

## Three phase low voltage power capacitors LPC

LPC 1..5 kVar

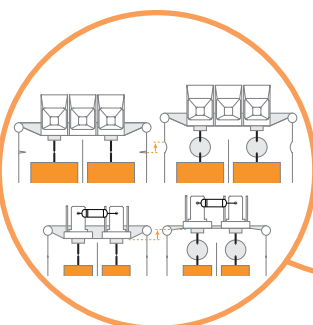


→ Equipped with discharge resistors  
(Discharge time  $\leq 3$  minutes to 75 V)

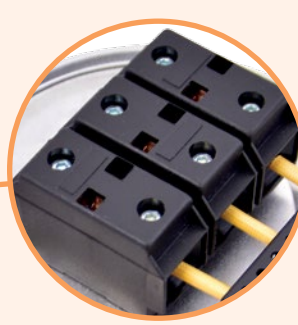
LPC 10..50 kVar



→ Capacitors 1 ... 5 kVar connected with a double FASTON connector  
Included protection cover for electrical parts



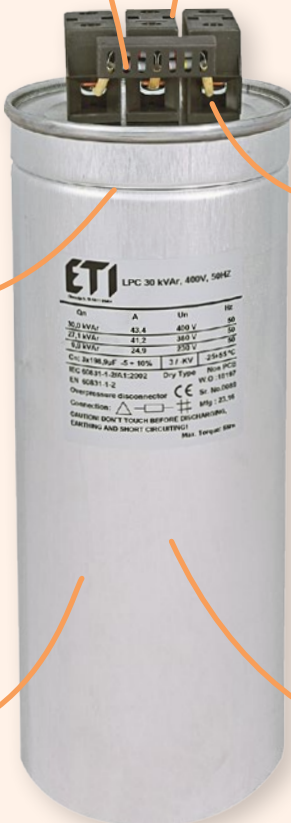
→ Overpressure  
disconnection system



→ 10 ... 50 kVar capacitor terminals with  
universal screws  
(for slot "flat" screwdriver + Allen key  
"Imbus")



→ Vertical use only



→ rated power range: 1 kVar  
to 50 kVar

→ Rated voltage range:  
400, 440 460, 480, 525 V



→ Ground fixation with  
thread, for vertical use only.

## Three Phase Capacitors

Rated voltage: 400-525V, 50Hz (60Hz upon request)

Rated power: 1-50kVar

### APPLICATION

The LPC capacitors are used for reactive power factor correction of inductive consumers (transformers, electric motors, rectifiers, fluorescent lamps and many others in industrial networks) individually or assembled into automatic capacitor banks.

### DESCRIPTION

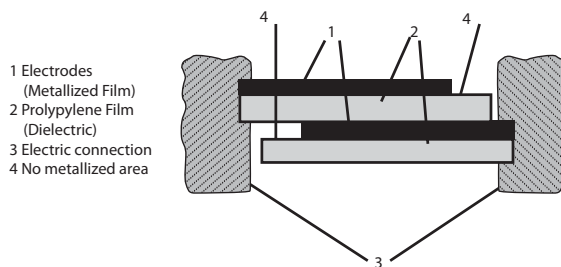
LPC capacitors are manufactured with low loss metallized self-healing polypropylene film. Dry type capacitors are filled with a non-toxic an ecological polyurethane resin, this resin provides an excellent heat dissipation properties. This capacitors are mounted in aluminium housing with overpressure disconnection system. Two types of connectors, faston connector for capacitors with rated power up to 5kVar, for higher values above 5kVar screw terminal type.

### FEATURES:

#### Self healing

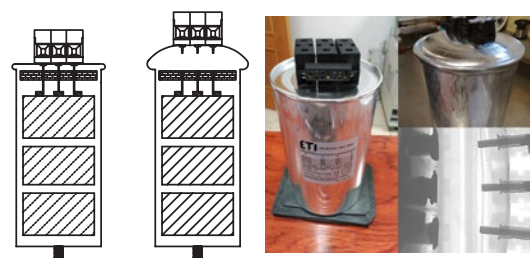
Depending on the values of the constants of every dielectric, there is a limit potential difference, which all materials can manage throughout the thickness. This limit is defined as dielectric strength. Because of determined electric-power system conditions or extreme temperatures, inadmissible for the correct working of the capacitor, this voltage limit can be exceeded. Thus, the dielectric can break down and an electric arc will be formed between the plates.

The propylene film self-healing means that the electric arc will not generate a short circuit, but will evaporate the metal which surrounds the breakthrough point. This way, the isolation between plates is repaired in the latter breakthrough point. After this self-healing, the capacitor can work in normal conditions, with a capacitance leak inferior to 100 pF.



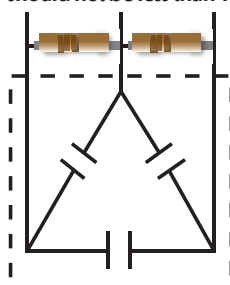
#### Overpressure disconnection system

In order to avoid problems caused by overvoltage, harmonics, high temperatures, etc. capacitors have been designed with an overpressure disconnection system. When the terminal cover expands, the internal connections are interrupted and disconnecting the capacitor.



#### Discharge resistor

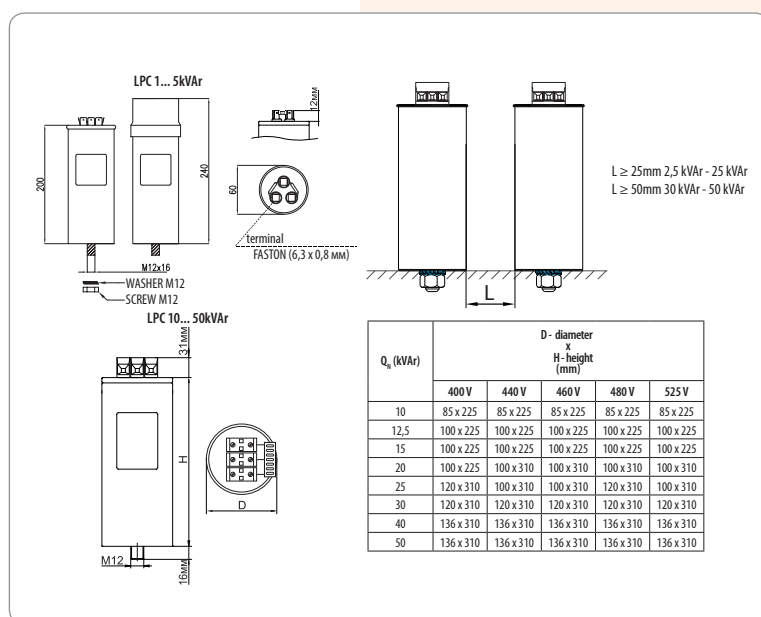
When handling a capacitor, there is a need of taking into account a series of security precautions. When a capacitor is disconnected off the voltage, it remains charged with the supply voltage. If the plates are shorten and touched, they can cause a dangerous accident due to the violent discharge of the capacitor. Three-phase capacitors must also be equipped with a discharge resistor, which can discharge voltage until its maximum value is 75V in an interval of 3 minutes as demanded by standard EN-60831-1/2. ETI's LPC capacitors already have discharge resistors, which ensure that this time is less than 2 minutes. It is therefore recommended that the reconnection time on the PFC controller should not be less than 120s. Except in case of using extra discharge resistors (page 313).



$$U_{(t)} = U_o e^{-\frac{t}{RC}}$$

### Three phase low voltage power capacitors LPC

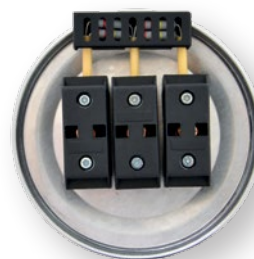
Rated voltage at 50Hz	Code No.	Type	Rated Power [kVAr]	Rated capacitance [uF]	Rated current [A]	D (diameter) x H (Height) [mm]	Terminal type	Weight [kg]	Packaging [pcs]
400	004656700	LPC 1 kVAr, 400V, 50Hz	1	3x 6,6	1,4	60x200	Faston	0,75	1
400	004656701	LPC 1.5 kVAr, 400V, 50HZ	1,5	3x 9,9	2,2		Faston	0,75	1
400	004656702	LPC 2.5 kVAr, 400V, 50HZ	2,5	3x 16,6	3,6	60x210	Faston	0,75	1
400	004656703	LPC 3 kVAr, 400V, 50HZ	3	3x 19,9	4,3		Faston	0,75	1
400	004656704	LPC 4 kVAr, 400V, 50HZ	4	3x 26,5	5,8		Faston	0,75	1
400	004656705	LPC 5 kVAr, 400V, 50HZ	5	3x 33,2	7,2		Faston	0,75	1
440	004656710	LPC 2.5 kVAr, 440V, 50HZ	2,5	3x 13,7	3,3	60x210	Faston	0,75	1
440	004656711	LPC 3 kVAr, 440V, 50HZ	3	3x 16,4	3,9		Faston	0,75	1
440	004656712	LPC 4 kVAr, 440V, 50HZ	4	3x 21,9	5,2		Faston	0,75	1
440	004656713	LPC 5 kVAr, 440V, 50HZ	5	3x 27,4	6,6		Faston	0,75	1
460	004656720	LPC 2.5 kVAr, 460V, 50HZ	2,5	3x 12,5	3,1	60x210	Faston	0,75	1
460	004656721	LPC 3 kVAr, 460V, 50HZ	3	3x 15,0	3,8		Faston	0,75	1
460	004656722	LPC 4 kVAr, 460V, 50HZ	4	3x 20,1	5,0		Faston	0,75	1
460	004656723	LPC 5 kVAr, 460V, 50HZ	5	3x 25,1	6,3		Faston	0,75	1
480	004656730	LPC 2.5 kVAr, 480V, 50HZ	2,5	3x 11,5	3,0	60x210	Faston	0,75	1
480	004656731	LPC 3 kVAr, 480V, 50HZ	3	3x 13,8	3,6		Faston	0,75	1
480	004656732	LPC 4 kVAr, 480V, 50HZ	4	3x 18,4	4,8		Faston	0,75	1
480	004656733	LPC 5 kVAr, 480V, 50HZ	5	3x 23,0	6,0		Faston	0,75	1
525	004656740	LPC 2.5 kVAr, 525V, 50HZ	2,5	3x 9,6	2,7	60x210	Faston	0,75	1
525	004656741	LPC 3 kVAr, 525V, 50HZ	3	3x 11,5	3,3		Faston	0,75	1
525	004656742	LPC 4 kVAr, 525V, 50HZ	4	3x 15,4	4,4		Faston	0,75	1
525	004656743	LPC 5 kVAr, 525V, 50HZ	5	3x 19,2	5,5		Faston	0,75	1

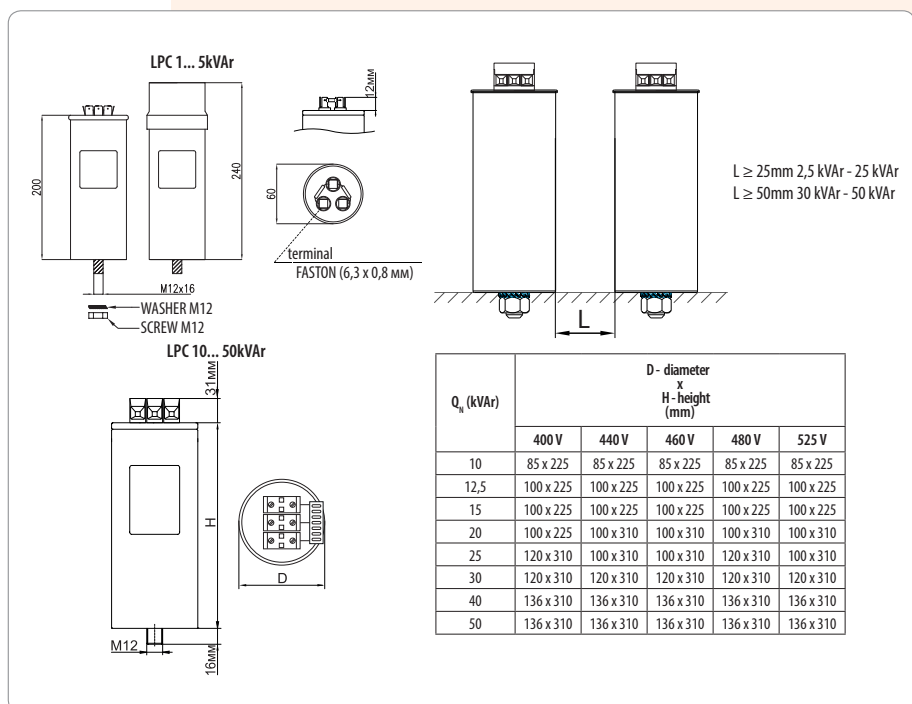


## Three Phase Capacitors

Three phase low voltage power capacitors LPC

Rated voltage at 50Hz	Code No.	Type	Rated Power [kVar]	Rated capacitance [uF]	Rated current [A]	D (diameter) x H (Height) [mm]	Terminal type	Weight [kg]	Packaging [pcs]
400	004656750	LPC 10 kVar, 400V, 50HZ	10	3x 66,3	14,4	85x225	Screw terminal	1,6	1
400	004656751	LPC 12.5 kVar, 400V, 50HZ	12,5	3x 82,9	18,0	100x225	Screw terminal	2,2	1
400	004656752	LPC 15 kVar, 400V, 50HZ	15	3x 99,5	21,7	100x225	Screw terminal	2,2	1
400	004656753	LPC 20 kVar, 400V, 50HZ	20	3x 132,6	28,9	100x225	Screw terminal	2,2	1
400	004656754	LPC 25 kVar, 400V, 50HZ	25	3x 165,8	36,1	120x310	Screw terminal	2,9	1
400	004656755	LPC 30 kVar, 400V, 50HZ	30	3x 198,9	43,3	120x310	Screw terminal	3,9	1
400	004656756	LPC 40 kVar, 400V, 50HZ	40	3x 265,3	57,7	136x310	Screw terminal	5,1	1
400	004656757	LPC 50 kVar, 400V, 50HZ	50	3x 331,6	72,2	136x310	Screw terminal	5,1	1
440	004656760	LPC 10 kVar, 440V, 50HZ	10	3x 54,8	13,1	85x225	Screw terminal	1,6	1
440	004656761	LPC 12.5 kVar, 440V, 50HZ	12,5	3x 68,5	16,4	100x225	Screw terminal	2,2	1
440	004656762	LPC 15 kVar, 440V, 50HZ	15	3x 82,2	19,7	100x225	Screw terminal	2,2	1
440	004656763	LPC 20 kVar, 440V, 50HZ	20	3x 109,6	26,2	100x310	Screw terminal	2,9	1
440	004656764	LPC 25 kVar, 440V, 50HZ	25	3x 137,0	32,8	100x310	Screw terminal	2,9	1
440	004656765	LPC 30 kVar, 440V, 50HZ	30	3x 164,4	39,4	120x310	Screw terminal	3,9	1
440	004656766	LPC 40 kVar, 440V, 50HZ	40	3x 219,2	52,5	136x310	Screw terminal	5,1	1
440	004656767	LPC 50 kVar, 440V, 50HZ	50	3x 274,0	65,6	136x310	Screw terminal	5,1	1
460	004656770	LPC 10 kVar, 460V, 50HZ	10	3x 50,1	12,6	85x225	Screw terminal	1,6	1
460	004656771	LPC 12.5 kVar, 460V, 50HZ	12,5	3x 62,7	15,7	100x225	Screw terminal	2,2	1
460	004656772	LPC 15 kVar, 460V, 50HZ	15	3x 75,2	18,8	100x225	Screw terminal	2,2	1
460	004656773	LPC 20 kVar, 460V, 50HZ	20	3x 100,3	25,1	100x310	Screw terminal	2,9	1
460	004656774	LPC 25 kVar, 460V, 50HZ	25	3x 125,4	31,4	100x310	Screw terminal	2,9	1
460	004656775	LPC 30 kVar, 460V, 50HZ	30	3x 150,4	37,7	120x310	Screw terminal	3,9	1
460	004656776	LPC 30.8 kVar, 460V, 50HZ	30,8	3x 154,4	38,7	120x310	Screw terminal	3,9	1
460	004656777	LPC 40 kVar, 460V, 50HZ	40	3x 200,6	50,2	136x310	Screw terminal	5,1	1
460	004656778	LPC 50 kVar, 460V, 50HZ	50	3x 250,7	62,8	136x310	Screw terminal	5,1	1
480	004656780	LPC 10 kVar, 480V, 50HZ	10	3x 46,1	12,0	85x225	Screw terminal	1,6	1
480	004656781	LPC 12.5kVar, 480V, 50HZ	12,5	3x 57,6	15,0	100x225	Screw terminal	2,2	1
480	004656782	LPC 15 kVar, 480V, 50HZ	15	3x 69,1	18,0	100x225	Screw terminal	2,2	1
480	004656783	LPC 20 kVar, 480V, 50HZ	20	3x 92,1	24,1	100x310	Screw terminal	2,9	1
480	004656784	LPC 25 kVar, 480V, 50HZ	25	3x 115,1	30,1	120x310	Screw terminal	3,9	1
480	004656785	LPC 30 kVar, 480V, 50HZ	30	3x 138,2	36,1	120x310	Screw terminal	3,9	1
480	004656786	LPC 40 kVar, 480V, 50HZ	40	3x 184,2	48,1	136x310	Screw terminal	5,1	1
480	004656787	LPC 50 kVar, 480V, 50HZ	50	3x 230,3	60,1	136x310	Screw terminal	5,1	1
525	004656790	LPC 10 kVar, 525V, 50HZ	10	3x 38,5	11,0	85x225	Screw terminal	1,6	1
525	004656791	LPC 12.5kVar, 525V, 50HZ	12,5	3x 48,1	13,7	100x225	Screw terminal	2,2	1
525	004656792	LPC 15 kVar, 525V, 50HZ	15	3x 57,7	16,5	100x225	Screw terminal	2,2	1
525	004656793	LPC 20 kVar, 525V, 50HZ	20	3x 77,0	22,0	100x310	Screw terminal	2,9	1
525	004656794	LPC 25 kVar, 525V, 50HZ	25	3x 96,2	27,5	100x310	Screw terminal	2,9	1
525	004656795	LPC 30 kVar, 525V, 50HZ	30	3x 115,5	33,0	120x310	Screw terminal	3,9	1
525	004656796	LPC 40 kVar, 525V, 50HZ	40	3x 154,0	44,0	136x310	Screw terminal	5,1	1
525	004656797	LPC 50 kVar, 525V, 50HZ	50	3x 192,5	55,0	136x310	Screw terminal	5,1	1









### Technical data

Standards	IEC 60831-1/2 EN 60831-1/2		
Capacitance tolerance	-5% +10%		
Frequency	50Hz (60Hz upon request)		
Temperature range	-25°C ... +55°C*		
Dielectric losses	≤0.2 W/kVar		
Total losses	≤0.45 W/kVar		
Maximum over voltage	1,1 x U <sub>n</sub>		
Maximum over current	1,5 x I <sub>n</sub>		
Max. THD in voltage	2%		
Max. THD in current	25%		
Discharge resistance	Incorporated; ≤ 2 min to 75V		
Connection	Delta		
Casing	Aluminium case		
Disconnection system	Overpressure		
Dielectric	Metalized polypropylene film, self-healing		
Voltage test between terminals	2,15 x U <sub>n</sub> 2 sec.		
Voltage test terminals to case	3KV for 10 second. AC		
Terminal type	Connector		
Inrush current	200 x I <sub>n</sub>		
Protection	IP 20, indoor mounting		
Humidity	Max 95%		
Expected	120.000 Hrs. (Temp. level C)		
Altitude	Max. 2000 above sea level		
Screw terminal Tightening torque	≤ 20 kVar 100Ncm ≥ 25kVar 250Ncm		
Ambient temperature °C	Max	Highest mean over any period of	
		24h	1 year
	55	45	35

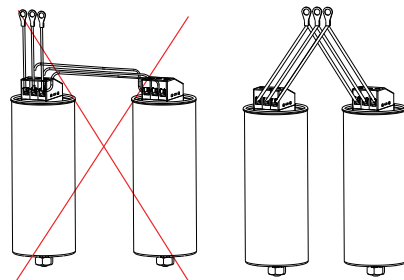
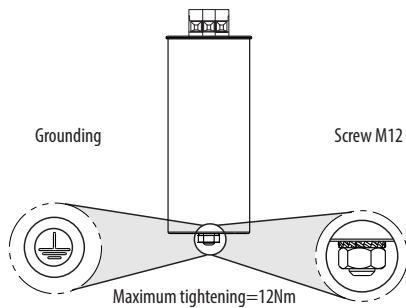
\*Special declaration for lower temperature (-40°C) available on request

## Three Phase Capacitors

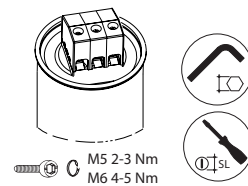
### Cable cross section

Q <sub>n</sub> (kVar)	Un		Terminal	Connection
	400V, 50Hz			
	I <sub>n</sub> (A)	(mm <sup>2</sup> , Cu)		
2,5	3,6	2,5		
5	7,4	2,5		
7,5	10,8	2,5		
10	14,4	4,0		
12,5	18,1	6,0		
15	21,6	6,0		
20	29,0	10,0		
25	36,0	10,0		
30	43,0	16,0		
40	58,0	25,0		
50	72,0	35,0		

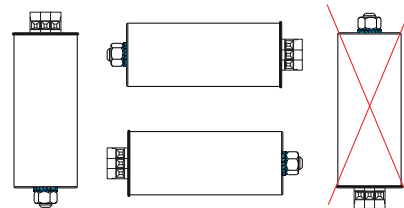
Cross – section values of the connection wires shown in the table are approximate and they are valid for normal operation conditions due to technical characteristics of the equipment.



**⚠ ATTENTION!** Parallel interconnection of two or more capacitors through the same terminals is prohibited.



M5 2-3 Nm  
M6 4-5 Nm



### Three phase low voltage power capacitors LPC with double winding

#### Advantages:

- Extra low size capacitors
- Triple safety
- Patented technology

#### Characteristics and utility:

- Three phase capacitor dual winding internally delta connected
- Discharge resistors incorporated
- Reactive power factor correction
- Dry type
- Connector type terminal
- Indoor mounting

#### Triple safety:

- Overpressure disconnection system
- Protection by internal fuses
- DWCAP system (patented) internal windings displacement

#### Construction and materials:

- Low losses metallized self-healing polypropylene film, high density, high temperature and greater dielectric resistance volt/μ
- Polyurethane self-extinguishing resin V0, developed under standard UL94
- Aluminium case with bottom fixing M12x16

#### Standards:

- IEC 60831-1 / 2
- EN 60831-1 / 2

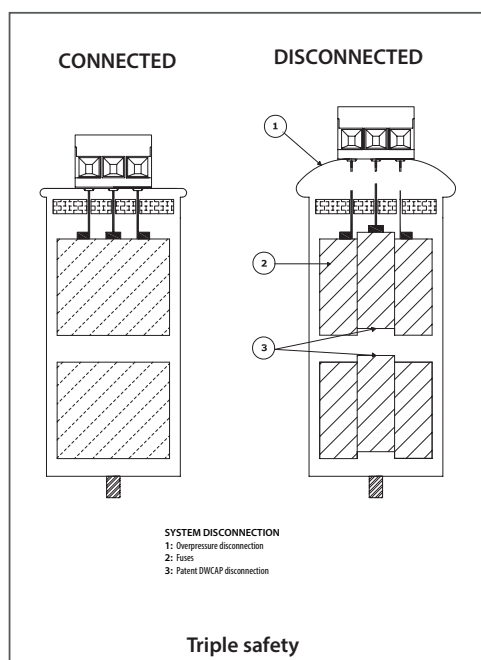
#### Certifications:





## Three phase low voltage power capacitors LPC with double winding

Rated voltage at 50Hz	Code No.	Type	Rated Power [kVar]	Rated capacitance [uF]	Rated current [A]	D (diameter) x H (Height) [mm]	Terminal type	Weight [kg]	Packaging [pcs]
400V	004656850	LPC-DW 7.5 kVar, 400V, 50HZ	7,5	3x 49,74	10,83	70 x 260	Screw terminal	1,1	1
400V	004656851	LPC-DW 10 kVar, 400V, 50HZ	10	3x 66,31	14,43	85 x 260		1,62	1
400V	004656852	LPC-DW 12.5 kVar, 400V, 50HZ	12,5	3x 82,89	18,04	85 x 260		1,62	1
400V	004656853	LPC-DW 15 kVar, 400V, 50HZ	15	3x 99,47	21,65	100 x 260		2,11	1
400V	004656854	LPC-DW 20 kVar, 400V, 50HZ	20	3x 132,63	28,87	120 x 265		3,23	1
400V	004656855	LPC-DW 25 kVar, 400V, 50HZ	25	3x 165,79	36,08	120 x 265		3,13	1
400V	004656856	LPC-DW 30 kVar, 400V, 50HZ	30	3x 198,94	43,3	136 x 265		4,01	1
400V	004656857	LPC-DW 35 kVar, 400V, 50HZ	35	3x 232	50,5	136 x 265		4,2	1
400V	004656867	LPC-DW 40 kVar, 400V, 50HZ	40	3x 265	57,7	136 x 265		4,2	1
440V	004656858	LPC-DW 7.5 kVar, 440V, 50HZ	7,5	3x 41,1	9,84	70x260		1,2	1
440V	004656859	LPC-DW 10 kVar, 440V, 50HZ	10	3x 54,81	13,12	70x260		1,1	1
440V	004656860	LPC-DW 12.5 kVar, 440V, 50HZ	12,5	3x 68,51	16,4	85x260		1,6	1
440V	004656861	LPC-DW 15 kVar, 440V, 50HZ	15	3x 82,21	19,68	85x260		1,6	1
440V	004656862	LPC-DW 20 kVar, 440V, 50HZ	20	3x 109,61	26,24	100x260		2,08	1
440V	004656863	LPC-DW 25 kVar, 440V, 50HZ	25	3x 137,01	32,8	120x265		3,21	1
440V	004656864	LPC-DW 30 kVar, 440V, 50HZ	30	3x 164,42	39,36	120x265		4,07	1
440V	004656865	LPC-DW 35 kVar, 440V, 50HZ	35	3x 191,82	45,93	136x265		4,11	1
440V	004656866	LPC-DW 40 kVar, 440V, 50HZ	40	3x 219,22	52,49	136x265		4	1



## Temperature (IEC 60831-1/2)

Symbol	Ambient temperature °C		
	Maximun	Highest mean over any period of	
		24h	1 year
A	40	30	20
B	45	35	25
C	50	40	30
D	55	45	35

## Dimensions

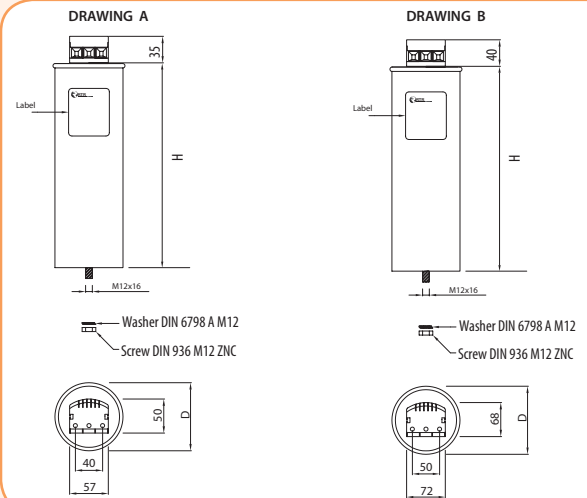
Dimensions	Connection terminal	DRAWING
D x H (mm <sup>2</sup> )	Max. cable section 1 kV-RV (mm <sup>2</sup> )	
70x230	10	DRAWING A
85x230	10	
100x230	10	
120x230	35	DRAWING B
136x230	35	

## Three Phase Capacitors

### Technical data

Standards	IEC 60831-1/2 EN 60831-1/2		
Capacitance tolerance	-5% +10%		
Frequency	50Hz (60Hz upon request)		
Temperature range	-25°C ... +55°C*		
Dielectric losses	≤0.2 W/kVAr		
Total losses	≤0.45 W/kVAr		
Maximum over voltage	8 h/day:	1,10 x Un	
	30 min/day:	1,15 x Un	
	5 min/day:	1,20 x Un	
	1 min/day:	1,30 x Un	
Maximum over current	1,5 x In		
Max. THD in voltage	2%		
Max. THD in current	25%		
Discharge resistance	Incorporated		
Connection	Delta		
Voltage test between terminals	2,15 x Un 2 sec.		
Voltage test terminals to case	3KV for 10 second. AC		
Inrush current	≤ 200 x In		
Protection	IP 20		
Humidity	Max 95%		
Expected	100.000 Hrs. (Temp. level D) 120.000 Hrs. (Temp. level C)		
Altitude	Max. 2000 above sea level		
Mounting position	Universal		
Ambient temperature °C	Max	Highest mean over any period of	
		24h	1 year
	55	45	35

\*without resistors

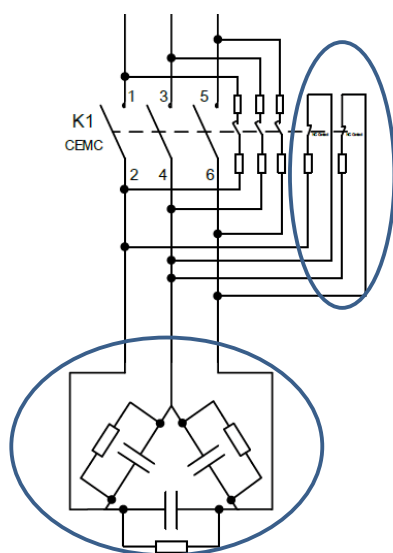


## Extra discharge resistors for fast and secure discharge of capacitors

### Set of 2 extra discharge resistors for fast and secure discharge of capacitors

Type	Code No.	Resistance [ohm]	Power [W]	Weight [g]	Packaging [pcs]
LPC EDR 1K8, 10W	004656798	1K8	10	30	200

To connect extra discharge resistors, 2 auxiliary contacts NC on capacitor duty contactor must be used



Extra discharge resistors 1K8 10W with auxiliary NC contacts (capacitor empty in less then 5s)

Integrated discharge resistors already included with capacitor for slow discharge (≤2min to 75V demand by IEC 60831 - 1 / 2)





## Individual Power Factor Correction for Low Voltage Motors

Rated motor power [kW]	Power rating of capacitor in (kvar) with respect to motor power, speed of rotation and load									
	3000 r / min		1500 r/min		1000 r/min		750 r/min		500 r/min	
	No load(kVAr)	Full load (kVAr)	No load(kVAr)	Full load (kVAr)	No load(kVAr)	Full load (kVAr)	No load(kVAr)	Full load (kVAr)	No load(kVAr)	Full load (kVAr)
5,5	2,2	2,9	2,4	3,3	2,7	3,6	3,2	4,3	4	5,2
7,5	3,4	4,4	3,6	4,8	4,1	5,4	4,6	6,1	5,5	7,2
11	5	6,5	5,5	7,2	6	8	7	9	7,5	10
15	6,5	8,5	7	9,5	8	10	9	12	10	13
18,5	8	11	9	12	10	13	11	15	12	16
22	10	12,5	11	13,5	12	15	13	16	15	19
30	14	18	15	20	17	22	22	25	22	28
37	18	24	20	27	22	30	26	34	29	39
45	19	28	21	31	24	34	28	38	31	43
55	22	34	25	37	28	41	32	46	36	52
75	28	45	32	49	37	54	41	60	45	68
90	34	54	39	59	44	65	49	72	54	83
110	40	64	46	70	52	76	58	85	63	98
132	45	72	53	80	60	87	67	97	75	110
160	54	86	64	96	72	103	81	116	91	132
200	66	103	77	115	87	125	97	140	110	160
250	75	115	85	125	95	137	105	150	120	175

It is useful to compensate rarely switched low voltage motors with a fixed connected capacitor due to technical and cost reasons.

Description - The required capacitor power is calculated with the following formula:

$$Q_n = 0,9 \cdot U_n \cdot I_{mag} \cdot \sqrt{3}$$

where:

$Q_n$  - capacitor power (VAr)

$U_n$  - rated voltage (V)

$I_{mag}$  - motor magnetising current (A)

Quick discharging with a bigger capacitor can cause self-excitation. If quick discharging of the motor is not possible, the motor can compensate itself according to the actual consumption of reactive power.

## Capacitor power versus working voltage

Capacitor working power depends on working voltage

$$(U_e / U_n)^2 \cdot Q_c = Q_f$$

where:

$U_e$  - mains voltage;

$U_n$  - capacitor rated voltage

$Q_c$  - capacitor power at rated voltage

$Q_f$  - capacitor actual power

Rated voltage	Rated capacity (μF)	Rated Power (kVAr) at $U_n = 380$ V	Rated Power (kVAr) at $U_n = 400$ V	Rated Power (kVAr) at $U_n = 420$ V	Rated Power (kVAr) at $U_n = 440$ V
400 V 50 Hz	3 x 16,6	2,3	2,5	-	-
	3 x 19,9	2,7	3	-	-
	3 x 26,5	3,6	4	-	-
	3 x 33,2	4,5	5	-	-
	3 x 66,3	9,0	10	-	-
	3 x 83,3	11,3	12,5	-	-
	3 x 100	13,6	15	-	-
	3 x 133,0	18,1	20	-	-
	3 x 165,8	22,6	25	-	-
	3 x 198,9	27,1	30	-	-
440 V 50 Hz	3 x 13,7	1,9	2,1	2,3	2,5
	3 x 16,5	2,2	2,5	2,7	3
	3 x 21,9	3,0	3,3	3,6	4
	3 x 27,4	3,7	4,1	4,6	5
	3 x 54,9	7,5	8,3	9,1	10
	3 x 68,6	9,3	10,3	11,4	12,5
	3 x 82,3	11,2	12,4	13,7	15
	3 x 110,0	14,9	16,5	18,2	20
	3 x 137,1	18,6	20,7	22,8	25
	3 x 164,4	22,4	24,8	27,3	30

## Three Phase Capacitors

Table definition of reactive power capacitor bank (kVAr), necessary to achieve a desired  $\cos \varphi$ 

The value of factor K read from table should be multiplied with the value of active power to determine kVAr required for power factor correction.

Capacitive reactive power is calculated by formula:

$$Q_c = P \cdot K$$

P – real power of the load

$\cos \varphi_0$  –  $\cos \varphi$  the system without power factor correction

$\cos \varphi_1$  – required  $\cos \varphi$  achieved with power factor correction

$Q_c$  – reactive power of compensation system

K – factor read from table defined by  $\cos \varphi_0$  and  $\cos \varphi_1$  (see table below)

Existing power factor $\cos \varphi_0$	Required power factor $\cos \varphi_1$												
	0,7	0,75	0,8	0,82	0,84	0,86	0,88	0,9	0,92	0,94	0,96	0,98	1,00
0,5	0,71	0,85	0,98	1,03	1,09	1,14	1,19	1,25	1,31	1,37	1,44	1,53	1,73
0,52	0,62	0,76	0,89	0,94	1	1,05	1,1	1,16	1,22	1,28	1,35	1,44	1,64
0,54	0,54	0,68	0,81	0,86	0,91	0,97	1,02	1,07	1,13	1,2	1,27	1,36	1,56
0,56	0,46	0,6	0,73	0,78	0,83	0,89	0,94	1	1,05	1,12	1,19	1,28	1,48
0,58	0,38	0,52	0,65	0,71	0,76	0,81	0,86	0,92	0,98	1,04	1,11	1,2	1,4
0,6	0,31	0,45	0,58	0,64	0,69	0,74	0,79	0,85	0,91	0,97	1,04	1,13	1,33
0,62	0,25	0,38	0,52	0,57	0,62	0,67	0,73	0,78	0,84	0,9	0,97	1,06	1,27
0,64	0,18	0,32	0,45	0,5	0,55	0,61	0,66	0,72	0,77	0,84	0,91	1	1,2
0,66	0,12	0,26	0,39	0,44	0,49	0,54	0,6	0,65	0,71	0,78	0,85	0,94	1,14
0,68	0,06	0,2	0,33	0,38	0,43	0,48	0,54	0,59	0,65	0,72	0,79	0,88	1,08
0,7		0,14	0,27	0,32	0,37	0,43	0,48	0,54	0,59	0,66	0,73	0,82	1,02
0,72		0,08	0,21	0,27	0,32	0,37	0,42	0,48	0,54	0,6	0,67	0,76	0,96
0,74		0,03	0,16	0,21	0,26	0,32	0,37	0,42	0,48	0,55	0,62	0,71	0,91
0,76			0,11	0,16	0,21	0,26	0,32	0,37	0,43	0,49	0,56	0,65	0,86
0,78			0,05	0,1	0,16	0,21	0,26	0,32	0,38	0,44	0,51	0,6	0,8
0,8				0,05	0,1	0,16	0,21	0,27	0,32	0,39	0,46	0,55	0,75
0,82					0,05	0,1	0,16	0,21	0,27	0,34	0,41	0,49	0,7
0,84						0,05	0,11	0,16	0,22	0,28	0,35	0,44	0,65
0,86							0,05	0,11	0,17	0,23	0,3	0,39	0,59
0,88								0,06	0,11	0,18	0,25	0,34	0,54
0,9									0,06	0,12	0,19	0,28	0,48
0,92										0,06	0,13	0,22	0,43
0,94											0,07	0,16	0,36

## Calculations

Three-phase capacitor power:

$$Q_c = C \cdot 3 \cdot V^2 \cdot 2 \cdot \pi \cdot f_n$$

Example:  $3 \times 331.5 \mu\text{F}$  at 400V/50Hz

$$0.0003315 \cdot 3 \cdot 400^2 \cdot 314.16 = 50 \text{ kVAr}$$

The resonant frequency ( $f_r$ ) and filtering factor (p) in systems with compensation filters:

$$f_r = f_n \cdot \sqrt{\frac{1}{p}} \quad \text{or} \quad p = \left( \frac{f_n}{f_r} \right)^2$$

Example: for  $p = 0.07$  at 50 Hz;  $f_r = 189 \text{ Hz}$

The calculation of the power factor  $\cos \varphi$ :

$$\cos \varphi = \frac{P}{S} \quad \text{or} \quad \cos \varphi = \sqrt{\frac{1}{1 + \tan^2 \varphi}} \quad \text{or} \quad \cos \varphi = \sqrt{\frac{1}{1 + \left( \frac{Q}{P} \right)^2}}$$

Fuse selection (gG):

$$I_n = 1,6 \cdot I$$

For  $U_{\text{main}} = 400\text{V}$ ,  $U_n = \text{min. } 690\text{V}$

Three-phase capacitor power with detuning reactor in series

$$Q_c = \frac{C \cdot 3 \cdot V^2 \cdot 2 \cdot \pi \cdot f_n}{1 - p}$$

Example:  $3 \times 331.5 \mu\text{F}$  at 400V/50Hz at  $p = 7\%$

$$0.0003315 \cdot 3 \cdot 400^2 \cdot 314.16 / 1 - 0.07 = 53.8 \text{ kVAr}$$

Phase current of capacitor:

$$I = \frac{Q_c}{V \cdot \sqrt{3}} \quad \text{or} \quad Q_c = I \cdot V \cdot \sqrt{3}$$

Example: 25 kVAr at 400V

$$25000 / (400 \cdot 1.73) = 36 \text{ A}$$

V = Rated voltage (V)

I = Rated current (A)

$f_n$  = Line frequency (Hz)

$f_r$  = Resonance frequency (Hz)

p = Filtering factor

$Q_c$  = Capacitor power (VAr)

C = Capacitance (F, farad)

P = Active power (W)

S = Apparent power (VA)

Q = Reactive Power (VAr)

$I_n$  = Rated current of fuse (A)

$U_n$  = Rated voltage of fuse (V)

Example:  $Q_c = 25 \text{ kVAr}$ ,  $U_{\text{main}} = 400\text{V}$ .

$$I_n = 1,6 \cdot 36 = 57,6 \Rightarrow 63 \text{ A}, U_n = 690\text{V}, \text{gG fuse.}$$