



CLMX capacitor banks for reactive power compensation



CONDO...

Condensator Dornit

Our plants and solutions serve users and the environment. By prevention of reactive power, harmonics and other system perturbations we reduce the energy consumption and the load in the grid.

The benefits for our customers are:

- Lower costs for energy (Active and reactive power)
- Higher reliability of electrical installations
- Prevention of investments for a network reinforcement

Reduction of losses is a contribution to the protection of our environment by reduction of CO₂ emission.

We offer a suitable solution for each customer specific network quality problem. Due to the multitude of variable business segments, in which our customers and we are active, there is a huge variation of different possibilities, to solve arising problems.

In times of increasing complexity of network and user structure we again and again create new ideas, to offer our customers advantages in competition. In many cases we are able, to offer an already existing solution, in sophisticated cases we invent and produce a tailor-made solution, meeting the requirements in a cost efficient way.

More than 55 years still at the same location

1950 DOMINIT-WERKE
1973 Lepper-Dornit
1981 ASEA Lepper
1982 ASEA Kondensatoren
1988 ABB Kondensatoren
2002 ABB Schaltanlagentechnik
2005 CONDENSATOR DOMINIT

More than 55 years of experience and innovation

1953 developed in Brilon
the first automatic PFC-bank
1972 new HV application:
the first tuned filter-bank
1991 developed in Brilon: COMFIL®
the filter-combination
1993 market introduction of: DYNACOMP®
the dynamic PFC-bank
1997 developed in Brilon: ALFC
the flicker compensation
1998 market introduction of: PQF
the active harmonic filter
2001 market introduction of: SCOMP
the arc-proof encapsulated HV-bank
2002 developed in Brilon: UBF
the wide-band filter

Why to use reactive power compensation equipment

The majority of electrical equipment has an inductive characteristic, such as motors and fluorescent lamps. They create a reactive load on the supply network, which generates additional losses in transformers and cables. Utilities take the reactive power percentage into account in their tariffs and the end user has to pay for his reactive power consumption. The use of power capacitors for reactive power compensation not only saves costs, but also results in better utilisation of the local network. The power reserves which are obtained can avoid otherwise necessary network extension and thus save on considerable investment costs.

One way for the dimensioning of the necessary size of a capacitor bank is given in the upper table on the following page. Assuming that the actual uncompensated $\cos \varphi$ or $\tan \varphi$ is known the necessary size of the compensation can be calculated, by taking the factor k from the table according to the target value.

Example:

- Motor 250 kW
- actual $\cos \varphi = 0,8$ (manufacturer data or measurement)
- Target $\cos \varphi = 0,95$

From the table: $k = 0,421 \Rightarrow Q_C = 250 \text{ kW} \times 0,421 \text{ kvar/kW} = 105 \text{ kvar}$

For dimensioning the size of a capacitor bank to avoid reactive power costs according to the energy bill, an estimation can be made using the data of an actual energy bill by dividing the value of reactive power consumption (kvarh) by the value of the active power consumption (kwh). This value is an average $\tan \varphi$ and together with the max power consumption (kW max) the necessary size can also be calculated by using the K-factor from the table on the following page.

The table on page 4 below is a guideline for dimensioning the connection cables and the protection of the equipment, independent of the actual information being available.

K-Factor for calculating the necessary compensation power

		Target value										
cos φ	tan φ	0,90	0,91	0,92	0,93	0,94	0,95	0,96	0,97	0,98	0,99	1
		0,40	2,29	1,807	1,836	1,865	1,896	1,928	1,963	2,000	2,041	2,088
0,45	1,98	1,500	1,529	1,559	1,589	1,622	1,656	1,693	1,734	1,781	1,842	1,985
0,50	1,73	1,248	1,276	1,306	1,337	1,369	1,403	1,440	1,481	1,529	1,590	1,732
0,52	1,64	1,158	1,187	1,217	1,247	1,280	1,314	1,351	1,392	1,440	1,500	1,643
0,54	1,56	1,074	1,103	1,133	1,163	1,196	1,230	1,267	1,308	1,356	1,416	1,559
0,56	1,48	0,995	1,024	1,053	1,084	1,116	1,151	1,188	1,229	1,276	1,337	1,479
0,58	1,40	0,920	0,949	0,979	1,009	1,042	1,076	1,113	1,154	1,201	1,262	1,405
0,60	1,33	0,849	0,878	0,907	0,938	0,970	1,005	1,042	1,083	1,130	1,191	1,333
0,62	1,27	0,781	0,810	0,839	0,870	0,903	0,937	0,974	1,015	1,062	1,123	1,265
0,64	1,20	0,716	0,745	0,775	0,805	0,838	0,872	0,909	0,950	0,998	1,058	1,201
0,66	1,14	0,654	0,683	0,712	0,743	0,775	0,810	0,847	0,888	0,935	0,996	1,138
0,68	1,08	0,594	0,623	0,652	0,683	0,715	0,750	0,787	0,828	0,875	0,936	1,078
0,70	1,02	0,536	0,565	0,594	0,625	0,657	0,692	0,729	0,770	0,817	0,878	1,020
0,72	0,96	0,480	0,508	0,538	0,569	0,601	0,635	0,672	0,713	0,761	0,821	0,964
0,74	0,91	0,425	0,453	0,483	0,514	0,546	0,580	0,617	0,658	0,706	0,766	0,909
0,76	0,86	0,371	0,400	0,429	0,460	0,492	0,526	0,563	0,605	0,652	0,713	0,855
0,78	0,80	0,318	0,347	0,376	0,407	0,439	0,474	0,511	0,552	0,599	0,660	0,802
0,80	0,75	0,266	0,294	0,324	0,355	0,387	0,421	0,458	0,499	0,547	0,608	0,750
0,81	0,72	0,240	0,268	0,298	0,329	0,361	0,395	0,432	0,473	0,521	0,581	0,724
0,82	0,70	0,214	0,242	0,272	0,303	0,335	0,369	0,406	0,447	0,495	0,556	0,698
0,83	0,67	0,188	0,216	0,246	0,277	0,309	0,343	0,380	0,421	0,469	0,530	0,672
0,84	0,65	0,162	0,190	0,220	0,251	0,283	0,317	0,354	0,395	0,443	0,503	0,646
0,85	0,62	0,135	0,164	0,194	0,225	0,257	0,291	0,328	0,369	0,417	0,477	0,620
0,86	0,59	0,109	0,138	0,167	0,198	0,230	0,265	0,302	0,343	0,390	0,451	0,593
0,87	0,57	0,082	0,111	0,141	0,172	0,204	0,238	0,275	0,316	0,364	0,424	0,567
0,88	0,54	0,055	0,084	0,114	0,145	0,177	0,211	0,248	0,289	0,337	0,397	0,540
0,89	0,51	0,028	0,057	0,086	0,117	0,149	0,184	0,221	0,262	0,309	0,370	0,512
0,90	0,48	0	0,029	0,058	0,089	0,121	0,156	0,193	0,234	0,281	0,342	0,484
0,91	0,46	-	0	0,030	0,060	0,093	0,127	0,164	0,205	0,253	0,313	0,456
0,92	0,43	-	-	0	0,031	0,063	0,097	0,134	0,175	0,223	0,283	0,426
0,93	0,40	-	-	-	0	0,032	0,067	0,104	0,145	0,192	0,253	0,395

Guideline for dimensioning connection cables and feeding breakers

HRC-fuses / A	Protection		Connection Cross-section / mm ²
		SACE-CB T-max ¹	
16		T2N160R016	4 x 2,5
25		T2N160R025	4 x 4
35		T2N160R040	4 x 6
50		T2N160R050	4 x 10
63		T2N160R063	4 x 16
80		T2N160R080	3 x 25 / 16
100		T2N160R100	3 x 35 / 16
125		T2N160R125	3 x 50 / 25
160		T2N160R160	3 x 70 / 35
200		T3N250R200	3 x 95 / 50
250		T3N250R250	3 x 120 / 70
315		T4N320R320	3 x 185 / 95
400		T5N400R400	2 3 x 95 / 70
500		T5N630R500	2 3 x 120 / 70
630		T5N630R630	2 3 x 185 / 95
800		T6N800R800	2 3 x 240 / 120

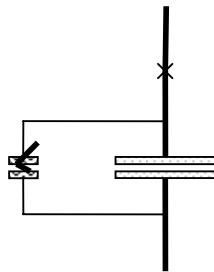
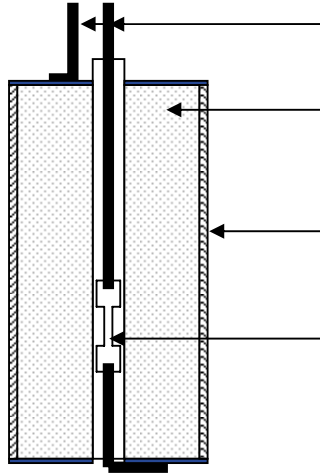
1 = Recommendation for Network with $I_{CU} \leq 36$ kA, in cases of higher values a different type of breaker is required (for example „S“ for $I_{CU} \leq 50$ kA)

Main components

Capacitors

The CLMD power capacitor consists of a number of single-phase cylindrical windings made of metallized polypropylene foil. Each element contains an internal winding fuse according to the IPE principle. The individual self-healing capacitors are installed together with cooling plates in a common sheet metal housing with fireproof granulate filling.

The IPE protection concept



In case of a dielectric breakdown in the non-self healing protection capacitor a short circuit arises, so that the fuse is activated and by this disconnects the capacitor element.

CLMD capacitor

- robust sheet steel enclosure
- Big cooling surface:
100 kvar = effective approx 6325 cm²
- Good cooling characteristic:
matt finish painting
- No sealing requirements:
IPE-protection concept
- Leakage- and burst-proof dry type technique

Cylindrical type capacitor

- Thin Al-can (thickness 0.5 mm)
- Small cooling surface:
100 kvar = effective approx 3880 cm²
- Bad cooling characteristic:
gleaming metal surface
- High sealing requirement:
Function of overpressure protection
- Gas, oil or resin filling => Danger of leakage or bursting

Reactors

Detuning reactors are used in reactive power compensation systems for networks with harmonic loads. Harmonics are primarily generated by non linear loads, such as rectifiers, frequency converters, variable speed drives and even electronic equipment for office or entertainment. They cause distortions of the sine-wave network voltage and can result in malfunction, breakdown, overload or even destruction of individual network elements.

The size of the reactors for capacitor banks is indicated by the reactor rate, for normal use 7% is the best choice. In industrial networks with a high percentage of non linear loads it is recommended to use a higher reactor rate. If the percentage is higher than 50% it might be necessary to install harmonic filters to avoid damages to capacitors and other equipment.

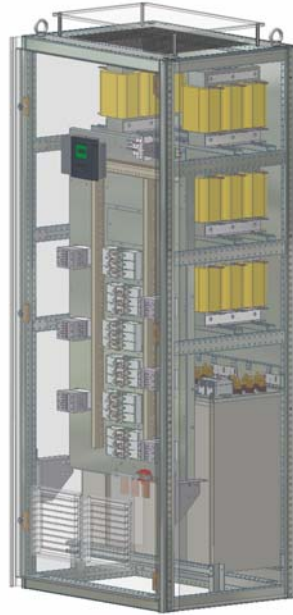
Besides this there are standards and local regulations limiting the harmonics one customer is allowed to feed back into the grid. If there is an audio frequency control system used in the net special care must be taken to avoid disturbances. For signals above 250 Hz a reactor rate of 7% is sufficient. For signal frequencies down to 190 Hz 12.5% reactors have to be used.

The detuning reactors in CLMX-banks are rated for permanent operation and harmonic level of 5% for 250 Hz and 5% total of higher harmonics. Technical data of CLMD capacitors and reactors are fully compatible. The detuning reactors are three phase, iron cored with air gap. The detuning reactors are completely vacuum impregnated in polyester resin and oven treated. The insulation level of the core is 3kV at 50 Hz.

Contactors

CLMX banks are equipped with specially designed contactors for capacitive switching. Each contactor bears a set of resistors switched with pre-closing auxiliary contacts. These resistors dampen the inrush current of the capacitors and help so avoiding the risk of reactor tripping. Reactor tripping is the effect, that the reactor comes into saturation due to a high inrush current. As a result the step remains in an over-current status which leads to damages.

Automatic capacitor banks CLMX-L



Application

The switchgear systems CLMX-L is designed for centralized compensation with high reactive power requirements in networks with harmonics. CLMX-L is specially designed for rough environmental conditions and available for networks up to 690 V.

Description

The bank is factory mounted and tested and ready for connection. The component arrangement guarantees optimized thermal conditions. The power controller RVC switches the compensation power in steps according the actual requirements. Capacitors and reactors are dimensioned according the step power, harmonics and remote control frequency.

Advantages

- Reactor for each step dimensioned for continuous operation with harmonics
- Quick discharge of capacitors with discharge reactors
- No audio frequency block necessary in networks with remote control
- Degree of Protection IP20
- Standard execution with cable entry from the bottom, optional from top

Rated voltage 400 V / 50 Hz (Three phase)						
Rated Power kvar	Switching steps kvar	Description	Protection fuse* A	Dimensions W x D x H mm	Weight net Kg	Article Code
Basic units with controller, Reactor rate 7%						
100	4x25	CLMX-400/50-4x25-L070	200	640 x 651 x 2084	270	A190-ORB
125	5x25	CLMX-400/50-5x25-L070	250	640 x 651 x 2084	390	A190-ORC
150	6x25	CLMX-400/50-6x25-L070	315	640 x 651 x 2084	405	A190-ORD
175	7x25	CLMX-400/50-7x25-L070	400	640 x 651 x 2084	430	A190-ORE
200	8x25	CLMX-400/50-8x25-L070	400	640 x 651 x 2084	445	A190-ORF
250	5x50	CLMX-400/50-5x50-L070	500	840 x 651 x 2084	490	A190-OTC
300	6x50	CLMX-400/50-6x50-L070	630	840 x 651 x 2084	510	A190-OTD
400	8x50	CLMX-400/50-8x50-L070	800	1240x 651x 2084	700	A190-OTF
500	10x50	CLMX-400/50-10x50-L070	800	1640x 651x 2084	900	A190-OTH
600	12x50	CLMX-400/50-12x50-L070	1250	1640x 651x 2084	940	A190-OTL
700	7x100	CLMX-400/50-7x100-L070	1600	2440x 651x 2084	1320	A190-OUA

*Cable dimensioning according page 4

Other voltages, frequencies, power-ratings, reactor-rates on request

Products and Services of Condensator Doment

Qualified network analysis

Caused by wrong measurements network problems are often analysed in-accurately.

Suitable measures can not be deducted. Our employees use top class equipment for qualified network analyses and give recommendations for the elimination of disturbances and the improvement of network quality.

Reactive power

Electrical equipments, which aside active power also require reactive current, cause significant higher grid load and by this increased transmission losses. We offer banks for reactive power compensation help to lower costs and to reduce CO₂-emission. Our customers by this save money and support the environment.

Harmonics

Frequency converters, power supplies for electronic devices etc. are non-linear loads and by this generate harmonics which cause increased losses and disturbances. We offer active and passive filters fitting to the source of disturbance and customer's requirements. Our customers by this avoid harmonic problems and save costs.

Voltage dips

Motors need a high starting current and by this may cause an unacceptable voltage drop during start-up time resulting in overload-tripping and mal-functions. We offer motor-start compensation, which does not limit the motor-current but only the grid load. Our customers by this achieve a save start without affecting other processes.

Voltage fluctuation

Repeatedly heavy load changes can cause a disturbing voltage fluctuation which often results in critical mal-function of other electrical equipment. We offer systems for dynamic compensation to stabilize the supply voltage. Our customers by this reduce production failures and achieve more constant product quality.

Flicker disturbance

Voltage fluctuation with high repetition rate is typical for equipments like grid-welders. Such productions can cause unacceptable flicker disturbance on the grid. We offer customer designed flicker compensation to fight excessive flicker. Our customers by this achieve a stable supply voltage and avoid disturbing flicker levels.

Voltage unbalance

Single-phase and two-phase electrical equipments can cause unacceptable voltage unbalance resulting in increased losses and reduced grid capacity. We offer customer designed compensation equipments for load-balancing. Our customers by this reduce the voltage unbalance and resulting excessive losses.

Commutation notches

Rectifiers and converters show commutations with high voltage steepness. Such notches cause malfunctions and may destroy electronic devices. We offer special commutation filters related to the generating load as well as to reduce the disturbing impact on separate sensitive network areas.

Transients and pulses

Load switching, pulse frequencies, atmospheric disturbances etc. can cause high voltage spikes on the grid, which disturb and destroy electrical devices. We offer over-voltage protection capacitors, but also special customer designed filters. Our customers by this can protect their grid and avoid costly production failure.

Neutral overload

The increasing use of non-linear single-phase loads results in overload of the neutral conductor and faults of electronic devices. An upgrade of the network to neutral cross-section according phase cross-section is difficult to realize. Filtering measures to unload the neutral conductor can help to avoid disturbances and the risk of fire.

Ripple control

Audio frequency control signals may not be inadmissibly affected, but should themselves not be the source of disturbances. With blocking circuits in front of generators or at the feeding point of your distribution systems we guarantee compatibility of your plant, with noise filters we prevent you from disturbances by ripple control signals in the grid.

Maintenance

The proper operation of a compensation- or filter system saves costs and provides sufficient voltage quality. Regular inspection and well timed maintenance ensure a high operational availability. Additionally we offer a cost efficient short check of the network compatibility.

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