Electrical Standard Products (ESP) Branch Offices:

REGISTERED OFFICE AND HEAD OFFICE
L&T House, Ballard Estate
P. O. Box 278
Mumbai 400 001
Tel: 022-6752 5656
Fax: 022-6752 5858
Website: www.Larsentoubro.com

ELECTRICAL STANDARD PRODUCTS (ESP)
501, Sakar Complex I
Opp. Gandhigram Rly. Station
Ashram Road
Ahmedabad 380 009
Tel: 079-66304007-11
Fax: 079-26580491 / 66304025
e-mail: esp-ahm@LNTEBG.com

38, Cubbon Road, Post Box 5098
Bangalore 560 001
Tel: 080-25020100, 25593613
Fax: 080-25580525
e-mail: esp-blr@LNTEBG.com

131/1, Zone II
Maharana Pratap Nagar
Bhopal 462 011
Tel: 0755-4098706 / 7 / 8 / 9
Fax: 0755-2769264
e-mail: esp-bho@LNTEBG.com

Plot No. 559, Annapurna Complex
Lewis Road
Bhubaneswar 751 014
Tel: 0674-6451342, 2436696
Fax: 0674-2537309
e-mail: esp-bbi@LNTEBG.com

SCO 32, Sector 26-D
Madhya Marg, P. O. Box 14
Chandigarh 160 026
Tel: 0172-4646841 to 7
Fax: 0172-4646802
e-mail: esp-chd@LNTEBG.com

10, Club House Road
Chennai 600 002
Tel: 044-28462072 / 4 / 5 / 2109
Fax: 044-28462102 / 3
e-mail: esp-maa@LNTEBG.com

67, Appuswamy Road
Post Bag 7156
Opp. Nirmala College
Coimbatore 641 045
Tel: 0422-2588120 / 1 / 5
Fax: 0422-2588148
e-mail: esp-cbe@LNTEBG.com

L&T House, Group MIG - 5
Padmanabhpur
Durg 491 001
Tel: 0788-2213833 / 14 / 28 / 29
Fax: 0788-2213820

A1/11, Astronauts Avenue
Bidhan Nagar
Durgapur 713 212
Tel: 0343-2536891 / 8952 / 7844
Fax: 0343-2536493
e-mail: esp-dgp@LNTEBG.com

Milanpur Road, Bamuni Maidan
Guwahati 781 021
Tel: 0361-2651297
Fax: 0361-2551308
e-mail: esp-gau@LNTEBG.com

II Floor, Vasantha Chambers
5-10- 173, Fateh Maidan Road
Hyderabad 500004
Tel: 040-66720250
Fax: 040-23296468
e-mail: esp-hyd@LNTEBG.com

D-24, Prithvi Raj Road, C-Scheme
Jaipur 302 001
Tel: 0141-2385916 / 8
Fax: 0141-2373280
e-mail: esp-jai@LNTEBG.com

Akashdeep Plaza, 2nd Floor
P. O. Golmuri
Jamshedpur 831 003
Jharkhand
Tel: 0657-2340864 / 387
Fax: 0657-2341250
e-mail: esp-jam@LNTEBG.com

Skybright Bldg. M. G. Road
Ravipuram Junction, Ernakulam
Kochi 682 016
Tel: 0484-4409420 / 4 / 5 / 7
Fax: 0484-4409426
e-mail: esp-cok@LNTEBG.com

3-B, Shakespeare Sarani
Kolkata 700 071
Tel: 033-44002572 / 3 / 4
Fax: 033-22822589
e-mail: esp-ccu@LNTEBG.com

A28,Indira Nagar, Faizabad Road
Uttar Pradesh,
Lucknow 226 016
Tel: 0522-2312904 / 5 / 6
Fax: 0522-2311671
e-mail: esp-Lko@LNTEBG.com

Plot No. 518
4th Main Road
K. K. Nagar
Madurai 625 020
Tel: 0452-2537404, 2521068
Fax: 0452-2537552
e-mail: esp-mdu@LNTEBG.com

EBG North Wing Office - 2
Powai Campus
Mumbai 400 072
Tel: 022-67052874 / 2737 / 1156
Fax: 022-67051112
e-mail: esp-bom@LNTEBG.com

#12, Shivaji Nagar
North Ambazari Road
Nagpur 440 010
Tel: 0712- 2260012 / 3
Fax: 0712- 2260020 / 30
e-mail: esp-nag@LNTEBG.com

32, Shivaji Marg
P. O. Box 6223
New Delhi 110 015
Tel: 011-41419514 / 5 / 6
Fax: 011-41419600
e-mail: esp-del@LNTEBG.com

L&T House
P. O. Box 119
191/1, Dhole Patil Road
Pune 411 001
Tel: 020-26135048
Fax: 020-26124910, 26135048
e-mail: esp-pnq@LNTEBG.com

3rd Floor
Vishwakarma Chambers
Majura Gate, Ring Road
Surat 395 002
Tel: 0261-2473726
Fax: 0261-2477078
e-mail: esp-sur@LNTEBG.com

Radhadaya Complex
Old Padra Road
Near Charotar Society
Vadodara 390 015
Tel: 0265- 2311744 / 6613610 / 1 / 2
Fax: 0265-2336184
e-mail: esp-bar@LNTEBG.com

48-8-16, Dwarakanagar
Visakhapatnam 530 016
Tel: 0891-6620411-2 / 3
Fax: 0891-6620416
e-mail: esp-viz@LNTEBG.com

Product improvement is a continuous process. For the latest information and special applications, please contact any of our offices listed here.

L&T SWITCHGEAR
SAFE & SURE

Electrical Standard Products
Larsen & Toubro Limited
Powai Campus, Mumbai 400 072
Customer Interaction Center (CIC)
BSNL / MTNL (toll free) : 1800 233 5858
Reliance (toll free) : 1800 200 5858
Tel : 022 6774 5858
Fax : 022 6774 5859
E-mail : cic@LNTEBG.com
Website: www.LNTEBG.com

LARSEN & TOUBRO
It's all about Imagineering

SP 50481

251109

Reactive Power Management Products

L&T SWITCHGEAR
SAFE & SURE

LARSEN & TOUBRO
It's all about Imagineering

About us

Larsen & Toubro is a technology-driven USD 8.5 billion company that infuses engineering with imagination. The Company offers a wide range of advanced solutions in the field of Engineering, Construction, Electrical & Electronics, Machinery and Information Technology.

L&T Switchgear, which forms 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 four decades of experience in this field, the Company today enjoys a leadership position in the Indian market with growing presence in international markets.

It offers a complete range of products including controlgear, powergear, motor starters, energy meters, wires and host of other accessories. Most of our product lines conform to international standards, carry CE markings and are *KEMA* certified.

Contents

Reactive Power Management Products

Range of Capacitors

Power Capacitors

Cylindrical Type

- Standard Duty

Range from 1-25 kVAr

- Heavy Duty Gas Filled / Heavy Duty

Range from 5-25 kVAr

Box Type

- Standard Duty

Range from 5-50 kVAr

- Heavy Duty

Range from 5-50 kVAr

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 deg lagging with respect to active power as shown in figure1. Figure 2 & 3 show the flow of kW, kVAr and kVA in a network.

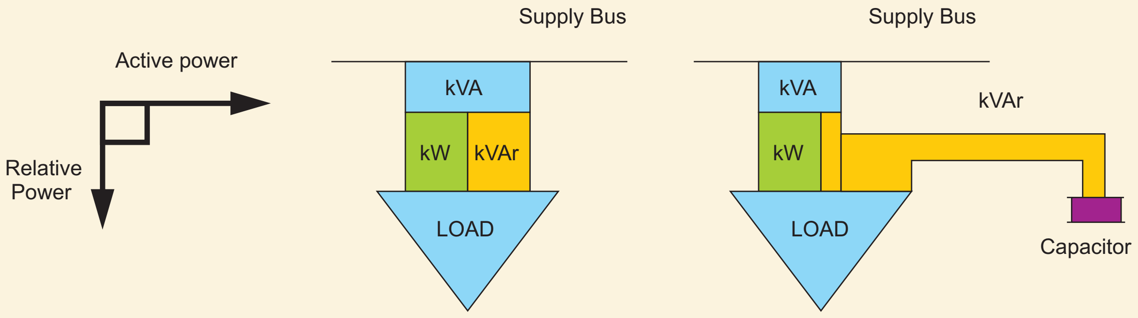


Figure 1 : Phase relationship between Active and Relative power

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.

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 evolve 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: Average PF = kW/kVA

Operating load kW = kV Demand x 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

kVAr = kW x multiplying factor from table = 500 x 0.590 = 295 kVAr

Note: Table is based on the following formula: kVAr required = kW ($\tan\O_1 - \tan\O_2$)
where $\O_1 = \cos^{-1}(PF_1)$ and $\O 2 = \cos^{-1}(PF_2)$.

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	0.061	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	0.699	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 Capacitors

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

- Standard duty
- Heavy duty
- Super Heavy duty
- 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	Temperature	Maximum switching operations/ year
Standard	1.5 x In	1.1 Un	200 x In	-25°C to 55°C	50000
Heavy Duty	1.8 x In	1.2 Un	300 x In	-25°C to 55°C	6000
Ultra Heavy	2.5 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:

Installed transformer rating = 1000 kVA
Non-linear loads = 100 kVA
%non-linear loads= (non-linear loads/transformer rating) x 100
= (100/1000) x 100
= 10%
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
$\leq$ 10%	Standard Duty
Upto 15%	Heavy Duty
Upto 25%	Ultra Heavy Duty
Above 25% $\leq$ 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 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, Super Heavy duty and Ultra Heavy duty. The Standard duty capacitors are manufactured using standard thickness of dielectric material with heavy edge metallization. Super 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.

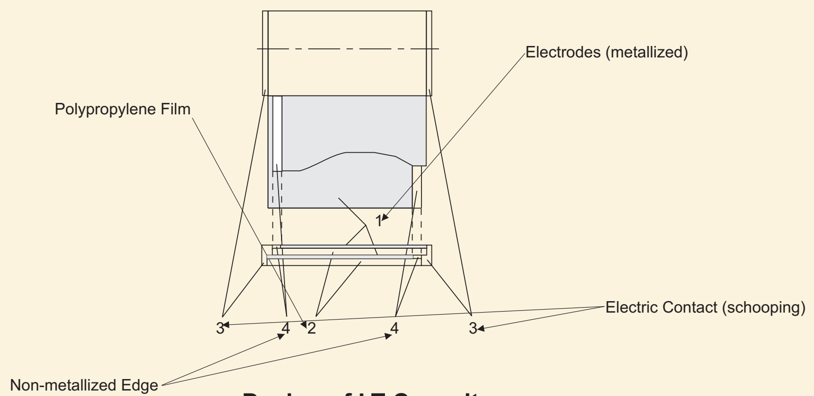
Step 5: To Achieve Transcent Free Unity PF

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 loads, fast presses etc.

Capacitor Technology

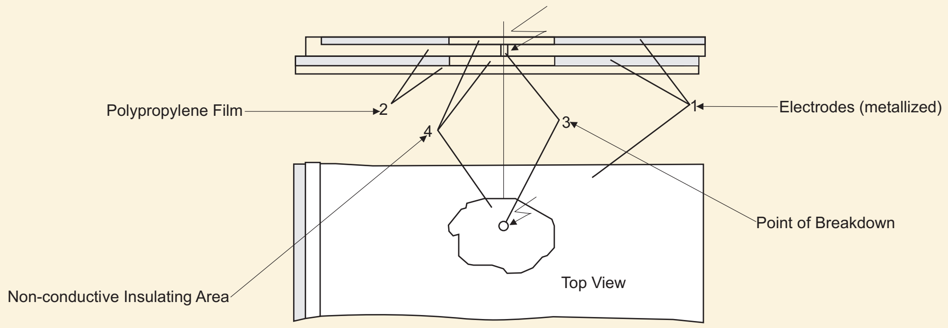
Capacitors are used in many diverse applications, and many different capacitor technologies are available. In low voltage applications, LT cylindrical capacitors which are made in accordance with metallized polypropylene technology have proved to be most appropriate and also the most cost effective.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

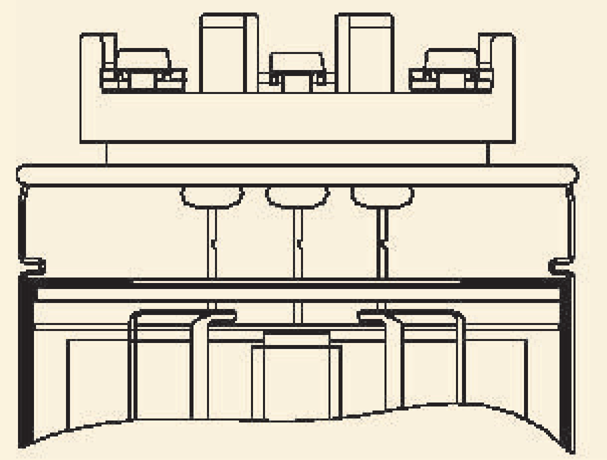
Self-Healing Breakdown

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.

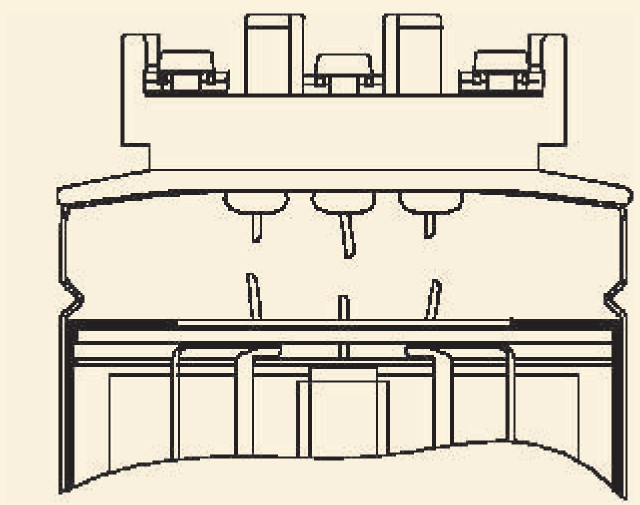
Over pressure Tear-off Fuse

At the end of service life, due to inadmissible electrical or thermal overload, an overpressure 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 of 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 5-50kVAr 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 disconnector and finger proof terminals. They can be used to provide effective power factor correction in industrial and semi industrial applications.

Technical Details

	Cylindrical	Box
Range (kVAr)	1-25	5-100
Standards	IEC 60831	IEC 60831
Impregnation	Resin	Resin
Over Voltage withstand		
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
Over Current withstand	1.5*In	1.5*In
Inrush Current withstand	200*In	200*In
No of Operations/ year	5000	5000
Terminals	Clamptite	Clamptite
Ambient Temperature	-25/D	-25/D
Operating Losses Dielectric	<0.2W/kVAr	<0.2W/kVAr
Operating losses Total	<0.45W/kVAr	<0.45W/kVAr

Heavy Duty Capacitors

L&T Heavy Duty Capacitors are available from 1-30kVAr in cylindrical and box type construction. These capacitors have an inrush current withstand of 300 In and an overload withstand capacity of 1.8In. These capacitors have all features of standard capacitors however; these are dry type capacitors.

Gas Filled Capacitors

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

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 power factor correction or 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

Standards	IEC 60289
Rated Voltage (V)	440
Rated Frequency (F)	50
Max Permissible Operating Voltage	1.05Un Continuously, 1.1Un for 8 hours
Max Permissible Operating Current	1.06In High Linearity, 1.75In Continuously
Duty Cycle	100%
Class of Protection	I
Ambient Temperature	40
Insulation Class	Class F
Protection	Thermal Switch
De-Tuning	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.

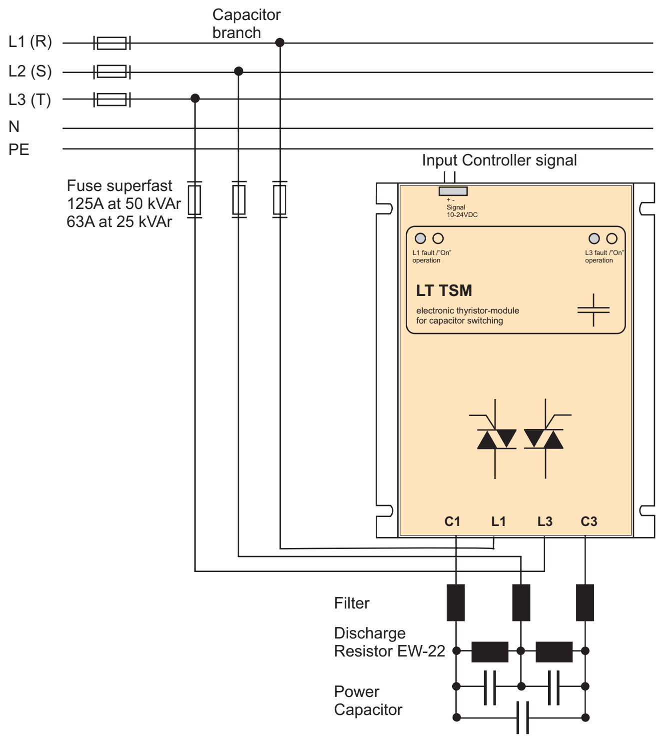
The solutions for this are dynamic power factor correction systems. With the thyristor module we provide the main component-“The Electronic Switch”-for dynamic powerfactor correction. The LT-TSM module series offers fast electronically controlled, self-observing thyristor switches for capacitive loads 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 display of operations, faults and activation.

Technical Details

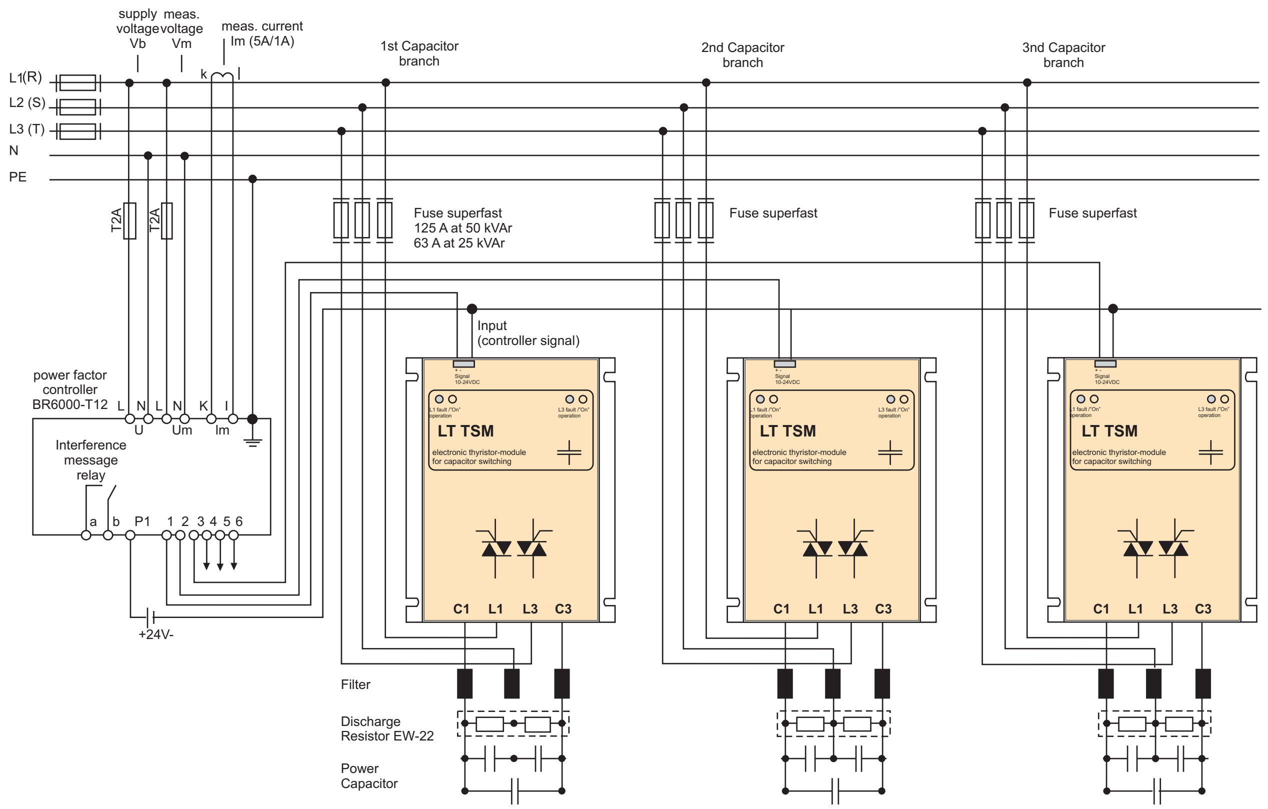
	LT TSM 12	LT TSM 25	LT TSM 50
Rated Voltage (V)		440V	
Frequency (Hz)		50/60	
Rating (kVAr)	12.5	25	50
Losses PD (W)	35	75	150
LED Display per Phase	2	2	2
Ambient Temperature (°C)		-10 to 55	
Aux. Supply Voltage Required		No	
Reaction Time (msec)		5	

Network of Thyristor Switching Modules

Dynamic PFC Network: Single stage



Dynamic PFC Network: Multiple stages



Note: Automatic Power Factor Correction Panels retain current data

Automatic Power Factor Correction Panel

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, maloperation 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 on 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 outs etc.
- To protect against any electrical faults in a manner that will ensure safe isolation of the power factor correction equipment

Salient Features:

Modular design which allows easy handling by the user and also capable of being extended/upgraded. The incoming switchgear provided has 9 kA, for 5 to 25 kVAr & 25 kA, for 25 < 50 kVAr fault interrupting capability. Copper busbar system suitable for withstanding 50 kA fault current. Minimal joints in all the connections to ensure better reliability and lower losses.

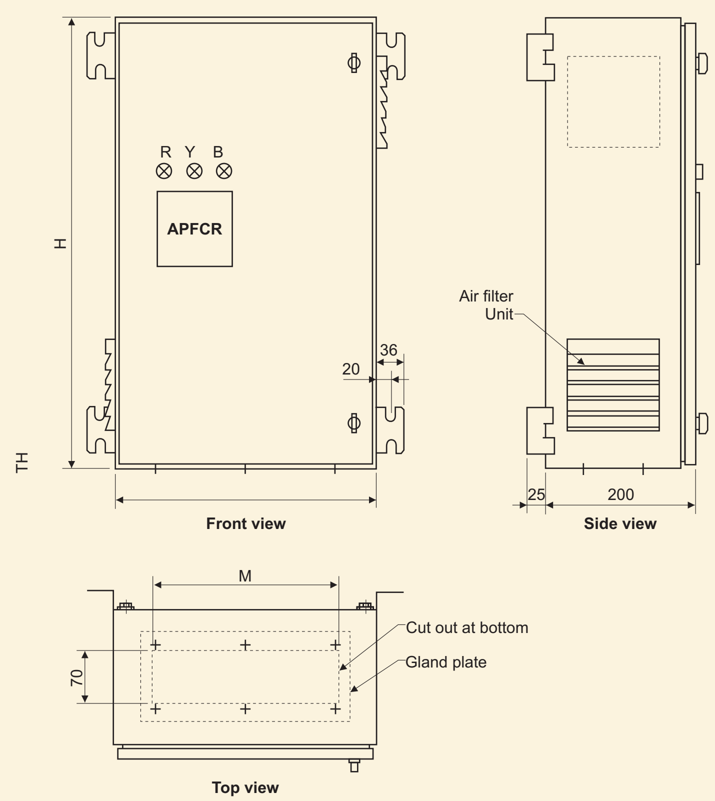
MINI VAr - Automatic Power Factor Control Panel suitable for 3Ph, 440V AC 50 Hz Auto

Power Range	5 kVAr, to 50 kVAr
Rated Voltage	440 V
Rated Frequency	50 H
Short Circuit Rating	9 kA, for 5 to 25 kVAr & 25 kA, for 25 < 50 kVAr
Altitude	1000 m
Duty	Continuous
Ambient temperature	-5°C to + 40°C
Standards	IEC-61921
Power Supply	Three phase, four line
Relay current input signal	-- / 5A, from CT on line
Relay voltage input signal	Tapped internally
The Enclosure	The basic structure is made of 1.2 mm sheet steel The front door is made of 1.6 mm sheet steel And the mounting plate of components is of 2 mm The internal components are accessible on opening the front door The protection rating is IP42 / IP52
Installation	Indoor, wall mounted, in a well ventilated non-dusty environment, cable entry from bottom
Incomer	A four pole MCB, upto 25 kVAr, and a three - pole MCCB, above 25 kVAr Using FRLS cable, of adequate section
Internal wiring	Cylindrical, dry type three phase units (see table for step ratings)
Capacitors	The capacitors are equipped with discharge device, and over pressure device Three pole Capacitor duty contactors of adequate ratings for respective steps
Contactors	A microprocessor based relay with 4 / 6 out put contacts for switching contactors
The controller Protection	Having PF indication, built in time delays, and alarm indication for CT reversal Apart from the protections associated with the capacitor itself, there is a thermostat which disconnect the entire panel in the event of excessive temperature rise in the enclosure. As a safety measure, an inter lock is provided so that when the front door is opened, the entire panel will trip

Table of Step Ratings

Rating	Steps x kVAr	Capacitor Steps in kVAr					Switching	Dimensions
kVAr	N x Q	C1	C2	C3	C4	C5	Sequence	W x H x D
5	5 x 1	1	2	2			1:2:2	300, 600, 200
8	8 x 1	1	2	2	3		1:2:2:3	300, 600, 200
10	10 x 1	1	2	3	4		1:2:3:4	300, 600, 200
12.5	5 x 2.5	2.5	5	5			1:2:2	300, 600, 200
15	6 x 2.5	2.5	5	7.5			1:2:3	300, 600, 200
20	8 x 2.5	2.5	2.5	5	10		1:1:2:4	300, 600, 200
25	10 x 2.5	2.5	5	7.5	10		1:2:3:4	300, 600, 200
35	7 x 5	5	5	5	10	10	1:1:1:2:2	500, 700, 200
40	8 x 5	5	10	10	15		1:2:2:3	500, 700, 200
50	10 x 5	5	5	10	15	15	1:1:2:3:3	500, 700, 200

Overall Dimensional of APFC Panel



Rating	L	H	M
kVAr	mm	mm	mm
</= 25	350	600	250
Upto 50	500	700	400

Notes:

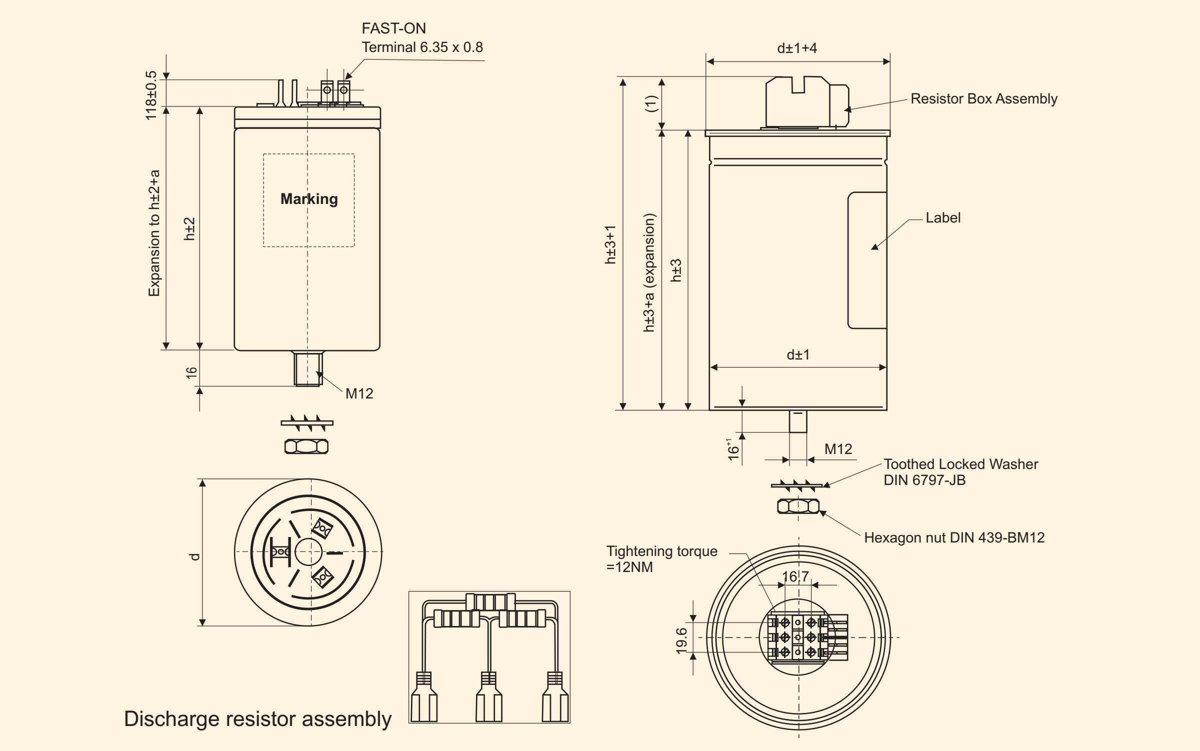
- Recommended front access : 800mm
- Recommended side clearance : 200mm
- Paint shade : ral 7035 Powder coated
- Tolerance on dimensions : ±10mm
- Cable entry : bottom

Ordering Information of Capacitors

L	T	C	C	S	3	2	5	B	2
L&t Capacitors		Type		Duty	Phase	Rating		Voltage	
		C-Cyl		S-Std	3P-3				
		B-Box		H-Heavy	1P-1				
				X-Super Heavy					
				G-gasfilled					

Overall Dimension

Cylindrical Type Capacitors



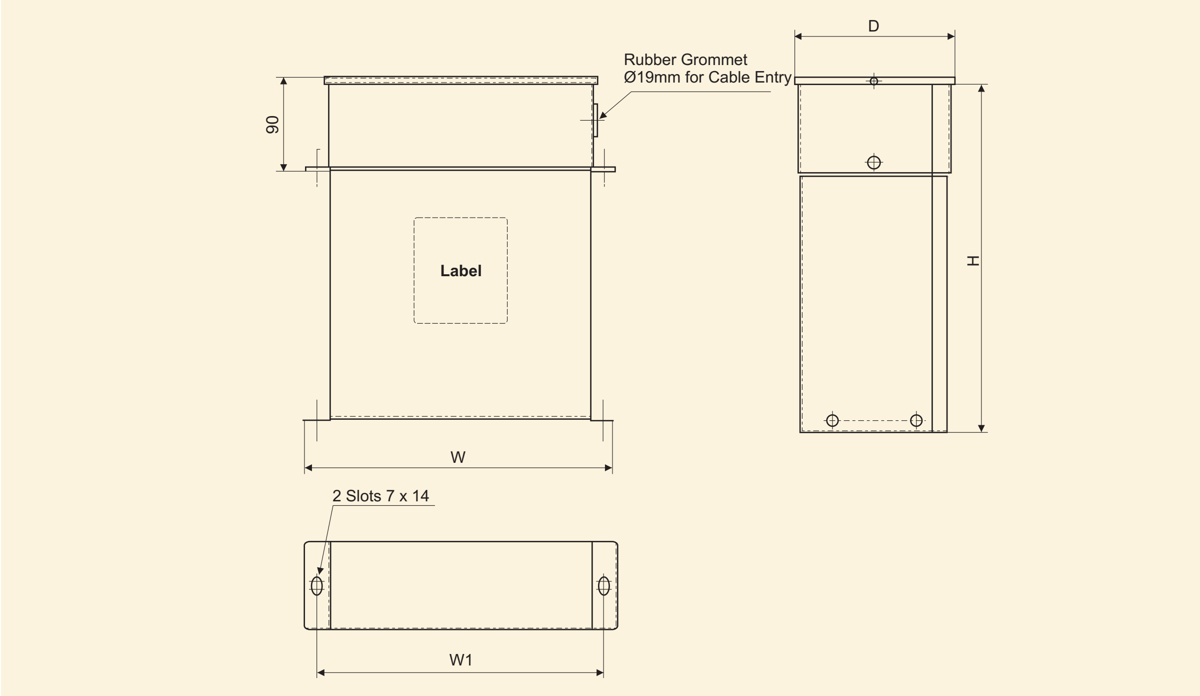
Standard Duty

Sr. No	Voltage (V)	Power (Q) kVAr		Capacitance (µf)	Rated current (A)		Dimension in (mm²)	Cat. Nos.
		50 Hz	60Hz		50 Hz	60Hz	DxH	
1	440	1.0	1.2	5.5	1.31	1.57	53x117	LTCCS301B2
2	440	2.0	2.4	11.0	2.62	3.15	53x117	LTCCS302B2
3	440	3.0	3.6	16.5	3.94	4.72	63.5x130	LTCCS303B2
4	440	4.0	5.0	22.2	5.25	6.30	63.5x130	LTCCS304B2
5	440	5.0	6.0	27.5	6.56	7.87	63.5x154	LTCCS305B2
6	440	7.5	9.0	41.0	9.8	11.8	75x162	LTCCS307B2
7	440	10.0	12.0	55.0	13.1	15.7	75x198	LTCCS310B2
8	440	12.5	15.0	68.5	16.4	19.7	75x270	LTCCS3121B2
9	440	15.0	18.0	82.2	19.7	23.6	75x270	LTCCS315B2
10	440	20.0	25.0	110	26.2	31.5	90x270	LTCCS320B2
11	440	25.0	30.0	137	32.2	39.4	90x270	LTCCS325B2

Heavy Duty

Sr. No	Voltage Vn	kVAr Qn (kVAr)		Capacitance (µf)	Rated current (A)		Dimension in (mm)		Cat. Nos.
		50 Hz	60Hz		50 Hz	60Hz	D	H	
1	440	15	18	83	19.68	23.6	100	280	LTCCH315B2
2	440	20	24	110	26.24	31.5	116	280	LTCCH320B2
3	440	25	30	138	32.8	39.4	116	280	LTCCH325B2

Box Type Capacitors



Standard Duty

Sr. No	Voltage (V)	Power (Q) (kVAr)		Capacitance (µf)	Rated current (A)		Dimensions in (mm)			Cat. Nos.
		50 Hz	60Hz		50 Hz	60Hz	H	W	D	
1	440	7.5	9.0	41.5	9.84	11.8	283	263	80	LTBCS307B2
2	440	8.0	9.60	44.0	10.50		283	263	80	LTBCS308B2
3	440	10.0	12.0	55.0	13.12	15.7	283	263	80	LTBCS310B2
4	440	12.5	15.0	69.0	16.40	19.7	283	263	80	LTBCS312B2
5	440	15.0	18.0	83.0	19.68	23.6	283	263	80	LTBCS315B2
6	440	20.0	24.0	110.0	26.24	31.5	283	263	80	LTBCS320B2
7	440	25.0	30.0	138.0	32.80	39.4	283	263	80	LTBCS325B2

Heavy Duty

Sr. No	Voltage Vn	kVAr Qn (kVAr)		Capacitance (µf)	Rated current (A)		Dimensions in (mm)			Cat. Nos.
		50 Hz	60Hz		50 Hz	60Hz	H	W	D	
1	440	10	12	55	13.1	15.7	325	263	80	LTBCH310B2
2	440	12.5	15	68.5	16.4	19.7	325	263	80	LTBCH312B2
3	440	15	18	82.5	19.7	23.6	325	263	160	LTBCH315B2
4	440	20	25	110	26.2	31.5	325	263	160	LTBCH320B2
5	440	25	30	137	32.8	39.4	375	263	160	LTBCH325B2