Let us help you reduce your energy costs

Reactive Power Compensation

Power factor correction is one of the best investments to reduce energy costs with a short payback. In a large number of cases, the design and dimensioning work has been made more difficult by the fact that, in a company´s internal low-voltage installation, and also in the medium-voltage supplying it, the proportion of network harmonics has grown increasingly over the last few years. Power converters, electronically controlled drives, static frequency converters, televisions and computers feed harmonic currents into the supply network. These harmonics might be amplified by the network impedances and capacitors installed. The freedom from harmonics also minimizes interference with other devices being powered from the same source.

Low voltage products for better power quality and improved network efficiency

ETI Prostik power compensation equipment (enclosures) helps customers improve performance through energy savings and better power quality. With our products and solutions, customers save money and reduce the environmental impact of their operations.

We offer a wide range of power compensation equipment for low voltage levels. We analyse your needs and engineer the right solutions for optimal efficiency and economy.

Key Benefits

- Reduce harmonics
- Compact solutions
- Lower losses
- Improved Power Quality
- Money savings

Power factor

Power factor is a way of describing how efficiently electrical power is consumed.

Power factor correction shapes the input current of off-line power supplies to maximize the real power available from the mains. Ideally, the electrical appliance should present a load that emulates a pure resistor, in which case the reactive power drawn by the device is zero. Inherent in this scenario is the absence of input current harmonics - the current is a perfect replica of the input voltage (usually a sine wave) and is exactly in phase with it. In this case the current drawn from the mains is at a minimum for the real power required to perform the needed work, and this minimizes losses and costs associated not only with the distribution of the power, but also with the generation of the power and the capital equipment involved in the process.

Power factor correction is simply defined as the ratio of real power to apparent power, or:

$$PF = \frac{\text{Real power (expressed in Watts)}}{\text{Apparent Power (expressed in VA)}}$$

where the real power is the average, over a cycle, of the instantaneous product of current and voltage, and the apparent power is the product of the rms value of current times the rms value of voltage. If both current and voltage are sinusoidal and in phase, the power factor is 1.0. If both are sinusoidal but not in phase, the power factor is the cosine of the phase angle. In elementary courses in electricity this is sometimes taught as the definition of power factor, but it applies only in the special case, where both the current and voltage are pure sine waves. This occurs when the load is composed of resistive, capacitive and inductive elements and all are linear (invariant with current and voltage).

MAIN COMPONENTS FOR REACTIVE POWER COMPENSATION

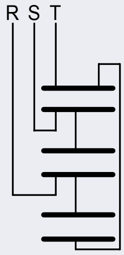
Three phase low voltage power capacitors

DESCRIPTION

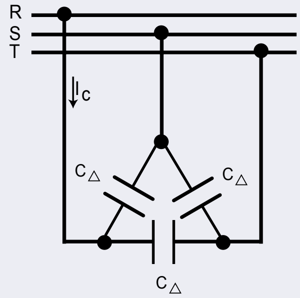
LPC capacitors are manufactured with low loss metallized self-healing polypropylene film. Dry type capacitors are filled with a nontoxic an ecological polyurethane resin, this resin provides an excellent heat dissipation properties. This capacitors are mounted in aluminium housing with overpressure disconnection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

Advantages

- Self healing
- Overpressure disconnection system
- Discharge resistor



DELTA CONNECTION



Contactors for capacitor banks

DESCRIPTION

Contactors for capacitor switching were specially designed for power factor correction capacitor operation (utilization category AC-6b). They are pre-charged through resistors that reduce the peak current to the contactor when CEM_CN special contactors are switched on. After the pre-charge, the main contactors close allowing passage of rated current.

Advantages

- Mounting on DIN rails and on mounting plates
- Technical specification according to IEC 60947-4
- Built-in pre-charge resistors
- High reliability
- Reduced dimensions
- Standard control voltage 230V AC

Operating principle:

When capacitor bank being switched on, the capacitors are uncharged and the system sees them as a short circuit for a quick period of time. The in-rush current is the result of this little short circuit and usually lasts for a few milliseconds. It may reach 100 times the rated current, being one of the main reasons for the short life of a capacitor. The CEM CN contactor is assembled with damping resistors which limit the high in-rush current when the capacitors are switched on. They are assembled with an early-make contact block, which is switched on before the main contacts, thus, limiting the in-rush current.

However, the damping resistors don't influence the final load, since they are switched off after 5 milliseconds, leaving only the capacitors in parallel with your inductive load, providing the proper power factor correction. This process increases the lifetime of the capacitors and also prevents net distortions.

Power factor controllers

DESCRIPTION

Power factor control relays measure cos φ of a supply system and control the automatic connection and disconnection of compensation capacitors according to desired cos φ. Microprocessor controlled power factor controller with measurement system.

Features

- Auto recognized capacitor bank
- Anti-hunting function
- Fixed step programmable
- Function & alarm relay programmable
- Fan relay programmable
- RJ11 - TTL standard - serial interface
- Owner / modbus communication protocol

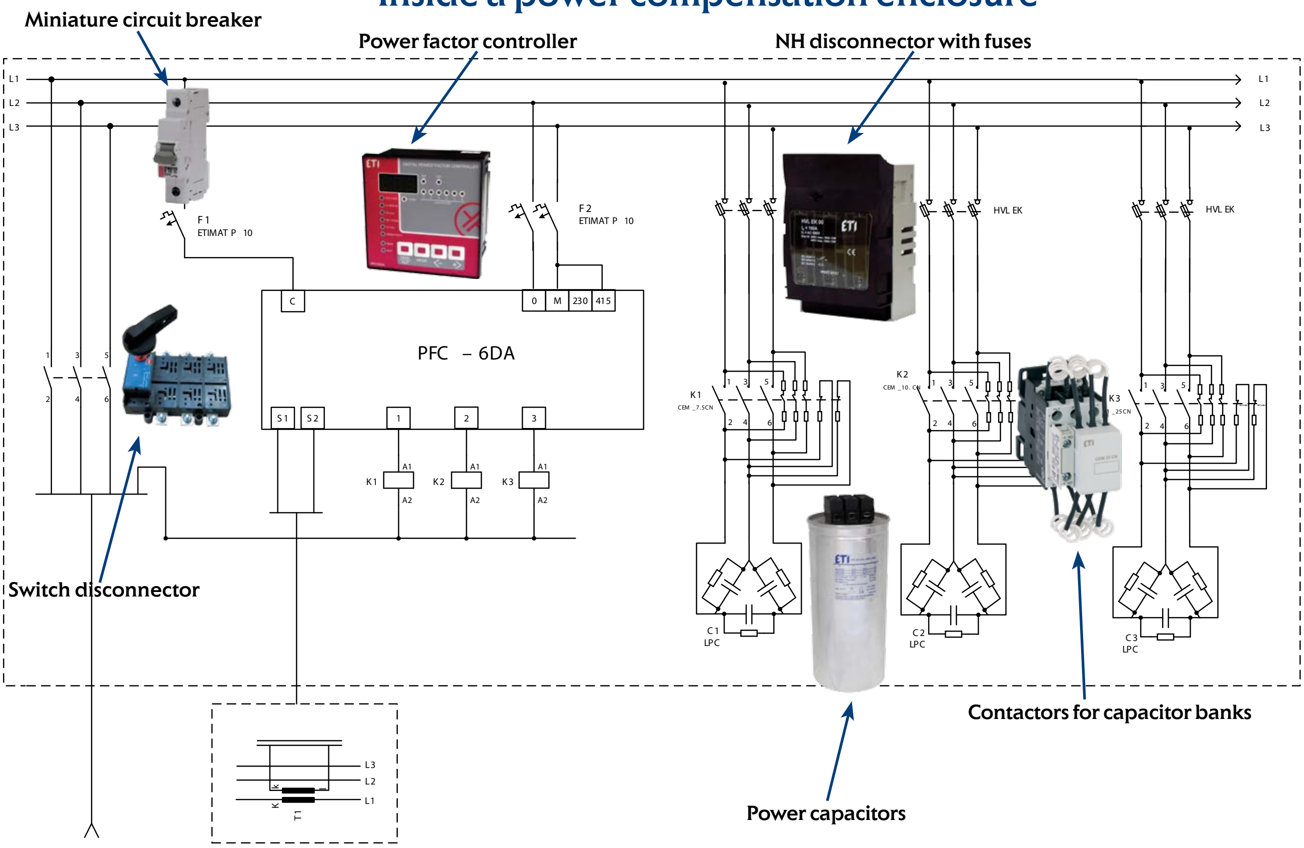
Measurements
- cos φ INDUCTIVE & CAPACITIVE
- phase to phase voltage & current
- cos φ desired
- total harmonic distortion
- ambient temperature

Metal enclosures IP65

DESCRIPTION
GT-Type metal enclosures cover a wide range of applications both for industrial and civil buildings. Due to their design they provide high IP protection level, mechanical strength and functionality. They are used in places where electrical equipment is exposed to adverse effect of factors such as water, dust, mechanical impact.

Main advantages:
- Enclosures made of high quality sheet steel thicknesses from 1,2 mm to 2 mm, resistant to external mechanical factors - IK10.
- Specially profiled edges of the housing ensure stiffness and excellent protection against water. Poured polyurethane gasket on the door providing IP65 protection.
- Door opening in the contour of the outer casing, which allows direct linking of several enclosures in series - a special structure hinges. The door mounting on the left or right side.

Inside a power compensation enclosure



HOW TO DECIDE THE OPTIMUM LEVEL OF COMPENSATION?

General method

Technical-economic optimization for an existing installation:
The optimum rating of compensation capacitors for an existing installation can be determined from the following principal considerations:

- Electricity bills prior to the installation of capacitors
- Future electricity bills anticipated following the installation of capacitors
- Costs of:
  - Purchase of capacitors and control equipment (contactors, relaying, cabinets, etc.)
  - Installation and maintenance costs
  - Cost of dielectric heating losses in the capacitors, versus reduced losses in cables, transformer, etc., following the installation of capacitors

Simplified method

Method based on the calculation and the table as shown in the example below.

For any technical assistance, please contact our product manager:
e-mail: matjaz.bobnar@eti.si
tel: +386 (0)3 56 57 451

EXAMPLE OF THE CALCULATION

We will look at an example automatic determination of compensation devices that can be used globally or just in a particular sector:

In the consumer with an installed power of 120 kW working with the current cos fi = 0,7. We want to improve on at 0,94.

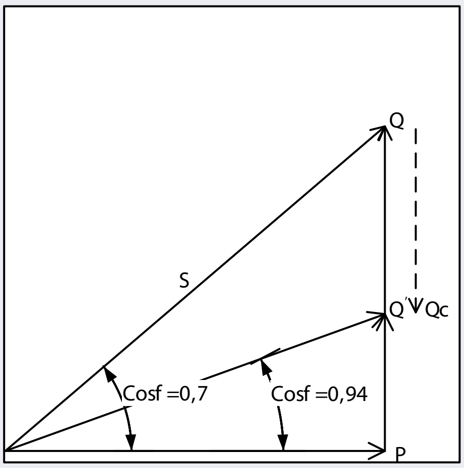
If we do not have table 1 at hand the factor "k" is calculated as:

$$k = tg\ \varphi_1 - tg\ \varphi_2 = 1{,}02 - 0{,}36 = 0{,}66$$ (where φ_1 is obtained from the current cosφ, φ_1 is of desired).

Thus, we obtain the necessary reactive power compensation circuit (capacitor bank) Q_{cb}:

$$Q_{cb} = P \cdot k = 120kW \cdot 0{,}66 = 79{,}2kVAr$$

Graphical representation of the vectors of power before and after compensation:



Reactive Power Compensation

Using the table, the factor to be read at the intersection of the current and desired cos fi.

Determination of the factor k

Existing power factor $\cos\varphi_1$	Desired power factor $\cos\varphi_2$													
	0,7	**0,75**	**0,8**	**0,82**	**0,84**	**0,86**	**0,88**	**0,9**	**0,92**	**0,94**	**0,95**	**0,96**	**0,98**	**1**
0,2	3,88	4,02	4,15	4,20	4,25	4,31	4,36	4,41	4,47	4,54	4,58	4,61	4,70	4,90
0,25	2,85	2,99	3,12	3,17	3,23	3,28	3,33	3,39	3,45	3,51	3,54	3,58	3,67	3,87
0,3	2,16	2,30	2,43	2,48	2,53	2,59	2,64	2,70	2,75	2,82	2,85	2,89	2,98	3,18
0,35	1,66	1,79	1,93	1,98	2,03	2,08	2,14	2,19	2,25	2,31	2,34	2,38	2,47	2,68
0,4	1,27	1,41	1,54	1,59	1,65	1,70	1,75	1,81	1,87	1,93	1,96	2,00	2,09	2,29
0,45	0,96	1,10	1,23	1,29	1,34	1,39	1,44	1,50	1,56	1,62	1,65	1,69	1,78	1,98
0,5	0,71	0,85	0,98	1,03	1,09	1,14	1,19	1,25	1,31	1,37	1,40	1,44	1,53	1,73
0,52	0,62	0,76	0,89	0,94	1,00	1,05	1,10	1,16	1,22	1,28	1,31	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	1,20	1,23	1,27	1,36	1,56
0,56	0,46	0,60	0,73	0,78	0,83	0,89	0,94	1,00	1,05	1,12	1,15	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	1,07	1,11	1,20	1,40
0,6	0,31	0,45	0,58	0,64	0,69	0,74	0,79	0,85	0,91	0,97	1,00	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	0,90	0,93	0,97	1,06	1,27
0,64	0,18	0,32	0,45	0,50	0,55	0,61	0,66	0,72	0,77	0,84	0,87	0,91	1,00	1,20
0,66	0,12	0,26	0,39	0,44	0,49	0,54	0,60	0,65	0,71	0,78	0,81	0,85	0,94	1,14
0,68	0,06	0,20	0,33	0,38	0,43	0,48	0,54	0,59	0,65	0,72	0,75	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	0,69	0,73	0,82	1,02
0,72		0,08	0,21	0,27	0,32	0,37	0,42	0,48	0,54	0,60	0,63	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	0,58	0,62	0,71	0,91
0,76			0,11	0,16	0,21	0,26	0,32	0,37	0,43	0,49	0,53	0,56	0,65	0,86
0,78			0,05	0,10	0,16	0,21	0,26	0,32	0,38	0,44	0,47	0,51	0,60	0,80
0,8				0,05	0,10	0,16	0,21	0,27	0,32	0,39	0,42	0,46	0,55	0,75
0,82					0,05	0,10	0,16	0,21	0,27	0,34	0,36	0,41	0,49	0,70
0,84						0,05	0,11	0,16	0,22	0,28	0,31	0,35	0,44	0,65
0,86							0,05	0,11	0,17	0,23	0,26	0,30	0,39	0,59
0,88								0,06	0,11	0,18	0,21	0,25	0,34	0,54
0,9									0,06	0,12	0,15	0,19	0,28	0,48
0,92										0,06	0,09	0,13	0,22	0,43
0,94											0,03	0,07	0,16	0,36

Let's change is analytical, before correction:

$$Q = tg\,\varphi_1 \cdot P = 1{,}02 \cdot 120 = 122{,}42kVAr$$

Reactive power after compensation:

$$Q' = Q - Q_{cb} = 122{,}42kVAr - 79{,}2kVAr = 43{,}22kVAr$$

If you check cos fi after compensation:

$$\cos\varphi_1 = \frac{P}{S'} = \frac{P}{\sqrt{Q'^2 + P^2}} = \frac{120}{127{,}55} = 0{,}94$$

However, as reactive power varies (on and off devices), it is necessary to use automatic compensation device.

Standard reactive power compensation solutions

Technical data	
Power range	see table 1
Rated voltage	400 V, 50 Hz three-phase, other voltages on request
Capacity tolerance	0 % to + 10 %
Overload capacity	1,0 × Un permanent 1,1 × Un 8 hours per day 1,3 × In permanent
Temperature range	-25 ˚C to +50 ˚C
Dielectric losses	≤ 0,2 W/kvar
Total losses of device	< 1,5 W/kvar
Level of mechanical protection	IP 20
Colour	RAL 7032

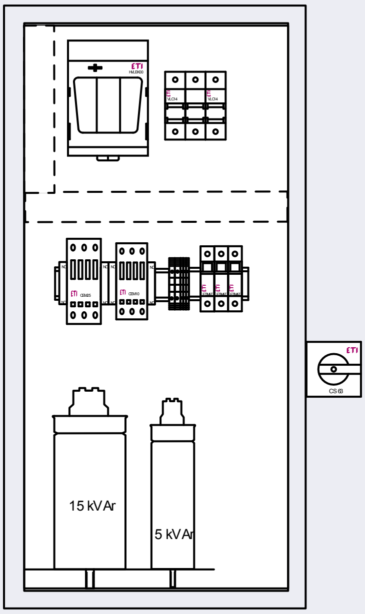
Type compensation

Power [kVar]	Code No.	Program	Type	Composition	Connecting cable Cu [mm²]	Connecting fuses [A]	Sleeve
20	001110101	1:3	RPC 20kVAr_5+15	1x5+ 1x15	4 x 16	50	PG21
30	001110102	1:2:3	RPC 30kVAr_10+20	10+20	4 x 16	63 (80)	PG29
40	001110103	1:2.2	RPC 40kVAr_2x10+20	2x10+20	3 x 25	100	PG29
50	001110104	1:2:2	RPC 50kVAr_10+2x20	10+2x20	3x35	125	PG36
60	001110105	1:1:2:2	RPC 60kVAr_2x10+2x20	2x10+2x20	3x50	125	PG36
70	001110106	1:2:2:2	RPC 70kVAr_10+3x20	10+3x20	3x70	160	PG36
80	001110107	1:1:2:2:2	RPC 80kVAr_2x10+3x20	2x10+3x20	3x70	160	PG36
90	001110108	1:2:3:3	RPC 90kVAr_10+20+2x30	10+20+2x30	3x95	200	PG42
105	001110109	1:2:2:2	RPC 105kVAr_15+3x30	15+3x30	2x3x50	250	PG42

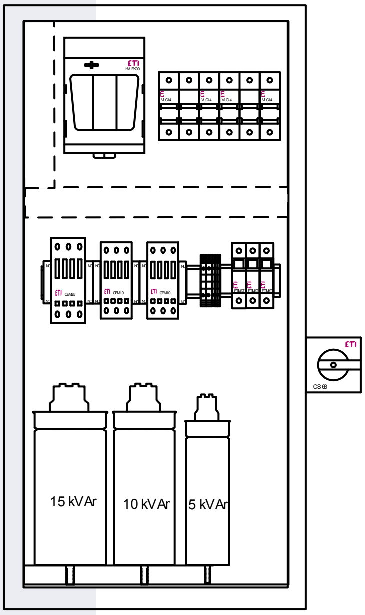
CUSTOM DESIGN: Other voltages and ratings also available upon request.

Compensation from 10 to 50 kVAr -> Dimensions enclosures 800x400x250 (mm).
Compensation from 60 to 100 kVAr -> Dimensions enclosures 1000x800x300 (mm).

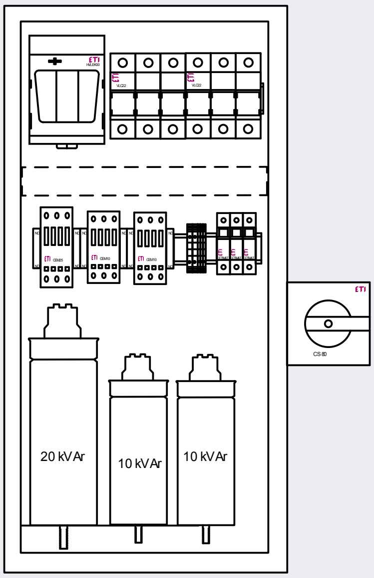
20 kVAr



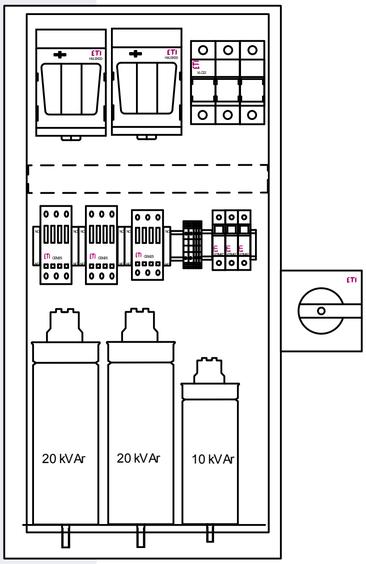
30 kVAr



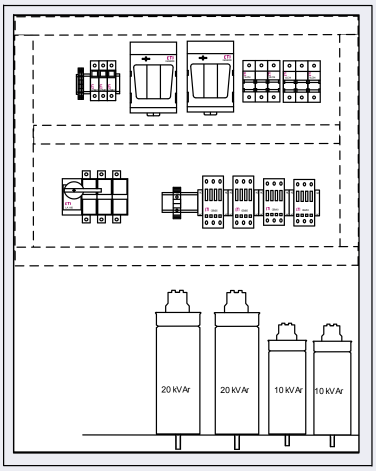
40 kVAr



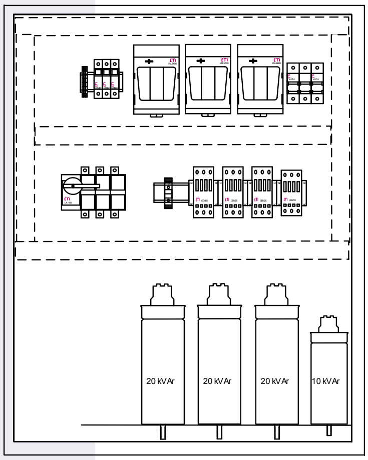
50 kVAr



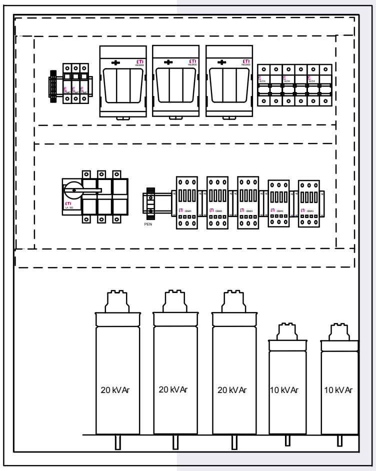
60 kVAr



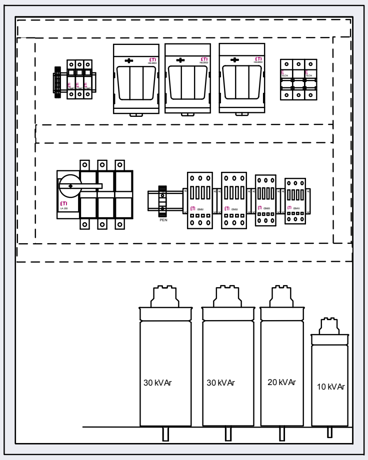
70 kVAr



80 kVAr



90 kVAr



105 kVAr