ALLSAI®

Innovating Power

QUALITY INNOVATION

ALLSAI POWER QUALITY

Power Quality Engineering
Capacitor & Filter Banks
Capacitors & Reactors

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Company Profile

Introduction

Allsai Group is in continuous development with its customer oriented activities, advanced engineerin know-how, R&D works, software developing abilities and with the continuous support of loyal customers that are attained and protected by precise work and ethical principles of the company.

The group companies have ISO 9001 since 90s and our factory has ISO 14001 Environment and ISO 18001 Occupational Health and Safety Certificates.

Technology

The most important activities of Allsai is R&D and increase the Employee quality which the investment amount of these activities are more than average.

All mechanical projects are designed by 3D-CAD platforms. Power flow, test and quality works are calculated by Worldwide accepted simulation software and ActWin software as well as developing software for different platforms.

In order to increase the production quality and capacity all machinery within the facility are renewed with latest technology equipment in 2009.

Mission

By the help of our followings mission is continuing to announce product quality and knowledge of our company and country in best possible way by meeting rising customer expectations.

- open minded approach
- high quality policy
- innovative ideas
- constantly improved processes
- polished employees
- knowledge based decisions

Vision

To increase the number of our loyal customers in global market, hence increasing the market share and becoming reputable, reliable and preferred company as worldwide with our;

prominent quality difference,
customer oriented approach,
innovative activities,
open minded approach.

Company Profile

Security

The human safety and security are the main concerns in all of our products.

Design, Interlock logics and documentation of our products are implemented, manufactured and tested in order to reach the highest safety level.

Furthermore, services and site works are done according to human safety rules by taking into account the dangerous of electricity.

High Performance, Durable and Simple

Endurance of our products, which are produced with high level of awareness and accurateness in addition to follow international standards, ensures an outstanding performance for the users. Therefore our products are considered as top of the line products.

Visual simplicity and being user friendly are the design criteria for the software and hardware of our products. Our products have the most simple and functional features for emergency applications as well as persistence of habits and customer satisfaction are basics in design, production and shipment.

Service Continuity

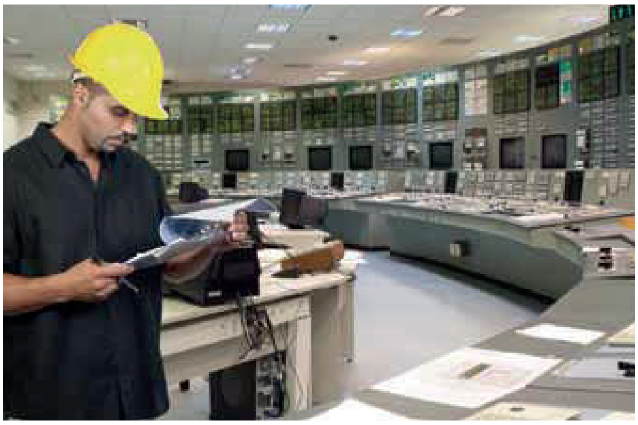
The service continuity means efficiency of power consequently profitability of the business.

Our products are designed and manufactured in order to ensure energy sustainability and provide the best service availability.

This policy is the cornerstone of our orientation and training programs and it is fully applied by our technical and administrative staff.

Energy continuity and efficiency can be ensured only by monitoring of equipments local and remotely.

Our products are designed with remote monitoring and management features by the help of our software development abilities on different platforms and hardware capabilities. This will ensure the saving and profitability, directly.



Technical Information

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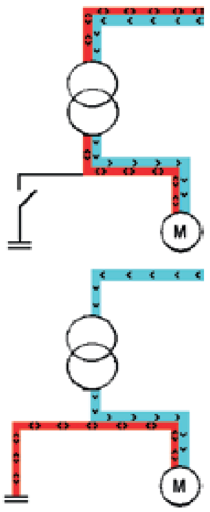
Technical Information



$I_p = I . \text{Cos}\,\varphi$

$I_q = I . \text{Sin}\,\varphi$

$I = \sqrt{I_p^2 + I_q^2}$

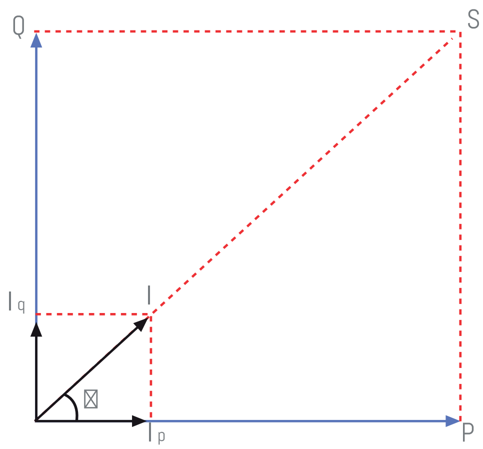
I_p = Active current
I_q = Reactive current
I = Line current

$P = S . \text{Cos}\,\varphi$

$Q = S . \text{Sin}\,\varphi$

$S = \sqrt{P^2 + Q^2}$

P = Active power
Q= Reactive power
S = Apparent power



A 1 What is Reactive Power?

The magnetization current which provides the required magnetic area for the operation of consumers working with electrodynamics principles such as generators, transformers, coils, motors is called reactive current and therefore the drawn power is called reactive power.

Compensating the reactive power by establishing a special reactive power producer in consumption centers is called compensation. Dynamic and static phase shifters are used for compensation. The most known and most widely used system in reactive power compensation systems is supplying the reactive demand through capacitors.

Another method, usage of over synchronized generators, is not preferred since their installation, operation and maintenance costs are higher than capacitors. Today, this application is only applied in rare systems where the requirements are fulfilled.

A 2 Some Formulas for Reactive Power Compensation

The power drawn by a consumer from the network is expressed as; $S = \sqrt{3}.U.I$

When the drawn power is an inductive load, a φ angle occurs between the voltage and the current, and thus;

Here, the ratio of the apparent power to the active power is the power factor. The power factor can simply be calculated by taking the cosine of the φ angle formed by the apparent power "S" and the active power "P". The power coefficient may vary between 0....+1. The reactive energy consumption of the system can easily be understood with this ratio. When the power factor equals to 1, the angle φ will be equal to zero and all the consumed energy will be active.

By the installation of compansation system, the necessity reactive power will be supplied compansation of system (by capacitor bank) instead of importing by network.

Thus, "S" apparent power imported by the network is decreased; therefore the angle φ between "S" apparent power. ("P" active power becomes narrower. As the angle φ becomes narrower and close to zero, the power coefficient (Cos φ) will close to 1.)

Power factor changes according to the facility, used devices and machines. Moreover, the power factor also changes depending on the full load or half load of devices.

The term tgφ is preferred in invoicing electric consumption. Active and reactive power consumption in energy measurement devices is measured by calculating the value Tg φ. The ratio between the reactive energy and active energy equals to Tg φ. The lower the tgφ value, the lower the reactive energy drawn from the network will be. This term can be simple and calculated easier than the term Cos φ.

The correlation between the values of Cos φ and Tg φ is given left side.

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$$\text{Cos } \varphi = \sqrt{\frac{1}{1 + (\text{Tg } \varphi)^2}}$$

A 3 Power Factors of Some Consumers

Reactive energy consumption is actualized specially by the following in the industry;

- Low charge motors,
- Welding machines,
- Arc and induction furnaces
- Power invertors.

CONSUMER		Cos φ	Tg φ
General		0,17	5,80
Asynchronous motor	with 25% load	0,55	1,52
	with 50% load	0,73	0,94
	with 75% load	0,8	0,75
	with 100% load	0,85	0,62
incandescent lamp		Approx. 1	Approx. 0
Fluorescent lamp		Approx. 0,5	Approx. 1,73
Discharge lamp		0,4-0,6	Approx. 2,29-1,33
Resistive furnace		Approx. 1	Approx. 0
Induction furnace (compensated)		Approx. 0,85	Approx. 0,62
Dielectrical heating melting furnaces		Approx. 0,85	Approx. 0,62
Resistive welding machines		0,8-0,9	0,75-0,48
Singlephase static arc welding machines		Approx. 0,5	Approx. 0,73
Arc welding units		0,7 - 0,9	1,02 - 0,75
Transformers and inverters for arc welding machines		0,7 - 0,8	1,02 - 0,75
Arc furnaces		0,8	0,75
Thyristor triggered power inverters		0,4 - 0,8	2,25 - 0,75

A 4 How to Improve Power Factor

Compensation can be provided by enabling and disabling the capacitor groups in accordance with the load change equivalent to the reactive energy imported by the network, thus power factor is closer to 1.

The reasons why capacitors are more preferred in compensation system;

- They have very low active energy consumption,
- They have low cost,
- They are easy to connect to the system,
- They have long life,
- They have low maintenance costs.z

$Q_1 = S_1 \,.\, \text{Sin}\ \varphi_1$

$Q_2 = S_2 \,.\, \text{Sin}\ \varphi_2$

$Q_c = Q_1 - Q_1$

$Q_c = S_1 \,.\, \text{Sin}\ \varphi_1 - S_2 \,.\, \text{Sin}\ \varphi_2$

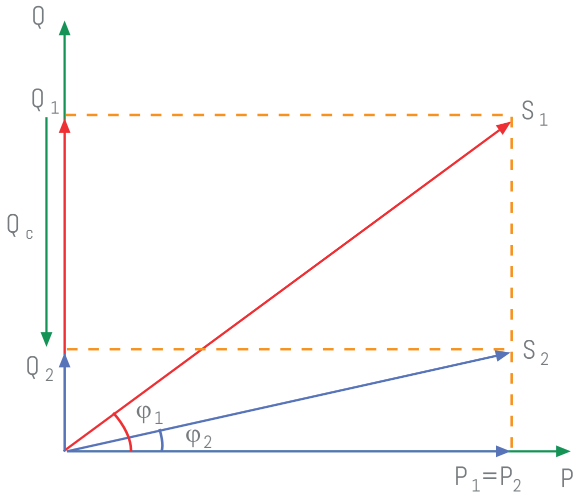
$P_1 = S_1 \,.\, \text{Cos}\ \varphi_1 \Rightarrow S_1 = \dfrac{P_1}{\text{Cos}\ \varphi_1}$

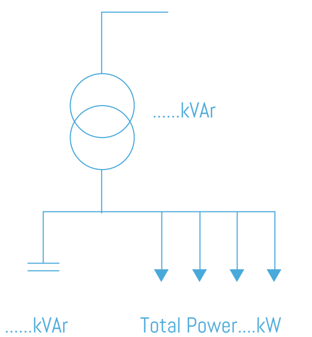
$P_2 = S_2 \,.\, \text{Cos}\ \varphi_2 \Rightarrow S_2 = \dfrac{P_2}{\text{Cos}\ \varphi_2}$

$Q_c = P_1 \,.\, \dfrac{\text{Sin}\ \varphi_1}{\text{Cos}\ \varphi_1} - P_2 \,.\, \dfrac{\text{Sin}\ \varphi_2}{\text{Cos}\ \varphi_2}$

$P_1 = P_2 = P$

$Q_c = P_1 \,.\, (\text{Tg}\ \varphi_1 - \text{Tg}\ \varphi_2)$





According to load ;

Active power of the loads (P)	= 750 kW
Measured or known (Cos φ_1)	= 0,70
Target (Cos φ_2)	= 0,99
Coefficient (K)	= 0,878

So;

$Q_c = P \,.\, (\text{Tg}\ \varphi_1 - \text{Tg}\ \varphi_2)$

$Q_c = 750 \times 0{,}878 = 658{,}5$ kVAr

A 5 Benefits of Improving Power Factor by Compensation

Improving Power factor provides maximum benefit with optimum spending. Thus;

- No reactive penalty is paid,
- Loads of generators, transformers and energy transfer lines are decreased, possibility for new loads is provided,
- Total voltage drop is decreased,
- Total losses are decreased,
- Thus it is possible to design the systems for lower powers or to import more power from current installations.

A 6 Reactive Power Calculation

For the consumer to determine the reactive power requirement the apparent power S imported from the network by the consumer, Cos φ_1 power coefficient thereof and the Cos φ_2 value required should be known. Also, a compensation system type to be established in an installation depends on;

- Reactive power distribution in the system.
- Change of reactive power demand.
- Amount of harmonic distortion in the system.
- Location of the system.

The calculation of reactive power, there are several methods can be implemented and there are some points to be taken into consideration in calculating this power

Q_c = required compensation power
p = active power
Cos φ_1 = measured or known power coefficient
Cos φ_1 = required power coefficient

A 6.1 Using Coefficient Table According to Distribution Transformer and Load

Tg φ_1 can be found by the coefficient table. It is the Tg φ value matching with measured Cos φ value.

Tg φ_2 can be found by the coefficient table. It is the Tg φ value matching with required Cos φ value.

$K = \text{Tg}\ \varphi_1 - \text{Tg}\ \varphi_2$

According to transformer power

Transformer power (S)	= 1000 kVA
Ratio of loads to transformer power	= 75%
Measured or known (Cos φ_1)	= 0,70
Target (Cos φ_2)	= 0,99
Coefficient (k)	= 0,878

So;

$Q_c = S.\ \%\ .\ \text{Cos}\ \varphi_1\ .\ k$

$Q_c = (1000 \times 0{,}75) \times 0{,}7 \times 0{,}878$ = 461 kVAr

A 6.2 Coefficient Table

The coefficient values required to calculate the compensation power per kW supplied from the network and corresponds tot the measured and required power factor values are given in the coefficient table below. Tg φ values corresponding to Cosφ value are also indicated.

Power Factor		Coefficient Table of Reactive Power (kVAr) Required for Load per kW										
Cos φ		0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00
	tgφ	0.484	0.456	0.426	0.395	0.363	0.329	0.292	0.251	0.203	0.142	0.000
0.40	2.291	1.807	1.836	1.865	1.896	1.928	1.963	2.000	2.041	2.088	2.149	2.291
0.41	2.225	1.740	1.769	1.799	1.829	1.862	1.896	1.933	1.974	2.022	2.082	2.225
0.42	2.161	1.676	1.705	1.735	1.766	1.798	1.832	1.869	1.910	1.958	2.018	2.161
0.43	2.100	1.615	1.644	1.674	1.704	1.737	1.771	1.808	1.849	1.897	1.957	2.100
0.44	2.041	1.557	1.585	1.615	1.646	1.678	1.712	1.749	1.790	1.838	1.898	2.041
0.45	1.985	1.500	1.529	1.559	1.589	1.622	1.656	1.693	1.734	1.781	1.842	1.985
0.46	1.930	1.446	1.475	1.504	1.535	1.567	1.602	1.639	1.680	1.727	1.788	1.930
0.47	1.878	1.394	1.422	1.452	1.483	1.515	1.549	1.586	1.627	1.675	1.736	1.878
0.48	1.828	1.343	1.372	1.402	1.432	1.465	1.499	1.536	1.577	1.625	1.685	1.828
0.49	1.779	1.295	1.323	1.353	1.384	1.416	1.450	1.487	1.528	1.576	1.637	1.779
0.50	1.732	1.248	1.276	1.306	1.337	1.369	1.403	1.440	1.481	1.529	1.590	1.732
0.51	1.687	1.202	1.231	1.261	1.291	1.324	1.358	1.395	1.436	1.484	1.544	1.687
0.52	1.643	1.158	1.187	1.217	1.247	1.280	1.314	1.351	1.392	1.440	1.500	1.643
0.53	1.600	1.116	1.144	1.174	1.205	1.237	1.271	1.308	1.349	1.397	1.458	1.600
0.54	1.559	1.074	1.103	1.133	1.163	1.196	1.230	1.267	1.308	1.356	1.416	1.559
0.55	1.518	1.034	1.063	1.092	1.123	1.156	1.190	1.227	1.268	1.315	1.376	1.518
0.56	1.479	0.995	1.024	1.053	1.084	1.116	1.151	1.188	1.229	1.276	1.337	1.479
0.57	1.441	0.957	0.986	1.015	1.046	1.079	1.113	1.150	1.191	1.238	1.299	1.441
0.58	1.405	0.920	0.949	0.979	1.009	1.042	1.076	1.113	1.154	1.201	1.262	1.405
0.59	1.368	0.884	0.913	0.942	0.973	1.006	1.040	1.077	1.118	1.165	1.226	1.368
0.60	1.333	0.849	0.878	0.907	0.938	0.970	1.005	1.042	1.083	1.130	1.191	1.333
0.61	1.299	0.815	0.843	0.873	0.904	0.936	0.970	1.007	1.048	1.096	1.157	1.299
0.62	1.265	0.781	0.810	0.839	0.870	0.903	0.937	0.974	1.015	1.062	1.123	1.265
0.63	1.233	0.748	0.777	0.807	0.837	0.870	0.904	0.941	0.982	1.030	1.090	1.233
0.64	1.201	0.716	0.745	0.775	0.805	0.838	0.872	0.909	0.950	0.998	1.058	1.201
0.65	1.169	0.685	0.714	0.743	0.774	0.806	0.840	0.877	0.919	0.966	1.027	1.169
0.66	1.138	0.654	0.683	0.712	0.743	0.775	0.810	0.847	0.888	0.935	0.996	1.138
0.67	1.108	0.624	0.652	0.682	0.713	0.745	0.779	0.816	0.857	0.905	0.966	1.108
0.68	1.078	0.594	0.623	0.652	0.683	0.715	0.750	0.787	0.828	0.875	0.936	1.078
0.69	1.049	0.565	0.593	0.623	0.654	0.686	0.720	0.757	0.798	0.846	0.907	1.049
0.70	1.020	0.536	0.565	0.594	0.625	0.657	0.692	0.729	0.770	0.817	0.878	1.020
0.71	0.992	0.508	0.536	0.566	0.597	0.629	0.663	0.700	0.741	0.789	0.849	0.992
0.72	0.964	0.480	0.508	0.538	0.569	0.601	0.635	0.672	0.713	0.761	0.821	0.964
0.73	0.936	0.452	0.481	0.510	0.541	0.573	0.608	0.645	0.686	0.733	0.794	0.936
0.74	0.909	0.425	0.453	0.483	0.514	0.546	0.580	0.617	0.658	0.706	0.766	0.909
0.75	0.882	0.398	0.426	0.456	0.487	0.519	0.553	0.590	0.631	0.679	0.739	0.882
0.76	0.855	0.371	0.400	0.429	0.460	0.492	0.526	0.563	0.605	0.652	0.713	0.855
0.77	0.829	0.344	0.373	0.403	0.433	0.466	0.500	0.537	0.578	0.626	0.686	0.829
0.78	0.802	0.318	0.347	0.376	0.407	0.439	0.474	0.511	0.552	0.599	0.660	0.802
0.79	0.776	0.292	0.320	0.350	0.381	0.413	0.447	0.484	0.525	0.573	0.634	0.776
0.80	0.750	0.266	0.294	0.324	0.355	0.387	0.421	0.458	0.499	0.547	0.608	0.750
0.81	0.724	0.240	0.268	0.298	0.329	0.361	0.395	0.432	0.473	0.521	0.581	0.724
0.82	0.698	0.214	0.242	0.272	0.303	0.335	0.369	0.406	0.447	0.495	0.556	0.698
0.83	0.672	0.188	0.216	0.246	0.277	0.309	0.343	0.380	0.421	0.469	0.530	0.672
0.84	0.646	0.162	0.190	0.220	0.251	0.283	0.317	0.354	0.395	0.443	0.503	0.646
0.85	0.620	0.135	0.164	0.194	0.225	0.257	0.291	0.328	0.369	0.417	0.477	0.620
0.86	0.593	0.109	0.138	0.167	0.198	0.230	0.265	0.302	0.343	0.390	0.451	0.593
0.87	0.567	0.082	0.111	0.141	0.172	0.204	0.238	0.275	0.316	0.364	0.424	0.567
0.88	0.540	0.055	0.084	0.114	0.145	0.177	0.211	0.248	0.289	0.337	0.397	0.540
0.89	0.512	0.028	0.057	0.086	0.117	0.149	0.184	0.221	0.262	0.309	0.370	0.512
0.90	0.484	0.000	0.029	0.058	0.089	0.121	0.156	0.193	0.234	0.281	0.342	0.484

$$Q\,res = \frac{S}{n^2 \cdot u_k\,\% \cdot \sin\varphi_k}$$

S = Transformer power (kVA)
S = Transformer power (kVA)
n = Harmonic level (3rd, 5th, 7th, etc.)
u_k % = Relative short circuit voltage of the transformer
Sin φ_k = Sinus of the short circuit power angle of the transformer

Nominal Transformer Power (kVA)	Off Load	75% load	100% load
100	3	5	6
160	4	7.5	10
200	4	9	12
250	5	11	15
315	6	15	20
400	8	20	25
500	10	25	30
630	12	30	40
800	20	40	55
1000	25	50	70
1250	30	70	90
2000	50	100	150
2500	60	150	200
3150	90	200	250
4000	160	250	320
5000	200	300	425

Maximum Asynchronous Motor Power		Maximum speed rpm		
		3000	1500	1000
HP	kW	Maximum Compensation Power (kVAr)		
11	8	2	2	3
15	11	3	4	5
20	15	4	5	6
25	18	5	7	7.5
30	22	6	8	9
40	30	7.5	10	11
50	37	9	11	12.5
60	45	11	13	14
100	75	17	22	25
150	110	24	29	33
180	132	31	36	38
218	160	35	41	44
274	200	43	47	53
340	250	52	57	63
380	280	57	63	70
482	355	67	76	86

A 6.3 The Calculation of Resonance Power

First of the matters to be taken into consideration in the project of a new installation is that the compensation power to be installed should be lower than the parallel resonance value. Parallel resonance power is calculated with the formula at the left side.

The resonance is in question when the compensation power is higher than the resonance power. When calculating this for a network, separate calculations should be made for each harmonic level which may occur because of the loads in the network.

In order to prevent any resonance danger which may occur in any harmonic level, compensation power should always be lower than the calculated resonance power.

A 6.4 The Calculation of Fixed Group for Transformer

The reactive energy required for magnetization of transformer coils should be provided from the network. The fixed compensation powers required for the transformer working percentage are given in the table below. These powers in the table may vary depending on the structure of the transformer. The producers should submit these definite values.

While applying fixed reactive power compensation to the secondary of transformer, internal reactive power consumption required by the transformer should also be taken into consideration and it should be considered that the transformer is working at least off load.

Generally, power of a fix capacitor to be connected to a secondary of transformer in a network can be practically taken as Q_s £ 3% . S

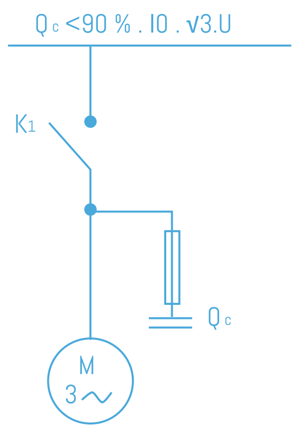
For instance, it is appropriate that the power of a fixed capacitor group to be chosen for a 1000 kVA transformer is 25 - 30 kVAr.

A 6.5 The Calculation of Fixed Group for Asynchronous Motors

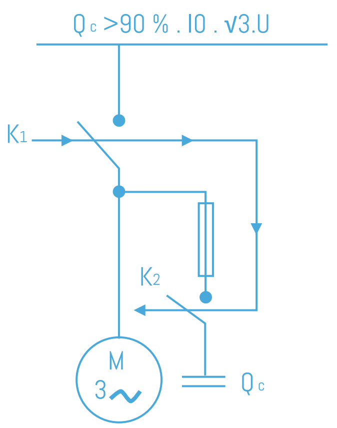
Maximum compensation powers which can be directly connected to stator terminals are given in the table below. Moreover, before compensation application, it should be made sure that whether the capacitor current does not exceed 90% of the magnetization current of the motor.

If the compensation power required for the motor is more than the values indicated in the table, the compensation power to be applied to motor terminals should rather be calculated by the formula
$Qc > 90\,\% \cdot I0 \cdot \sqrt{3}.U$

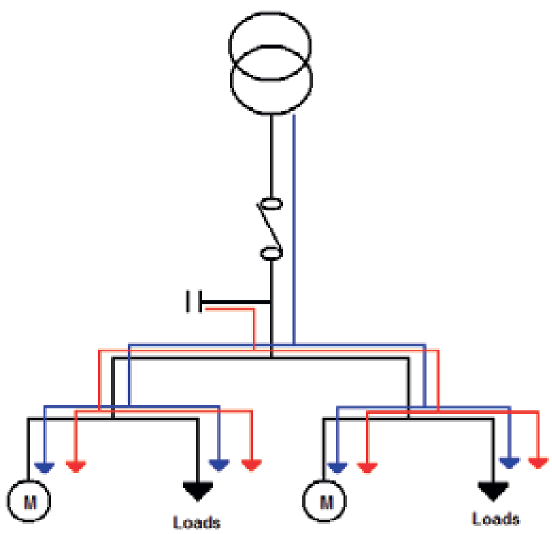
Compensation contactor (K1) should be serial connected with the motor contactor (K2) and the compensation should be enabled and disabled in order to run the motor.



Motor Compensation 1



Motor Compensation 2



A 6.6 Reactive Power Compensation

We can examine the compensation methods which can be applied in LV network under 2 main groups:

- Individual (Central) Compensation
- Local compensation

A 6.6.1 Individual (Central) Compensation

Applying central and automatic compensation in systems where there are many and distributed loads with reactive power requirements is the most economic solution.

Central compensation is applied parallel to the load in the secondary side of the LV transformer. In such systems, every consumer does not constantly and continuously consume reactive power. Therefore compensation system which will be installed in order to provide the required reactive power should be designed in order to provide the required reactive power and keep the Tg φ value of the system fixed.

Required compensation power in central compensation systems is provided by enabling and disabling the capacitor groups depending on the change in the power factor.

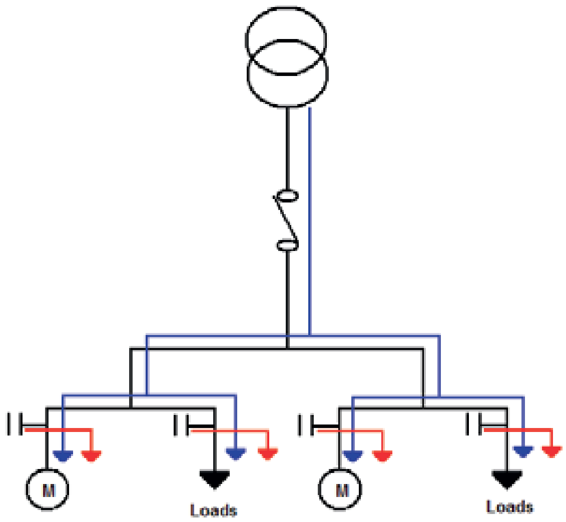
Calculating required compensation power and enabling and disabling required capacitor groups is provided by the reactive power control relay.

Such compensation systems are used in:

- Electric systems with variable power,
- Main distribution panels, or
- Distribution systems with high power.

Advantages:

- Reactive penalty is prevented.
- Applying individual compensation in systems with many distributed loads with reactive power requirements is the most economic solution.
- It allows more effective usage of the transformer. It reliefs the transformer.



A 6.6.2 Local Compensation

This is a method which can be applied when there are loads with fixed reactive power requirement and which is in a distant location from the transformer in the system.

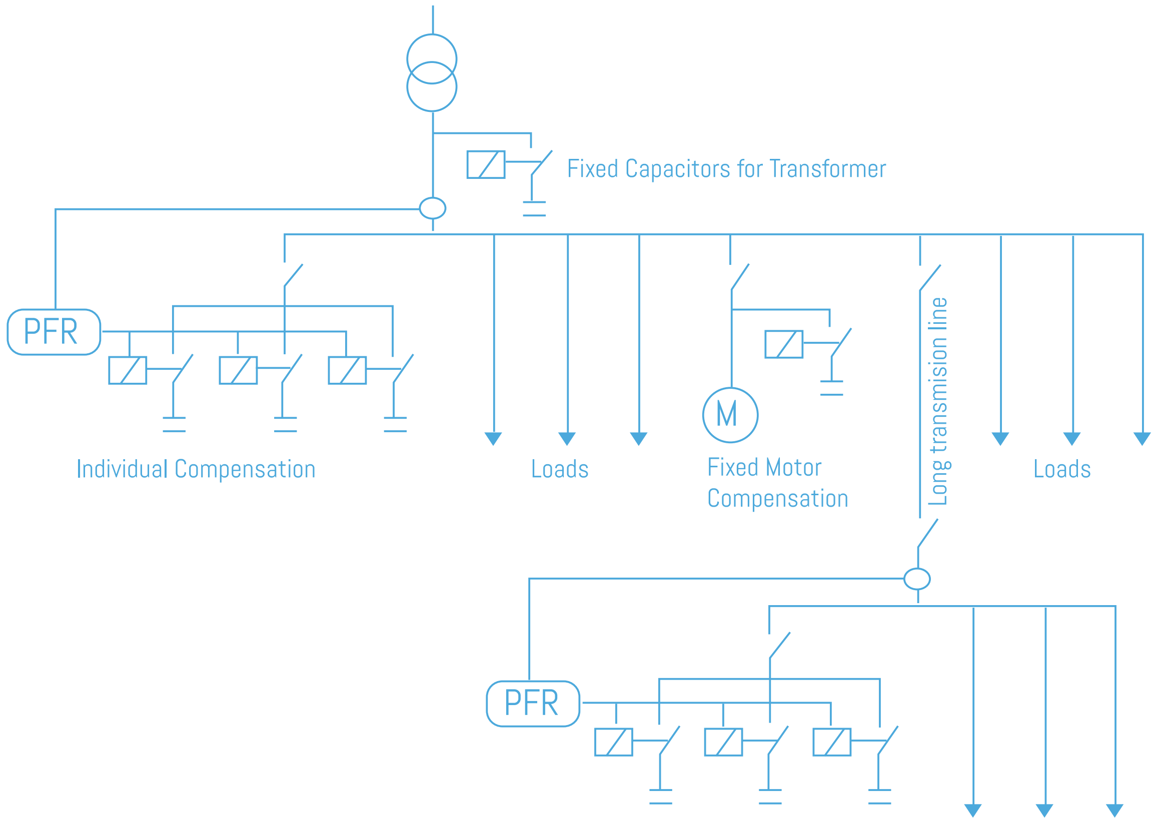
Calculation of compensation system to be applied in order to supply the reactive power requirement of the motors should be made depending on the active power imported by the motor. Active power and Tan φ values are defined in the labels of the motors.

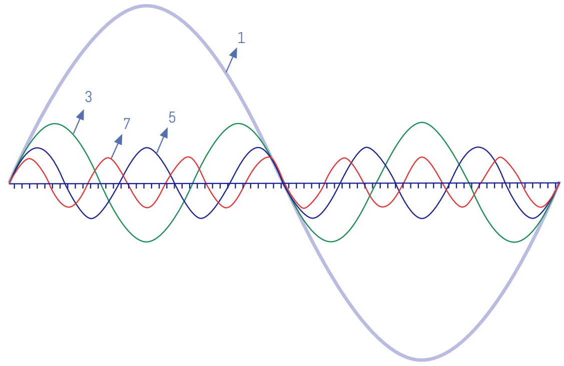
Advantages:

- No billing for reactive energy.
- Decrease in the subscribed power in kVA.
- Limitation of active energy losses in cables given the decrease in the current conveyed in the plant.
- Improvement in the voltage level at the and of the line.
- Additional power avaible at the power transformer if the compensition is performed in the secondary winding.

Explanation:

- It is a higher-cost application compared to other applications.



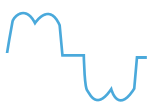
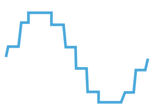


$$I_{rms} = \sqrt{I_1^2 + I_2^2 + I_3^2 + ... + I_n^2} = \sqrt{I_1^2 + \sum_{h-2}^{n} I_h^2}$$

True RMS current

$$V_{rms} = \sqrt{V_1^2 + V_2^2 + V_3^2 + ... + V_n^2} = \sqrt{V_1^2 + \sum_{h-2}^{n} V_h^2}$$

True RMS voltage

Switching Type	Current Waveform	THD i
Single Phase Inverters		~ 85%
6 Pulse Diode Inverters (with filter capacitor)		~ 70%
6 Pulse Diode Inverters (with filter capacitor & absorve reactor)		40%- 60%
6 Pulse Thyristor Inverter (with absorve reactor)		25% - 40%
12 Pulse Thyristor Inverter (with absorve reactor)		~ 15%

Harmonic Level	(Number of semiconductor elements)	
	6 pulses (%)	12 pulses (%)
5	20.0	-
7	14.3	-
11	9.1	9.1
13	7.7	7.7
17	5.9	-
19	5.3	-
23	4.3	4.3
25	4.0	4.0

A 7.1 What is Harmonic?

In electric systems it is ideal to have current and voltage as a Sinusoidal wave in a basic frequency of 50-60Hz during the production and distribution of energy.

However, with improved power electronics technology, all loads which can perform high frequency triggering in operations such as thyristor and IGBT cause some currents which we call harmonic in several frequency levels because of their electrical working characteristics.

In a system, if the ammeter used in measuring the phase current can measure rms value, the measured phase current can be calculated as quadratic average of other high frequency harmonic currents together with the 50Hz component available main current.

When the same measurement is made with an ammeter which does not use rms measurement technique, only 50Hz component available main current wave will be measured.

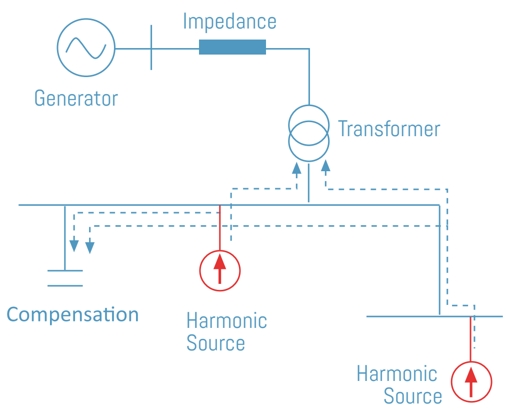
Ofcourse,inthiscaseifthereexisthighfrequencyharmoniccurrents in the system, the values indicated by the rms ammeter and the ammeter measuring the basic frequency current will be different. As it is clear from the formula, the harmonic currents in the system will cause higher rms currents.

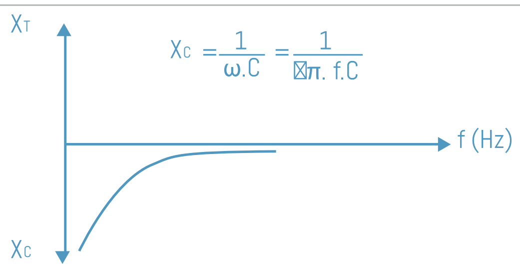
Measurements and detections for the current are also valid for voltage measurements. Also during voltage measurement, it is possible to have differences between devices with rms measurement and without rms measurement depending on the existence of high-frequency harmonics.

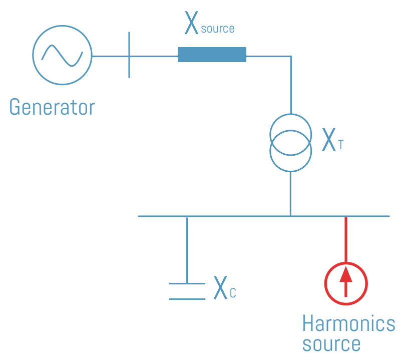
A 7.2 Harmonic Sources

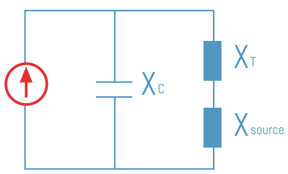
- Static AC/DC power transformers
- Rectifiers,
- Inverters,
- Arc furnaces and electrolysis units,
- DC motors
- AC speed control units
- Soft starters
- Frequency transformers
- UPS
- Data processing and TV broadcasting system, office equipments such as PC,
- Armatures with electronic ballasts,
- And other control systems with wave change and phase adjustment.

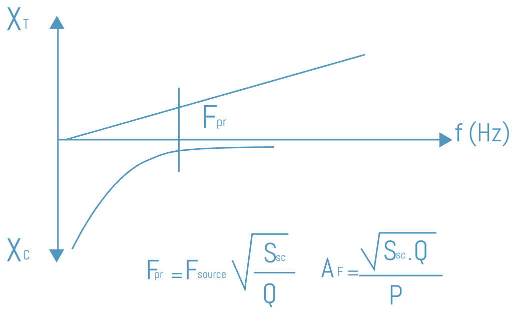
In the networks, effects on harmonics by the capacitors basically used for compensation should also be taken into consideration.
In electrical applications, harmonic currents produced by systems with semiconductor technique are given in the table below.
Harmonic currents created by nonlinear loads depending on their switching types are as given in the table left side.











A 7.3 Effects of Harmonics

Assuming the network as an inductance connected to the generator, capacitor creates a parallel resonance circuit. By switching the capacitors, a circulation current and resonance frequency occurs. Some of the harmonic currents flow to the network while most of them flow to the capacitors because of their low impedance.

Decreasing capacitor impedance depending on increasing frequency causes the high frequency harmonic currents to flow towards the capacitors which show the lowest impedance towards them.

While transformer reactance increases in direct proportion to the frequency, and capacitor reactance decreases depending on the frequency. In any "Fpr" frequency these reactance levels may be equal to each other and in this frequency harmonic currents increase between the capacitor and the transformer because of parallel resonance.

The more the transformer short circuit power (Ssc) increases, the further it will be from the harmonic frequency values whose resonance frequency may cause dangerous results.

The primary problems which may arise because of harmonics are listed below.

- Warming in electromechanical devices and cables,
- Mechanical vibration in machines,
- Abnormal operation of ignition circuits
- Deletion of memory in CAD/CAM terminals
- Electronic card failures,
- Power losses, penetration and explosion in power capacitors, blowing compensation fuses
- Opening in breakers and switches,
- Failure or abnormal operation of relay signals,
- Energy losses.

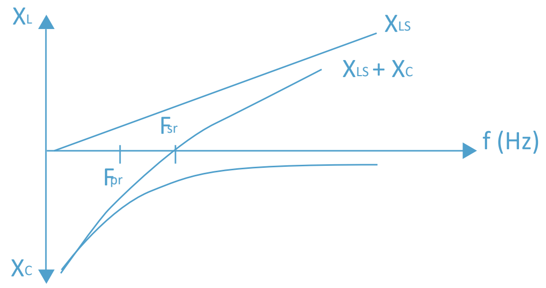
Resistance of Capacitors Against Harmonic Currents

While designing and producing capacitors, some standards (EN 60831-1 and 2) should be complied with. According to the standards, in nominal voltage and frequency values, it should be resistant to an effective current of at least 1.3 times of the nominal current it draws and 1.1 times of the voltage for 8 hours.

Existence of harmonic currents and increase of voltage affected by impedance determine the effective current coefficient which the capacitor should be resistant to.

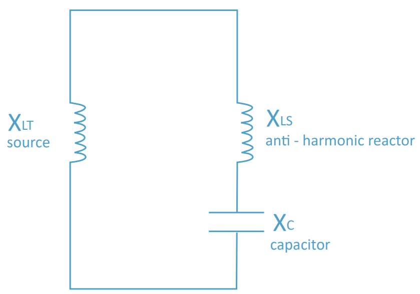
Because of the harmonic interaction SH in the system (harmonic current sources in the system), resistance coefficient of the capacitor cannot be determined precisely. This coefficient is much higher than the parallel resonance coefficient as a value.
Moreover, it is required to know the transformer power STR changing depending on the short circuit power in order to determine this coefficient.

Depending on the SH and STR parameters indicated above, 3 different electrical systems can be identified and capacitor types to be used in the system can be determined according to these parameters.



Fpr: Parallel resonance frequency created by harmonic filter reactors, capacitors and transformer impedances.

Fsr: Serial resonance frequency occurring between the capacitor and the harmonic filter (mostly preferred serial resonance frequency values are 189, 205, 210, 215 and 225 Hz).



Protecting capacitors with harmonic filter reactors

In compensation application to be made in systems with high level harmonic interaction, using harmonic filter reactors serial to capacitors is an effective solution. There are basically two aims of using harmonic filter reactors. These are:

- To increase the impedance of the capacitor against harmonic currents,
- To shift the resonance frequency (Fpr) arising from the impedance between the capacitor and the network and keep the resonance frequency below the frequencies arising from main harmonic currents.
- In frequency points below serial resonance frequency (Fsr) reactor and capacitor serial circuit provide capacity effect and provide compensation.
- In frequency points above serial resonance frequency (Fsr) reactor and capacitor serial circuit provide inductance effect and eliminate parallel resonance risk in 3rd, 5th, 7th... harmonic frequencies.

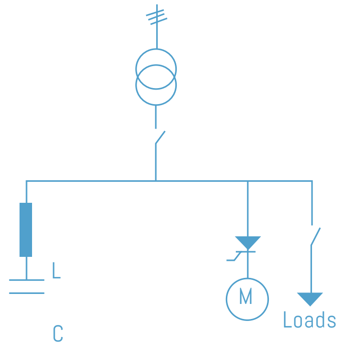
A 7.4 Harmonic Filter Compensation Systems

Two main problems that the users are facing in systems with high harmonic distortion values are:

- To make reactive power compensation and protect the capacitors against harmonic currents;
- To make sure that the voltage distortion values are in proper levels and that critical loads operate without failure.

Compensation systems with harmonic filters, may also be called as passive filters, Passive filter systems are classified into two depending on their structure:

- Detuned
- Tuned



$I_{TH} = I_H + I_{CH}$

$I_{CH} = 0$

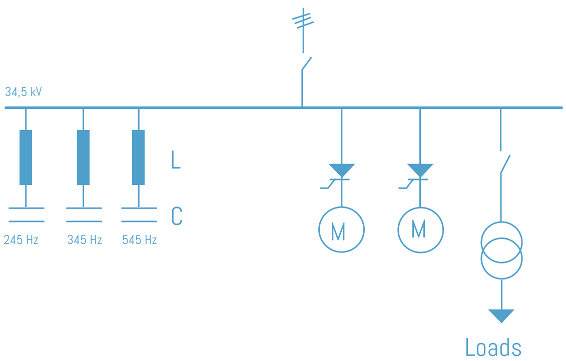
$I_{TH} = I_H + 0 = I_H$

$V_{TH} = Z_H \cdot I_{TH} = 0 \cdot I_H = 0$

I_{TH} = Total harmonic current
I_{CH} = Harmonic current on the capacitor
V_{TH} = Harmonic voltage
Z_H = Harmonic impedance

$$F_r = \frac{1}{2\pi\sqrt{LC}}$$

Serial resonance condition Æ $X_L = X_C$



$I_{TH} = I_H + I_{CH}$

$I_{CH} = 0$ & $I_H = 0$

$\Rightarrow I_{TH} = 0$

$V_{TH} = Z_H \cdot I_{TH} = 0$

I_{TH} = Total harmonic current
I_{CH} = Harmonic current on the capacitor
V_{TH} = Harmonic voltage
Z_H = Harmonic impedance

A 7.4.1 Detuned Passive Filters

The purpose of detuned passive filter systems is to eliminate the parallel resonance effect of capacitors on the system and at this point to equate the impedance to zero in determined resonance frequency and to minimize harmonic voltages.

In detuned passive filter compensation systems, harmonics in the network are not eliminated, but parallel resonance that the capacitors may create in the system is prevented and increase of harmonic current and voltage levels is prevented.

Consequently in detuned passive filter compensation applications, the harmonic currents and also harmonic voltages in the network are decreased to the levels at the moments when the compensation is out of service. However, the system continues to provide compensation perfectly at the same time.

A LC circuit adjusted to a certain serial resonance frequency is placed parallel to the system.
Detuned passive filters;

- Eliminate the harmonic interaction of the compensation to the system.
- Decrease harmonic voltage.
- Are economic and beneficial.
- Are ineffective against harmonic currents produced in the network.

A 7.4.2 Tuned Passive Filters

In tuned passive filters are designed to be equal to the harmonic frequencies effective in the network.

The tuned passive filters are more effective but have more power losses and more installation costs than the detuned harmonic filter compensations.

For instance, if 5th, 7th and 11th harmonics are dominant in the network, the resonance frequencies are tuned at 250 Hz, 350 Hz and 550 Hz.

However, when 5th, 7th, 11th and 13th harmonics are dominant in the network, the resonance frequencies are tuned at 250 Hz and 350 Hz and a broad band filter circuit is designed for over 500 Hz.

The tuned passive filters;

- Filter the harmonic current in the frequency it is adjusted to.
- Minimize the harmonic voltages.
- Have high power losses and installation costs.

A 7.5 The Matters to be Considered in Applications

An increase in voltage occurs on the capacitor because of the inductance coil in filtration application.
This increasing in the voltage will vary approximately 20 - 30 V depending on the resonance frequency applied in a system designed according to 5th Harmonics (189 - 225 Hz) according to the formula.

$$dU = \frac{F_n^2}{F_r^2 - F_n^2} - 1$$

$$Q_n = Q_c \frac{U_n^2}{U_c^2}$$

In this case, it is appropriate to choose nominal voltages of Asset VCB capacitors used in filter compensation systems to be applied in 400 V network voltage as 440 V. 440 V Assivar capacitors can resist up to 520 V voltage level for 24 hours a day, therefore they work for many years with a perfect performance against high voltages arising from an application or those occur in the network.

When the capacitors are connected to a lower network voltage than their labels' value, the power of capacitors decrease than their labels' value according to proportion to the square of the voltages. This is expressed with on the left side formula.

Therefore, as the voltage value in the capacitor label increases, effective reactive power in the network voltage decreases and this requires compensation with higher power.

Technically and practically, it is the best to calculate the voltage increase on the capacitor and the differential voltage increase in the network to select the capacitor power.

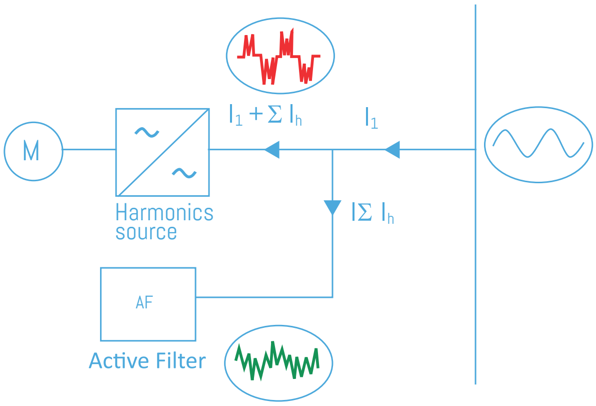
When designing inductance coils in the selected frequency value;

- In order to obtain a good result, the adjustment frequency should be selected as close to the frequency with harmonics as possible,
- Deviation in inductance value in each phase should not be higher than 3%.
- Imax value (linearity) should be minimum 2 . I_n and deviation in the inductance value even at this value should not exceed 5%.

Type of electrical system	Impurity criteria	Application model at 400 V
Low level harmonic interaction	$\frac{S_H}{S_{TR}}$ £ 10 %	400 / 415 V ASSET LTC Series Tube Capacitor
Medium level harmonic interaction	10 % < $\frac{S_H}{S_{TR}}$ £ 25 %	415 V ASSET VCB Series capacitor which resist 1,18 x U_n voltage continuos over voltage
High level harmonic interaction	$\frac{S_H}{S_{TR}}$ > 25 %	440 V ASSET VCB Series capacitor which resist 1,18 x U_n continuously over voltage with serial Antivar reactor group

SH: Power imported from secondary of distribution transformer which will be compensated because of harmonic sources in the system (kVA).

STR: Power of distribution transformer (total power of parallel connected transformers).



A 7.6 Active Filter

Active filters operate in a completely different structure and logic compared to either detuned or tuned passive filters. Active filters are not accorded to a certain harmonic frequency and they operate in order to filter against all high frequency current components in the system (usually for harmonics between 1 - 50 depending on active filter structure and operating logic).

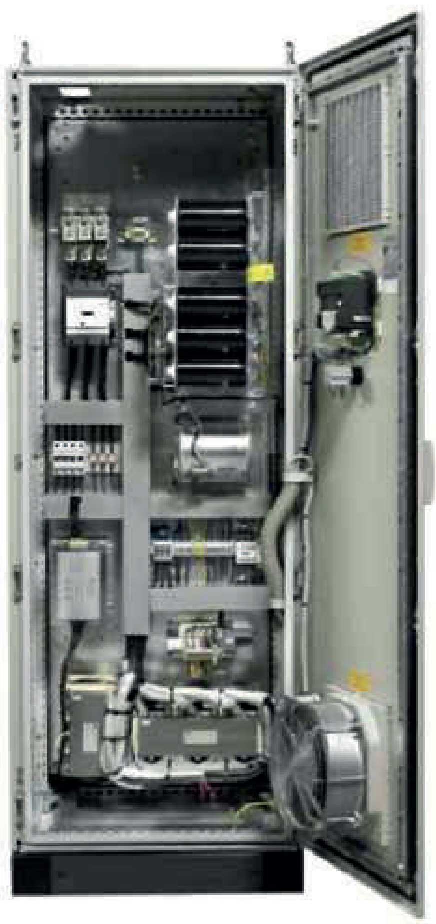
Active filters, thanks to their operation independently from power coefficient of the system, may be used without any problems where power coefficient is 1 or close to 1. Active filters are usually connected parallel to the load which produces harmonic.

Working logic of active filters is to determine the harmonic currents in the point they are connected to, and to deliver antiharmonic currents to the system, thus to prevent flow of harmonic currents produced by the loads to the network.

Theoretically, active filters are designed to decrease harmonic current levels to 0 (zero), and it is assumed that voltage harmonics will be eliminated by preventing circulation of harmonics in the system.

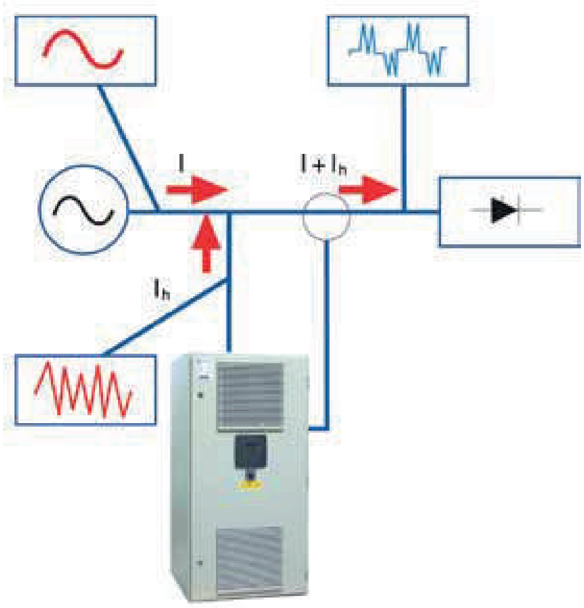
Theoretically decreasing harmonic currents to zero does not occur in practice, either because of harmonic components arising from the network, or harmonics produced at other points in the operation. Because of these reasons, the aim in active filters is to decrease the harmonic current levels in the system below the levels which may cause a risk for the operation and to provide harmonic current and voltage levels determined by the standards.

Active filters also provide sensitive reactive power compensation for 50 Hz main component of the system. Thus, for unbalanced loads and rapidly changing reactive powers, power coefficient can perfectly be maintained in 1 with active filter.



Active Filter Applications;

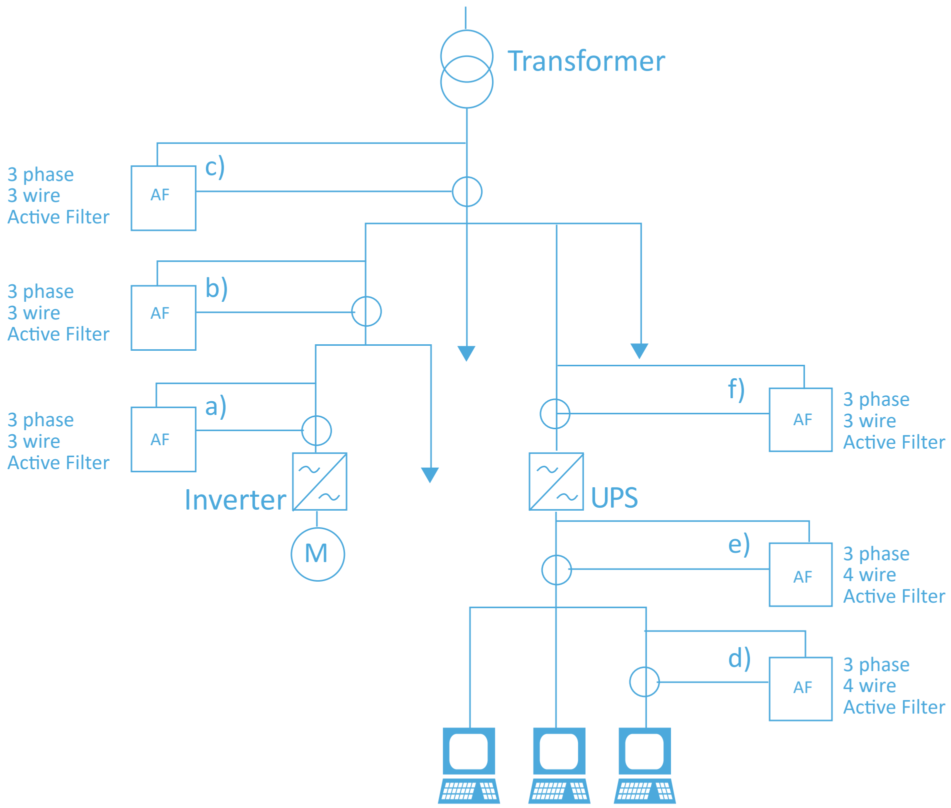
Before applying active filter, harmonic measurement and analysis should be performed, obtained data should be verified by simulations and active filter model to be applied should be determined according to the measured harmonic current levels and amplitude in order to obtain the maximum efficiency from active filter application.



In cases where active filters are used in order to filter harmonic currents, harmonic current levels in the system must definitely be determined. Thus, it will be made sure that the anti-harmonic current capacity of the active filter to be applied will not be exceeded.
From another perspective, the levels that the harmonic currents will be reduced to by the active filter to be applied will be predicted. Therefore a maximum efficiency will be obtained from active filter applications.

As mentioned above, one of the most important criteria in active filter selection is the levels, amplitudes and angles of harmonic currents. Along with this, another important value that should be measured is CF (Crest Factor) level of the rms current. CF level is very important in order to determine correctly the peak currents of sinus wave which is distorted by the harmonic components and calculate active filter anti-harmonic capacity accordingly.

Performing measurements towards active filter applications, interpreting these measurements correctly, choosing and designing correct products and systems in order to achieve aimed harmonic levels require high level of engineering knowledge (especially specialization in harmonic and active filters) as well as experience (to have applied several active filters before and have always achieved positive results that are aimed).



A 7.7 Static VAR Compensation (SVC)

General Information;

Static VAR Compensation (SVC) systems make the quality of energy that used in a plant better in several ways. Besides reactive power compensation, they have a lot of advantages for customer such as higher voltage stability and reduced distortion levels.

As a result of the usage of SVC system; efficiency of the production will be increased, total active power losses will be decreased and penalties caused from reactive energy usage will be prevented.

Technical Explanation

In SVC systems, basically thyristor controlled components are used. Basic reactive power elements that make up an SVC system can be specified as; thyristor controlled reactor (TCR) and thyristor switched capacitor (TSC). The most common SVC type that used in industrial plants is Fixed Capacitor - Thyristor Controlled Reactor (FC-TCR).

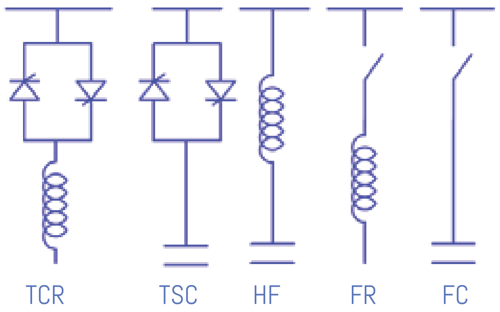
SVC systems are able to compensate the reactive power very fast between the maximum inductive and maximum capacitive limits that are chosen.

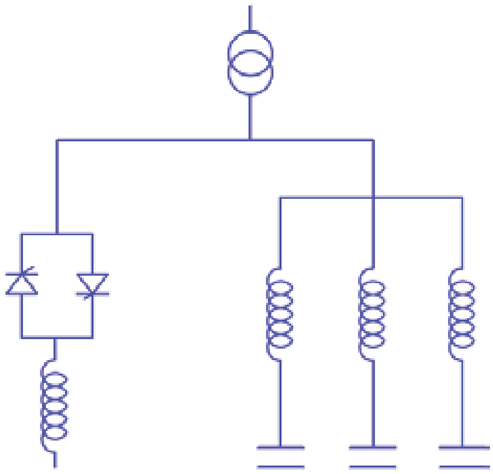
Also, while compensating the reactive power quite fast and synchronous way, over voltages in the power frequency are prevented, voltage sags are decreased and voltage becomes more stabile, harmonics that are produced by the loads are absorbed.

SVC systems that contain Fixed Capacitor - Thyristor Controlled Reactor (FC-TCR), are composed of fixed capacitor groups and changing reactor which is shunted to these capacitor groups.

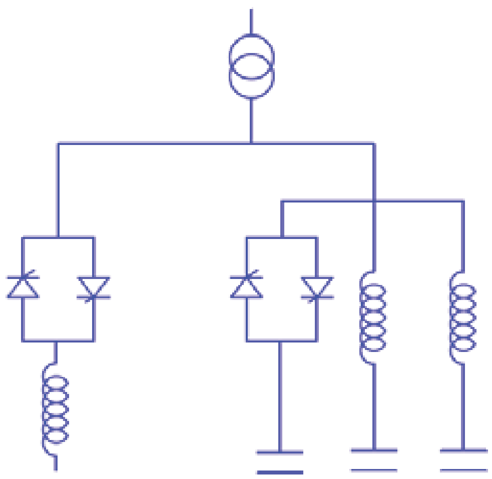
With FC-TCR system, during capacitive reactive power is produced by capacitors, inductive reactive power is produced by thyristor controlled reactor. Under limited voltage, the capacitive reactive power that is produced by fixed capacitors is restricted. So inductive reactive power that is produced by reactors, is adjusted by changing the trigger angle of the thyristors.

Changing the trigger angle of the thyristor, will control the fundamental current of the reactor, in consequence it will control the value of the reactive power. Besides, fixed capacitor groups and changing reactor which is shunted to these capacitor groups are made up the tuned harmonic filters. As a result, harmonics that are produced by loads and TCR are absorbed.





Sample Circuit Diagram including TCR



Sample Circuit Diagram including TCR and TSC

Voltage peaks and fluctuations during the switching are reduced to the minimum levels by using the thyristors as switching elements in SVC systems. It is possible to design much faster reactive power compensation systems than the ones that are switched by the vacuum breakers or SF6 isolated breakers thanks to developing semiconductor technology.

Briefly, positive effects of the Static Var Compensation:

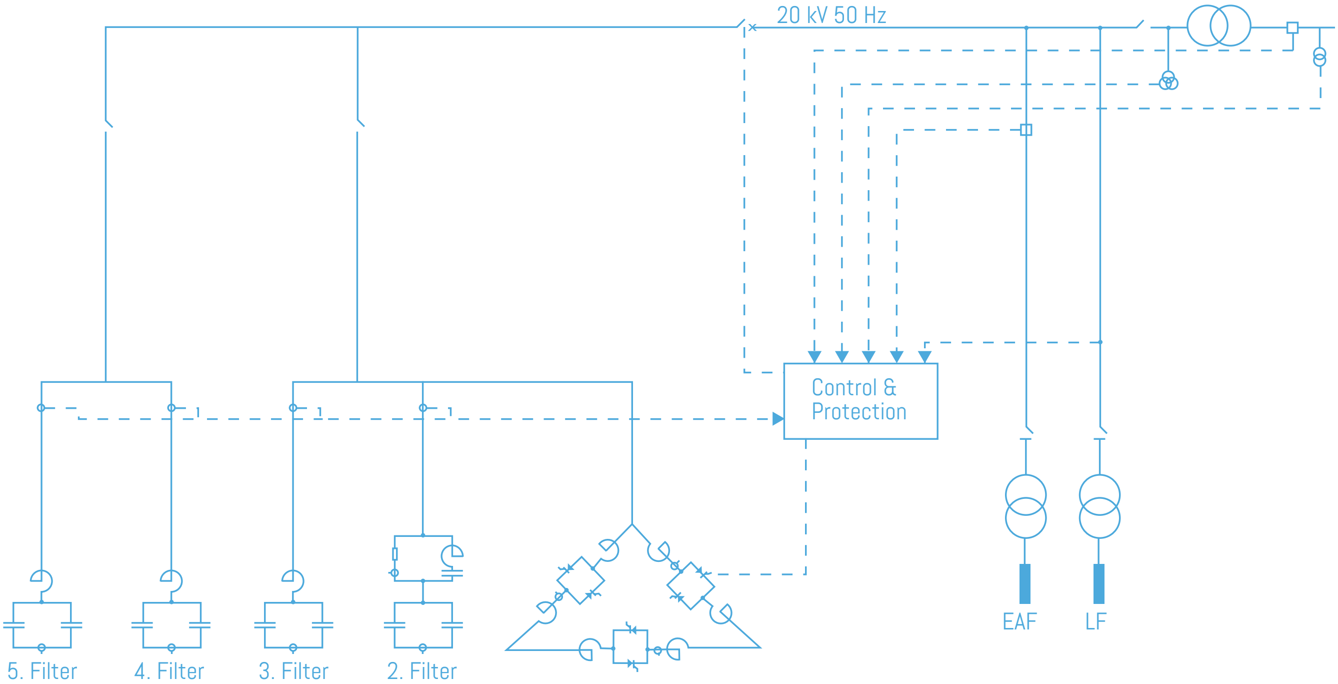
- Reduced flicker levels
- Voltage stabilization
- Reactive power compensation
- Increase of the power factor
- Voltage rise on the load busbar
- Damping the harmonics

Energy savings

Compensation and improving the quality of power increases the capacity of active power transmission and reduces energy consumption. Thus, the unnecessary overload of the power network can be avoided. Both your company and the environment benefit from the more efficient use of electricity and saving in the consumption of energy.

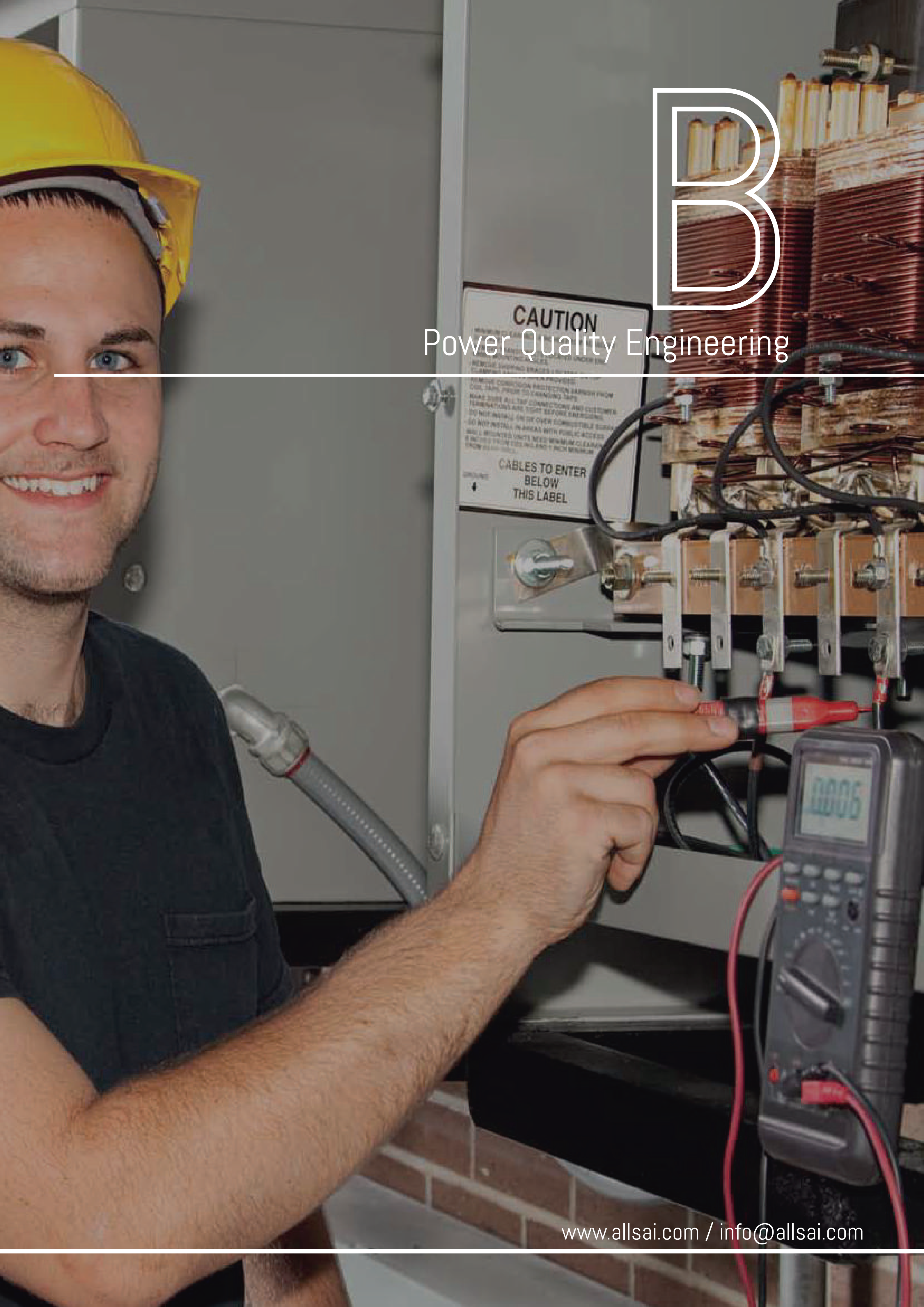
Benefits to the Customer

- Increase in productivity
- Energy savings
- Reduction in consumption of electrodes with more stabilized arc
- Reduction of heat losses
- Short payback period



Power Quality Engineering

B



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Power Quality Engineering

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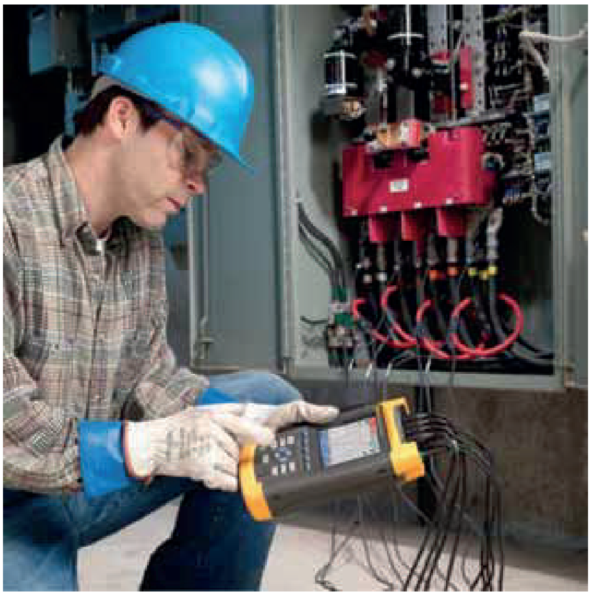


B 1 Engineering Services

First of all, the measuring and reporting of Power Quality requires to be used the equipments that can measure and analyze in conformity with related standards by professional engineers who are the competent in their field of activity.

The true method of measurements is capturing all parameters at the correct measuring points with appropriate periods and sampling sensitivity according to EN 50160, IEC 61000-4-7, IEC 61000-4-15 and IEC 61000-4-30 standards.

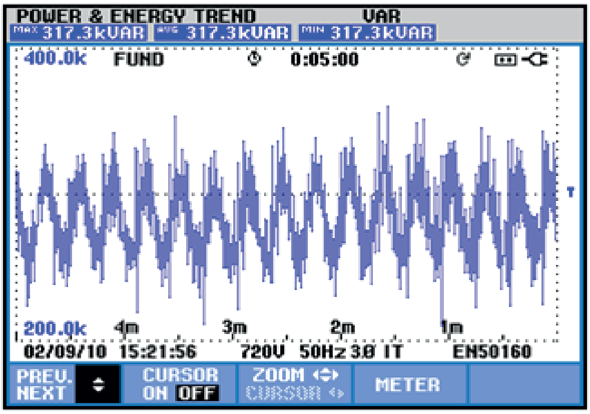
The following data should be recorded during measuring;

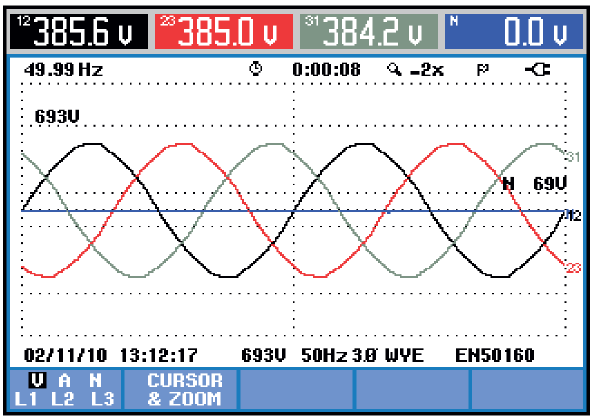
- Voltage Sag
- Voltage Swell
- Voltage Interruption
- Voltage Unbalance
- Power Frequency
- Flicker
    - Pst
    - Plt
- Notch
- Transient
- Harmonics

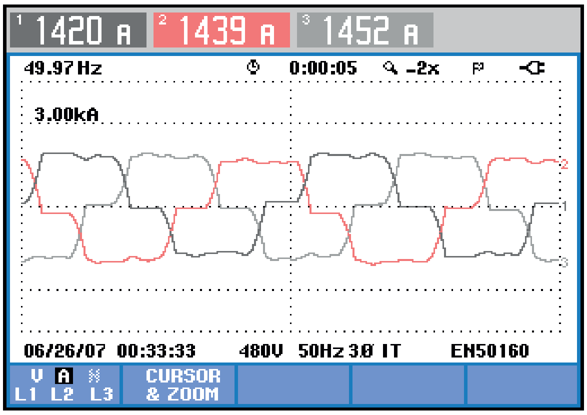
In addition to above measurements, the following data should be recorded during measuring;

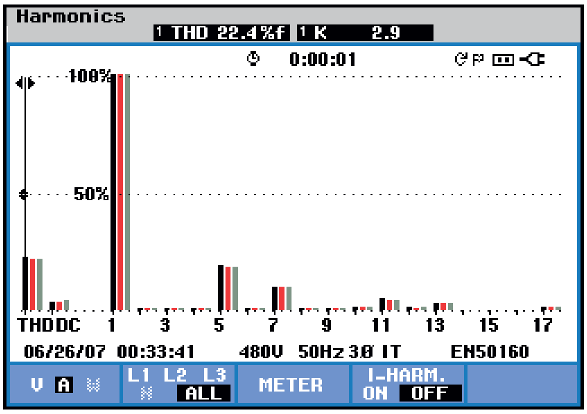
- Voltage Measurements
  V_{rms}, V_R, V_S, V_T, V_0, V_{POZ}, V_{NEG}
- Current Measurements
  I_{rms}, I_R, I_S, I_T, I_0, I_{POZ}, I_{NEG}
- Crest Factor Measurements
  CF-V_R, CF-V_S, CF-V_T
  CF-I_R, CF-I_S, CF-I_T
- Power Measurements
  P_{3F}, Q_{3F}, D_{3F}, S_{3F}
- Power Factors Measurements
  PF_{3F}, PF_R, PF_S, PF_T
  $Tg\ \varphi_{3F}$, $Tg\ \varphi_R$, $Tg\ \varphi_S$, $Tg\ \varphi_T$

The report is prepared with recorded data, by determining the maximum and minimum values due to related standards. The report includes the each measuring points' graphics, tables of events for detail analzying . Also graphical oscilloscopic fault analyzes are attached for each event.







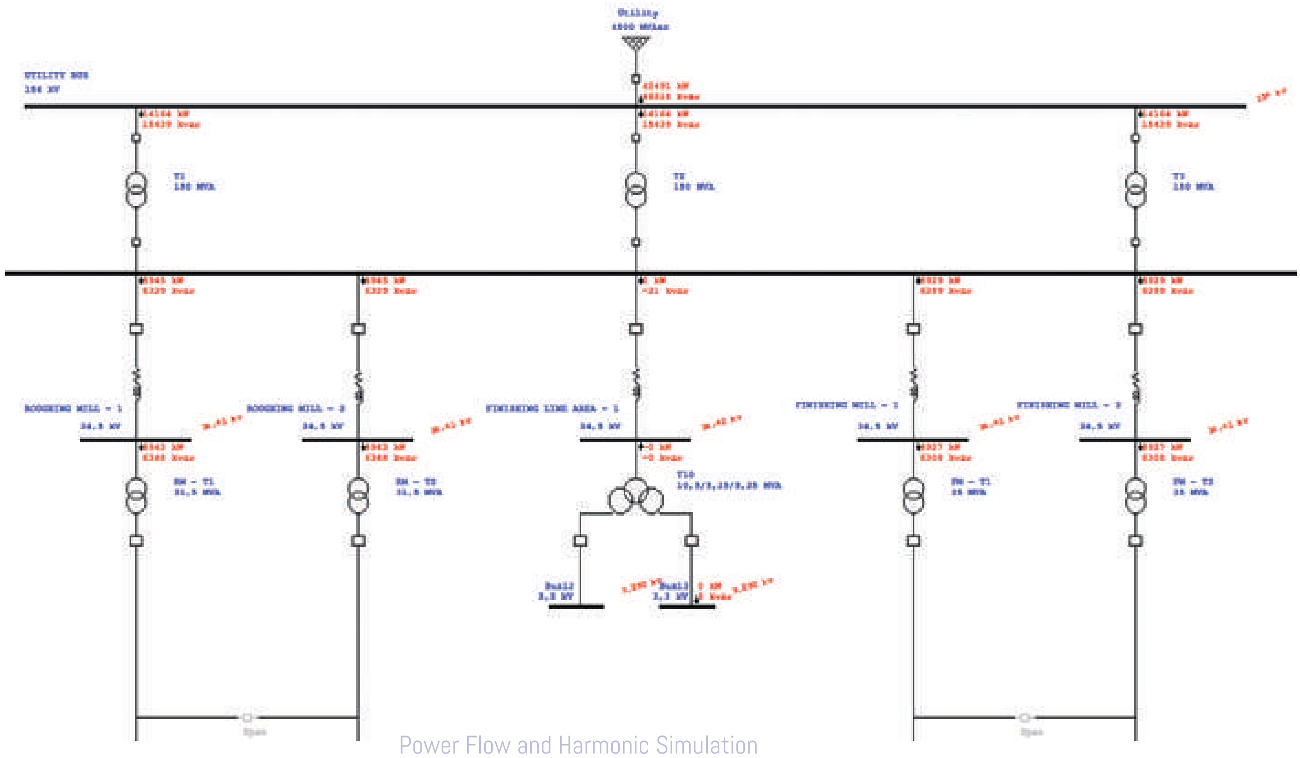


n case of determining any event, at first it is determined the reason of event and rarely recorded measurements and evaluation of these measurements leads to the solution. Most of time, the electrical structure of the plant is simulated on a PC and thus they can be analyzed the power flow and power quality parameters for different operating conditions.

With addition the solving suggestions to the simulation, optimum solution is determined (minimum cost, maximum gain). Thus, there is any suprise after the application of solutions at the plant. This is very important for the customers because the solution runs perfectly and continiously without any problem.

Than, the optimum solution is offered to the costumer. After application, the power quality measurements are recorded again and represented to the customer with simulation results and realtime results together, it is clearly shown that the simulations and application results are same.

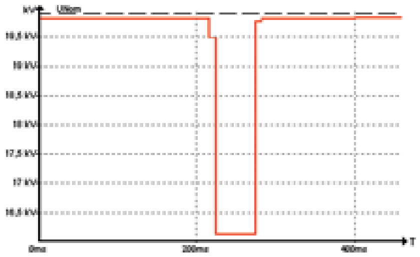
Thanks to substructure of upper level engineering and experience, Aktif Group can analyze and solve all the problems for all type of facilities in all industries.



Power Flow and Harmonic Simulation

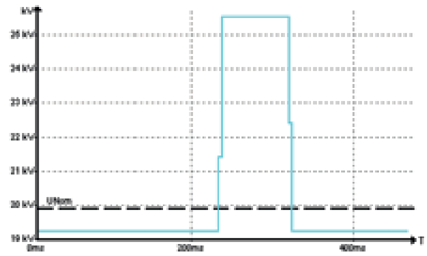
B 2 Power Quality Information

B 2.1 Voltage Sag



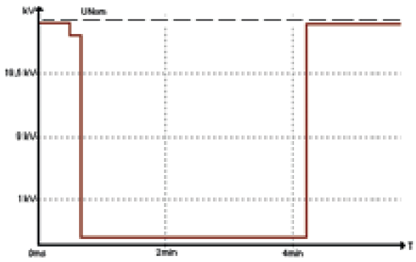
Sags are fast deviations from the normal voltage. Magnitude may be decrease ten up to hundreds of volts. Duration may vary from a half cycle to a few seconds as defined in EN61000-4-30.

B 2.2 Voltage Swell



Swells are fast deviations from the normal voltage. Magnitude may be increase ten up to hundreds of volts. Duration may vary from a half cycle to a few seconds as defined in EN61000-4-30.

B 2.3 Interruptions

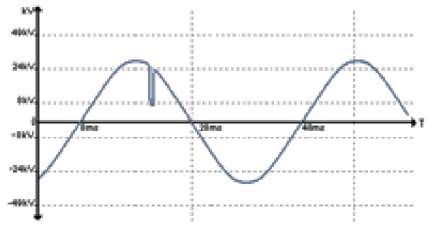


During an Interruption the voltage sinks well below its nominal value. In three phase systems an interruption begins when the voltage on all phases are below threshold and ends when one phase is equal to or above the interruption threshold plus hysteresis. The trigger conditions for interruptions are threshold and hysteresis. Interruptions are characterized by duration, magnitude and time of occurrence.

Short Interruptions- a decrease to between 0 and 0.01 pu in rms voltage at the power frequency for durations of 0.5 cycle to 3 minutes.

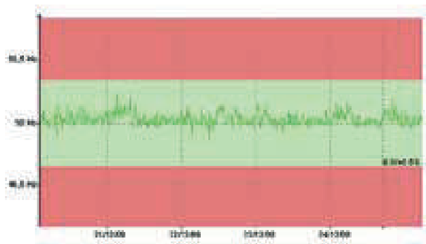
Long Interruptions- a decrease to between 0 and 0.01 pu in rms voltage at the power frequency for over 3 minutes.

B 2.4 Notch



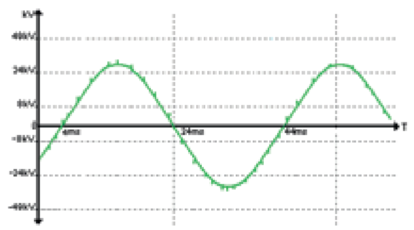
A disturbance of the normal voltage waveform of duration less than 0.5 cycles is of a polarity that is opposite to the waveform and is hence subtracted from the normal waveform with respect to the peak value of the disturbance voltage.

B 2.5 Power Frequency Variation



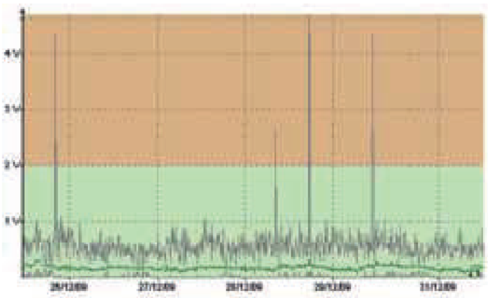
Observation period of one week in fixed steps of 10 seconds. These values must be between 49,5 and 50,5 Hz for 95% acceptable percentage. And the other hand these values must be between 47 and 52 Hz for 100% acceptable percentage.

B 2.6 Flicker



Flicker quantifies the luminance fluctuation of lamps caused by supply voltage variations. The algorithm behind the measurement meets EN61000-4-15 and is based on a perceptual model of the human eye / brain sensory system.

B 2.7 Voltage Unbalance



The supply voltage unbalance is evaluated using the method of symmetrical components. In addition to the positive sequence component, under unbalance conditions there also exists at least one of the following components: negative sequence component u2 and/or zero sequence component u0.

The fundamental component of the r.m.s. voltage input signal is measured over a 10-cycle time interval for 50 Hz power systems.

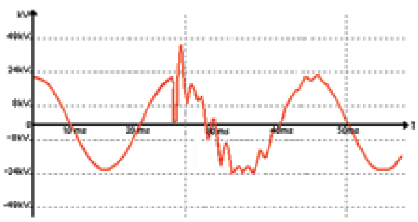
The negative sequence component u2 is evaluated by the following ratio, expressed as a percentage:

u2 = (negative sequence / positive sequence) *100%

The zero-sequence u0 component is evaluated by the magnitude of the following ratio, expressed as a percentage:
uo = (zero sequence / positive sequence) *100%

When a 3-phase a.c. voltage that fulfils the requirements "Testing state 1" conditions , except for negative- and zero-sequence unbalance in the range 1 % to 5 % of Udin, is applied at the input then the instrument shall present an uncertainty less than ±0,15 % for both negative and zero sequence.

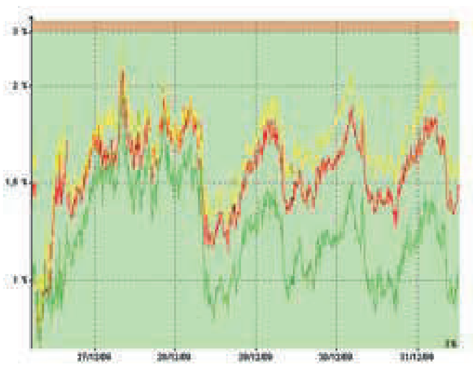
B 2.8 Transient



Transients in A.C. power circuits occur over a wide range of waveforms, amplitudes, and duration. It is difficult to describe these by a simple set of parameters, but obtaining their signatures allows them to be classified into a few typical waveforms that are used for test purposes. The frequency spectrum of several representative test waveforms in general use is useful in developing algorithms that will be necessary for appropriate reduction of the analogue signals into the digital recordings and data processing of these events.

For voltage, the spectra of common test waveforms for A.C. mains transients contain frequencies that range up to approximately 10 MHz (lasting for 200 s), with large amplitudes up to 1 MHz (lasting for 2 ms). For end-use A.C. mains connections, the amplitudes of common test waveforms range up to 6 kV.

B 2.9 Harmonics



Harmonics are periodic distortions of voltage, current, or power sine waves. A waveform can be considered as a combination of various sine waves with different frequencies and magnitudes. The contribution of each of these components to the full signal is measured. Readings can be given as a percentage of the fundamental, or as a percentage of all harmonics combined.

THD's Observation period of one week in fixed steps of 10 minutes. These values must be under %8 for 95% acceptable percentage. Each voltage harmonic's observation period of one week in fixed steps of 10 minutes. These values must be under limits for 95% acceptable percentage on standards as EN 50160,IEC 61000-4-30, IEC 61000-2-2,IEC 61000-2-4,IEC 61000-3-2,IEC 61000-3-6.

EN
50160

IEC
61000

IEEE
519

B 3 Related Standards

EN 50160 Measurement Guide for Voltage Characteristics

IEC 61000-2-4 Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances

IEC 61000-3-6 Assessment of emission limits for disturbing loads in MV and HV power systems

IEC 61000-3-7 Limits - Assessment of emission limits for fluctuating loads in MV and HV power systems

IEC 61000-4-7 Testing and Measurement Techniques General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto

IEC 61000-4-30 Power Quality Measurement Methods

IEEE 519-1992 IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

B 4 Measuring Equipments

Measurements are made by high quality and high performanced portable Power Quality Recorders.

- Control of the Power Quality of the Distribution and Transportation Networks following EN50160 and CEI 61000-3-6/7
- Compliant to CEI 61000-4-30 class A
- Systematic recording of ALL the statistical data
- Record the Dips, Swells and Interruptions
- Edit conformity reports automatically

Generalities;

Power Quality Recorders are the essential instruments to analyze the quality of the electrical Networks according to related standards (EN50160, CEI 61000-4-7...).

Power Quality Recorders simultaneously allows a real time monitoring of all the electric parameters such as: Flicker, harmonics, interharmonics, power, symetrical components, imbalance and energy.

Power Quality Recorders allows to communicate via modem, Gsm modem, USB, Ethernet, RS485 or RS232.

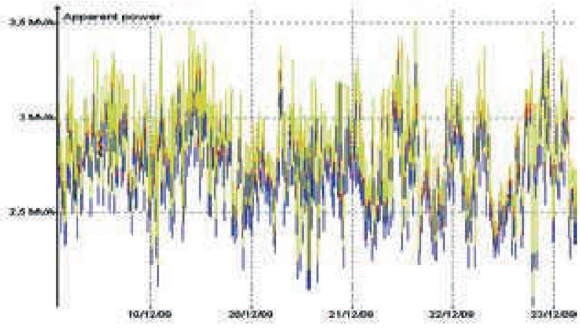
Power Quality Recorders are upgradable, adaptable to the changes in the Standards by remote downloading.

The application software allows to download the data, to store the data, to compare data from a whole fleet of devices for analyze and reports printing the "fast" connectors allow to start the device running in a wink.

The Current measurement is made through Current clamps or flexible Current core giving a high safety level to the device.

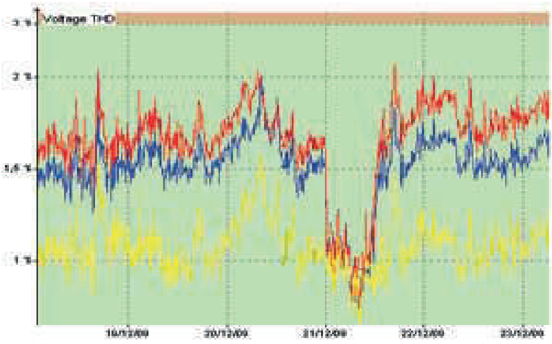
Applications Measurements software permanently and simultaneously records the following data;

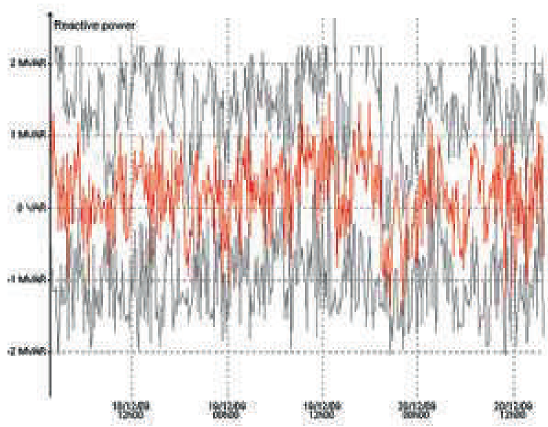
- RMS Voltage
- RMS Current
- True, Reactive, Apparent and Distortion Power
- Power Factor, tangent Phi
- Harmonics (up to 52 th), Interharmonics
- Pst, Plt (Flicker)
- Imbalance and Symetrical component
- Frequency
- Energy
- Signaling voltage



The statistical data are systematically recorded on the memory card of the device on 10 minutes, 1h, 24h and 7 days intervals;

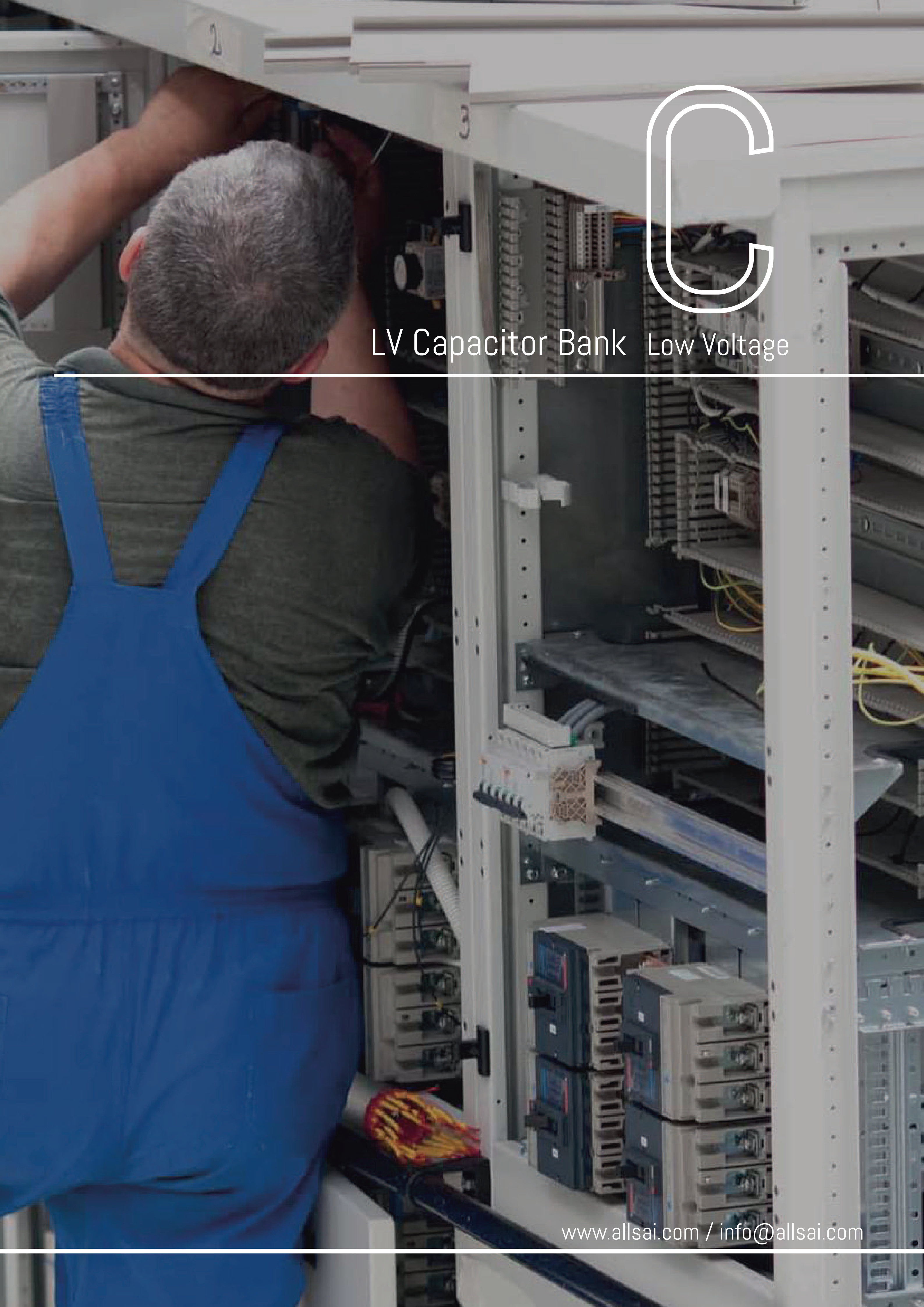
- Dips, Swells and Interruptions
- Analyze of the Power Quality of the Network following
- EN 50160
- CEI 1000-3-6/7
- EN 61000-4-30 class A
- User defined thresholds





LV Capacitor Bank

C



C

LV Capacitor Bank Low Voltage

C 1 M series Capacitor Banks

Asset M series capacitor banks have been designed by using 415 V modular units and high technology digital reactive power control relays.

Thus, Asset M series capacitor banks operate perfectly and continuously up to 490 V thanks to its withstand values 18% over voltages and 50% over current.

Inrush current limiting characteristics of Asset P5 series compensation racks help to network to not increase the inrush when capacitor units switched on and occur long life and more safety in all plant by the using of high quality equipments.
Using the P5 series compensation racks in Asset M series capacitor banks provides a modular structure to the entire system and allows operator to add and modify the steps very easily and practically.

M series capacitor banks are switched on/off of their capacitor steps automatically by state of the art digital reactive power control relays. Further to current and voltage information coming from current and voltage transformers, define the required reactive power and switch the steps. Reactive power control relay knows the nominal power of each step and can calculate the reactive power demand, because of this only required steps are switched on/off by relay. Thanks to this, reactive power is provided quickly with less contactor switching and less variation, consequently the life time of capacitors and switching system is became longer.

Advantages;

Assimatic capacitor banks are manufactured in accordance with IEC standards and tested & delivered as operative with all power connections completed. The system is ready to commission after connecting its power cables to the boards.

- High level protection against to touching
- High resistance and long life
- Ensuring durability of capacitors, contactors and switching system through out the plant by limiting inrush currents
- Thanks to its modular design, power increasing capabilities by the addition of Asset P5 series compensation racks.
- Standard fabrication manufacture
- Fast delivery and competetive prices

Technical Specification;	
Nominal Voltage	415 V
Nominal Frequency	50/60 Hz
Continuos Over Voltage	490 V
Continuos Over Current	1.5 I_n
Environment Temperature	10 ... +45°C
Storing Temperature	-30 ... +60°C
Color	RAL 7035 / RAL 9003
Monitoring	Steps, Voltage, Current, Cos φ , Active Power, Reactive Power
Operating	Automatic C/K setting ant step power determination, Smart commissioning - decommissioning based on required power, Time-balanced switching, Independent from sequence directory, Automatic and manual operating modes, Different Cosφ setting for Mains and Generator
Response Time	1 - 60 sec
Output	General alarm output.
Protection Class	IP 41 (Optional IP 54)
Framework / Door Thickness	2,5 mm / 1,5 mm
Type of Lamination	A1 quality, DKP, Stainless Steel, Galvanized
Standard Packing	Air bubble nylon packing over palette (over sea pacing optional)
Transportation	By hook from the top
Standards	EN 60439-1, IEC 60439-1,2

Standard Product Range;			
M 10041	100 kVAr, 400 V	2x6,25 + 12,5 + 25 + 50 kVAr	600 x 500 x 2050 mm
M 12541	125 kVAr, 400 V	2x6,25 + 12,5 + 2x25 + 50 kVAr	600 x 500 x 2050 mm
M 15041	150 kVAr, 400 V	2x6,25 + 12,5 + 25 + 2x50 kVAr	600 x 500 x 2050 mm
M 17541	175 kVAr, 400 V	2x12,5 + 2x25 + 2x50 kVAr	600 x 500 x 2050 mm
M 20041	200 kVAr, 400 V	2x12,5 + 25 + 3x50 kVAr	600 x 500 x 2050 mm
M 22541	225 kVAr, 400 V	2x12,5 + 2x25 + 3x50 kVAr	600 x 500 x 2050 mm
M 25041	250 kVAr, 400 V	2x12,5 + 25 + 4x50 kVAr	600 x 500 x 2050 mm
M 27541	275 kVAr, 400 V	2x12,5 + 2x25 + 4x50 kVAr	600 x 500 x 2050 mm
M 30041	300 kVAr, 400 V	2x25 + 5x50 kVAr	600 x 500 x 2050 mm
M 32541	325 kVAr, 400 V	25 + 6x50 kVAr	600 x 500 x 2050 mm
M 35041	350 kVAr, 400 V	2x25 + 6x50 kVAr	600 x 500 x 2050 mm
M 37541	375 kVAr, 400 V	25 + 7x50 kVAr	600 x 500 x 2050 mm
M 40041	400 kVAr, 400 V	2x25 + 7x50 kVAr	600 x 500 x 2050 mm
M 45041	450 kVAr, 400 V	2x25 + 8x50 kVAr	600 x 500 x 2050 mm
M 50041	500 kVAr, 400 V	2x25 + 9x50 kVAr	600 x 500 x 2050 mm
M 55041	550 kVAr, 400 V	2x25 + 10x50 kVAr	600 x 500 x 2050 mm
M 60041	600 kVAr, 400 V	2x25 + 9x50 + 100 kVAr	1200 x 500 x 2050 mm
M 65041	650 kVAr, 400 V	2x25 + 8x50 + 2x100 kVAr	1200 x 500 x 2050 mm
M 70041	700 kVAr, 400 V	2x25 + 7x50 + 3x100 kVAr	1200 x 500 x 2050 mm
M 75041	750 kVAr, 400 V	2x25 + 8x50 + 4x100 kVAr	1200 x 500 x 2050 mm
M 80041	800 kVAr, 400 V	2x25 + 5x50 + 5x100 kVAr	1200 x 500 x 2050 mm
M 85041	850 kVAr, 400 V	2x25 + 4x50 + 6x100 kVAr	1200 x 500 x 2050 mm
M 90041	900 kVAr, 400 V	2x25 + 3x50 + 7x100 kVAr	1200 x 500 x 2050 mm
M 95041	950 kVAr, 400 V	2x25 + 2x50 + 8x100 kVAr	1200 x 500 x 2050 mm
M 100041	1000 kVAr, 400 V	2x25 + 50 + 9x100 kVAr	1200 x 500 x 2050 mm
M 105041	1050 kVAr, 400 V	2x25 + 2x50 + 9x100 kVAr	1200 x 500 x 2050 mm
M 110041	1100 kVAr, 400 V	2x25 + 50 + 10x100 kVAr	1200 x 500 x 2050 mm
M 115041	1150 kVAr, 400 V	2x25 + 2x50 + 10x100 kVAr	1200 x 500 x 2050 mm
M 120041	1200 kVAr, 400 V	2x50 + 9x100 + 200 kVAr	1200 x 500 x 2050 mm

C 2 MT series Thyristor Switched Capacitor Banks for Unbalanced Load

MT series Thyristor-controlled unbalanced load capacitor banks can be used for real time reactive power compensation at low voltage systems. These systems can compensate the reactive power for each phase individually.

MT series Thyristor-controlled unbalanced load capacitor banks are formed by Asset P3 series modular thyristor controlled unbalanced-phase compensation racks and state of the art single phase-controlled digital reactive power control relays.

P3 series modular thyristor controlled unbalanced-phase compensation racks are able to switch on/off either 3 phases or single phase steps in the same time. Thanks to this point, fast and simultaneous compensation is performed through zero-crossing electronic switcher for each phase individually.

Another advantage of P3 series compensation racks is that; capacitors which are used in these racks are 6-pole connected and their 1.18*Un overvoltage withstand. As a result of 6-pole connection of the capacitors, this module is more successful than the similar ones for single phase and three phase switching options.

MT series Thyristor-controlled unbalanced load capacitor banks which manufactured and complied to IEC standardare the best simultaneous compensation solution for the unbalanced distributed loads.

Advantages,

MT series Thyristor-controlled unbalanced load capacitor banks which manufactured and complied to IEC standardare the best simultaneous compensation solution for the unbalanced distributed loads.

- For each fast, sensitive and individual compensation for unbalanced loads
- Thanks to its modular design, power increasing capabilities by the addition of P3 series compensation racks.
- High level protection against to touching
- Standard fabrication manufacture
- Fast delivery and competetive prices

Disadvantages;

- Single phase capacitor banks cause voltage rise between neutral and earth. Please ask our special solutions for the plants which includes very sensitive devices about neutral to earth voltage.

Technical Specification;	
Nominal Voltage	440 V
Nominal Frequency	50/60 Hz
Continuos Over Voltage	520 V
Continuos Over Current	1.5 I_n
Environment Temperature	10 ... +45°C
Storing Temperature	-30 ... +60°C
Color	RAL 7035 / RAL 9003
Monitoring	Steps, Voltage, Current, Cos φ , Active Power, Reactive Power
Operating	Automatic C/K setting ant step power determination, Smart commissioning - decommissioning based on required power, Time-balanced switching, Independent from sequence directory, Automatic and manual operating modes, Different Cosφ setting for Mains and Generator
Response Time	< 40 ms
Output	General alarm output.
Protection Class	IP 41 (Optional IP 54)
Framework / Door Thickness	2 mm / 2 mm
Type of Lamination	A1 quality, DKP, Stainless Steel, Galvanized
Standard Packing	Air bubble nylon packing over palette (over sea pacing optional)
Transportation	By hook from the top
Standards	EN 60439-1, IEC 60439-1,2

Standard Product Range;

Model	Nominal	Step Design				Dimensions
	Power	Three - Phase	Single - Phase			(W x L x H)
		RST (kVAr)	Rn (kVAr)	Sn (kVAr)	Tn (kVAr)	(mm)
MT 10	10 kVAr, 400 V	5,2	0.57 + 1.14	0.57 + 1.14	0.57 + 1.14	500 x 500 x 1750
MT 17,5	17,5 kVAr, 400 V	5,2	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	500 x 500 x 1750
MT 22,5	22,5 kVAr, 400 V	10,3	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	500 x 500 x 1750
MT 32,5	32,5 kVAr, 400 V	2 x 10,3	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	500 x 500 x 1750
MT 45	45 kVAr, 400 V	10,3 + 20,7	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	500 x 500 x 1750
MT 55	55 kVAr, 400 V	2 x 10,3 + 20,7	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	600 x 500 x 2100
MT 65	65 kVAr, 400 V	10,3 + 2 x 20,7	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	0.57 + 1.14 + 2.28	600 x 500 x 2100
MT 85	85 kVAr, 400 V	10,3 + 20,7 + 41,3	1.14 + 2.28	1.14 + 2.28	1.14 + 2.28	500 x 500 x 1750
MT 90	90 kVAr, 400 V	10,3 + 20,7 + 41,3	1.14 + 2.28 + 2.28	1.14 + 2.28 + 2.28	1.14 + 2.28 + 2.28	600 x 500 x 2100
MT 100	100 kVAr, 400 V	10,3 + 20,7 + 41,3	2.28 + 2.28 + 4.55	2.28 + 2.28 + 4.55	2.28 + 2.28 + 4.55	600 x 500 x 2100
MT 125	125 kVAr, 400 V	20,7 + 2 x 41,3	1.14 + 2.28 + 4.55	1.14 + 2.28 + 4.55	1.14 + 2.28 + 4.55	600 x 500 x 2100
MT 145	145 kVAr, 400 V	10,3 + 2 x 20,7 + 2 x 41,3	1.14 + 2.28	1.14 + 2.28	1.14 + 2.28	1000 x 500 x 1750
MT 165	165 kVAr, 400 V	10,3 + 20,7 + 3 x 41,3	1.14 + 2.28	1.14 + 2.28	1.14 + 2.28	1000 x 500 x 1750
MT 175	175 kVAr, 400 V	10,3 + 20,7 + 3 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1000 x 500 x 1750
MT 200	200 kVAr, 400 V	10,3 + 2 x 20,7 + 3 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1000 x 500 x 1750
MT 220	220 kVAr, 400 V	10,3 + 20,7 + 4 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1000 x 500 x 1750
MT 250	250 kVAr, 400 V	20,7 + 5 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1000 x 500 x 1750
MT 260	260 kVAr, 400 V	10,3 + 20,7 + 5 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1000 x 500 x 1750
MT 300	300 kVAr, 400 V	10,3 + 20,7 + 6 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1000 x 500 x 1750
MT 310	310 kVAr, 400 V	2 x 20,7 + 6 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1000 x 500 x 1750
MT 330	330 kVAr, 400 V	20,7 + 7 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1000 x 500 x 1750
MT 340	340 kVAr, 400 V	10,3 + 20,7 + 7 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1200 x 500 x 2100
MT 380	380 kVAr, 400 V	10,3 + 20,7 + 8 x 41,3	2.28 + 4.55	2.28 + 4.55	2.28 + 4.55	1200 x 500 x 2100
MT 420	420 kVAr, 400 V	10,3 + 20,7 + 9 x 41,3	4.55	4.55	4.55	1200 x 500 x 2100

C 3 MS series Capacitor Banks with Detuned Reactors

In a system consist of various harmonics sources, the impact of the harmonics appears on the weakest point of impedance, i.e. on the capacitors in the capacitor banks. Harmonics caused over current and over voltages on the capacitors. In addition, current and voltage distortions caused by resonance that may occur due to the existing harmonics in the system will damage compensation and also cause electronic board failures and power losses.

Asset MS series capacitor banks with harmonic filters have been designed by using 440 V modular units and high technology digital reactive power control relays.

Thus, Asset MS series capacitor banks with harmonic filters operate perfectly and continuously up to 520 V thanks to it is withstand values 18% over voltages and 50% over current.

Inrush current limiting characteristics of Asset R7 series compensation racks help to network to not increase the inrush when capacitor units switched on and occur long life and more safety in all plant by the using of high quality equipments.

Using the Asset R7 series compensation racks in Asset MS series capacitor banks with harmonic filters provides a modular structure to the entire system and allows operator to add and modify the steps very easily and practically.

MS series capacitor banks are switched on/off of their capacitor steps automatically by state of the art digital reactive power control relays. Further to current and voltage information coming from current and voltage transformers, define the required reactive power and switch the steps. Reactive power control relay knows the nominal power of each step and can calculate the reactive power demand, because of this only required steps are switched on/off by relay. Thanks to this, reactive power is provided quickly with less contactor switching and less variation.

Advantages;

Asset MS series capacitor banks are manufactured in accordance with IEC standards and tested & delivered as operative with all power connections completed. The system is ready to commission after connecting its power cables to the boards.

- High level protection against to touching
- High resistance and long life
- Thanks to absorbing the harmonics, eliminates the parallel resonance risk.
- Protects the switching equipments and precise loads in the plant to the problem caused by harmonics.
- Ensuring durability of capacitors, contactors and switching system through out the plant by limiting the inrush currents
- Prevents of electronic board failures
- Thanks to its modular design, power increasing capabilities by the addition of Asset R7 series compensation racks.
- Standard fabrication manufacture
- Fast delivery and competetive prices

Technical Specification;	
Nominal Voltage	440 V
Nominal Frequency	50/60 Hz
Continuos Over Voltage	520 V
Continuos Over Current	1.5 I_n
Standard Resonance Frequency	189 Hz, 210 Hz, 215 Hz (others optional)
Environment Temperature	-10 ... +45 °C
Storing Temperature	-30 ... +60 °C
Color	RAL 7035 / RAL 9003
Monitoring	Steps, Voltage, Current, Cosφ , Active Power, Reactive Power
Operating	Automatic C/K setting ant step power determination, Smart commissioning - decommissioning based on required power, Time-balanced switching, Independent from sequence directory, Automatic and manual operating modes, Different Cosφ setting for Mains and Generator
Response Time	1 - 60 sec
Output	General alarm output.
Protection Class	IP 41 (Optional IP 54)
Framework / Door Thickness	2,5 mm / 1,5 mm
Type of Lamination	A1 quality, DKP, Stainless steel, Galvanized
Standard Packing	Air bubble nylon packing over palette (over sea packing optional)
Transportation	By hook from the top
Standards	EN 60439-1, IEC 60439-1,2

Standard Product Range;			
MS 12544	125 kVAr, 440 V	2x12,5 + 2x25 + 50 kVAr	800 x 600 x 2050 mm
MS 15044	150 kVAr, 440 V	2x12,5 + 25 + 2x50 kVAr	800 x 600 x 2050 mm
MS 17544	175 kVAr, 440 V	2x12,5 + 2x25 + 2x50 kVAr	800 x 600 x 2050 mm
MS 20044	200 kVAr, 440 V	2x12,5 + 25 + 3x50 kVAr	800 x 600 x 2050 mm
MS 22544	225 kVAr, 440 V	25 + 4x50 kVAr	800 x 600 x 2050 mm
MS 25044	250 kVAr, 440 V	2x25 + 4x50 kVAr	800 x 600 x 2050 mm
MS 27544	275 kVAr, 440 V	25 + 5x50 kVAr	800 x 600 x 2050 mm
MS 30044	300 kVAr, 440 V	2x25 + 3x50 + 100 kVAr	800 x 600 x 2050 mm
MS 35044	350 kVAr, 440 V	2x25 + 2x50 + 2x100 kVAr	800 x 600 x 2050 mm
MS 40044	400 kVAr, 440 V	2x25 + 50 + 3x100 kVAr	800 x 600 x 2050 mm
MS 45044	450 kVAr, 440 V	2x25 + 2x50 + 3x100 kVAr	800 x 600 x 2050 mm
MS 50044	500 kVAr, 440 V	2x25 + 50 + 4x100 kVAr	1600 x 600 x 2050 mm
MS 55044	550 kVAr, 440 V	2x25 + 2x 50 + 4x100 kVAr	1600 x 600 x 2050 mm
MS 60044	600 kVAr, 440 V	2x25 + 50 + 5x100 kVAr	1600 x 600 x 2050 mm
MS 65044	650 kVAr, 440 V	2x25 + 2x 50 + 5x100 kVAr	1600 x 600 x 2050 mm
MS 70044	700 kVAr, 440 V	2x25 + 50 + 6x100 kVAr	1600 x 600 x 2050 mm
MS 75044	750 kVAr, 440 V	2x25 + 2x 50 + 6x100 kVAr	1600 x 600 x 2050 mm
MS 80044	800 kVAr, 440 V	2x25 + 50 + 7x100 kVAr	1600 x 600 x 2050 mm
MS 90044	900 kVAr, 440 V	2x25 + 50 + 8x100 kVAr	1600 x 600 x 2050 mm
MS 100044	1000 kVAr, 440 V	2x50 + 9x100 kVAr	1600 x 600 x 2050 mm
MS 110044	1100 kVAr, 440 V	2x50 + 10x100 kVAr	2400 x 600 x 2050 mm
MS 120044	1200 kVAr, 440 V	2x50 + 9x100 + 200 kVAr	2400 x 600 x 2050 mm
MS 130044	1300 kVAr, 440 V	2x50 + 8x100 + 2x200 kVAr	2400 x 600 x 2050 mm
MS 140044	1400 kVAr, 440 V	2x50 + 7x100 + 3x200 kVAr	2400 x 600 x 2050 mm
MS 150044	1500 kVAr, 440 V	2x50 + 6x100 + 4x200 kVAr	2400 x 600 x 2050 mm
MS 160044	1600 kVAr, 440 V	2x50 + 5x100 + 5x200 kVAr	3200 x 600 x 2050 mm
MS 170044	1700 kVAr, 440 V	2x50 + 4x100 + 6x200 kVAr	3200 x 600 x 2050 mm
MS 180044	1800 kVAr, 440 V	2x50 + 3x100 + 7x200 kVAr	3200 x 600 x 2050 mm
MS 190044	1900 kVAr, 440 V	2x50 + 2x100 + 8x200 kVAr	3200 x 600 x 2050 mm
MS 200044	2000 kVAr, 440 V	2x50 + 100 + 9x200 kVAr	3200 x 600 x 2050 mm

C 4 MST series Thyristor switched Capacitor Banks with Detuned Reactors

The main difference between the real time static capacitor banks and conventional capacitor banks is the switching of capacitors by thyristors instead of contactors.

Asset MST series capacitor banks are a low voltage real-time reactive power compensation units using solid state switches. And also inrush current limiting characteristics help to network to not increase the inrush when capacitor units switched on and occur long life and more safety in all plant by the using of high quality equipments.

To face increasingly sophisticated industrial processes including large numbers of devices sensitive to voltage variations (PLCs, industrial computers, etc.) or having ultra-fast cycles (robots, welding machines, variable speed drives, etc.), Assetatic has been developed.

Asset MST series capacitor banks are a “soft and fast” reactive energy compensation systems suitable for this new generation of receiving devices.

Asset MST series capacitor banks has three main advantages compare to conventional systems using electromechanical switching;

- No transient currents when capacitors are switched on which might cause voltage troughs.
- No transient voltages on switching of capacitors due to difficulties in cutting off the electrical arc.
- Very short response time less than 40 milliseconds.

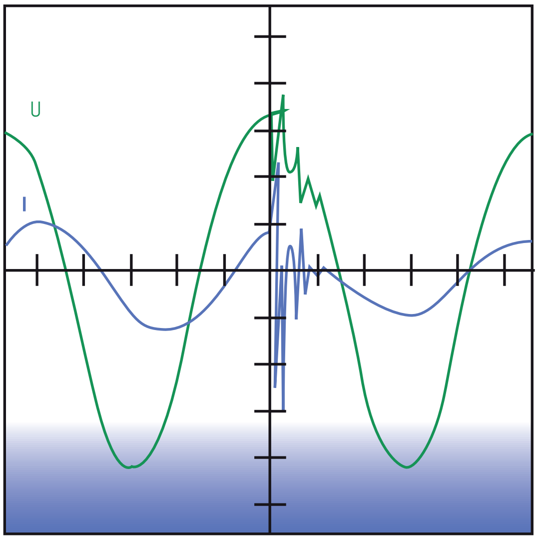
Asset MST series capacitor banks are primarily designed for:

- Compensation of reactive power factor of main
- Reducing total energy consumption
- Optimisation of generator units.
- Increasing of power quality

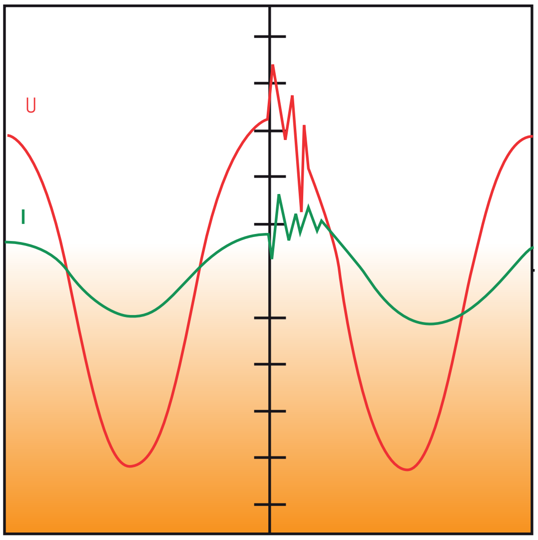
Asset MST series capacitor banks are particularly suitable for compensation of following loads:

- Which can not work with transient currents or voltage (PLCs, computer equipment...)
- Ultra-fast loads (welding machines, lifts, robots, variable speed drives...)
- With pulsating torques (rolling mills, compressors, reciprocating saws...)
- Loads which generate flicker (devices with extremely inductive loads, arc furnaces, welding machines...)

Conventional switching using electromechanical contactors;



Coupling a stage



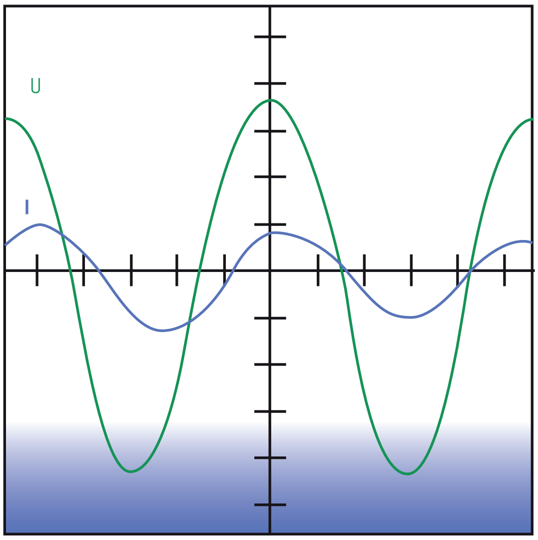
Uncoupling a stage

During switching, the followings may occur:

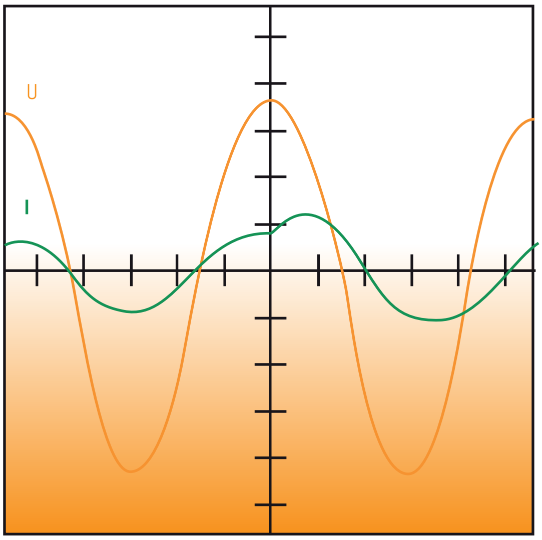
- Transient over currents exceeding 200 In
- Significant transient over and under - voltages

These disturbances may lead to malfunctions on control equipment (PLCs, industrial computers, etc.).

Soft switching using Assetatic solid state contactors;



Coupling a stage



Uncoupling a stage

- Soft switching using Assetatic solid state contactors does not prevent network disturbance
- The reaction speed (<40 milliseconds) ensures that power is controlled immediately.

Main Characteristics Compared;

Sensitive Data	Assetatic	Conventional
Presence of electromechanical contactors	No	Yes
Wear of moving parts	No	Yes
Contact bounce phenomenon	No	Possible
Contact fatigue	None	High
Occuring of inrush current at capacitor switch on and switch of	No	Yes (May exceed 200In)
Transient under-voltages	None	Yes (Up to 100%)
Compatibility (PLCs, computer equipment, etc.)	Excellent	Average
Compatibility (welding machines, generators, etc.)	Excellent	Poor
Response time (switch on and switch of)	40 milliseconds max.	Approx. 10 second
Number of operations	Unlimited	Limited (Electromechanical contactor)
Sound level during operation	None	Low (Electromechanical contactor)
Flicker reduction	Yes	No
Prevent of harmonics	No	No

Technical Specification;	
Nominal Voltage	440 V
Nominal Frequency	50/60 Hz
Continuous Over Voltage	520 V
Continuous Over Current	1.5 I_n
Standard Resonance Frequency	189 Hz, 210 Hz, 215 Hz (others optional)
Environment Temperature	-10 ... +45 °C
Storing Temperature	-30 ... +60 °C
Color	RAL 7035 / RAL 9003
Monitoring	Steps, Voltage, Current, Cosφ , Active Power, Reactive Power Operating Automatic C/K setting ant step power determination, Smart commissioning - decommissioning based on required power, Time-balanced switching, Independent from sequence directory, Automatic and manual operating modes, Different Cosφ setting for Mains and Generator
Response Time	<40 ms
Output	General alarm output.
Protection Class	IP 41 (Optional IP 54)
Framework / Door Thickness	2,5 mm / 1,5 mm
Type of Lamination	A1 quality, DKP, Stainless Steel, Galvanized
Standard Packing	Air bubble nylon packing over palette (oversea packing optional)
Transportation	By hook from the top
Standards	EN 60439-1, IEC 60439-1,2

Standard Product Range;			
MST 12544	125 kVAr, 440 V	2x12,5 + 2x25 + 50 kVAr	800 x 600 x 2050 mm
MST 15044	150 kVAr, 440 V	2x12,5 + 25 + 2x50 kVAr	800 x 600 x 2050 mm
MST 17544	175 kVAr, 440 V	2x12,5 + 2x25 + 2x50 kVAr	800 x 600 x 2050 mm
MST 20044	200 kVAr, 440 V	2x12,5 + 25 + 3x50 kVAr	800 x 600 x 2050 mm
MST 22544	225 kVAr, 440 V	25 + 4x50 kVAr	800 x 600 x 2050 mm
MST 25044	250 kVAr, 440 V	2x25 + 4x50 kVAr	800 x 600 x 2050 mm
MST 27544	275 kVAr, 440 V	25 + 5x50 kVAr	800 x 600 x 2050 mm
MST 30044	300 kVAr, 440 V	2x25 + 3x50 + 100 kVAr	800 x 600 x 2050 mm
MST 35044	350 kVAr, 440 V	2x25 + 2x50 + 2x100 kVAr	800 x 600 x 2050 mm
MST 40044	400 kVAr, 440 V	2x25 + 50 + 3x100 kVAr	800 x 600 x 2050 mm
MST 45044	450 kVAr, 440 V	2x25 + 2x50 + 3x100 kVAr	800 x 600 x 2050 mm
MST 50044	500 kVAr, 440 V	2x25 + 50 + 4x100 kVAr	1600 x 600 x 2050 mm
MST 55044	550 kVAr, 440 V	2x25 + 2x 50 + 4x100 kVAr	1600 x 600 x 2050 mm
MST 60044	600 kVAr, 440 V	2x25 + 50 + 5x100 kVAr	1600 x 600 x 2050 mm
MST 65044	650 kVAr, 440 V	2x25 + 2x 50 + 5x100 kVAr	1600 x 600 x 2050 mm
MST 70044	700 kVAr, 440 V	2x25 + 50 + 6x100 kVAr	1600 x 600 x 2050 mm
MST 75044	750 kVAr, 440 V	2x25 + 2x 50 + 6x100 kVAr	1600 x 600 x 2050 mm
MST 80044	800 kVAr, 440 V	2x25 + 50 + 7x100 kVAr	1600 x 600 x 2050 mm
MST 85044	850 kVAr, 440 V	2x25 + 2x 50 + 7x100 kVAr	1600 x 600 x 2050 mm
MST 90044	900 kVAr, 440 V	2x25 + 50 + 8x100 kVAr	1600 x 600 x 2050 mm
MST 95044	950 kVAr, 440 V	2x25 + 2x 50 + 8x100 kVAr	1600 x 600 x 2050 mm
MST 100044	1000 kVAr, 440 V	2x50 + 9x100 kVAr	1600 x 600 x 2050 mm
MST 110044	1100 kVAr, 440 V	2x50 + 10x100 kVAr	2400 x 600 x 2050 mm
MST 120044	1200 kVAr, 440 V	2x50 + 9x100 + 200 kVAr	2400 x 600 x 2050 mm
MST 130044	1300 kVAr, 440 V	2x50 + 8x100 + 2x200 kVAr	2400 x 600 x 2050 mm
MST 140044	1400 kVAr, 440 V	2x50 + 7x100 + 3x200 kVAr	2400 x 600 x 2050 mm
MST 150044	1500 kVAr, 440 V	2x50 + 6x100 + 4x200 kVAr	2400 x 600 x 2050 mm
MST 160044	1600 kVAr, 440 V	2x50 + 5x100 + 5x200 kVAr	3200 x 600 x 2050 mm
MST 170044	1700 kVAr, 440 V	2x50 + 4x100 + 6x200 kVAr	3200 x 600 x 2050 mm
MST 180044	1800 kVAr, 440 V	2x50 + 3x100 + 7x200 kVAr	3200 x 600 x 2050 mm
MST 190044	1900 kVAr, 440 V	2x50 + 2x100 + 8x200 kVAr	3200 x 600 x 2050 mm
MST 200044	2000 kVAr, 440 V	2x50 + 100 + 9x200 kVAr	3200 x 600 x 2050 mm

C 5 MaxSine series Active Filters

The most effective way to eliminate harmonics is active harmonic filter.

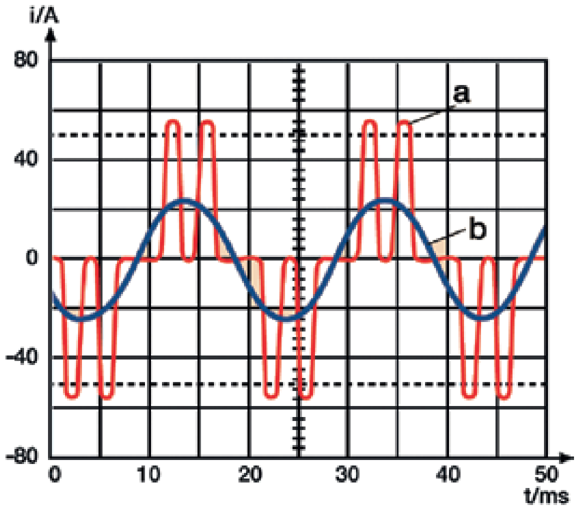
There is an increasing number of electrical equipment with non-linear voltage-current characteristics connected to the network. Harmonic currents produced by them cause harmonic voltages in network impedances, which add to the fundamental system voltage resulting in voltage distortion.

This voltage distortion is experienced by all electrical equipment connected to the network, leading to higher thermal loading of motors, transformers, capacitors, switch-gear and cabling. Some of the electrical equipment develops a more audible noise when supplied with distorted voltage. Sensitive electronic protection, control and ripple control systems are not likely to operate properly when supplied with distorted voltage.

A variety of solutions exist to eliminate the problems of harmonics. Active filter's patented Direct Phase Current Control (DPCC) technology together with advanced digital processing provides your network with efficient and fast harmonic reduction and reactive power compensation.

General features;

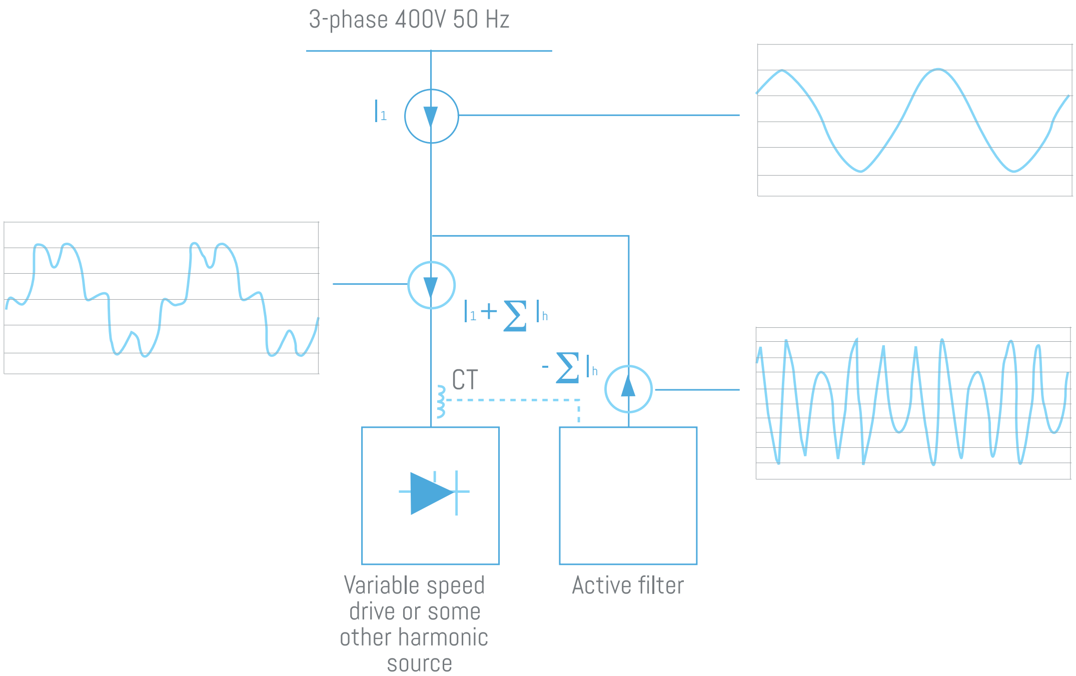
- User interface consists of graphical display and push buttons for easy operation
- Indication of status information
- Easy browsing in the menus
- Viewing of electrical information
- User friendly setup of the operating parameters
- Measurements shown on display
- Network voltage and load current
- Total harmonic distortion
- Graphical analysis of networks harmonic voltages and currents
- Modbus communication connection to RS485
- Two isolated inputs for remote control
- Two relay outputs for run / alarm indications
- Two compensation modes
- Selective 1-25th
- Real-time - Selective
- Selection of individual harmonics up to 25th,compensation factor 0-100%



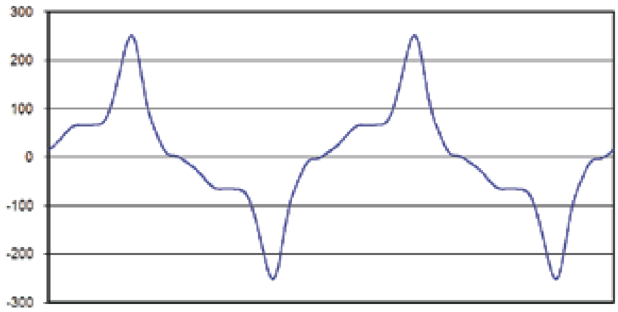
- Selection of fundamental reactive power compensation, compensation factor 0-100%. With 100% the power factor is forced to 1 and the line current becomes balanced
- Global three-phase compensation of current harmonics to approx. 50th harmonics, ultra fast mode
- By application of 4-wire technology, the neutral current is eliminated
- Excellent dynamics, response time < 1ms with ultra fast mode and 20ms (50Hz) with fast mode
- Standby in case of small load current
- Safe for operation on the load side of generators, UPS etc.
- No influence on ripple control systems
- Electronic overload protection
- Can be used in combination with conventional choked capacitor banks
- Applications are economic even for small to medium power ranges

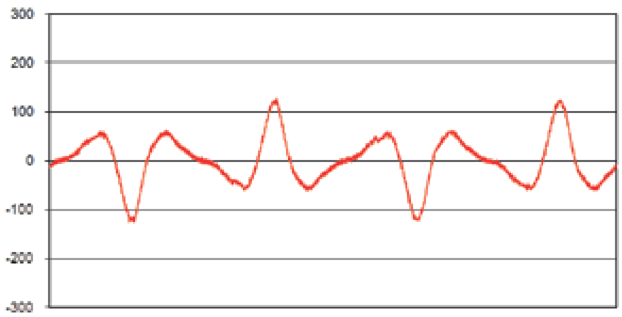
Active filters is independent of;

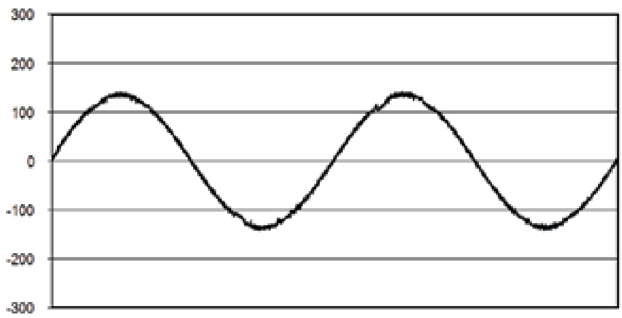
- The curve form of the current to be compensated
- The dynamics of the current changes
- The phase of the current (inductive/capacitive)
- The direction of the current (generator/load)
- The phase of the load (symmetrical/asymmetrical)
- The quality of the mains voltage
- The network impedance



Network Voltage	400 V		Compensation	Order	I Peak/A	Phase/°
Network frequency	50 Hz		(0-100%):	1	95.11	0
Load current factor	1.44		100%	3	38	130
MaxSine	100A-4Lx1		100%	5	27.12	-82
Parallel Maxsine	1		100%	7	9.52	68
Perform AF	100%		100%	9	4.54	-144
MaxSine Current IRMS	49 A		100%	11	2.22	0
Load %THDI IRMS	45%	108 A	100%	13	2	95
Mains %THDI IRMS	3.8%	95 A	100%	15	1	-140







One product many possibilities;

Harmonic filtering

According to figure 2 there is a controlled current source (active filter) connected parallel to a harmonics producing load. This controlled current source produces the same harmonic currents as produced by the load but with opposite phase. Therefore the supply system is loaded with fundamental current only.

Power Factor Correction

Active filter is able to correct power factor by injecting fundamental reactive current into the network. Compensation factor can be adjusted 0%-100%. With 100% the power factor is forced to 1 and the line current becomes balanced. The operation is independent of the phase shift of the load, capacitive/inductive.

Flicker compensation/ac tive peak leveling

Active filter can be used to prevent voltage sags caused by large amounts of dynamic reactive load. Such a load causing flickering lasts typically only a couple of periods. An active peak leveling device is developed to also feed active power to network for short period.

Hybrid Dynamic VAR Compensation

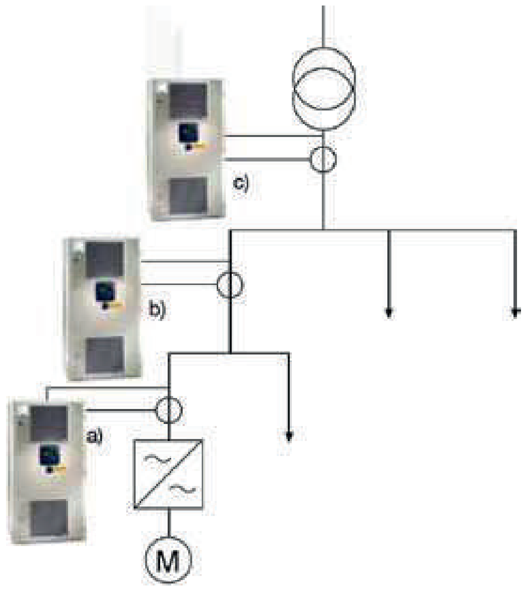
Hybrid Dynamic VAR Compensation is flicker compensation application where nearly half of the requested reactive power is produced by a traditional fixed detuned capacitor bank installed parallel to Active filter.

Installation;

Installation of Active filter can be made to any point of the network. When measurements are done and harmonic distortion is known in various key points in the network, the selection of compensation method between

a) compensation of one certain load,
b) compensation of a group of loads or
c) central compensation must be made.

The most cost-effective solution depends on the type of non-linear loads and network. Rated output of the device defines the fundamental reactive power compensation capacity. 4-wire device is recommended for use when the harmonics current of the neutral exceeds 5 % of phase current.



Data required for dimensioning Active filter;

- Schematic diagram of the system to be compensated
- Rated voltage and frequency
- Harmonic currents
- Reactive power

Technical Specification;	
Nominal Voltage	3 x 400 V +10% -20% (deviations from mains voltage on request)
Nominal Frequency	50/60 Hz
Current Hysteresis	approx. 10% of the RMS-value of rated current
Overload Capability	1.2 x I_{RMS} (dynamically)
Switching Frequency	10 kHz (average)
Potential Free Output Contacts	2 pcs (run / alarm), 2A/250Vac
Response Time	< 1 ms, ultra fast mode < 20 ms, fast mode
CT Ratio	100-3000 / 1 A, class 0,5 requested
Power Dissipation	< 3% of the rated power of the device< 3% of the rated power of the device
Noise Level	< 60 dB
Environmental Temperature	-10°... +45°C
Temperature of Storage	-30 ... +60°C
Elevation of Installation	< 1000 m above sea level (in case of deviation please contact your supplier)
Atmospheric Humidity	0-85%
Cabinet	2 mm sheet iron, RAL 7035
Protection Class	IP41
EMC	EN 61000-6-2 / EN 50081-2
Communication	Modbus, RS 485
Standards	EN 60439-1, IEC 60439-1,2

Standard types (400 V, 50/60 Hz);

Number of units	Rated output	Line current	Neutral current	Dimension			
Type	(kVA)	(A)	(A)	(mm)	(mm)	(mm)	(kg)
AF 50A-3L	35	50	-	600	600	1200	150
AF 100A-3L	70	100	-	600	500	1800	240
AF 400A-3L	280	400	-	1200	800	2100	870
AF 60A-4Lx2	40	60	120	600	500	1800	325
AF 100A-4Lx1	70	100	100	800	500	2000	350

HV Capacitor Bank

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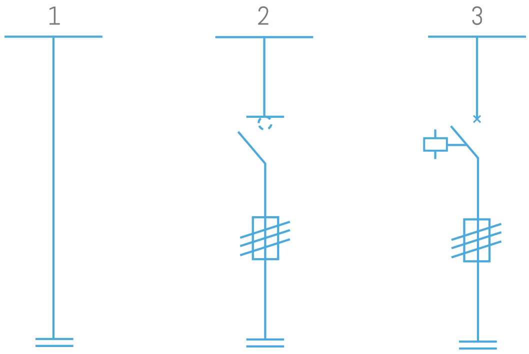
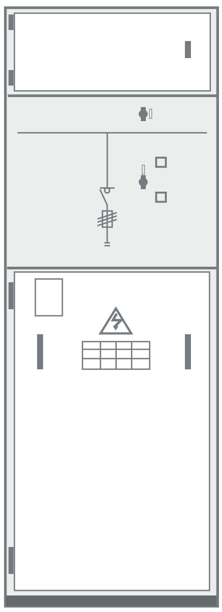
HV Capacitor Bank High Voltage





D 1 Enclosed Capacitor & Filter Banks

Power factor correction systems, especially automatic ones, have increased their presence in the power utilities, large industrial and commercial consumer environments during the last years. The main reason behind this increase is the need to maintain voltage at acceptable levels and to compensate reactive power to reduce losses in medium voltage distribution systems.

Enclosed capacitor banks are used for power factor correction, voltage support, harmonic suppression and to maximize network capacity in industrial applications and distribution systems. They supply individual, group or central reactive power compensation of fluctuating loads in three-phase networks from 3 kV up to 17,5 kV.

Different cubicle types and star/double star connections can be designed according to the necessity.

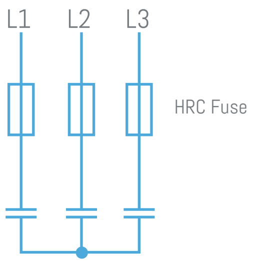
1- Capacitor bank can be used near the switching cubicle which includes circuit-breaker, disconnector or load break switch, connected with cable or busbar to that cubicle.

2- Capacitor bank can be used with a cubicle which protected by a HV fuse and disconnector/load break switch

3- Capacitor Bank can be used with a cubicle protected by a HV fuse and switched a contactor.

General Features;

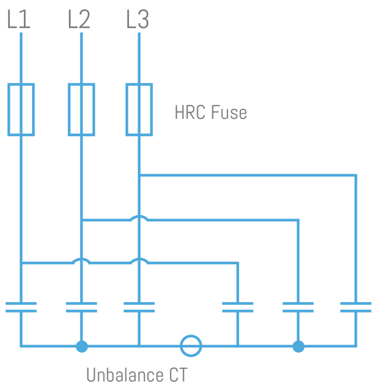
- Modular, compact and robust design optimised for easy future expansion of the system, facilitating transport, storage an installation.
- Galvanised steel enclosures available for indoor and outdoor installations, with different ventilation systems.
- Protection class ranges from IP30 to IP54.
- Design and testing complies with the requirements of the latest edition of relevant standards and the specific technical requirements set by the customers.
- Use of simplified design and proven components ensures high reliability and low maintenance costs.
- Several communication protocols and the possibility of using arc sensors available in protection relays.
- Optimised to give a low environmental load by using recycled materials.
- The banks are supplied as fully assembled units, factory tested and ready for connection.



Star Connection

This type of connection is used for the low-power capacitor banks up to 12 kV nominal voltage.

Mostly, these banks are designed for fixed compensation of HV motors. Capacitors can be chosen three-phase or single-phase according to designing network voltage and rated power.



Double Star Connection

Double star connection is the best solution for the whole voltage and power levels of capacitor banks. (here, single phase capacitors are chosen to the phase-neutral voltage of the system)

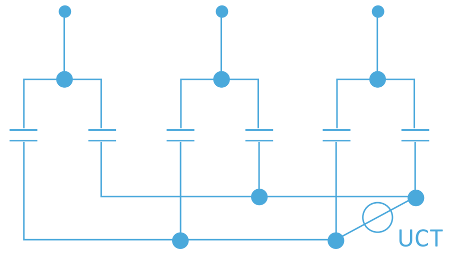
The current between two neutral points is shown continuously by an unbalance protection system (ct and relay) and if there is an internal fault on a capacitor unit, capacitor bank will switched off automatically.

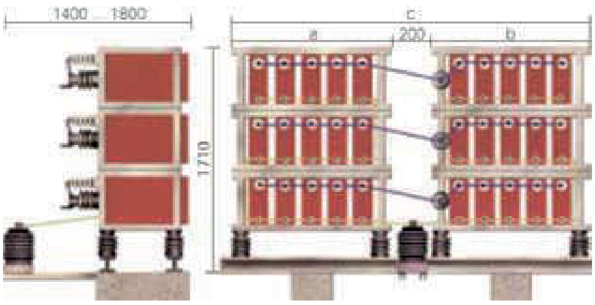
Technical Specification;

	MD series	ME series	MEC series	MDA series	MECA series
Description	Capacitor Bank	Capacitor Bank with Fuse Disconnector	Capacitor Bank with Fuse & Load Break switch	Capacitor Bank with Damping or Filter Reactors	Capacitor Bank with Damping or Filter Reactors
Rated Voltage	3 - 17.5 kV				
Rated Frequency	50/60 Hz				
Rated Power	50 - 1200 kVAr			50 - 2000 kVAr	
Number Steps				1 - 12 steps	
Capacitance Tolerance	-%5...+%10				
Insulation Level	20/70 kV				
Over Voltage	1.1 x In				
Continuously Over Current	1.3 x In				
Type of Banks	Fixed			Automatic	
Step Control	-			Yes	
Switching Device	-	Disconnector	Disconnector	-	VC / VCB / SF6 CB
Electrical Protection	With Internal Fuse inside Capacitors and/or external HV Fuse	With Internal Fuse inside Capacitors and/or external HV Fuse	With Internal Fuse inside Capacitors and external HV Fuse	With Internal Fuse inside Capacitors	With Internal Fuse inside Capacitors and external HV Fuse
Mounting	Indoor or Outdoor				
Protection Degree	IP30...IP54				
Standard Color	RAL 7035 / RAL 9003				
Cooling	Natural or Forced				
Condensation Protection	Thermostat controlled cell heater				
Main Incoming	Cable			Cable or Busbar	
Main Incoming Side	Bottom			Bottom or Side	
Environmental Temperature	-10 ... +45 °C				
Relative Humidity	< %90				
Standards	IEC 60871-1, IEC 62271-200				

D 2 Open-Type Capacitor & Filter Banks

High voltage capacitor banks are built up from high voltage, all-film dielectric capacitor units with separate internal fuses for each element. The impregnation liquid is both non-PCB and non-chlorine, and the individual units are fully sealed in welded weather resistant stainless steel cases (AISI 409). The cases are also given a protective coating of paint selected according to conditions at the installation site. The frame is constructed of either weather resistant aluminum or hot dip galvanized steel This ensures that capacitor banks will withstand any weather conditions.

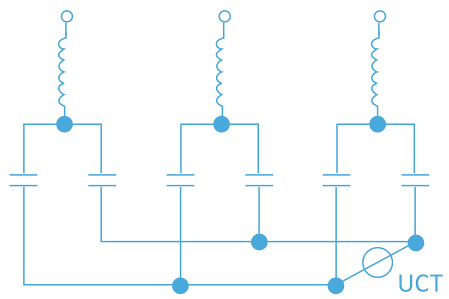


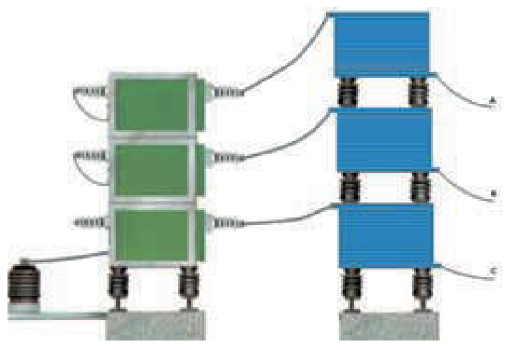


Capacitor units/phase 1 in series n+m in parallel.

General Features;

- Modular, compact and robust design optimised for easy future expansion of the system, facilitating transport, storage and installation.
- Galvanized steel or aliminum open type construction available for indoor and outdoor installations.
- Protection class IP00.
- Design and testing complies with the requirements of the latest edition of relevant standards and the specific technical requirements set by the customers.
- Use of simplified design and proven components ensures high reliability and low maintenance costs.
- Several communication protocols and the possibility of using arc sensors available in protection relays.
- Optimized to give a low environmental load by using recycled materials.
- The banks are supplied as fully assembled units, factory tested and ready for connection.





Number of units	In parallel (n+m)	Dimensions (mm)		
		A	B	C
12	2+2	435	435	1070
15	2+3	805	805	1440
18	3+3	805	805	1810
21	3+4	1000	1000	2005
24	4+4	1000	1000	2200
27	4+5	1195	1195	2395
30	5+5	1195	1195	2590
36	6+6	1390	1390	2980
42	7+7	1465	1465	3130

D 3 Static VAR Compensators (SVC)

Nowadays, the quality of the electricity supply is becoming more important due to the use of sophisticated computer controlled systems. This has been recognised by the electrical utilities, which penalise user for disturbances.

The Static VAR Compensator (SVC) is designed to decrease disturbances caused by changes in reactive power and voltage fluctuations in the normal operation of transmission lines and industry distribution systems. Disturbances may be caused by line switching, line faults, non-linear components such as thyristor controls and rapidly varying active or reactive loads. A typical source for these kind of disturbances are electric arc furnaces and rolling mills. These disturbances result in harmonics that load the supply network and cause voltage fluctuations. Varying loads can also create disturbances in the form of phase unbalance and voltage flicker phenomenon as well as create a need for additional reactive power.

SVC is the best solution for the high voltage plants which have these type of distrubances. Thanks to SVC, reactive power compensation and voltage stabilization are provided and harmonic distortion and flicker level are reduced below the standards. Other advantages are energy saving and shorten production period.

D 3.1 Functional Benefits of Static VAR Compensator

D 3.1.1 Flicker Reduction

Rapidly varying reactive power causes voltage fluctuations at the point of common coupling of a steel plant. The human eye perceives this frequency of voltage fluctuations as flickering lights. SVC can reduce the voltage fluctuations, thanks to this, reduce the flicker effect.

D 3.1.2 Voltage Stabilization

Electrical Arc Furnace (EAF) operations can be intensely unbalanced especially in the beginning of the melting process. The three-phase induction motors suffer due to the unbalanced voltage supply. The unbalanced voltage causes reduced efficiency, overheating, noise, torque pulses and speed pulses to motor operations. The SVC operates in single-phase control mode, thus balancing the voltage.

D 3.1.3 Reactive Power Compensation

Transmission of reactive power leads to significant voltage drops and current increases in the networks, which limits the transmission capacity of active power. Public utilities maximise their transmission line capacities by advising their customers to utilise local reactive power compensation.

The Static VAR Compensator maintains the demand of reactive power within the limits set by utilities, thus avoiding penalties.

D 3.1.4 Reduction of harmonics

Non-linear loads, like Electrical Arc Furnaces, generate harmonic currents. The harmonic currents load the network and lead to voltage distortions. Distorted voltage may cause malfunctions in sensitive computerised devices or process control equipment. The filter circuit of the SVC system is designed to absorb harmonics generated by loads as well as by Thyristor Controlled Reactors (TCR). The total harmonic distortion (THD) and individual harmonic voltages are limited below specified levels.

D 3.2 Economical Benefits of Static VAR Compensator

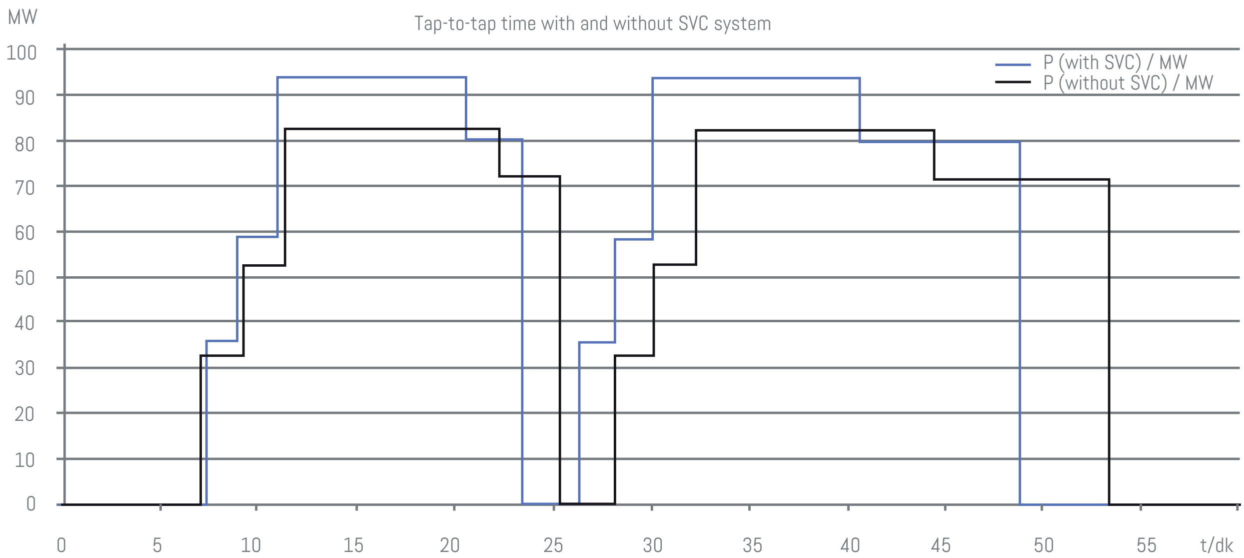
D 3.2.1 Energy savings

Compensation and improving the quality of power increases the capacity of active power transmission and reduces energy consumption. Thus, the unnecessary overload of the power network can be avoided. Both your company and the environment benefit from the more efficient use of electricity and saving in the consumption of energy.

D 3.2.2 Increase in productivity

The SVC system can keep a steel plant bus voltage practically at a constant level. This decreases the steel processing time and thus increases productivity. The SVC system also reduces production breaks and expensive restart procedures. The arc furnace, stabilised by the SVC, also has a considerable positive effect on the consumption of electrodes, heat losses and the lifetime of the furnace's inside lining. As the improved quality of power from the network reduces the stress on equipment, its lifespan increases, thus lowering the maintenance and replacement costs.

The figure shows the influence of the shortened tap-to-tap time as increased steel production. The melting time of the changes decreased from 53 minutes to 48 minutes once the SVC was installed. This is a 9.4% reduction of one heat time - the total increase of the productivity can be transferred to the steel tons via saved time for each heat.



Auxiliary Equipment

E

E

Auxiliary Equipment

E 1 Capacitor Units

E 1.1 Resin type Capacitors

Asset VCB series patented capacitors are totally dry units with no impregnation or insulation liquid.

They are designed by assembling individual single-phase coils, coupled in a delta arrangement to obtain a three-phase unit.

The coils are produced from two films of polypropylene with zinc plating on one side:

- The metal plating forms the electrode.
- The polypropylene film forms the insulator.

All coils are then coated under vacuum into self-extinguishing thermoset polyurethane resin which forms the casing, providing mechanical and electrical protections.

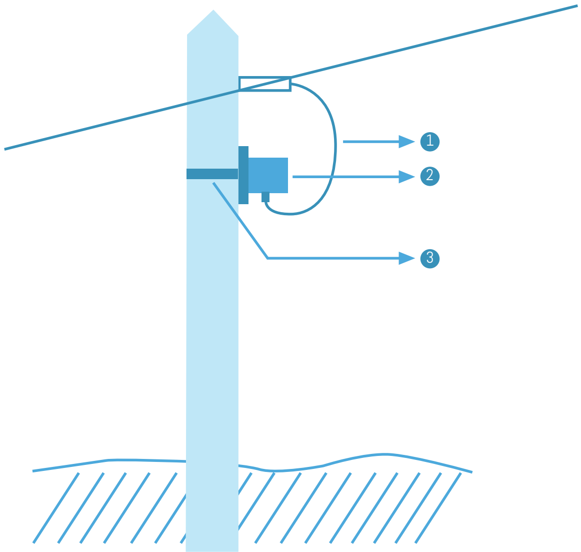
Unique vacuum potting technique ensures that Asset VCB series capacitors have excellent resistance over time and much longer service life than conventional units.

Vacuum potting ensures that no air or humidity remains close to the coils after coating. This design provides excellent resistance to over voltages and partial discharges.

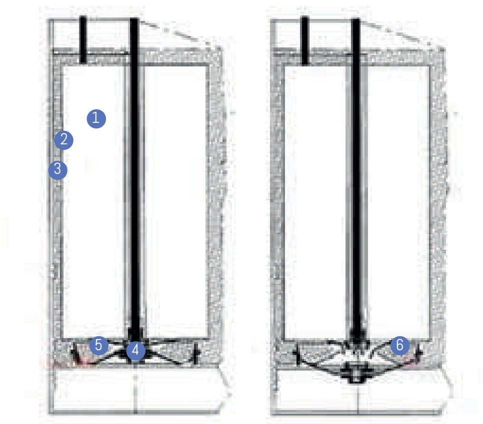
Furthermore, the unit complies fully with environmental protection requirements (non PCB). No insulation or impregnation liquid is used in the Asset VCB series capacitor.

Presentation;

Monobloc or modular, Asset VCB series capacitors meet all user requirements. The modular version in particular can be quickly and easily assembled to produce units with various power ratings, enabling integrators and distributors to make significant savings on storage costs.



1. Integrated connection table
2. Asset VCB series
3. Asset VCB series attachment support



1. Self-healing dielectric polypropylene film
2. Resin coated under vacuum
3. Plastic case (VOUL 94)
4. Electrical fuse
5. Over pressure disconnecting device (CLOSED)
6. Over pressure disconnecting device (OPEN)

Installation;

The compact format simplifies installation and significantly reduces cubicle or rack costs. The casing is particularly resistant to all solvents and atmospheric agents (rain, sun, salty air, etc.).

Asset VCB series capacitors are thus particularly suitable for installations:

- Outdoors (on poles)
- In a corrosive atmosphere

Conection;

- The terminal blocks are easily accessible on the top of the unit, making Asset VCB series capacitors particularly easy to connect
- The use of socket-type terminals enables cable and eye connections to be made directly to the unit's various ranges

Asset VCB series capacitors are double-insulated or class 2 units, which do not need earthing.

Internal Protection

Self-healing dielectric:
This is a result of the characteristics of the metal deposit which forms the electrode and the nature of the insulating support (polypropylene film).

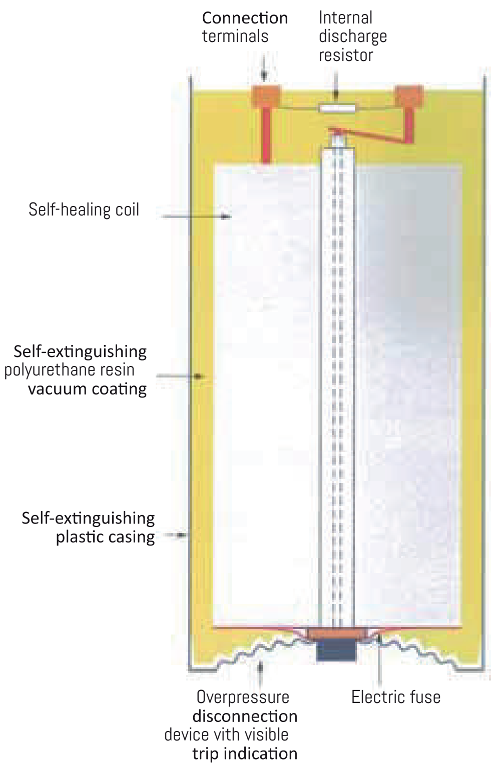
This special manufacturing technique avoids blowing the capacitor due to overvoltages. The dielectric is perforated when overvoltage occurs, causing discharges which vaporize the metal around the short circuit and instantaneously restore electrical insulation

Electrical fuse: One per coil

Over pressure disconnecting device:

If an electrical fault cannot be overcome by the self-healing dielectric or the electrical fuse, gas is emitted, deforming a membrane and taking the defective coil out of the circuit.

These three protection mechanisms, associated with the under vacuum coated coils form a highly advanced unit.



Discharge Resistors

The discharge resistors enable the unit to be discharged in compliance with applicable standards. They are fitted externally on the connection terminals to enable visual inspection.

Loss Factor

Asset VCB series capacitors have a loss factor of less than 0,1 x 10-3. This leads to a total wattage consumption of less than 0.3 W per kvar including the discharge resistors.

Capacitance

Tolerance on the capacitance value is ± 5%. Our manufacturing process, which avoids any air inclusions in the coils, ensures that the capacitance remains exceptionally stable throughout the service life of the Asset VCB series capacitor.

Max. permissible voltage

- 1.18 Un continuous (24 h/24)

Max. Permissible Current (continuously)

- Standard Type : 1.5 In
- H Type : 2 In

Insulation Class

- Withstand 1 minute at 50 Hz: 6 kV
- Withstand 1.2/50 µs shock wave: 25 kV

Standards

Asset VCB series capacitors comply with the following standards:

- French standard: NF C54 108 and 109
- European standard: EN 60831-1 and 2
- International standard: IEC 60831-1 and 2
- Canadian standard: CSA 22-2 No. 190
- US standard: UL 810
- End-of-life behaviour tests passed successfully in EDF and LCIE laboratories

Temperature Class

Asset VCB series capacitors are designed for a standard temperature rating of -40 / +55°C

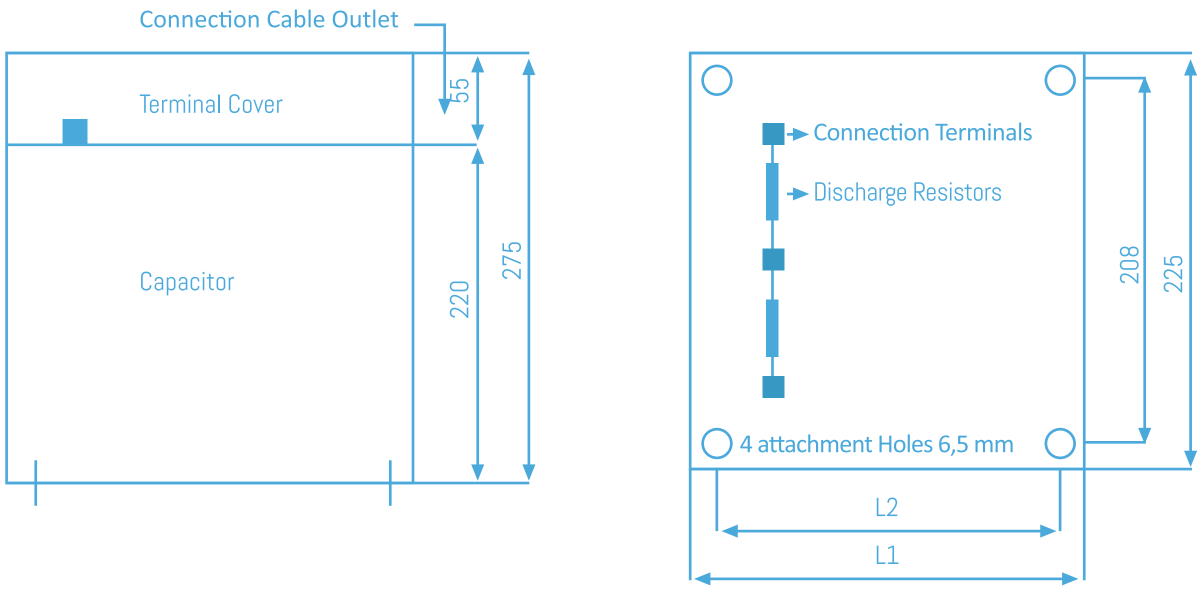
- Maximum temperature : 55°C
- Average over 24 hours : 45°C
- Annual average : 35°C
- Other temperature classes on request

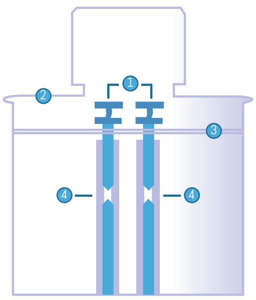
Nominal voltage 415 V, 50/60 Hz, 3-phase

Nominal power (kVAr)	Dimensions (mm)			
	Reference	Without Cover (WxLxH)	With Cover (WxLxH)	Weight (kg)
6,25	VCB 06415	90x225x225	90x225x275	3,5
12,5	VCB 12415	90x225x225	90x225x275	3,5
25	VCB 25415	90x225x225	90x225x275	3,5
50	VCB 50415	180x225x225	180x225x275	7
75	VCB 75415	270x225x225	270x225x275	10,5
100	VCB 100415	360x225x225	360x225x275	14

Nominal voltage 440 V, 50/60 Hz, 3-phase

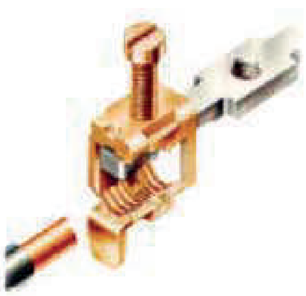
Nominal power (kVAr)	Dimensions (mm)			
	Reference	Without Cover (WxLxH)	With Cover (WxLxH)	Weight (kg)
6,25	VCB 0644	90x225x225	90x225x275	3,5
12,5	VCB 1244	90x225x225	90x225x275	3,5
25	VCB 2544	90x225x225	90x225x275	3,5
50	VCB 5044	180x225x225	180x225x275	7
75	VCB 7544	270x225x225	270x225x275	10,5
100	VCB 10044	360x225x225	360x225x275	14





Three cascade pressurize process

1. Over current
2. Expansion
3. Without impress
4. Over Pressure



Strong connection terminals

E 1.2 Aluminium Can Capacitors

Asset LTC series capacitors are new excellent design in cylindrical aluminum capacitors, designed for power factor correction at low voltage system.

Asset LTC series capacitors are designed to minimize the initial costs and mounting periods.

Applications;

- Automatic power factor correction(PFC) and capacitor banks
- Fixed power factor corrections individual (e.g.motor, transformers, lighting, etc)
- Group fixed power factor correction (several equipments connected in a group)
- Capacitor banks of tuned and detuned.
- Harmonic trap applications

Features;

- Dry technology
- Non-flammable
- Touch-proof terminals
- Maintenance-free
- Easy disposal
- Reduced mounting cost
- Excellent self -healing
- Internal discharge
- Environmentally friendly

Long useful life;

It is extended the useful life 100,000.00 operation hours, thanks to the technology of high vacuum & inrush current tests and special production process control.

Quintuple safety system;

- Dry technology

Instead of a liquid impregnating agent like oil or PCB, the capacitor is filled with gas or gas mixed with the dry resin. Non SF design for ecologically sensitive applications.

- Self-healing

The capacitor repairs itself after overload

- Overpressure disconnector

It prevents the capacitors to burst due to the end of its useful life or electrical and/or thermal overload or harmonics.

- One form capacitor cane and three cascade cylinder sealing, no possibility for leaks

- Reliable double terminals connection technology with benefits like

Clamping device to prevent loosening of screws, Internal discharge system for extra reliability and safety.

Another advantage of this design is to reduce the time for discharging in addition with very low resistor losses and minimum safety space for installing the capacitor.

Technical Specification;	
Over voltage	1.1U_n / 8 h daily, 1.15 U_n / 30 min daily, 1.3 U_n / 1 min
Over current	1.3 x I_n
Inrush current	200 x I_n
Losses	≤ 0.25 W/kVAr
Tolerance	±5%
Test Voltage (Terminal/Terminal)	2.15 U_n, 10 sec
Test Voltage (Terminal/Case)	U_n ≤ 660 V : 3000 V_{ac} / 10 sec U_n > 660 V : 6000 V_{ac} / 10 sec
Useful Life	100000 hours
Temperature	-25...+55 ^{0}C
Cooling	Natural or forced
Humidity	Max. 95%
Altitude	≤1000m
Mounting	Random
Install	M12 mm stud on bottom of case
Safety	New dry technology, self-healing, overpressure and over current disconnector protection
Discharge	Included (internal discharge resistor system)
Case	Extruded aluminum cases
Protection	IP20 (optionally with lid for outdoor of IP54)
Dielectric	Metallized polypropylene film
Impregnation	Protection gas, resin or resin mixed with the protection gas
Terminals	Dual three - way terminal, max. 32mm ^{2} cable
Standard	IEC 60831-1,2, EN60831-1,2, VDE0560-46,47, GB12747-91, CE

Nominal voltage 415 V, 50/60 Hz, 3-phase

Nominal power (kVAr)	Reference	Dimensions (mm) (Diameter x Height)	Weight (kg)
1	LTC 3-1/415	76 x 160	0,65
1,5	LTC 3-1,5/415	76 x 160	0,65
2,5	LTC 3-2,5/415	76 x 160	0,65
5	LTC 3-5/415	86 x 230	0,95
7,5	LTC 3-7,5/415	86 x 230	0,95
10	LTC 3-10/415	86 x 290	1,50
12,5	LTC 3-12,5/415	86 x 290	1,50
15	LTC 3-15/415	86 x 310	1,50
20	LTC 3-20/415	116 x 310	3,00
25	LTC 3-25/415	116 x 310	3,20
30	LTC 3-30/415	116 x 360	3,40

Nominal voltage 440 V, 50/60 Hz, 3-phase

Nominal power (kVAr)	Reference	Dimensions (mm) (Diameter x Height)	Weight (kg)
1	LTC 3-1/440	76 x 160	0,65
1,5	LTC 3-1,5/440	76 x 160	0,65
2,5	LTC 3-2,5/440	76 x 160	0,65
5	LTC 3-5/440	86 x 230	0,95
7,5	LTC 3-7,5/440	86 x 230	0,95
10	LTC 3-10/440	86 x 290	1,50
12,5	LTC 3-12,5/440	86 x 290	1,50
15	LTC 3-15/440	86 x 310	1,50
20	LTC 3-20/440	116 x 310	2,40
25	LTC 3-25/440	116 x 310	2,50
30	LTC 3-30/440	116 x 360	2,90

E 1.3 Stainless Steel HV Capacitors

High voltage power capacitors are designed and manufactured by using latest technology and high quality materials. They have all-film dielectric and are impregnated with dielectric liquid which is biodegradable in environment. Each capacitor element has a separate internal fuse. In addition, each capacitor is provided with an internal discharge resistor.

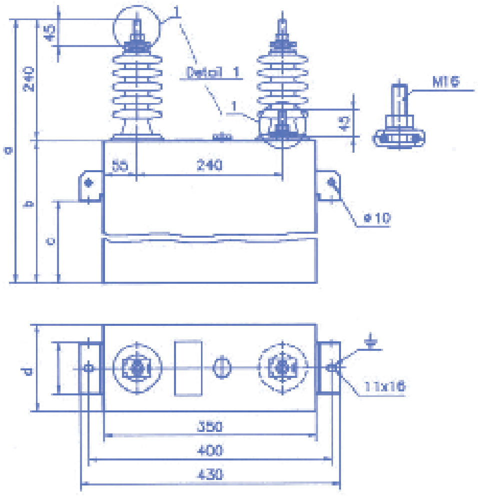
All capacitors have low losses, and are constructed to be light in weight. The high voltage power capacitors comply with most national and international capacitor standards.

Dielectric Liquid;

The dielectric liquid is specially made for power capacitors and it is chosen because of its excellent electrical properties and heat stability at both lower and elevated temperatures. It is non-pcb, non-chlorine and biodegradable.

- The capacitor units are equipped with weld type porcelain bushings.
- Capacitor containers are made of stainless steel and painted with suitable primer coat prior to finishing coat to ensure prolonged durability.
- Capacitors for specific purposes can be designed and manufactured to meet customers' requirements.
- Fuseless/External fuse on request.
- Internal discharge resistor.

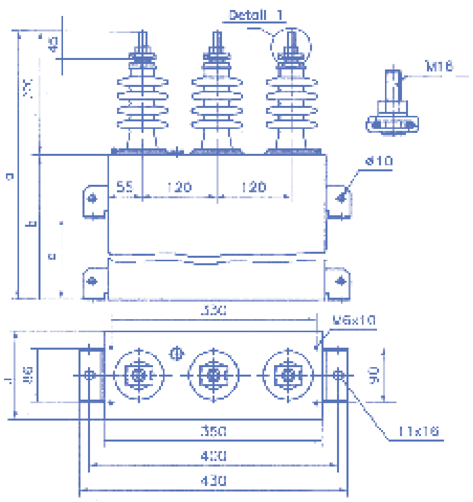
Technical Specification;	Single Phase	Three Phase
Type	Impregnated all-film dielectric	
Rated frequency	50/60 Hz	
Average losses	0.08...0.15 W/kVAr	
Dielectric liquid	non-pcb	
All-film dielectric	polypropylene	
Temperature category	-40...+55°C	
Standards to be applied	IEC, BS, IEC 60871-1 ANSI/IEEE, CSA	
Standard color	grey (RAL 7035)	
Standard bushings	125 kV BIL Creep 380 mm 150 kV BIL Creep 620 mm 200 kV BIL Creep 820 mm	
Power range	100...1000 kVAr	
Voltage range (with internal fuses)	1000...14000 V	1000...8000 V
(without internal fuses)	above 14000 V	above 8000 V



E 1.3.1 Single-Phase Capacitors

Standard types (≤ 8000 V, 50/60 Hz)

Type	Nominal Power (kVAr)	Dimension (mm)				Weight (kg)
		A	B	C	D	
PILP	100	640	400	300	145	31
PILP	200	780	540	440	145	40
PILP	300	880	640	540	145	47
PILP	400	960	740	640	145	53
TILP	500	860	620	520	200	63
TILP	600	960	720	620	200	71
TILP	700	1080	840	740	200	81
TILP	800	1180	940	840	200	89



E 1.3.2 Three-Phase Capacitors

Standard types (3300 -7200 V, 50/60 Hz)

Type	Nominal Power (kVAr)	Dimension (mm)				Weight (kg)
		A	B	C	D	
QYLP	50	500	280	180	145	28
QYLP	75	520	300	200	145	29
QYLP	100	580	360	260	145	33
QYLP	150	680	460	360	145	39
QYLP	200	800	580	480	145	47
QYLP	250	920	700	600	145	55
QYLP	300	1040	820	720	145	63
QYLP	350	1140	920	820	145	69
QYLP	400	1200	980	880	145	73
HYLP	450	1000	780	680	200	80
HYLP	500	1080	860	760	200	87
HYLP	550	1140	920	820	200	92
HYLP	600	1220	1000	900	200	98

E 2 Filter Units

E 2.1 Iron Core Filter Reactors

The high level of harmonic pollution in the enterprises, the user may be faced with two requirements;

- Compensating for reactive energy and protecting the capacitors
- Reducing the voltage distortion rate to acceptable values compatible with the correct operation of most sensitive receivers (automatic control systems, industrial computer hardware, capacitors, etc.).

Asset iron core filter reactors have been designed for answer these needs. Thus, it is possible to compensate the reactive power with reducing the harmonics and protecting the capacitors at the same time.

Asset iron core filter reactors covers the entire spectrum of single & three phase iron reactors for detuning and tuning harmonic filter applications.

Asset iron core filter reactors are produced with aluminum sheet winding with copper bar terminals. Solid copper bar terminals are secured to the aluminum by a low resistance cold pressure welding method. Thanks to computer designed PolyGapTM cores, asset filter reactors operates with constant inductance over a wide range of current and frequency. The complete assembly has been impregnated by using a sophisticated vacuum-pressure impregnation process for achieving minimum losses and reducing noise dissipation.

Advantages;

Asset iron core filter reactors are manufactured in accordance with IEC standards and tested & delivered as operative with all power connections completed.

- Easy installation to all kind of panels
- High resistance and long life
- Fast delivery and reasonable price

Technical Specification;	
Type	Single or Three Phase, Magnetic Core
Rated System Voltage	200 - 1000V
Rated Frequency	50/60 Hz
Over Current	1.35 I_n Continuosly
Linearity Current	2.35 I_n
P %	4 % ... 14 %
Inductance Tolerance	Max. 3 %
Insulation Level	3 kV / 1 min.
Temperature Category	-10...+45 °C
Storing Temperature	30...+65 °C
Loses	< 3.5 W / kVAr, 115°C
Standards to be applied	EN 60289, VDE 0550, VDE 0551

E 2.2 Air Core Filter Reactors

Because of the growing harmonic distortion and pollution of the electrical power networks, in particular in those areas with high concentration of industrial facilities, reactive power compensation equipment may experience voltage and current harmonics over load which will ultimately result in capacitor failures and can no longer be used with acceptable life expectancy unless it is protected by detuning & tuning reactors.

Air core filter reactors have two functions, namely to produce capacitive reactive power at basic frequency and to filter out harmonics. Asset high voltage filter reactors are designed to have small impedance between phase and earth, or between the phases at required harmonic frequency. Therefore the harmonic current will flow into the filter and not into the network. Normally each harmonic frequency required has a separate filter circuit. For higher harmonic frequencies, a wide-band filter is used.

Advantages;

Air core filter reactors are manufactured in accordance with IEC standards and tested & delivered as operative with all power connections completed.

- Easy installation
- High resistance and long life
- Fast delivery and reasonable price

Technical Specification;	
Type	Single or Three Phase
Design	Air core
Rated System Voltage	3.3 - 154 kV
Rated Frequency	50/60 Hz
Over Current	1.35 I_n Continuously
Linearity Current	2.35 I_n / Magnetic Core, Non Saturation / Air core
Inductance Tolerance	Max. 3 %
Insulation Level	Due to the standard of corresponding system voltage
Temperature Category	-10 ... +45 °C
Storing Temperature	-30 ... +65 °C
Standards to be applied	EN 60289, VDE 0550, VDE 0551

ALLSAI
Innovating Power

E 3 Rack Units

E 3.1 P5 series Rack Unit

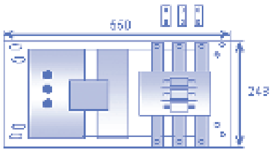
P5 series compensation racks allow the users to create various level combinations with their own boards due to its modular design.

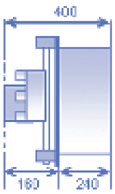
Thanks to high technology Asset VCB series capacitors, resist and operate continuously up to 490 V thanks to 18% over voltage and 50% over current, thus ensures safety of entire equipments in the system.

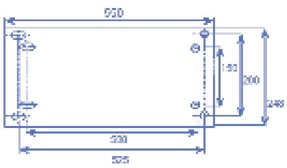
Advantages;

P5 series compensation racks are manufactured in accordance with IEC standards and tested & delivered as operative with all power connections completed.

- Easy installation to all kind of panels
- Labor ant time saving
- No additional material is required
- High level protection against to touching
- High resistance and long life
- Possibility to increase power by additional racks
- Fast delivery and competetive prices



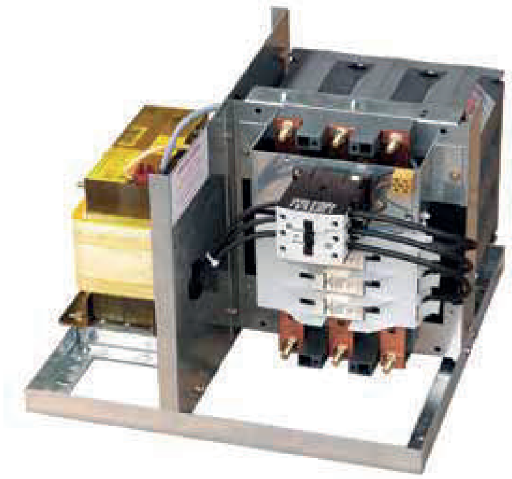


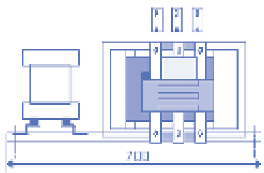


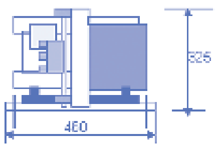
Technical Specification;	
Rated Voltage	415 V
Rated Frequency	50/60 Hz
Over Voltage	1.18 U_n Continuously
Over Current	1.5 I_n Continuously
Temperature Category	-10 ... +45 °C
Storing Temperature	30 ... +65 °C
Standards to be applied	EN 60429 - 1, IEC 60439 - 1, 2

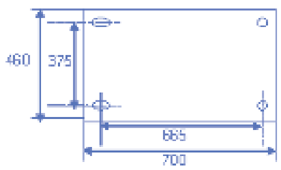
Standard types (415 V, 50/60 Hz)

Nominal Power (kvar)	Reference	Number of Steps	Weight (kg)
6,25	P5-06141	1	5
2x6,25	P5-06241	2	10
12,5	P5-12141	1	6
2x12,5	P5-12241	2	11
25	P5-25141	1	9
2x25	P5-25241	2	16
50	P5-50141	1	16
2x50	P5-50241	2	24









E 3.2 R7 series Rack Unit with Detuned Reactor

R7 series compensation racks with detuned reactor allow the users to create various level combinations with their own boards due to its modular design.

Thanks to high technology Asset VBC series capacitors and Asset low voltage filter reactors, resist and operate continuously up to 520 V thanks to 18% over voltage and 50% over current and reduce the harmonics and transient current, thus ensures safety of entire equipments in the system.

Advantages;

R7 series compensation racks are manufactured in accordance with IEC standards and tested & delivered as operative with all power connections completed.

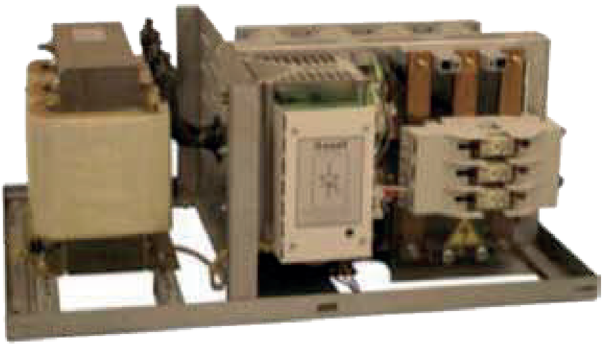
- Easy installation to all kind of panels
- Labor ant time saving
- No additional material is required
- High level protection against to touching
- High resistance and long life
- Possibility to increase power by additional racks
- Fast delivery and competetive prices

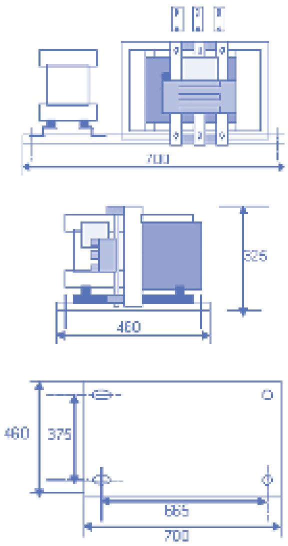
Technical Specification;	
Rated Voltage	440 V
Rated Frequency	50/60 Hz
Resonance Frequency	189 Hz, 210 Hz, 215 Hz
Over Voltage	1.18 U_n Continuously
Over Current	1.5 I_n Continuously
Temperature Category	-10 ... +45 °C
Storing Temperature	30 ... +65 °C
Standards to be applied	EN 60429 - 1, IEC 60439 - 1, 2

Standard types (440 V, 50/60 Hz)

Nominal Power (kvar)	Reference	Number of Steps	Weight (kg)
6,25	R7-06144	1	20
12,5	R7-12144	1	30
2x12,5	R7-12244	2	35
25	R7-25144	1	35
2x25	R7-25244	2	45
50	R7-50144	1	50
2x50	R7-50244	2	60
100	R7-10044	1	80

E 3.3 R7s series Static Switched Rack Unit with Detuned Reactor





Main difference of conventional compensation racks and static switched real-time automatic compensation racks is that “static switches” (thyristors) is used instead of “contactor” in static switched real time compensation racks.

R7s series capacitor banks with detuned harmonic filter, are the real time compensation racks for low voltage systems that use Asset ThyMod static switching modules. As a result of R7s series racks have harmonic filter reactors, they are able to filter the harmonics that are result of loads and instant load changes without any resonance risk.

R7s series have been developed to balance the reactive power and solve the energy quality problems in complex industrial plants where used devices that are sensitive to voltage changes such as PLCs, industrial computers, industrial robots, welding machines.

Thanks to VCB series capacitors that can operate continously 18% over voltage and 50% over current, system could bear the over volatges and over currents and can protect the equipment.

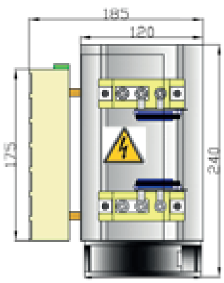
R7s compensation racks are produced and tested according to IEC standards. Products are forwarded as ready to be used, after all the connections made.

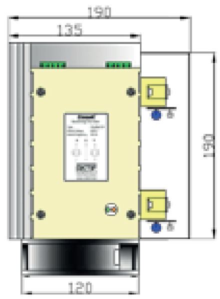
- Easy installation to all kind of panels
- Labor ant time saving
- No additional material is required
- High level protection against to touching
- High resistance and long life
- Possibility to increase power by additional racks
- Fast delivery and competetive prices

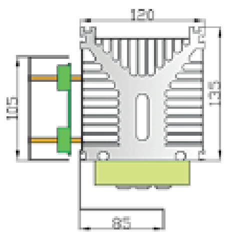
Technical Specification;	
Rated Voltage	440 V
Rated Frequency	50/60 Hz
Resonance Frequency	189 Hz, 210 Hz, 215 Hz
Over Voltage	1.18 U_n Continuously
Over Current	1.5 I_n Continuously
Temperature Category	-10 ... +45 °C
Storing Temperature	30 ... +65 °C
Standards to be applied	EN 60429 - 1, IEC 60439 - 1, 2

Standard types (440 V, 50/60 Hz)

Nominal Power (kvar)	Reference	Number of Steps	Weight (kg)
6,25	R7s-06144	1	15
12,5	R7s-12144	1	25
25	R7s-25144	1	30
50	R7s-50144	1	45
100	R7s-10044	1	75







E 3.4 ThyMod series Static Electronic Contactors

ThyMod series Static Electronic Contactors are the electronic switching units that used for switching the capacitor banks without any discharge delay in the plants that switching the capacitor banks according to load changement cannot be possible.

ThyMod series Static Electronic Contactors have been developed according to the related IEC standards to balance the reactive power and solve the energy quality problems in complex industrial plants where used devices that are sensitive to voltage changes such as PLCs, industrial computers, industrial robots, welding machines.

ThyMod series Static Electronic Contactors can switch the capacitor banks that controlled by these contactors, maximum in 20 ms. As a result of ThyMod series Static Electronic Contactors, transients which can be seen during switching of standart contactors, will not be seen.

The electronic card that controlls the switching of ThyMod Static Electronic Contactors, can also control the temperature of the aluminium cooler body where thyristor- diode groups are attached. In addition these cards are able to check the network voltage, dc charge voltage through the capacitor, switching of the thyristor- diode groups continously and in case of any fault, they can produce visual alarms and stop the switching process.

- Easy installation to all kind of panels
- Labor ant time saving
- No additional material is required
- High level protection against to touching
- High resistance and long life
- Fast delivery and competetive prices

Technical Specification;	
Rated Voltage	440 V
Rated Frequency	50/60 Hz
Resonance Frequency	189 Hz, 210 Hz, 215 Hz
Over Voltage	1.18 U_n Continuously
Over Current	1.5 I_n Continuously
Temperature Category	-10 ... +45 °C
Storing Temperature	30 ... +65 °C
Standards to be applied	EN 60429 - 1, IEC 60439 - 1, 2

Standard types (440 V, 50/60 Hz)

Nominal Power (kvar)	Reference	Number of Steps	Weight (kg)
Up to 50 kVAr	ThyMod -50	1	3.5
Up to 100 kVAr	ThyMod -100	1	3.6

ALLSAI POWER QUALITY

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ACERCA DE ALLSAI

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Actualmente contamos con un amplio portafolio de soluciones que agrega valor al negocio de nuestros clientes, logrando posicionar nuestra marca en toda la región con un sello de calidad y respaldo que hace la diferencia.