CAPACITOR & POWER FACTOR SOLUTIONS

- **NSL-10 & NSL-10-HD Modular Capacitors**
- **LL-10 Series Long Life Capacitors**
- **Modulo50 Long Life Cylindrical Capacitors**
- **MG Units - NSL-10 & LL-10**
- **Harmonic Circuit Filter Reactors - 5.6%, 7%, 14%**
- **Automatic Power Factor Controllers (Rego, RM, NAAC-3P, RC Series)**
- **Thyristor Switched Solutions for P.F. Correction & Harmonic Filtration**

General Information:

Why install a P.F. Correction System?

There are many objectives to be pursued in the planning of an electrical system. In addition to safety and reliability, it is very important to ensure that electricity is properly used. Each circuit, each piece of equipment, must be designed so as to guarantee the maximum global efficiency in transforming the source of energy into work.

Among the measures that enable electricity use to be optimized, improving the power factor of electrical systems is undoubtedly one of the most important.

If we quantify this aspect from the utility company's point of view, raising the average operating power factor of the network from 0.7 to 0.9 means:

- cutting costs due to ohmic losses in the network by 40%;
- increasing the potential of production and distribution plants by 30%.

These figures speak for themselves: it means saving hundreds of thousands of tons of fuel and making several power plants and hundreds of transformer rooms available. In the case of low power factors utility companies charge higher rates in order to cover the additional costs they must incur due to the inefficiency of the system that taps energy. It is a well-known fact that electricity users relying on alternating current – with the exception of heating elements – absorb from the network not only the active energy they convert into mechanical work, light, heat, etc. but also an inductive reactive energy whose main function is to activate the magnetic fields necessary for the functioning of electric Machines.

The power factor is thus the ratio between active power and apparent power (vectorial sum of active and reactive power), an indicator of the quality of a facility's electric system since the lower the power factor is, the higher the inductive reactive component will be in relation to the active component. It is possible to produce reactive energy, where necessary, by installing power capacitors or automatic power factor correction systems. Capacitors absorb a current that is 180% out of phase with the inductive reactive current; the two currents are algebraically summed together so that circulating upstream from the point of installation of the capacitor is a reactive current that is equal to the difference between the inductive and capacitive currents. The exchange occurs between the capacitor and user; this is why we say that the capacitor supplies reactive energy to the user.

How to correct the Power Factor?

Theoretically speaking, when you must choose where to locate the capacitive power the most appropriate solution from a technical standpoint would be to assign each load its own power factor correction capacitor, to be switched on together with the machine.

In practice, however, this entails excessive costs and technical problems in most cases, since it requires the installation of a larger number of low-power capacitors distributed in many different points, which cannot be effectively monitored over time; plus little benefit is to be derived from reducing losses in the cables, negligible compared to those in the power transformer. Therefore, this solution is only feasible in large plants or where there are very high power loads.

The most appropriate power factor correction system thus consists in the installation of an automatic capacitor bank on the bus bars of the distribution panel and, if necessary, fixed capacitor banks for correcting the power factor of the transformer, asynchronous motors and any loads absorbing large quantities of reactive power. The automatic system of the capacitor bank has the task of switching in the necessary capacitance according to the load requirements at each given moment.

The effect of Harmonics in Electrical System.

A harmonic is defined as one of the components obtained from the breakdown of a periodic wave in the Fourier series. The order of a harmonic is further defined as the ratio between the frequency of the harmonic and the fundamental frequency of the periodic wave considered. In the case of a perfectly sinusoidal waveform (as should characterize the voltage supplied by the utility) only the fundamental harmonic of the first order will be present, which in India has a frequency of 50 Hz. If a sinusoidal voltage is applied to a load, the circulating current will also have a sinusoidal waveform only in the presence of loads with “linear characteristics”. In the presence of a “non-linear” load the current waveform will deviate from the ideal pattern and breaking down the wave according to the Fourier theorem will show evidence of harmonics whose number and amplitude will increase with the degree of distortion in the current waveform. The increasingly frequent use of non-linear loads in industrial facilities (inverters, fluorescent lamps, welders, etc.) creates elevated distorsions in the waveform of circulating current. This is true in the case of ac/dc converters, for which the input current theoretically displays only harmonics of the order

$$h = mp \pm 1$$

where m is an integer other than 0 (thus 1, 2, 3, 4, ...) and p is the number of solid-state switches of the bridge. Therefore, a converter with six-phase reaction (p=6) generates characteristic harmonics of the 5th and 7th order (m=1), 11th and 13th order (m=2), 17th and 19th order (m=3) etc., whereas a converter with twelve-phase reaction (p=12) generates characteristic harmonics of the 11th and 13th order (m=1), 23rd and 25th order (m=2).

The parameter used to determine the level of harmonic distortion presents in an electrical network is THD% (Total Harmonic Distortion), defined as:

$$THD\% = \frac{\sqrt{\sum_{k=2}^{\infty} I_k^2}}{I_1}$$

Where I_1 is the effective value of the fundamental and I_k represents the effective values of harmonics of order k.

The presence of current harmonics in the system is therefore an indication of a distortion (deviation from a sinusoidal pattern) in the waveform of the current itself. This results in increased losses due to the Joule effect and the skin effect in the cables and increased losses due to hysteresis and parasite currents in the iron of transformers and motors. In addition, because of the equivalent cable impedances, the mains voltage may also be distorted.

Installing power factor correction capacitors in the network serves to create a condition of parallel resonance between the equivalent capacitance of the capacitors and the equivalent inductance of the system (which may usually be approximated by calculating the equivalent inductance of the transformer) in correspondence to a frequency fr.

Where Scc indicates the short circuit power of the system (expressed in MVA) at the point where the capacitors are connected and Q is the installed reactive power (expressed in MVAr), the parallel resonance frequency fr is thus determined:

$$f_r = f_1 \cdot \sqrt{\frac{S_{cc}}{Q}}$$

The short circuit power Scc of the system may beapproximated by calculating the short circuit power of the MV/LV transformer, indicated as Scct, which is given as:

$$S_{cct} = \frac{A}{V_{cc}\%} \cdot 100$$

Where A is the rated power of the transformer (expressed in MVA) and Vcc% is the percentage short circuit voltage of the transformer.

The voltage harmonics present in the system - having a frequency close to the parallel resonance frequency fr - are amplified. For this reason, an extremely high voltage comes to be created at the capacitor terminals, which causes the dielectric to age rapidly and hence significantly shortens the life span of the capacitor.

Choice and Sizing of P.F. Correction System.

Calculating the dimensions of the capacitor bank you need to install in your system is very simple: note the cosφ of the system without power factor correction and the cosφ you want to obtain and it will take just a few calculations to derive the reactive power necessary in order to reach the target power factor.

The power factor can differ greatly between two users because it depends both on the type of equipment installed and how it is used.

For Eg., asynchronous motors – by far the most widely used, though brushless motors actuated by static AC/DC or AC/AC converters have been gaining popularity in recent years – have a P.F. that varies greatly according to the motor load and type of construction and can reach very low values in the absence of loads. Similar observations may be made with respect to transformers.

For all these types of electric machines, recourse is often made to fixed power factor correction at the motor or transformer level. Other significant differences can be seen in electrical equipment such as lamps, furnaces, welders and converters.

Calculation of Reactive Power Necessary for Power Factor Correction

P	=	active power of the system
$Cos\varphi_0$	=	Cosφ of system without p.f. Correction
$Cos\varphi_1$	=	target Cosφ
Qc	=	reactive power of P.F.C System to installed
K	=	$cos\varphi_0$ and $cos\varphi_1$; this data is derived from the table below
Qc	=	$P . (tan\varphi_0 = tan\varphi_1) = P . K$

TECHNOLOGY - NSL-10

The continuous research conducted in Ducati energia laboratories has led to the development of a polypropylene film with a special metallization, whose purpose is to favour the self-healing process and reduce dielectric losses.

Thanks to this innovative metallization treatment, the polypropylene is subjected to less stress during operation. Therefore it maintains its dielectric properties for a significantly longer time while delivering significantly better performance in terms of both current and voltage.

LONG LIFE (Heavy Duty) series - High performance PPMh capacitors - LL-10

This innovative range of industrial power factor correction capacitors featuring elements wound with PPMh film sets new standards in terms of **reliability, performance and compactness.**

More effective self-healing and reduced dielectric losses make it possible to obtain a lifespan of up to 150,000 hours and performances in terms of voltage and current that are comparable to those of paper and oil capacitors while reducing size by up to 40%.

Capacitors of this type belong to the families:

- Series LL-10 Capacitors
- Series MODULO50 Cylindrical three-phase capacitors

Coefficient K by which to multiply the active energy consumed in KW in order to determine the KVAR necessary for correcting the power factor (cosφ is the initial PF, Cosφ1 is the PF obtainable with correction),

Recommended final cos φ =0.95 upto 1.00

Technology

Coefficient K																	
Value		Cosφ															
Tgφ	cosφ	0,85	0,86	0,87	0,88	0,89	0,90	0,91	0,92	0,93	0,94	0,95	0,96	0,97	0,98	0,99	1,00
3,18	0,30	2,560	2,586	2,613	2,640	2,667	2,695	2,724	2,754	2,785	2,817	2,851	2,888	2,929	2,977	3,037	3,180
3,0	0,31	2,447	2,474	2,500	2,527	2,555	2,583	2,611	2,641	2,672	2,704	2,738	2,775	2,816	2,864	2,924	3,067
2,96	0,32	2,341	2,367	2,394	2,421	2,448	2,476	2,505	2,535	2,565	2,598	2,632	2,669	2,710	2,758	2,818	2,961
2,86	0,33	2,241	2,267	2,294	2,321	2,348	2,376	2,405	2,435	2,465	2,498	2,532	2,569	2,610	2,657	2,718	2,861
2,77	0,34	2,146	2,173	2,199	2,226	2,254	2,282	2,310	2,340	2,371	2,403	2,437	2,474	2,515	2,563	2,623	2,766
2,68	0,35	2,057	2,083	2,110	2,137	2,164	2,192	2,221	2,250	2,281	2,313	2,348	2,385	2,426	2,473	2,534	2,676
2,59	0,36	1,972	1,998	2,025	2,052	2,079	2,107	2,136	2,166	2,196	2,229	2,263	2,300	2,341	2,388	2,449	2,592
2,51	0,37	1,891	1,918	1,944	1,971	1,999	2,027	2,055	2,085	2,116	2,148	2,182	2,219	2,260	2,308	2,368	2,511
2,43	0,38	1,814	1,841	1,867	1,894	1,922	1,950	1,979	2,008	2,039	2,071	2,105	2,143	2,184	2,231	2,292	2,434
2,36	0,39	1,741	1,768	1,794	1,821	1,849	1,877	1,905	1,935	1,966	1,998	2,032	2,069	2,110	2,158	2,219	2,361
2,29	0,40	1,672	1,698	1,725	1,752	1,779	1,807	1,836	1,865	1,896	1,928	1,963	2,000	2,041	2,088	2,149	2,291
2,22	0,41	1,605	1,631	1,658	1,685	1,712	1,740	1,769	1,799	1,829	1,862	1,896	1,933	1,974	2,022	2,082	2,225
2,16	0,42	1,541	1,567	1,594	1,621	1,648	1,676	1,705	1,735	1,766	1,798	1,832	1,869	1,910	1,958	2,018	2,161
2,10	0,43	1,480	1,506	1,533	1,560	1,587	1,615	1,644	1,674	1,704	1,737	1,771	1,808	1,849	1,897	1,957	2,100
2,04	0,44	1,421	1,448	1,474	1,501	1,529	1,557	1,585	1,615	1,646	1,678	1,712	1,749	1,790	1,838	1,898	2,041
1,98	0,45	1,365	1,391	1,418	1,445	1,472	1,500	1,529	1,559	1,589	1,622	1,656	1,693	1,734	1,781	1,842	1,985
1,93	0,46	1,311	1,337	1,364	1,391	1,418	1,446	1,475	1,504	1,535	1,567	1,602	1,639	1,680	1,727	1,788	1,930
1,88	0,47	1,258	1,285	1,311	1,338	1,366	1,394	1,422	1,452	1,483	1,515	1,549	1,586	1,627	1,675	1,736	1,878
1,83	0,48	1,208	1,234	1,261	1,288	1,315	1,343	1,372	1,402	1,432	1,465	1,499	1,536	1,577	1,625	1,685	1,828
1,78	0,49	1,159	1,186	1,212	1,239	1,267	1,295	1,323	1,353	1,384	1,416	1,450	1,487	1,528	1,576	1,637	1,779
1,73	0,50	1,112	1,139	1,165	1,192	1,220	1,248	1,276	1,306	1,337	1,369	1,403	1,440	1,481	1,529	1,590	1,732
1,69	0,51	1,067	1,093	1,120	1,147	1,174	1,202	1,231	1,261	1,291	1,324	1,358	1,395	1,436	1,484	1,544	1,687
1,64	0,52	1,023	1,049	1,076	1,103	1,130	1,158	1,187	1,217	1,247	1,280	1,314	1,351	1,392	1,440	1,500	1,643
1,60	0,53	0,980	1,007	1,033	1,060	1,088	1,116	1,144	1,174	1,205	1,237	1,271	1,308	1,349	1,397	1,458	1,600
1,56	0,54	0,939	0,965	0,992	1,019	1,046	1,074	1,103	1,133	1,163	1,196	1,230	1,267	1,308	1,356	1,416	1,559
1,52	0,55	0,899	0,925	0,952	0,979	1,006	1,034	1,063	1,092	1,123	1,156	1,190	1,227	1,268	1,315	1,376	1,518
1,48	0,56	0,860	0,886	0,913	0,940	0,967	0,995	1,024	1,053	1,084	1,116	1,151	1,188	1,229	1,276	1,337	1,479
1,44	0,57	0,822	0,848	0,875	0,902	0,929	0,957	0,986	1,015	1,046	1,079	1,113	1,150	1,191	1,238	1,299	1,441
1,40	0,58	0,785	0,811	0,838	0,865	0,892	0,920	0,949	0,979	1,009	1,042	1,076	1,113	1,154	1,201	1,262	1,405
1,37	0,59	0,749	0,775	0,802	0,829	0,856	0,884	0,913	0,942	0,973	1,006	1,040	1,077	1,118	1,165	1,226	1,368
1,33	0,60	0,714	0,740	0,767	0,794	0,821	0,849	0,878	0,907	0,938	0,970	1,005	1,042	1,083	1,130	1,191	1,333
1,30	0,61	0,679	0,706	0,732	0,759	0,787	0,815	0,843	0,873	0,904	0,936	0,970	1,007	1,048	1,096	1,157	1,299
1,27	0,62	0,646	0,672	0,699	0,726	0,753	0,781	0,810	0,839	0,870	0,903	0,937	0,974	1,015	1,062	1,123	1,265
1,23	0,63	0,613	0,639	0,666	0,693	0,720	0,748	0,777	0,807	0,837	0,870	0,904	0,941	0,982	1,030	1,090	1,233
1,20	0,64	0,581	0,607	0,634	0,661	0,688	0,716	0,745	0,775	0,805	0,838	0,872	0,909	0,950	0,998	1,058	1,201
1,17	0,65	0,549	0,576	0,602	0,629	0,657	0,685	0,714	0,743	0,774	0,806	0,840	0,877	0,919	0,966	1,027	1,169
1,14	0,66	0,519	0,545	0,572	0,599	0,626	0,654	0,683	0,712	0,743	0,775	0,810	0,847	0,888	0,935	0,996	1,138
1,11	0,67	0,488	0,515	0,541	0,568	0,596	0,624	0,652	0,682	0,713	0,745	0,779	0,816	0,857	0,905	0,966	1,108
1,08	0,68	0,459	0,485	0,512	0,539	0,566	0,594	0,623	0,652	0,683	0,715	0,750	0,787	0,828	0,875	0,936	1,078
1,05	0,69	0,429	0,456	0,482	0,509	0,537	0,565	0,593	0,623	0,654	0,686	0,720	0,757	0,798	0,846	0,907	1,049
1,02	0,70	0,400	0,427	0,453	0,480	0,508	0,536	0,565	0,594	0,625	0,657	0,692	0,729	0,770	0,817	0,878	1,020
0,99	0,71	0,372	0,398	0,425	0,452	0,480	0,508	0,536	0,566	0,597	0,629	0,663	0,700	0,741	0,789	0,849	0,992
0,96	0,72	0,344	0,370	0,397	0,424	0,452	0,480	0,508	0,538	0,569	0,601	0,635	0,672	0,713	0,761	0,821	0,964
0,94	0,73	0,316	0,343	0,370	0,396	0,424	0,452	0,481	0,510	0,541	0,573	0,608	0,645	0,686	0,733	0,794	0,936
0,91	0,74	0,289	0,316	0,342	0,369	0,397	0,425	0,453	0,483	0,514	0,546	0,580	0,617	0,658	0,706	0,766	0,909
0,88	0,75	0,262	0,289	0,315	0,342	0,370	0,398	0,426	0,456	0,487	0,519	0,553	0,590	0,631	0,679	0,739	0,882
0,86	0,76	0,235	0,262	0,288	0,315	0,343	0,371	0,400	0,429	0,460	0,492	0,526	0,563	0,605	0,652	0,713	0,855
0,83	0,77	0,209	0,235	0,262	0,289	0,316	0,344	0,373	0,403	0,433	0,466	0,500	0,537	0,578	0,626	0,686	0,829
0,80	0,78	0,183	0,209	0,236	0,263	0,290	0,318	0,347	0,376	0,407	0,439	0,474	0,511	0,552	0,599	0,660	0,802
0,78	0,79	0,156	0,183	0,209	0,236	0,264	0,292	0,320	0,350	0,381	0,413	0,447	0,484	0,525	0,573	0,634	0,776
0,75	0,80	0,130	0,157	0,183	0,210	0,238	0,266	0,294	0,324	0,355	0,387	0,421	0,458	0,499	0,547	0,608	0,750
0,72	0,81	0,104	0,131	0,157	0,184	0,212	0,240	0,268	0,298	0,329	0,361	0,395	0,432	0,473	0,521	0,581	0,724
0,70	0,82	0,078	0,105	0,131	0,158	0,186	0,214	0,242	0,272	0,303	0,335	0,369	0,406	0,447	0,495	0,556	0,698
0,67	0,83	0,052	0,079	0,105	0,132	0,160	0,188	0,216	0,246	0,277	0,309	0,343	0,380	0,421	0,469	0,530	0,672
0,65	0,84	0,026	0,053	0,079	0,106	0,134	0,162	0,190	0,220	0,251	0,283	0,317	0,354	0,395	0,443	0,503	0,646
0,62	0,85		0,026	0,053	0,080	0,107	0,135	0,164	0,194	0,225	0,257	0,291	0,328	0,369	0,417	0,477	0,620
0,59	0,86			0,027	0,054	0,081	0,109	0,138	0,167	0,198	0,230	0,265	0,302	0,343	0,390	0,451	0,593
0,57	0,87				0,027	0,054	0,082	0,111	0,141	0,172	0,204	0,238	0,275	0,316	0,364	0,424	0,567
0,54	0,88					0,027	0,055	0,084	0,114	0,145	0,177	0,211	0,248	0,289	0,337	0,397	0,540
0,51	0,89						0,028	0,057	0,086	0,117	0,149	0,184	0,221	0,262	0,309	0,370	0,512
0,48	0,90							0,029	0,058	0,089	0,121	0,156	0,193	0,234	0,281	0,342	0,484
0,46	0,91								0,030	0,060	0,093	0,127	0,164	0,205	0,253	0,313	0,456
0,43	0,92									0,031	0,063	0,097	0,134	0,175	0,223	0,284	0,426
0,40	0,93										0,032	0,067	0,104	0,145	0,192	0,253	0,395
0,36	0,94											0,034	0,071	0,112	0,160	0,220	0,363
0,33	0,95												0,037	0,078	0,126	0,186	0,329
0,29	0,96													0,041	0,089	0,149	0,292
0,25	0,97														0,048	0,108	0,251
0,20	0,98															0,061	0,203
0,14	0,99																0,142

LL-10 & Long Life Modulo50 Capacitors

Applications:

Three-phase Modulo50 capacitors are latest from Neptune-Ducati and has been designed for power factor correction in high harmonic current content. They are capable of withstanding 4xIn which is Maximum in comparison to other technologies offered in the market.

Technology:

The capacitor has been made by three elements connected in a delta configuration to keep as low as possible the Stress voltage on the film. The elements are housed into an aluminium can and finally impregnated by natural oil.

Electrical Characteristics:

- Each element is made by Metallized Polypropylene.
  - The metallization has been made in a special "profile" to allow:
  - an higher voltage stress on the film
  - an higher operating over-voltage
  - a better way to control the self-healing
  - an heavy edge to improve the contact from the active area and the spraying head to reach an higher inrush current (more than 300 times rated current)
  - very low losses (less than 0,2 W/kVAr)

The impregnation technology allow:

- to treat the capacitor in a vacuum
- to eliminate gas and humidity from the active area
- impregnate the element
- to control the "partial discharge effect" which is one of the reason to have precocious ageing (life longer than 150,000 operating hours)

Mechanical Characteristics

- the capacitor is equipped with an over-pressure device which allow to protect itself from the destructive short circuit coming from an electrical or thermal over-load
- this over-pressure device works on all the three phases
- the oil is the best to transmit to the mechanical safety device, in a shortest way, the over-ressure coming from a destructive short-circuit.

Claw profile

The capacitor has been equipped with a new claw profile to assure that no leakage can occur during all capacitor's life.

The mastic, is spread just before clawing, so it can run through all the space from cover and can The mastic is made by silicon. After a few minutes, the mastic join cover and can and the oil, that fill the capacitor, can't go outside.

The picture has been taken from a real capacitor by microscope
To be sure that the capacitor can without the expected life (more than 150,000 h), we have put, itself, under :

- 1,25 Un
- 1,35 Un

Power Quality Studies/Fault Analysis/ Selection Criteria of PFC System

NEPTUNE *can* offer comprehensive Load Studies, Energy Monitoring, Harmonic Analysis by connecting portable highly accurate Real Time

Load & Harmonic Analyzer. It can generate the computer data for complete network analysis which is useful in analyzing & offering solutions for Harmonics, network problems, type of Power Factor Compensation system & Energy saving.

Criteria for choosing Automatic Equipment according to network conditions:

Once the maximum necessary power has been determined, the choice of which type of equipment to adopt must be based on the conditions of the electrical network and the types of loads present.

The selection table below, drawn up on the basis of general plant characteristics (and thus not usable for planning purposes), aims to provide an indication of the power factor correction system generally suited to the most frequently encountered conditions; electrical systems with mains voltage of 440V-50Hz, characterized by the presence of distorting loads with a spectrum composed of 5th, 7th, 11th and 13th harmonics.

Where:
- **THD**: Total Harmonics Distortion of the current in the network. If no measurements of this parameter is available, it can be estimated by multiplying the ratio between the apparent power of the distorting loads and the total apparent power of the system by the coefficient 30 (NB: this method will provide only an approximate value and is based on an assumption of averagely distorting loads with a spectrum composed of 5th and 7th harmonics).

- **THD_{MAXC}**: Total Harmonics Distortion of the max current accepted on the capacitors.

In cases where the distorting loads represent an overall power exceeding 25% of the available apparent power, it's always recommended to use power factor correction equipment with Harmonic Block Reactors to avoid amplifying the harmonic currents present in the network and to limit low-frequency electromagnetic pollution.

Moreover, it must always be verified that there are no significant harmonics in proximity to the frequency of parallel resonance between the equivalent capacitance of the capacitors and equivalent inductance of the plant (usually estimated as the equivalent inductance of the transformer), which may be calculated.

For further details contact our Sales Office.

NSL-10 Modular Capacitors

Standard Life

Neptune-Ducati NSL-10 is award winning design Modular Capacitor. It is offers "Safety-Reliability-Long Life Expectancy - Easy Handling and Mounting".

- Capacitive elements provided with a sensitive "FLOPPY CAP" over pressure device - low loss metallized polypropylene film as dielectric impregnated with polyurethanic resins.
- Excellent dissipation of the internally-generated heat. The triple word vertical structure improves the heat-dissipation area for a better cooling of the internally-fit capacitive elements especially when two or more modules are used.

  A lower dielectric temperature means an extended life expectancy of the capacitor.
- The Modular design permits a most simple mechanical assembly. No extra accessory metal parts are required. Electrical connections are made by copper-links available on request.
- Most easy mounting
- Capacitor "Modules" already include all fittings required for their correct operation such as:

  Protection cover - Feed - Through groumet- switch-on current limitation reactors. Over pressure protection device on each capacitive element - Discharge resistors 50V after 1 min.) - Self Extinguishing plastic container.

NSL10 capacitors are particularly suitable in the production of automatic power factor correction systems. They are also used in power factor correction of motors and transformers. The NSL10 three-phase capacitor is made with three 3 single-phase capacitors. The three switch-on reactors are made of copper windings.

TECHNICAL SPECIFICATIONS : (NSL-10)

Standard Voltage (Un)	:	440/450V
Other Voltage on request (Un)	:	415V - 550V
Rated frequency	:	50 Hz
Capacitance tolerance	:	-5 + 10%
A.C. test voltage bet. terminals	:	2, 15 Un per 10"
A.C. test volt. bet. terminals & case	:	3 kV per 10"
Installation	:	Internal
Ambient air temperature category	:	-40 + 55°C
Altitude	:	< 2000 m

The external case, made with insulating material, (Class V2 according to UL 94 standard flammability classification) eliminates the need to provide a protective earthing connection. The easy assembly using "small feet" make the capacitor a universal one.

Heavy Duty NSL-10Capacitors

NSL-10 - Heavy Duty Type range for use in the P.F. Correction of industrial & office electrical networks. It is a series of quality products which has been designed to cater to the most demanding users where operating conditions are particularly critical and where reliability is of prime importance. The NSL-10 HD range also satisfies the demand for a product with durability and longer life.

Total lack of air between the capacitors plates ensures that the dielectric - and hence the capacitor too-lasts a long time. The dielectric consist of heavy film of polypropylene.

The capacitors are designed with a very low loss dielectric & high quality film is used. They combine these high-tech advantages with the safety and reliability of the traditional technology of impregnation used for Medium Voltage capacitors. The capacitive elements are housed in a cylindrical container made of aluminum.

All of the materials employed are non-toxic and biodegradable. Thanks to the above characteristics the capacitor has an expected life which greatly exceeds 1,00,000 hours. It is characterized by the capability of bearing high harmonic components up to R.M.S. Currents level in excess of 2 In.

Service	:	Continuous
Protection degree	:	IP 40
Discharge resistor	:	Internal (50V after 1 min)
Max. permissible current	:	1.3 In maximum
Max. permissible current (NSL-10-HD)	:	2 In maximum
Terminals	:	3 x M 8
Dielectric losses	:	< 0.3 W/kvar
Reference standard	:	EN 60831-1/2

Ordering Information:

Un (V)	Qn (KVAr)	In (A)	Cn (uF)	L (mm)	Code NSL-10.
	5	6,4	3x28	79	.0005.450
	7.5	9,6	3x39,3	79	.0075.450
	10	12,8	3x55	79	.0010.450
	12,5	16	3x65,5	79	.0125.450
	15	19,2	3x78,6	148	.0015.450
440/	20	25,6	3x110	148	.0020.450
450v	25	32	3x131	148	.0025.450
	30	38,5	3x165	217	.0030.450
	40	51,3	3x220	286	.0040.450

Un (V)	Qn (KVAr)	In (A)	Cn (uF)	L (mm)	Code NSL-10HD
	5	6,4	3x26,2	79	.2005.450
	7.5	9,6	3x39,3	79	.2075.450
	10	12,8	3x52,4	79	.2010.450
	12,5	16	3x65,5	148	.2125.450
	15	19,2	3x78,6	148	.2015.450
440/	20	25,6	3x105	148	.2020.450
450v	25	32	3x131	217	.2025.450
	30	38,5	3x157	217	.2030.450
	40	51,3	3x209	286	.2040.450
	50	64,1	3x262	355	.2050.450

NSM-4 -
For Low Rated Banks

- Unique Modular Thermo Plastic Enclosure
- Suitable for Static & Automatic Compensation
- Voltage Rating 440V
- Rating available - 2, 3, 4, 5 KVAR

MG Unit Assemblies

for Direct Mounting in APFC System

Neptune-Ducati MG Units have been specifically designed for fitting in APFC Panels. They not only offer space saving, easy installation but better life also. The option is available with pre-fitted fuse / MCCB and Capacitor Duty Combination. They offer time saving and economy for panel builders.

Ordering Information:

Un (V)	Qn (KVAr)	In (A)	Cn (uF)	H (mm)	L (mm)	W (mm)	Code MG-NSL-10
	5	6,4	3x32,8	175	250	175	.5005.450*
	7,5	9,6	3x39,3	200	250	175	.5075.450*
	10	12,8	3x55	200	250	175	.5010.450*
	12.5	16	3x65,5	200	250	175	.5125.450*
	15	19,2	3x78.6	200	250	175	.5015.450*
440/	20	25,6	3x110	200	250	175	.5020.450*
450V	25	32	3x131	200	250	175	.5025.450*
	30	38,4	3x165	200	250	284	.5030.450*
	40	51,2	3x220	205	275	315	.5040.450*
	50	64	3x262	205	275	315	.5050.450*

*Put suffix of "-S" for option with complete switchgear. For dimension of S-version contact our Sales Office.

Long Life LL-10 Series

Neptune-Ducati LL-10 or Long Life Modulo50 series are manufactured using elements wound with the new PPMh film and housed in metal cases with metal lids. The parts are assembled by crimping to ensure perfect airtightness of the system and efficient operation of the over pressure safety device.

The use of oil impregnation technology greatly enhances the capacitor's performance in terms of heat dissipation as well as ensuring a long life and excellent ground insulation. This series is used in practically all the Neptune-Ducati Tuned & Detuned APFC Systems which rely on single-phase capacitors. In fact, the above-described characteristics make these capacitors especially suitable for continuous duty under highly demanding conditions in harmonic rich environments.

TECHNICAL SPECIFICATIONS : (LL-10 & Modulo50)

Standard Voltage (Un)	:	450V
Rated frequency	:	50 Hz (60 Hz on request)
Capacitance tolerance	:	-5 + 10%
Dielectric losses	:	$\leq$ 0.2 W/kvar
Altitude	:	$\leq$ 2000 m a.s.l.
Service	:	Continuous
A.C. test voltage bet. terminals	:	2, 15 Un x 2 s
A.C. Test volt. bet. terminals & case	:	3 kV x 10 s

Ordering Information:

Un (V)	Qn (KVAr)	In (A)	Cn (uF)	L (mm)	Code LL-10
	5	6,4	3x26	75	.3005.450
	7.5	9,6	3x39,3	75	.3075.450
	10	12,8	3x52	75	.3010.450
	12,5	16	3x66	75	.3125.450
450	15	19,2	3x79	150	.3015.450
	20	25,6	3x105	150	.3020.450
	25	32	3x131	150	.3025.450
	30	38,5	3x157	225	.3030.450
	40	51,3	3x210	300	.3040.450
	50	64,1	3x262	300	.3050.450
	75	96,1	3x393	450	.3750.450

MG Unit Assemblies

for Direct Mounting in APFC System

Similar to MG Unit Assemblies in NSL-10, they are available with LL-10 series Capacitors.
Options are available with switchgear mounted assemblies.
For dimension & prices, contact our Sales Office.

Temperature class	:	-25/D
Terminals	:	M8 bolt
Max. Inrush current	:	200 In
Max. Overload In	:	4 x In
Life expectancy	:	$\geq$ 130000h - 25/D > 150000h - 25/C
Max dV/dt	:	$\leq$ 100V / µs
Reference standard	:	IEC 831-1/2

Long Life Series Modulo50 - 3 Phase Cylindrical Capacitor

The capacitors making up the **MODULO50** series are used in static & automatic power factor correction equipment. The series has three capacitor elements wired internally in a delta connection.

The overpressure protection system is specifically dimensioned so as to constantly ensure maximum safety in terms of ground protection and protection against the risk of arcing, even in conditions where there is a high energy density.

The capacitors making up the new series are obtained using three elements wound with the new PPMh and positionated inside metal case. The parts are assembled by crimping to ensure perfect airtightness of the system and efficient operation of the overpressure safety device. The use of vegetable oil impregnation technology and positioning of the individual elements inside the case assure extremely high capacitor performance in terms of heat dissipation, as well as ensuring a long life and excellent ground insulation. This series is used in practically all Neptune-Ducati Thyristor Switched Power Factor Correction Systems which rely on three-phase capacitors. In fact, the above-described characteristics make these capacitors
especially suitable for continuous duty under highly demanding conditions in harmonic rich environments. Special care has been taken in the crimping and sealing of the case; a sealant is first applied on the lid to guarantee the perfect airtightness of the system.

1 Aluminium Case
2 Elastic Washer
3 Internal insulated case
4 Bottom protection carton
5 Lateral protection carton
6 Wounded + Zinc capacitive element
7 Protection polypropylene
8 Group cover and tags
9 Connection cable

10 Connection cable
11 Protection polypropylene
12 Group cover and base
13 Cover for base
14 Oil
15 Connection Cable
16 Tin

Ordering Information

Un (V)	Qn (KVAr)	In (A)	Cn (uF)	DxH (mm)	Code Modulo50-
	5	6,42	3x26	65x200	3050.450
	7.5	9,62	3x39	65x200	3080.450
	10	12,83	3x52	75x200	3100.450
	12,5	16,04	3x66	75x200	3150.450
450V	15	19,25	3x79	85x200	3200.450
	20	25,66	3x105	90x200	3250.450
	25	32,08	3x131	100x200	3300.450
	30	38,49	3x157	100x240	3350.450
	40	51,32	3x210	116x300	3380.450

Harmonic Circuit Filter Reactors
5.6%, 7%, 14%

Applications

Harmonic generated by non-linear loads such as variable speed drives or other static power conversion equipment have grown rapidly in recent years. Harmonic currents and the voltage distortion, created by these currents have devastating effects on power supply and distribution systems and its connected loads. This can result in failure of power factor correction capacitors due to overloading, system resonance, overheating of cables and transformers as well as misoperation of PLC's, computer and other sensitive applications. A present method to treat harmonic problems is the use of filter circuit reactors combined with power capacitors in detuned and tuned filters as well as the improvement of the power factor and the power quality, harmonics are also absorbed from the networks. Furthermore, a critical amplification of the current harmonics caused by a parallel resonance between the power capacitors and the inductances of the power supply system can be avoided.

Dimensioning

The dimensioning of the filter circuit reactors is based on the recommendation of allowable limits of voltage harmonics in public and industrial networks according of IEC 10002-4. In case of higher harmonic loads in networks, special designed filter circuit reactors have to be used. The actual loads can be detected by means of a harmonic analysis. The measured values from the basis for the dimensioning of the filter circuit reactors.

TECHNICAL SPECIFICATIONS:

Rated Voltage	:	3 x 415/440V
Rated (KVAr)	:	5-100 kvar
Frequency	:	50 Hz
Constructional Max. Voltage	:	1000 V
Test Voltage	:	5000 V
Filtering factors / Tuning freq.	:	5.6%(210 Hz), 7%(189 Hz) 14%(133 Hz)
Tolerance of inductance	:	±3%
Linearity (L> 0.95 x Ln)	:	200%

Design Features

Neptune reactor are single layer winded design with an iron core & air gap. They are made out of highest quality material and very stringent quality control. It has been designed with properties like low temperature rise and lower flux density so that it can operate in worst conditions of ambient and harmonic overloads. It offer very good degree of linearity. Cheaper & non-linear reactors may trigger undesirable chain phenomena during periods of operation with high harmonic values, such as reducing in the inductance with consequent increase in the resonance frequency of the LC group, which would drain off more harmonic current, further reducing its inductance and overload the reactor more and more. Reactors are available with filtering factor of 5.6%, 7% and 14% in 5, 7.5, 10, 12.5, 15, 20, 25, 50, 75 and 100 KVAr rating. Any other filtering factor and rating can be made on request.

Losses
The 50 Hz losses are comparatively low but when the filter circuit reactors are installed into the cabinets, they are charged with additional currents, predominately those of the 5th, 7th & 11th harmonics. Then the total heat losses dissipated can be of a level whereby they have to be extracted from the cabinets, by means of fans.

Terminals
The terminals for filter circuit reactors are designed as cable terminals (d=8,5mm)
Ordering Information:

	Type	A	B	C	D	E*	E	Ø
	5	225	195	135	133	108	82	8
	7.5	225	195	140	133	112	88	8
	10	225	195	145	133	116	92	8
	12.5	225	195	160	133	135	110	8
	15	225	195	160	133	135	110	8
7%	20	250	223	155	195	125	98	10
	25	250	223	160	195	130	101	10
	50	305	280	260	213	160	124	9x14L
	75	400	371	280	270	170	132	13x19L
	100	400	371	295	270	178	138	13x19L

Ambient temperature	:	+ 55°C
Winding material	:	Cu
Insulation class	:	H
Cooling method	:	Natural cooling (AN)
Installation	:	Indoor
Protection degree	:	IP 00
Operating altitude	:	1000m above sea level at Rated operation
Temp. sensor (normally closed)	:	155°C
Reference standard	:	IEC 61558-2-20

Automatic Power Factor Controller Series - REGO

The new digital **REGO** series not only offers a high reliability and accuracy in the reactive power compensation but also a user interface for the configuration and programming, which is extremely intuitive and suitable to all applications. The new microprocessor also permits a better management of the innovative functions implemented.

Automatic reactive power control relays are microprocessor controlled systems that automatically manage capacitor banks to compensate for the reactive power absorbed by the load. REGO series available in a 144x144mm with 7 or 12 output relays, and 96x96 mm with 5 output relays.

Capacitor banks are switched on and off as the capacitive reactive power required to reach the set value of the load cosφ in the regulator exceeds 70% of the power of the first bank for a time corresponding to the set delay.

These generation control relays also offer measurement, protection and Data Acquisition for PC Transmission and Storage (Rego 7-12). The Rego 7-12 version can perform net data communication by means of Neptune-Ducati instruments / Analyzers.

The most innovative features of REGO are:
- Sole parameter to be set up during installation: CT ratio (i.e 1000/5 : set 200).
- CT circulation direction is automatically adjusted to control relay internal data.
- Cosφ linear setting from 0.8 IND to 0.8 CAP.
- C/k automatic setting.
- Banks manual control, regardless of the line value measured.
- Inhibition of the unused output relays.
- Setting for PF Correction of asynchronous generators.

TECHNICAL SPECIFICATIONS: (Rego)

Voltage input	:	415V
Voltage tolerance	:	± 20%
Frequency	:	50 Hz
Voltage consumpiton	:	15VA
Current input (by C.T.)	:	...../5A
Current consumption	:	0,5 VA Max.
Max. admissible overload	:	30 In x 10 sec.
Sensitvity C/k value	:	Automatic

- Operating time setting from 0.5 to 300 sec.
- Discharge time setting from 5 to 255 sec.
- 3 logics to connect/disconnect banks, with automatic detection
- Universal geometric logic (1:2:4), in which it is possible to obtain a high number of steps, while minimising the number of banks;
- Circular and linear logic (1:1:1), in which the output relays are controlled in a circular sequence, thus allowing a more even distribution of operations on contacts and considerably reducing maintenance required;
- Semicircular and linear logic (1:2:2), in which it is possible to obtain a higher number of steps than the logic (1:1:1).

The REGO family shows on its front display:
Line Cosφ; Line current; Mains voltage; Line active power; Line reactive power; CT current crest factor (THD); Counter of operations performed by each output relay; Number of alarm conditions; Powers of individual steps; Internal panel inside temperature, in the area around the power control relay.

The **PROTECTION SYSTEM** which protects power factor correction system includes:
- Overvoltage alarm activated even when no bank is connected; it protects the regulator from any overvoltage which is higher than the allowed one, that is more than 30 seconds;
- Over temperature protection which is active even when no capacitor bank is on; it is tripped when the air temperature around the control relay exceeds the limit for at least 15 seconds;
- Harmonic overload protection which protects the capacitors from peak voltages;
- P.F correction fault which indicates that the cosφ value remains below the set value for more than two hours, while all banks are switched on;
- No voltage protection which cuts out relays when there is no voltage for more than two periods. When power voltage is back, the control unit will operate under automatic control.

Except for the latter, protections can have a remote control through a clean contact.

All the protections (except the last one) can be either inhibiten or made self-resettable (the regulator will start again after 30 m's stand-by under alert conditions).

Fan contact	:	NO (10A-250V AC)
Ambient temperature range	:	-10 + 55°C
Degree of protection	:	IP 40
Connection	:	Extractable screw connectors
Dimensions (mm)	:	144 x 144 x 60 mm
Drilling	:	91 x 89 mm
Casing	:	Plastic material auto Extinguishing
Standards	:	EN-61010-1, EN-50081-1 EN-50082-2

Automatic Power Factor Controllers
Series - RM, NAAC 3P (3 Phase) & Economy Series RC7

RM Series P.F. Controllers are used for measurement and control of P.F. control units for central reactive power compensation. The P.F. measured by Neptune RM is compared with the set values and in order to provide necessary compensation. P.F. Controller switches capacitor banks ON & OFF automatically. RM is Single Phase CT Sensing micro controller relay, designed for above application in 144x144 case for flush mounting with rear plug-in connectors. In addition, Neptune RM displays the following values.

1) Power Factor
2) Cos φ
3) Ph-Ph volt. (VAC)
4) Current (I)
5) Active power (W)
6) Total active power (IW)
7) Reactive power (Var)
8) Apparent power (VA)

Microcontroller based programmable RM series relays are manufactured with 8 & 12 capacitor steps. It can work either in automatic or manual mode.

NAAC-3P Series are ultimate solution for compensation of unbalanced loads. Further to RM series standard features, NAAC-3P series controllers function as if a reactive energy meter. The Compensation is realized by measuring the reactive power of system, through 3 current transformers from 3 phases. This makes NAAC-3P Series a unique solution for unbalanced load compensation.

TECHNICAL SPECIFICATIONS : (RM & NAAC 3P)

Voltage input	:	415V
Power supply	:	240VAC (Ph-Neutral) 415V AC (Ph.-Ph.) ± 10%, 50 / 60Hz (optional)
Operating current	:	../5A, 100mA to 5.5A
Setting Range	:	0, 85< cos phi <1 (inductive) Manual C/k: (0.02-1.00), CT ratio:5-10000
Accuracy	:	Class 1%+1 Digit
Relative humidity	:	95%

Features (RM Series & NAAC-3P Series)

- Measurement of A,V, PF, Cosφ, W, VAr, VA
- Compensation for Reactive Power
- Auto/Man. mode selection with indicator light
- Automatic calculation of C/k value
- Program entry for targeted cos phi value
- Number of capacitor steps are user definable
- The consequent switching time between capacitor steps is adjustable from 2 to 50 sec.
- C+NORMAL/C-condition lights indicate actual system state
- Over Voltage, Insufficient Compensation, Over Compensation state alarm indicator lights with output contact
- Adjustable programmable Over Voltage protection for capacitor blanks
- Micro controller based digital design complying with international standards
- For flush mounting with rear panel connectors
- Designed to use with CT's (.../5A)

Automatic Power Factor Controller Series - RC-7

RC-7 is a economy series for P.F. Control. The Power Factor which is measured by the RC-7 is compared with the set point values. Power Factor controller switches capacitor banks ON and OFF automatically or user can switch them manually in Manual operating mode. RC-7 is microprocessor based controller in 96 x 96 case for flush mounting with rear plug-in connectors.

The target Cosφ value can be adjusted between 0.85 - 1.00 inductive, RC-7 switches ON/OFF capacitors in order to bring system's power factor to the adjusted value.

Protection class	:	IP20 (for front panel)
Equipment protection	:	Double Insulation ( )
Standards	:	CE
Dimensions	:	144x144 mm
Switchboard Cutout	:	139x139mm
Cable diameter (for term.)	:	2.5mm2
Installation	:	Flush-mounting with Rear terminals
Weight	:	0.8 kg

ACTIVCOMP - Thyristor Switched P.F. Cum Harmonic Filtration Solution for Fast Changing & Non Linear Loads.

The Activcomp is a state of the art, electronic switching system designed for Power factor Correction & Harmonic filtration. Connection and disconnection of the capacitors to and from the network occurs at zero current crossing. This smooth connection avoids the transient effects typically created by electro mechanically switched PFC systems.

Power-IQ - Complete Power Quality Management System

PowerIQ displays the harmonics spectrum, both as a graph and table, in addition to harmonic analysis parameters (THD, K-Factor and Crest-Factor). Compliance monitoring of international power quality standards, such as IEEE-519, allows easy network analysis.

Scope Displays waves and their phase shifting, and enables detection of existing or potential power quality problems.

Features

- Power Factor Correction & Harmonic Filtration system (Tuned & Detuned)
- Fast & Accurate Compensation, Unlimited Number of Transient Free operation

- Low Cost State-of-the-art Alternative for replacing electro-mechanical systems
- Saves energy & reduce electric billing
- Accurate P.F. control, even with harmonics present
- Extreme long life expectancy.
- Simultaneous Group Connection
- Reduced Maintenance Cost
- Easy to Use and Maintain
- Integral power, harmonic & waveform analyzer

Application of Activcomp

- Industries with Fast Changing & Non-Linear Loads
- Hospitals and other Medical Centres
- Data Centres
- Extrusion
- Office Buildings

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