
			B - Box		H - Heavy				C - 480 V	
					N - Heavy gas filled				A - 415 V	
					U - Ultra heavy LTXL				H - 525 V	
									W - 690 V	
									Y - 850 V	
									Z - 1000 V	



A software package developed specially for generating bill of materials for Automatic Power Factor Correction Panels. *etaPRO* is an innovative and user friendly software package, which also incorporates some technical presentations and articles on basics and correct practices in the area of Reactive Power Management.

**Features of etaPRO :**

- BoM generation up to 1400 kVAr panels with maximum 14 steps
- Auto-calculation of rated in-comer and branch currents
- Switchgear selection options for main in-comer (ACB, MCCB and SDF) and branch protection (MCCB, SDF and HRC Fuse)
- Accessories selection for the selected switchgear
- Capacitors and reactor selection
- Instant catalogue access for selected switchgear/capacitors
- Final BoM in two forms:
  - Branch-wise list of items
  - Consolidated list of item
- Simple user interface and pleasant GUI

**Benefits of etaPRO :**

**End customers and panel builders will be benefitted by the following ways:**

- Error free switchgear ratings selection
- Time saving while preparing APFC quotations
- Optimum step size selection
- Automatic selection of capacitor-reactor combinations
- BoM can be exported to Microsoft Excel format



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**Mumbai 400 001**  
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Fax: 022-67525858  
Website: www.Larsentoubro.com

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