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CATALOGUE

POWER FACTOR CORRECTION
INTERNATIONAL VERSION

ALPES TECHNOLOGIES

ALPES TECHNOLOGIES

CONDITIONS OF SALE
See our current tariffs and price lists.
The information given in this catalogue (technical characteristics, dimensions, diagrams, photos) are for guidance and cannot be held binding on the Company.

POWER FACTOR CORRECTION

An AC electrical installation incorporating receivers such as transformers, motors, fluorescent tube ballasts or any other receivers whose current is phase-shifted in relation to the voltage, consumes reactive energy.

This reactive energy (expressed in kilovar-hours – kVArh) is billed in the same way as active energy by energy suppliers. Reactive energy therefore results in more power being used and thus contributes to higher electricity bills.

POWER FACTOR

By definition, the power factor of an electrical installation (PF) is equal to the active power P (kW) over the apparent power S (kVA).

PF = P (kW)/S(kVA)

Usually PF ≃ Cos φ

A good power factor is:
- high cos φ (close to 1)
- or low tg φ (close to 0)

A power factor of 1 will result in no reactive energy consumption and vice versa.

Energy metering devices record active and reactive energy consumption. Electricity suppliers generally use the term tg φ on their bills.

Cos φ and tg φ are linked by the following equation:

$$\cos \varphi = \frac{1}{\sqrt{1 + (\operatorname{tg} \varphi)^2}}$$

+ Determining the capacitor power in kVAr, see p. 4

ADVANTAGES

By supplying reactive energy on demand, Alpes Technologies capacitor banks allow the subscriber to:

1. Increase the power available to the distribution transformers

EXAMPLE

For a 1000 kVAr transformer with cos φ = 0.75 and a 750 kW installation: by increasing the cos φ to 0.96 a further 210 kW can be gained (+28%).

Correlation between power factor/gain in available power

Level of power factor cos φ	Additional power available to the transformer
0.8	+7%
0.85	+13%
0.9	+20%
0.96	+28%
1	+33%

2. Limit energy losses in the cables by the Joule effect (limiting voltage drops) given the decrease in the current carried in the installation

EXAMPLE

For a 1000 kVA transformer with cos φ = 0.75 and a 750 kW installation: by increasing the cos φ to 0.96, we get a reduction in current of around 22%.

3. Achieve energy savings regardless of the type of electricity supplier contract.

- Installing a capacitor bank allows users to:
- **save energy**
- **avoid the penalties** applied by the electricity supplier or
- **optimise the electricity contract**

OPERATING PRINCIPLE

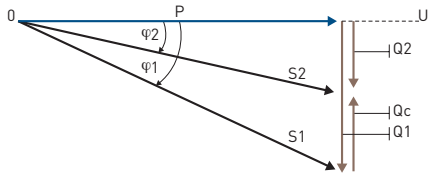
Capacitor banks can improve the power factor of an electrical installation by giving it a proportion of the reactive energy it consumes.

The capacitor is a receiver made up of two conductive parts (electrodes) separated by an insulator. When this receiver is subjected to a sinusoidal voltage, it shifts its current, and hence its power (capacitive reactive), by 90° ahead of the voltage.
Conversely, all other receivers (motors, transformers, etc) shift their reactive component (current or inductive reactive power) by 90° behind the voltage.

The vectorial composition of these currents or reactive powers (inductive and capacitive) gives a reactive resultant current or power below the value which existed before the capacitors were installed.

In simple terms, it is said that inductive receivers (motors, transformers, etc) consume reactive energy whereas capacitors (capacitive receivers) produce reactive energy.

Power diagram



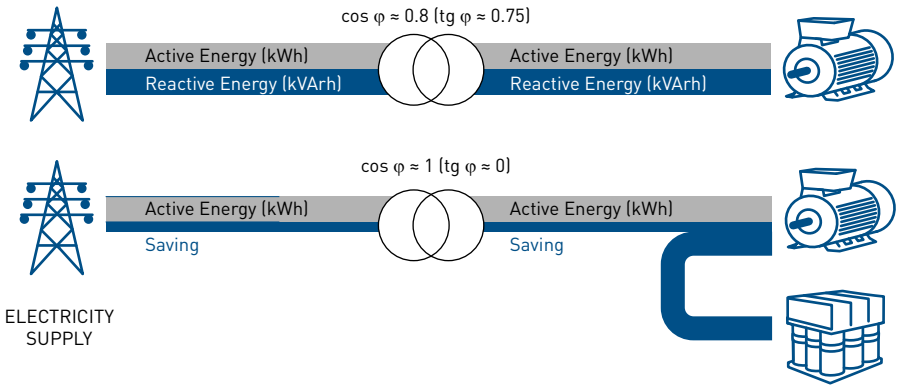
P: Active power
S1 and S2: apparent powers (before and after compensation)
Qc: capacitor reactive power
Q1: reactive power without capacitor
Q2: reactive power with capacitor

Equations

Q2 = Q1 - Qc
Qc = Q1 - Q2
Qc = P.tg φ 1 - P.tg φ 2

Qc = P(tg φ 1 - tg φ 2)

φ 1 phase shift without capacitor
φ 2 phase shift with capacitor



DETERMINING THE LV POWER FACTOR CORRECTION SOLUTION

In a low voltage electrical installation, determining the reactive energy compensation solution requires several stages such as :

STEP 1

Determining the capacitor power (kVAr) to compensate for the reactive energy required for the installation

see p.4

STEP 2

Determining the general configuration

see p.6

- Global compensation for the whole installation
- Compensation by sector
- Individual compensation in high power loads

STEP 3

Determining the compensation mode

see p.6

- Fixed compensation for stable load
- Automatic compensation for variable or unstable load
- Dynamic compensation for very unstable load

STEP 4

Determining the capacitor bank type according to the level of harmonics

see p.7

- Identify the level of harmonic pollution by Thdi–Thdu measurements or if necessary (eg: new installation) by estimating the percentage of "non-linear loads" (Sh/St).

SELECTION GUIDE
P. 8-9

STEP 1

DETERMINING THE CAPACITOR POWER IN KVAR

To determine the capacitor power (kVAr) to compensate for the reactive energy required for the installation, use one of the following methods:

- Measurement of the reactive power and Cos φ with measurement control units (such as those in IME's Nemo range) or with network analysers for complete diagnostics of the various phenomena ("Measurement" Audit). see p. 16
- Analysis of the electricity supplier's bills according to the subscription type (subscribed demand, reactive energy billed in kVArh and tg φ). see p. 77
- In the context of future installations, compensation is frequently required right from the commissioning stage. In this case, it is not possible to calculate the capacitor bank using conventional methods (electricity bill).

  For this type of installation, it is advisable to install a capacitor bank with approximately **25% of the nominal power of the corresponding MV/LV transformer.**

EXAMPLE

1000 kVA transformer, capacitor Q = 250 kVAr

NB: This type of ratio corresponds to the following operating conditions:
- 1000 kVA transformer
- Actual transformer load = 75%
- Cos φ of the load = 0.80 } k = 0.421
- Cos φ to be obtained = 0.95 } (see table on opposite page)

Qc = 1000 x 75% x 0.80 x 0.421 = 250 kVAr

- Estimated total amount of reactive energy needed for all loads in the installation, especially motors and transformers according to the manufacturer's data.

Initial power factor		Capacitor power to be installed, in kVAr per kW of load, to read the power factor at cos φ_2:										
cos φ_1	tg φ_1	cos φ_2:	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1
		tg φ_2:	0.48	0.46	0.43	0.40	0.36	0.33	0.29	0.25	0.20	0.14	0.0
0.40	2.29		1.805	1.832	1.861	1.895	1.924	1.959	1.998	2.037	2.085	2.146	2.288
0.41	2.22		1.742	1.769	1.798	1.831	1.840	1.896	1.935	1.973	2.021	2.082	2.225
0.42	2.16		1.681	1.709	1.738	1.771	1.800	1.836	1.874	1.913	1.961	2.002	2.164
0.43	2.10		1.624	1.651	1.680	1.713	1.742	1.778	1.816	1.855	1.903	1.964	2.107
0.44	2.04		1.558	1.585	1.614	1.647	1.677	1.712	1.751	1.790	1.837	1.899	2.041
0.45	1.98		1.501	1.532	1.561	1.592	1.626	1.659	1.695	1.737	1.784	1.846	1.988
0.46	1.93		1.446	1.473	1.502	1.533	1.567	1.600	1.636	1.677	1.725	1.786	1.929
0.47	1.88		1.397	1.425	1.454	1.485	1.519	1.532	1.588	1.629	1.677	1.758	1.881
0.48	1.83		1.343	1.730	1.400	1.430	1.464	1.467	1.534	1.575	1.623	1.684	1.826
0.49	1.78		1.297	1.326	1.355	1.386	1.420	1.453	1.489	1.530	1.578	1.639	1.782
0.50	1.73		1.248	1.276	1.303	1.337	1.369	1.403	1.441	1.481	1.529	1.590	1.732
0.51	1.69		1.202	1.230	1.257	1.291	1.323	1.357	1.395	1.435	1.483	1.544	1.686
0.52	1.64		1.160	1.188	1.215	1.249	1.281	1.315	1.353	1.393	1.441	1.502	1.644
0.53	1.60		1.116	1.144	1.171	1.205	1.237	1.271	1.309	1.349	1.397	1.458	1.600
0.54	1.56		1.075	1.103	1.130	1.164	1.196	1.230	1.268	1.308	1.356	1.417	1.559
0.55	1.52		1.035	1.063	1.090	1.124	1.156	1.190	1.228	1.268	1.316	1.377	1.519
0.56	1.48		0.996	1.024	1.051	1.085	1.117	1.151	1.189	1.229	1.277	1.338	1.480
0.57	1.44		0.958	0.986	1.013	1.047	1.079	1.113	1.151	1.191	1.239	1.300	1.442
0.58	1.40		0.921	0.949	0.976	1.010	1.042	1.073	1.114	1.154	1.202	1.263	1.405
0.59	1.37		0.884	0.912	0.939	0.973	1.005	1.039	1.077	1.117	1.165	1.226	1.368
0.60	1.33		0.849	0.878	0.905	0.939	0.971	1.005	1.043	1.083	1.131	1.192	1.334
0.61	1.30		0.815	0.843	0.870	0.904	0.936	0.970	1.008	1.048	1.096	1.157	1.299
0.62	1.27		0.781	0.809	0.836	0.870	0.902	0.936	0.974	1.014	1.062	1.123	1.265
0.63	1.23		0.749	0.777	0.804	0.838	0.870	0.904	0.942	0.982	1.030	1.091	1.233
0.64	1.20		0.716	0.744	0.771	0.805	0.837	0.871	0.909	0.949	0.997	1.058	1.200
0.65	1.17		0.685	0.713	0.740	0.774	0.806	0.840	0.878	0.918	0.966	1.007	1.169
0.66	1.14		0.654	0.682	0.709	0.743	0.775	0.809	0.847	0.887	0.935	0.996	1.138
0.67	1.11		0.624	0.652	0.679	0.713	0.745	0.779	0.817	0.857	0.905	0.966	1.108
0.68	1.08		0.595	0.623	0.650	0.684	0.716	0.750	0.788	0.828	0.876	0.937	1.079
0.69	1.05		0.565	0.593	0.620	0.654	0.686	0.720	0.758	0.798	0.840	0.907	1.049
0.70	1.02		0.536	0.564	0.591	0.625	0.657	0.691	0.729	0.796	0.811	0.878	1.020
0.71	0.99		0.508	0.536	0.563	0.597	0.629	0.663	0.701	0.741	0.783	0.850	0.992
0.72	0.96		0.479	0.507	0.534	0.568	0.600	0.634	0.672	0.721	0.754	0.821	0.963
0.73	0.94		0.452	0.480	0.507	0.541	0.573	0.607	0.645	0.685	0.727	0.794	0.936
0.74	0.91		0.425	0.453	0.480	0.514	0.546	0.580	0.618	0.658	0.700	0.767	0.909
0.75	0.88		0.398	0.426	0.453	0.487	0.519	0.553	0.591	0.631	0.673	0.740	0.882
0.76	0.86		0.371	0.399	0.426	0.460	0.492	0.526	0.564	0.604	0.652	0.713	0.855
0.77	0.83		0.345	0.373	0.400	0.434	0.466	0.500	0.538	0.578	0.620	0.687	0.829
0.78	0.80		0.319	0.347	0.374	0.408	0.440	0.474	0.512	0.552	0.594	0.661	0.803
0.79	0.78		0.292	0.320	0.347	0.381	0.413	0.447	0.485	0.525	0.567	0.634	0.776
0.80	0.75		0.266	0.294	0.321	0.355	0.387	0.421	0.459	0.499	0.541	0.608	0.750
0.81	0.72		0.240	0.268	0.295	0.329	0.361	0.395	0.433	0.473	0.515	0.582	0.724
0.82	0.70		0.214	0.242	0.269	0.303	0.335	0.369	0.407	0.447	0.489	0.556	0.698
0.83	0.67		0.188	0.216	0.243	0.277	0.309	0.343	0.381	0.421	0.463	0.530	0.672
0.84	0.65		0.162	0.190	0.217	0.251	0.283	0.317	0.355	0.395	0.437	0.504	0.645
0.85	0.62		0.136	0.164	0.191	0.225	0.257	0.291	0.329	0.369	0.417	0.478	0.602
0.86	0.59		0.109	0.140	0.167	0.198	0.230	0.264	0.301	0.343	0.390	0.450	0.593
0.87	0.57		0.083	0.114	0.141	0.172	0.204	0.238	0.275	0.317	0.364	0.424	0.567
0.88	0.54		0.054	0.085	0.112	0.143	0.175	0.209	0.246	0.288	0.335	0.395	0.538
0.89	0.51		0.028	0.059	0.086	0.117	0.149	0.183	0.230	0.262	0.309	0.369	0.512
0.90	0.48			0.031	0.058	0.089	0.121	0.155	0.192	0.234	0.281	0.341	0.484

For example: 200 kW motor - cos φ_1 = 0.75 - desired cos φ_2 = 0.93 - Qc = 200 x 0.487 = 98 kVAr

The table opposite can be used to calculate the capacitor power in order to switch from an initial power factor to a desired power factor based on the receiver power in kW. It also gives the equivalence between cos φ and tg φ.

DETERMINING THE LV POWER FACTOR CORRECTION SOLUTION (continued)

STEP 2

DETERMINING THE GENERAL CONFIGURATION

Depending on the installation architecture, the location and power of the receivers consuming reactive energy, the following are possible:

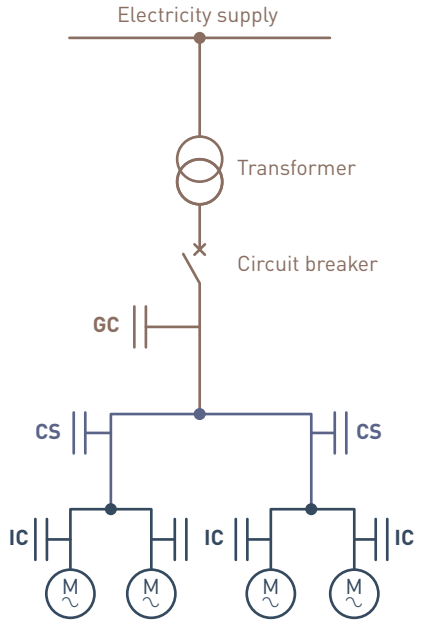
GLOBAL COMPENSATION in the main LV distribution board > choose an automatic or dynamic bank (Alpimatic or Alpistatic)

COMPENSATION BY SECTOR in the secondary distribution boards, for example: workshop secondary distribution board > choose an automatic or dynamic bank (Alpimatic or Alpistatic)

INDIVIDUAL COMPENSATION as close as possible to the load consuming the reactive energy (depending on how much the loads vary, a fixed bank Alpibloc may suffice).

EXAMPLE

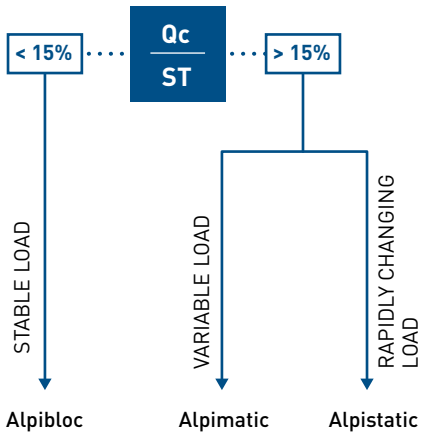
Compensating the reactive energy at a motor terminals by a fixed capacitor bank controlled at the same time as the motor.



GC = Global compensation
CS = Compensation by sector
IC = Individual compensation
M = Typical motor load

STEP 3

DETERMINING THE COMPENSATION MODE



Qc = Power of the compensation system in kVAr
ST = Power of the MV/LV transformer in kVA (or MV/LV transformers if there are two or more transformers in parallel)

	GLOBAL COMPENSATION	COMPENSATION BY SECTOR	INDIVIDUAL COMPENSATION
ADVANTAGES	▸ No billing of reactive energy ▸ Increased power available at the transformer secondary ▸ Cheapest solution	▸ No billing of reactive energy ▸ Reduction of losses along the line between transformer and mains secondary distribution boards ▸ Inexpensive solution	▸ No billing of reactive energy ▸ Reduction of losses along the whole line between transformer and the load ▸ Reactive energy compensation as close as possible to the devices consuming reactive energy
COMMENTS	▸ No reduction in losses along the line (voltage dips for loads a long way from the capacitor bank) ▸ No savings in terms of sizing electrical equipment	▸ Solution generally used for very extensive factory networks	▸ Most expensive solution given the high number of installations

STEP 4

DETERMINING THE CAPACITOR BANK TYPE ACCORDING TO THE LEVEL OF HARMONICS

For supplies with a high level of harmonic pollution, Alpes Technologies recommends capacitor banks with SAH, reinforced SAH and extra-reinforced SAH type detuned reactors.

The detuned reactor performs a threefold role:

- Increasing the impedance of the capacitor in relation to the harmonic currents.
- Shifting the parallel resonance frequency (Fr.p) of the source and the capacitor to below the main frequencies of the harmonic currents that are causing interference.

Tuning frequency (Hz)	Blocking factor (P%)	Tuning number (n)
215	5.4	4.3
189	7	3.78
135	14	2.7

- Helping to reduce harmonic levels in the supply.

The table opposite can be used to select the capacitor bank type according to the degree of harmonic pollution, by measuring the percentage of THDi and THDu or by estimating the percentage total power of SH/ST non-linear loads.

Measurements		Estimates	Type of capacitor to be used	
THDU %	THDI %	SH/ST %		
⩽ 4	⩽ 15	⩽ 25	H type	
⩽ 6	⩽ 30	⩽ 35	SAH type[1][2]	Reactor tuned to 189 Hz Reactor tuned to 135 Hz if high level of 3rd order harmonics
⩽ 8	⩽ 40	⩽ 50	Reinforced SAH type[1]	Reactor tuned to 189 Hz
⩽ 11	⩽ 55	⩽ 65	Extra-reinforced SAH type[1] OR Active filter	Installation audit required, please consult us Measurement Audit see p. 16 Reactor tuned to 215 Hz
> 11	> 55	> 65	Active filter	Installation audit required, please consult us Measurement Audit see p. 16

ST: power in kVA of the MV/LV transformer (or MV/LV transformers if there are two or more transformers in parallel).

SH: expanded power in kVA of the harmonic generators in the secondary of the MV/LV transformer(s) to be compensated.

THDi: percentage of total harmonic current pollution.

THDu: percentage of total harmonic voltage pollution.

(1) SAH, reinforced SAH and extra-reinforced SAH type capacitor banks are enclosures with a detuned reactor, check compatibility with your local operator's centralised remote control frequency, for other tuning frequencies please consult us.

(2) SAH type capacitor banks with 135 Hz reactor are recommended for an installation with a significant level of 3rd order harmonics, for example if Ih3 > 0.2*Ih5.
Ih3: 3rd order harmonic currents
Ih5: 5th order harmonic currents

ALPES TECHNOLOGIES

Selection guide

determining the reactive energy compensation solution

CAPACITOR BANK POWER/TRANSFORMER POWER RATIO (QC/ST)	LOAD	COMPENSATION
≤ 15%	STABLE	FIXED
> 15%	VARIABLE	AUTOMATIC
> 15%	RAPIDLY CHANGING	DYNAMIC

ALPIBLOC (p. 25)

ALPES TECHNOLOGIES RANGES	HARMONIC POLLUTION LEVEL				
	MEASUREMENTS		ESTIMATES	TYPE OF CAPACITOR TO BE USED	
	THDU %	THDI %	SH/ST %		
WITH CIRCUIT BREAKER **ALPIBLOC** p. 25	⩽ 4	⩽ 15	⩽ 25	**H type**	
WITH/WITHOUT CIRCUIT BREAKER **ALPIMATIC** p. 27-29	⩽ 6	⩽ 30	⩽ 35	**SAH type**[2]	189 Hz reactor
					135 Hz reactor[3]
	⩽ 8	⩽ 40	⩽ 50	**SAH type Reinforced**[2]	189 Hz reactor
WITH/WITHOUT CIRCUIT BREAKER **ALPISTATIC**[1] p. 33-34	⩽ 11[4]	⩽ 55[4]	⩽ 65[4]	**SAH type Extra-reinforced**[2]	215 Hz reactor
				Active filter	

ALPIMATIC (p. 27-29)

ALPISTATIC (p. 33-34)

(1) The Alpistatic range is only available in a version with detuned reactor.

(2) SAH, reinforced SAH and extra-reinforced SAH type capacitor banks are enclosures with a detuned reactor. Check compatibility with your local operator's centralised remote control frequency, for other tuning frequencies please consult us.

(3) SAH type capacitor banks with 135 Hz reactor are recommended for an installation with a significant level of 3rd order harmonics.

(4) From this harmonic level, an audit should be made of the installation to determine the size of the most suitable reactive energy compensation solution and/or treatment of harmonics with active filter, please consult us.

Solutions for all applications

Alpes Technologies offers reactive energy compensation solutions that are perfectly suited to different types of application[1].

(1) These equivalences are given for information purposes only. Reactive energy compensation solutions must be chosen according to the actual characteristics of the installation site.

H type

H type

H and SAH types

H and SAH types

Reinforced SAH
and extra-reinforced
SAH types

SAH, reinforced SAH
and extra-reinforced
SAH types

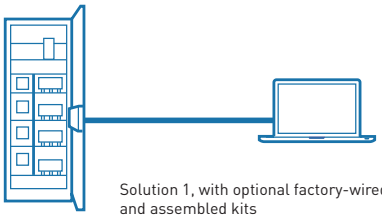
Smart capacitor banks

Supervision of capacitor banks: an efficient solution for managing your installation.

Alpes Technologies now offers its customers smart capacitor banks which, in addition to the measurement function, are able to transfer information and control installations remotely. The offer consists of 2 efficient solutions that can optimise installation safety.

SOLUTION 1

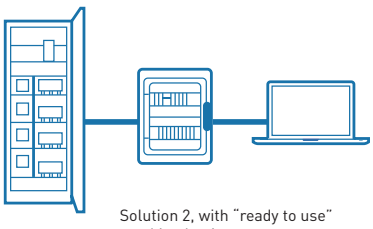
For a new capacitor bank installation, optional "smart capacitor bank" kits, factory-wired and assembled (order at the same time as the capacitor bank).



Solution 1, with optional factory-wired and assembled kits

SOLUTION 2

For existing installations, a "ready to use" offer available in the form of combined units, which can be added to the capacitor banks already installed to make them "smart".



Solution 2, with "ready to use" combined units

THE ASSURANCE OF OPTIMUM SAFETY

- Your capacitor bank power circuit will trip automatically if smoke is detected
- Remote alert sent by email from all safety alarms

ALL YOUR OPERATIONS OPTIMISED AND SIMPLIFIED

- Option of setting your capacitor bank to rest-mode remotely during periods when no reactive energy is being billed, thereby extending its service life
- Optimises visits to site by simplifying preventive and remedial maintenance operations (initial diagnosis made remotely and analysis of the alarm and measurement logs, before travelling to site)
- Optimises the maintenance schedule by means of alert messages (emails) advising the next due date for maintenance operations

For more information on supervision of capacitor banks, download a brochure, available on **alpestechnologies.com**

TWO SERVICE LEVELS FOR YOUR INSTALLATIONS

The new smart capacitor bank offer includes different functions which perform:
remote control, status feedback or measurement of electrical values, depending on the desired service level.

	LEVEL 1*			LEVEL 2		
SOLUTION 1 with optional factory-wired and assembled kits	●			●		
SOLUTION 2 with "ready to use" combined units	-			●		
Functionality according to the desired service level	1) Capacitor bank controlled via the power factor controller which manages step control (ON/OFF). 2) Capacitor bank circuit breaker trips automatically if smoke is detected, for complete shutdown.			1) Capacitor bank controlled via the power factor controller which manages step control (ON/OFF) + option of tripping the capacitor bank circuit breaker remotely via Nemo SX supervision modules. 2) Capacitor bank circuit breaker trips automatically if smoke is detected, for complete shutdown + dedicated email alert.		
	Power factor controller (built-in)  Web server** 	Smoke detector (built-in) 	Circuit breaker (built-in or installed upstream of the capacitor bank) 	Power factor controller (built-in)  Web server** 	Smoke detector (built-in)  Nemo SX supervision modules 	Circuit breaker (built-in or installed upstream of the capacitor bank) 
Remote control	YES	-	-	**YES**	-	**YES**
Status feedback	**YES**	-	-	**YES**	**YES**	**YES**
Measurement	**YES**	-	-	**YES**	-	-

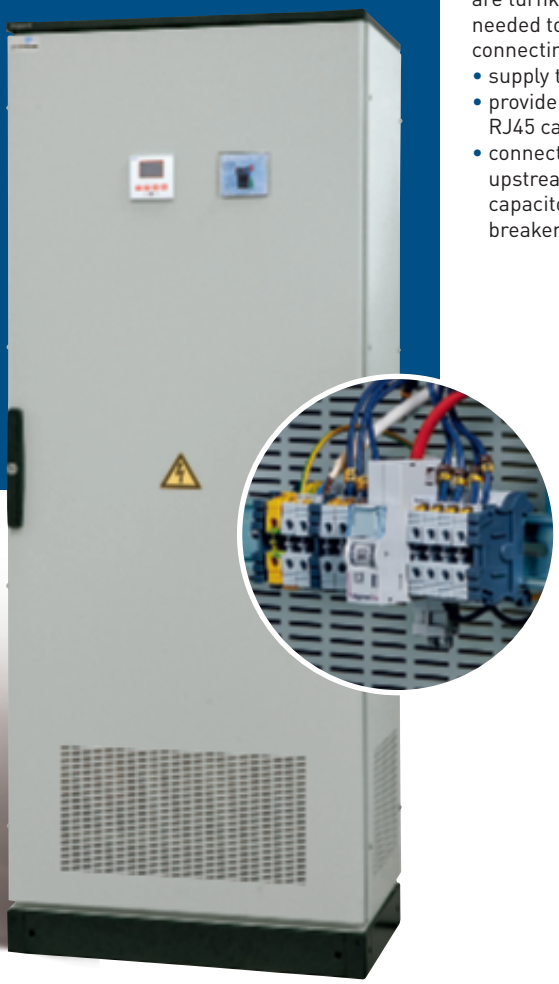
*Only available for optional factory-wired and assembled kits. **Or via IP interface and external Web server.

Smart capacitor banks (continued)

Solution 1

OPTIONAL KITS

Solution for installation of a new capacitor bank.



CHOICE OF A NEW SMART CAPACITOR BANK

The kit should be defined according to the:
- capacitor bank model, in the Alpimatic and Alpistatic ranges
- desired service level (2 levels available)
- auxiliary circuit supply voltage
- number of capacitor banks to be supervised (one or more capacitor banks)

INSTALLATION OF OPTIONAL KITS

Optional factory-wired and assembled kits are turnkey solutions. The only operation needed to install them consists of simply connecting up a terminal block to:
- supply them with power (230 V or 400 V)
- provide access to the IP network via an RJ45 cable
- connect the signalling contact and the upstream circuit breaker release (for capacitor banks without a built-in circuit breaker).

OPTIONAL KITS FOR SMART CAPACITOR BANK LEVEL 1 & 2

Level 1: capacitor bank controlled via the power factor controller

These kits can be used to:
- Remotely view instantaneous values and the log of all electrical measurements provided by the Alptec 3.2/5.2/8.2/8 power factor controllers (fitted on the capacitor banks) such as for example:
  - Reactive, active and apparent power
  - Voltage and current
  - THDi/THDu %
  - Power factor
  - cos φ
  - Enclosure temperature
- View operation of each step: ON/OFF status, residual power, number of switching operations and step operating time.
- Be informed about the remaining time before maintenance is due to assist with programming the maintenance schedule.
- Cut/restore control to all the steps.

If smoke is detected, the circuit breaker protecting the capacitor bank trips automatically to power down the bank.

Level 2: capacitor bank controlled under complete supervision

To provide complete supervision of the capacitor bank, power factor controller, main circuit breaker and smoke detectors. In addition to the functions included in the level 1 optional kits, these kits incorporate Nemo SX signalling and control modules to supervise:
- The status of the smoke detection safety kit (with dedicated email alerts if smoke is detected)
- The status and control of the capacitor bank main circuit breaker.

Solution 2

COMBINED UNITS

Ready to use solution for existing installation.

UPGRADE YOUR INSTALLATION TO MAKE IT "SMART"

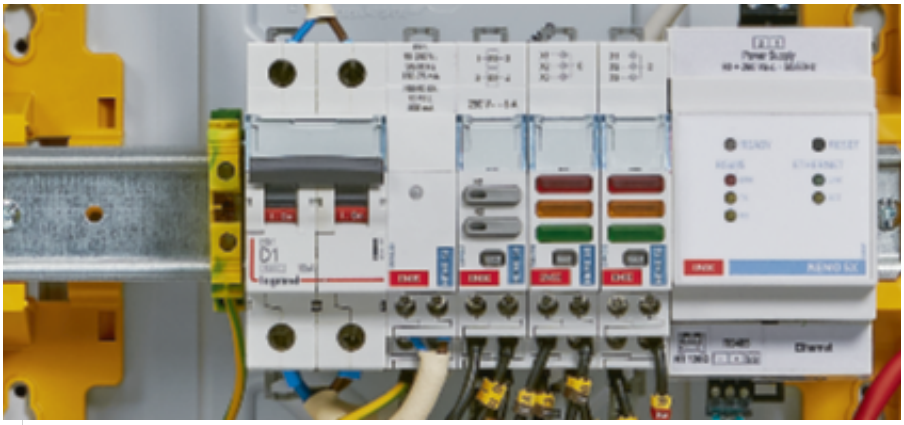
Combined units are the ideal solution for connecting existing capacitor banks to the grid. These units are built in the factory and are very easy to install on capacitor banks without altering the existing installation. Simply connect up a terminal block to supply them with power, allow access to the IP network, connect the Alptec power factor controller to the RS485 Modbus network, connect the signalling contacts and the upstream circuit breaker release.

COMBINED UNITS FOR SMART CAPACITOR BANK LEVEL 2

Capacitor bank controlled under complete supervision

A "ready to use" solution to provide complete supervision of the capacitor bank via the power factor controller.
Combined units incorporate Nemo SX signalling
and control modules to supervise:

- The status of the smoke detection safety kit (with dedicated email alerts if smoke is detected)
- The status and control of the capacitor bank main circuit breaker.



Combined unit with Web server

Combined unit with IP interface

COMBINED UNITS WITH VARYING NUMBER OF SMART CAPACITOR BANKS

The key steps for successful management of your electricity supply

During use, your capacitor bank may be exposed to different factors that may prevent it working properly and affect its service life. It is therefore important to analyse the quality of your supply to ensure optimum sizing of the capacitor bank, and to carry out maintenance operations as outlined in the annual maintenance schedule.

MEASUREMENT AUDIT

It is strongly recommended that you perform a network analysis upstream of a capacitor bank installation.

The measurement audit can highlight any faults on the mains supply to ensure optimum sizing of the capacitor bank (power, number of steps, version with or without detuned reactor). The network analysis should be conducted over a period of operation that is sufficiently representative of the installation's actual operation (minimum one week).

Our technical sales teams may suggest installation of a portable network analyser, analysis of the data by our experts and can provide you with a detailed report of the measurements with recommendations.

COMMISSIONING CAPACITOR BANKS

Our technicians travel to site and carry out the following operations in the presence of the operator and the installer:

- Visual inspection of the capacitor bank and its environment
- Checking the power factor controller settings
- Performance tests
- Configuring the remote supervision option
- Handing over the capacitor bank maintenance guidelines to the operator and installer

For capacitor banks with reactive power higher than or equal to 150 kVAr, the guarantee is dependent on them having been commissioned or checked on site by the manufacturer.

MAINTAINING CAPACITOR BANKS

During use, your capacitor bank may be exposed to different factors such as harmonics, high temperatures, voltage surges, an installation upgrade, environmental conditions (dust, vapours, etc), wear and tear (contactors, capacitors), etc.

These factors are likely to prevent the capacitor bank working properly and to affect its service life.

It is therefore important to carry out maintenance operations as outlined in the annual maintenance schedule in your maintenance manual, thereby extending the service life of your capacitor bank.

Preventive maintenance

Our technicians travel to site and carry out the following operations in the presence of the operator:

- Checking the tightening torque of the capacitor bank components (busbars, contactors, etc)
- Visual inspection of and cleaning the capacitor bank
- Functional check and measurements (measuring the capacitance on each step, reading the power factor controller settings, measurements and alarms)
- Diagnostics of wear parts and components to be replaced

Remedial maintenance

This is a bespoke service depending on the problem encountered on site. A "Measurement" audit with a network analyser may be necessary.

SHOULD YOU REQUIRE A "MEASUREMENT" AUDIT, COMMISSIONING OR MAINTENANCE OF YOUR ALPES TECHNOLOGIES CAPACITOR BANKS, YOU CAN RELY ON OUR NETWORK OF EXPERTS. YOUR LEGRAND REPRESENTATIVE WILL BE ABLE TO PUT TOGETHER A SALES PROPOSAL AND OFFER YOU THE SOLUTION THAT PERFECTLY MEETS YOUR NEEDS.

LOW VOLTAGE RANGE

SEE THE PRODUCTS

Optional kits and combined units
for supervision of capacitor banks
(p. 36)

Safety kits
for existing capacitor banks
(p. 38)

P. 25
Alpibloc fixed capacitor banks with integrated circuit breaker

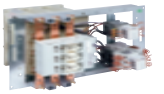
P. 26
Alpibloc fixed capacitor banks with integrated circuit breaker and detuned reactor

P. 28
Alpimatic with SAH, reinforced SAH and extra-reinforced SAH type detuned reactor

P. 33
Alpistatic with SAH, reinforced SAH and extra-reinforced SAH type detuned reactor

P. 36
Combined units for smart capacitor banks

P. 38
Safety kits for existing capacitor banks

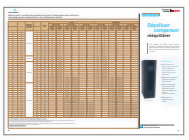


P. 39
Alpimatic racks, H type

P. 41
Alpistatic racks with SAH, reinforced SAH and extra-reinforced SAH type detuned reactor

P. 42
Alptec automatic power factor controllers

P. 43
Accessories for Alptec power factor controllers



P. 48
Cross-section of connection cables for capacitor bank power supplies

P. 51
CTX³ power contactors and switching units

CAPACITORS

Alpivar 3

Alpivar 3 patented capacitors with vacuum technology are totally dry units with no impregnation or insulation liquid.

ADVANTAGES OF THE RANGE

Alpivar 3 capacitors are designed by combining individual single-phase windings, connected in a delta or star configuration depending on the nominal voltage, to produce a three-phase unit.

These windings are created using two metallised polypropylene films with zinc coating on one side.
- The metal coating forms the electrode
- The polypropylene film forms the insulation

They are then vacuum-coated with a self-extinguishing thermosetting polyurethane resin which forms the casing, providing mechanical and electrical environmental protection.

This vacuum coating technique for the windings, which is unique to ALPES TECHNOLOGIES, gives Alpivar 3 capacitors excellent resistance over time.

Vacuum sealing ensures that no air or moisture can get into the windings. This design provides excellent resistance to voltage surges and partial discharges.
This unit complies fully with environmental protection requirements (PCB-free).

INSTALLATION

Its compact form makes it easy to install and significantly reduces the costs of enclosures or racks.
The casing is particularly resistant to all solvents and atmospheric agents (rain, sun, salty air, etc.).

CONNECTION

- The easy accessibility of the terminals on the top of the unit makes the Alpivar 3 capacitor very easy to connect.
- The use of a system of "socket" terminals enables direct connection of the unit via cables and lugs.
- The Alpivar 3 double-insulated or class 2 capacitor does not need earthing.

MOUNTING POSITION

- **Vertical or horizontal mounting.**

Alpibloc

ALPIBLOC AND ALPIBLOC WITH DETUNED REACTOR

Ready-to-use fixed capacitor bank assembly with main circuit breakers
- Without H type detuned reactor, up to 125 kVAr, optional wall-mount bracket
- With SAH, reinforced SAH and extra-reinforced SAH type detuned reactors, up to 100 kVAr

Conforming to standard IEC 61921.

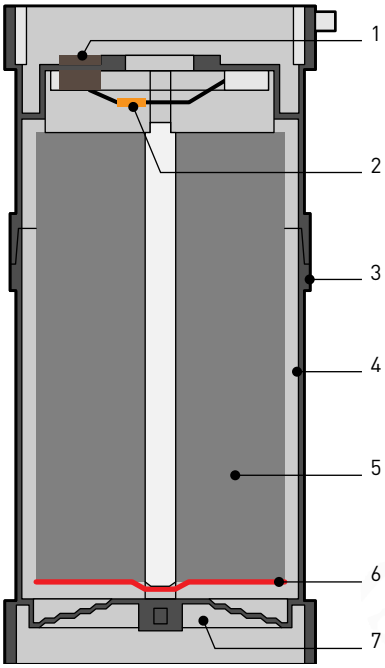
ELECTRICAL PROTECTION DEVICES

• **Self-healing dielectric:** This self-healing property is connected with the characteristics of the metal deposit which forms the electrode and the nature of the insulating support (polypropylene film).
This special manufacturing technique prevents breakdown of the capacitor due to electrical overvoltages. Such overvoltages pierce the dielectric and cause discharges which vaporise the metal near the short-circuit, thus instantaneously restoring the electrical insulation.

• **Internal fuses:** one per winding.

• **Pressure monitoring devices:** if an electrical fault cannot be overcome by the film self-healing or by means of the electrical fuse, gas is emitted, causing a membrane to deform and disconnecting the faulty winding. Triggering of the pressure monitoring devices is visible from outside the capacitor.
This feature makes it easy to quickly check the status of the unit.

These three protection devices, together with the vacuum coating on the windings (technique patented by ALPES TECHNOLOGIES), result in a very high-tech unit.



1 – Socket terminals for direct connection via cables and lugs
2 – Internal discharge resistor
3 – Self-extinguishing plastic casing
4 – Vacuum-cast resin
5 – Self-healing coil
6 – Electrical fuse
7 – Pressure monitoring devices with visible trip indication

AUTOMATIC CAPACITOR BANKS

Alpimatic

Alpimatic capacitor banks are automatic banks with switching via electromechanical contactors.

RACK COMPOSITION

- H type for the MH series
- SAH, reinforced SAH and extra-reinforced SAH types for the MS series

The assembly is controlled by a power factor controller and built into an enclosure.
Available in 2 versions: with or without main circuit breaker

GENERAL CHARACTERISTICS

- IP 30 - IK 10 cabinet or enclosure
- Standard: IEC 61921
- Ambient temperature on the installation site:
  - Operation 5/+40°C (average over 24 hours: 35°C)
  - Ventilation: natural or forced (depending on the version)
- Colour: RAL 7035 grey enclosure

SPECIFIC CHARACTERISTICS

- Fully modular design for easy extension and maintenance
- Power factor controller with easy commissioning
- Extendable enclosure on request

ELECTRICAL CHARACTERISTICS

- Built-in power supply for auxiliary circuits
- Connector block for built-in load-shedding contact (generator set, etc)
- Possible remote alarm feedback
- Smoke detection (depending on the version)

OPTIONS

- Air conditioning
- IP 54
- Summing current transformer

CONNECTION (to be provided)

- Power cables in accordance with table on p. 48-51
- A current transformer to be placed on phase L1 of the installation upstream of all the receivers and the capacitor bank.

- primary: adapted to the installation
- secondary: 5 A
- power: 10 VA (recommended) - Class 1

The current transformer can be supplied separately on request.

Alpistatic

Alpistatic capacitor banks are automatic banks with switching via thyristor-controlled solid state contactors.
They provide "soft, fast" reactive energy compensation suitable for receivers that are sensitive to voltage variations (PLCs, industrial computers) or that have ultra-fast cycles (robots, welding machines, variable speed drives).

COMPOSITION

- The capacitor bank is subdivided into a number of steps depending on the total power
- One three-pole solid state contactor per step (breaking all three phases)
- Cooling of each solid state contactor by a fan-cooled heat sink
- SAH, reinforced SAH and extra-reinforced SAH types: 1 three-phase detuned reactor protecting the solid state contactor and providing protection against harmonics
- One set of 3 HRC fuses per step
- A system for controlling the solid state contactors, including a reactive energy controller for automatic control: with "auto-man" operation
  - Front panel display showing the number of steps in operation and the installation cos φ
  - Display of a number of other electrical parameters (harmonics, etc)
- A system for controlling the solid state contactors, including a microprocessor instrumentation and control card for each solid state contactor, that:
  - activates and deactivates the solid state contactors within 40 ms max.
  - avoids any transient voltage and current phenomena when steps are activated or deactivated
- Available in 2 versions: with or without circuit breaker

GENERAL CHARACTERISTICS

- IP 30 - IK 10 enclosure
- Standard: IEC 61921
- Ambient temperature on the installation site:
  - operation –5/+40°C (average over 24 hours: 35°C)
- Ventilation: forced

ELECTRICAL CHARACTERISTICS

- Built-in power supply for auxiliary circuits
- Connector block for built-in load-shedding contact (generator set)
- Smoke detection

OPTIONS

- Air conditioning
- IP 54
- Summing current transformer

CONNECTION (to be provided)

- Power cables in accordance with table on page 48-51
- A current transformer to be placed on phase L3 of the installation upstream of all the receivers and the capacitor bank:
  - primary: adapted to the installation
  - secondary: 5 A
  - power: 10 VA (recommended) – Class 1

SENSITIVE DATA	ALPISTATIC	CONVENTIONAL SYSTEM WITH ELECTROMECHANICAL CONTACTORS
Electromechanical contactors present	no	yes
Worn moving parts	no	yes
Contact bounce phenomenon	no	possible
Contact fatigue	none	significant
Transient overcurrents (deactivation of steps)	no	yes (may exceed 200 In)
Transient undervoltages	none	yes (up to 100%)
Compatibility (PLCs, computer equipment, etc)	excellent	average
Compatibility (welding machines, generator sets, etc)	excellent	low
Response time (activation and deactivation)	40 milliseconds max.	approx. 30 seconds
Number of operations	unlimited	limited (electromechanical contactor)
Sound level during operation	none	low (electromechanical contactor)
Reduction of FLICKER	yes (for highly inductive loads)	no

V7540CB

Technical characteristics **opposite**

400 V - 50 Hz three-phase network
Double or class II insulation. Totally dry
Self-extinguishing polyurethane resin casing
Internal protection for each winding using:
- a self-healing metallised polypropylene film
- an electrical fuse
- a disconnection device in case of a pressure surge
- Colour: casing RAL 7032
  cover RAL 7035

Conforming to standard IEC 60831-1 and 2

Pack	Cat.Nos	**H type** **Max. harmonic pollution level THDU ≤ 4%, THDI ≤ 15%** Nominal power (kVAr)
1	VH2.540CB	2.5
1	VH540CB	5
1	VH6.2540CB	6.25
1	VH7.540CB	7.5
1	VH1040CB	10
1	VH12.540CB	12.5
1	VH1540CB	15
1	VH2040CB	20
1	VH2540CB	25
1	VH3040CB	30
1	VH3540CB	35
1	VH4040CB	40
1	VH5040CB	50
1	VH6040CB	60
1	VH7540CB	75
1	VH8040CB	80
1	VH9040CB	90
1	VH10040CB	100
1	VH12540CB	125

For other power ratings, voltages, frequencies, **please consult us**

Alpivar 3 capacitors

Technical specifications

Discharge resistors
Fitted inside (unless otherwise requested), these discharge the unit in accordance with current standards (discharge time 3 minutes)

Loss factor
Alpivar 3 capacitors have a loss factor of less than 0.1 x 10-3
This value leads to a power consumption of less than 0.3 W per kVAr, including the discharge resistors

Capacitance
Tolerance on the capacitance value: ±5%
Excellent stability of the capacitance throughout the Alpivar 3 capacitor service life

Permissible overvoltage:
1.5 x U_n, 12/24 hrs

Permissible overcurrent:
• up to 2 x In

Mounting position:
indoors, vertical or horizontal

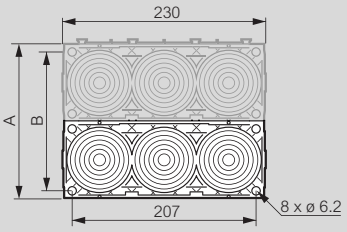
Current peak withstand:
• up to 500 x In

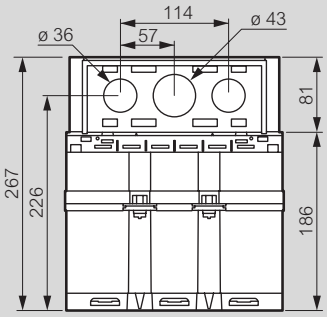
Standards
Capacitors conforming to standard IEC 60831-1 and 2

Temperature class
Standard temperature class -25/+55°C
• maximum temperature: 55°C
• average over 24 hours: 45°C
• annual average: 35°C
• other temperature classes on request

Dimensions

H type





H type	No. of modules	Dimensions (mm)		Weight (kg)
		A	B	
VH2.540CB	1	93	70	3.5
VH540CB	1	93	70	3.5
VH6.2540CB	1	93	70	3.5
VH7.540CB	1	93	70	3.5
VH1040CB	1	93	70	3.5
VH12.540CB	1	93	70	3.5
VH1540CB	1	93	70	3.5
VH2040CB	1	93	70	3.5
VH2540CB	1	93	70	3.5
VH3040CB	2	180	157	7
VH3540CB	2	180	157	7
VH4040CB	2	180	157	7
VH5040CB	2	180	157	7
VH6040CB	3	267	244	10.5
VH7540CB	3	267	244	10.5
VH8040CB	4	354	331	14
VH9040CB	4	354	331	14
VH10040CB	4	354	331	14
VH12540CB	5	441	418	17.5

Alpibloc fixed capacitor banks with integrated circuit breaker

BH2040

BH6040

Technical characteristics **opposite**

400 V - 50 Hz three-phase network
Alpibloc is an Alpivar 3 capacitor with integrated circuit breaker
Equipment supplied ready for connection, for fixed compensation of low and medium power electrical devices
For certain applications (remote control, etc), the circuit breaker can be replaced by a contactor and HRC fuses
Conforming to standard IEC 61921

H type

Max. harmonic pollution level THDU ≤ 4%, THDI ≤ 15%

Pack	Cat.Nos	Nominal power (kVAr)	Circuit breaker rating	Breaking capacity
1	BH1040	10	20 A	50 kA
1	BH1540	15	32 A	50 kA
1	BH2040	20	40 A	50 kA
1	BH2540	25	50 A	50 kA
1	BH3040	30	63 A	50 kA
1	BH4040	40	100 A	25 kA
1	BH5040	50	100 A	25 kA
1	BH6040	60	125 A	25 kA
1	BH7540	75	160 A	25 kA
1	BH9040	90	250 A	36 kA
1	BH10040	100	250 A	36 kA
1	BH12540	125	250 A	36 kA

Fixing accessory

Pack	Cat.Nos	
1	SUPP/ALPIBLOC	Wall-mount bracket for H type Alpibloc up to 60 kVAr

For other power ratings, voltages, frequencies, IP 54, **please consult us**

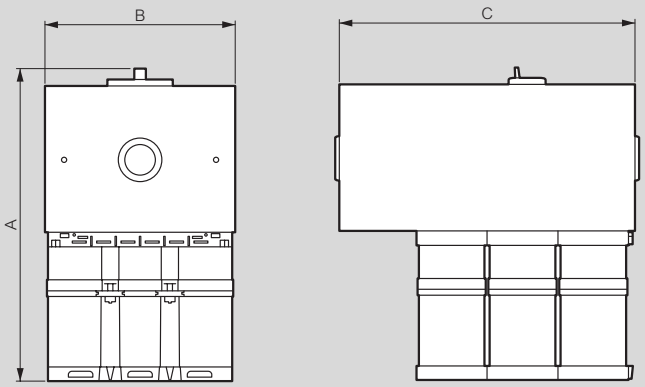
Alpibloc fixed capacitor banks with integrated circuit breaker

Dimensions

H type

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure
	A	B	C		
BH1040	380	190	230	8	BL type
BH1540	380	190	230	8	BL type
BH2040	380	190	230	8	BL type
BH2540	380	190	230	8	BL type
BH3040	380	190	230	12	BL type
BH4040	380	365	230	20	BL type
BH5040	380	365	230	20	BL type
BH6040	380	365	230	24	BL type
BH7540	380	365	230	24	BL type
BH9040	380	540	230	37	BL type
BH10040	380	540	230	37	BL type
BH12540	380	540	230	40	BL type

Dimensions of Alpibloc on its own - BL type



Alpibloc fixed capacitor banks with circuit breaker and detuned reactor

BS10040.189

Technical characteristics **opposite**

400 V - 50 Hz three-phase network
Alpivar 3 capacitor combined with a detuned reactor and a main circuit breaker
Assembly fitted and wired in enclosure
IP 30 - IK 10 enclosure
Conforming to standard IEC 61921

SAH type

Max. harmonic pollution level
THDU ≤ 6%, THDI ≤ 30%
189 Hz (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Circuit breaker rating	Breaking capacity
1	BS5040.189	50	125 A	25 kA
1	BS7540.189	75	250 A	36 kA
1	BS10040.189	100	250 A	36 kA

Reinforced SAH type

Max. harmonic pollution level
THDU ≤ 8%, THDI ≤ 40%
189 Hz (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Circuit breaker rating	Breaking capacity
1	BS.R4040.189	40	125 A	25 kA
1	BS.R8040.189	80	250 A	36 kA

Extra-reinforced SAH type

Max. harmonic pollution level
THDU ≤ 11%, THDI ≤ 55%
215 Hz (p = 5.4%)
At this level of harmonic pollution, we strongly recommend that you contact us to take measurements on site

Pack	Cat.Nos	Nominal power (kVAr)	Circuit breaker rating	Breaking capacity
1	BS.RS7240.215	72	250 A	36 kA

Optional safety kit

Pack	Cat.Nos
1	KSBSD

Detects smoke and monitors the temperature inside the capacitor bank; the main circuit breaker trips automatically in the event of a fault
Factory-assembled; MUST be ordered at the same time as the capacitor bank
For Alpibloc fixed capacitor banks with integrated circuit breaker and detuned reactor

For other power ratings, voltages, frequencies, IP 54, **please consult us**

Alpibloc fixed capacitor banks with circuit breaker and detuned reactor

Dimensions

SAH type

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure
	A	B	C		
BS5040.189	1400	600	500	118	PL2-F
BS7540.189	1400	600	500	124	PL2-F
BS10040.189	1400	600	500	130	PL2-F

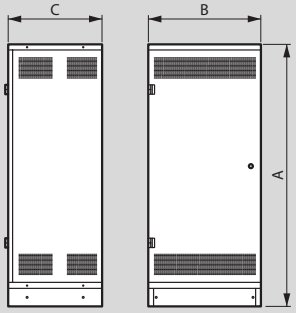
Reinforced SAH type

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure
	A	B	C		
BS.R4040.189	1400	600	500	97	PL2-F
BS.R8040.189	1400	600	500	144	PL2-F

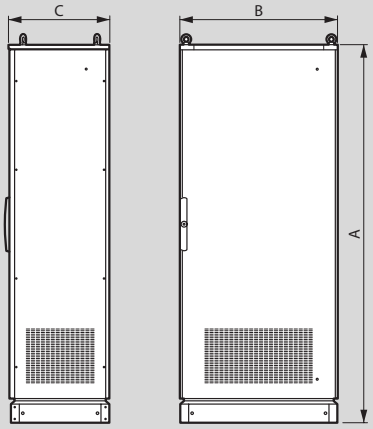
Extra-reinforced SAH type

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure
	A	B	C		
BS.RS7240.215	2100	1000	600	240	AL-F

PL2-F type enclosures with natural ventilation



AL-F type enclosures with forced ventilation



Optional lifting rings

Alpimatic automatic capacitor banks


MH10040/DISJ


MH35040/DISJ

Technical characteristics **p. 30-31**

400 V - 50 Hz three-phase network. IP 30 - IK 10 enclosure. Fully modular design for ease of maintenance (enclosure version)
Alpimatic is made up of several enclosures, depending on the capacitor bank model and the nominal current
The contactors are controlled by the Alptec power controller with a simple commissioning procedure
Step control using CTX³ electromechanical contactors with damping resistors suitable for capacitive currents
Capacitor banks with nominal power > 150 KVAr can be fitted with optional kits/combined units for supervision of capacitor banks (p. 36)
Capacitor banks without circuit breaker: connection via the top up to 150 kVAr and via the bottom up to 175 kVAr (via the top: on request)
Capacitor banks with circuit breaker: connection via the top. RAL 7035 enclosure. Conforming to standard IEC 61921

H type

Max. harmonic pollution level
THDU ≤ 4%, THDI ≤ 15%

Cabinet version - without circuit breaker

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)
1	MH7540	75	(7.5+15+22.5)+30
1	MH87.540-F	87.5	12.5+(25+50)
1	MH87.540	87.5	(12.5+25+25)+25
1	MH10040-F	100	25+(25+50)
1	MH10040	100	(12.5+25+25)+37.5
1	MH112.540	112.5	(12.5+25+25)+50
1	MH12540	125	(25+50)+50
1	MH15040	150	(25+50)+75

Enclosure version - without circuit breaker
With integrated smoke detection

Pack	Cat.Nos		
1	MH17540	175	(25+50)+50+50
1	MH20040	200	50+2x75
1	MH22540	225	(25+50)+2x75
1	MH25040	250	2x50+2x75
1	MH27540	275	(25+50)+50+2x75
1	MH30040	300	(25+50)+3x75
1	MH35040	350	50+4x75
1	MH40040	400	2x50+4x75
1	MH45040	450	6x75
1	MH50040	500	50+6x75
1	MH55040	550	2x50+6x75
1	MH60040	600	8x75
1	MH67540	675	9x75
1	MH75040	750	10x75
1	MH82540	825	11x75
1	MH90040	900	12x75

For other power ratings, voltages, frequencies, air conditioning, IP 54, **please consult us**

H type (continued)

Cabinet version - with circuit breaker

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)	Circuit breaker rating (A)	Breaking capacity (kA)
1	MH1040/DISJ	10	(2.5+2.5+5)	25	25
1	MH12.540/DISJ	12.5	(2.5+5+5)	25	25
1	MH1540/DISJ	15	(2.5+5+7.5)	40	25
1	MH2040/DISJ	20	(2.5+5+12.5)	40	25
1	MH2540/DISJ	25	(5+10+10)	63	25
1	MH3040/DISJ	30	(5+10+15)	63	25
1	MH3540/DISJ	35	(5+10+20)	100	25
1	MH4040/DISJ	40	(5+10+25)	100	25
1	MH47.540/DISJ	47.5	(7.5+15+25)	100	25
1	MH5040/DISJ	50	(10+15+25)	100	25
1	MH6040/DISJ	60	(10+25+25)	125	25
1	MH67.540/DISJ	67.5	(7.5+15+22.5)+22.5	125	25
1	MH7540-F/DISJ	75	(25+25+25)	160	25
1	MH7540/DISJ	75	(7.5+15+22.5)+30	160	25
1	MH87.540-F/DISJ	87.5	12.5+(25+50)	160	25
1	MH87.540/DISJ	87.5	(12.5+25+25)+25	160	25
1	MH10040-F/DISJ	100	25+(25+50)	250	36
1	MH10040/DISJ	100	(12.5+25+25)+37.5	250	36
1	MH112.540/DISJ	112.5	(12.5+25+25)+50	250	36
1	MH12540/DISJ	125	(25+50)+50	250	36

Enclosure version - with circuit breaker
With integrated smoke detection

Pack	Cat.Nos				
1	MH15040/DISJ	150	(25+50)+75	400	36
1	MH17540/DISJ	175	(25+50)+50+50	400	36
1	MH20040/DISJ	200	50+2x75	400	36
1	MH22540/DISJ	225	(25+50)+2x75	630	36
1	MH25040/DISJ	250	2x50+2x75	630	36
1	MH27540/DISJ	275	(25+50)+50+2x75	630	36
1	MH30040/DISJ	300	(25+50)+3x75	630	36
1	MH35040/DISJ	350	50+4x75	1250	50
1	MH40040/DISJ	400	2x50+4x75	1250	50
1	MH45040/DISJ	450	6x75	1250	50
1	MH50040/DISJ	500	50+6x75	1250	50
1	MH55040/DISJ	550	2x50+6x75	1250	70
1	MH60040/DISJ	600	8x75	1250	70

Alpimatic automatic capacitor banks with detuned reactor

MS15040.189

MS25040.189/DISJ

Technical characteristics **p. 30-31**

400 V - 50 Hz three-phase network. IP 30 - IK 10 enclosure
Fully modular design for ease of maintenance
Alpimatic with detuned reactor is made up of several enclosures, depending on the capacitor bank model and the nominal current
The contactors are controlled by the Alptec power controller with a simple commissioning procedure
Step control using CTX³ electromechanical contactors
Can be fitted with optional kits/combined units for supervision of capacitor banks (p. 36)
Capacitor banks without circuit breaker: connection via the bottom (or via the top on request)
Capacitor banks with circuit breaker: connection via the top
Grey enclosure (RAL 7035) with black base. Conforming to standard IEC 61921

SAH type

Max. harmonic pollution level
THDU ≤ 6%, THDI ≤ 30%
With integrated smoke detection

Without 189 Hz circuit breaker (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)
1	MS7540.189	75	25+50
1	MS10040.189	100	2x25+50
1	MS12540.189	125	25+2x50
1	MS15040.189	150	3x50
1	MS20040.189	200	50+2x75
1	MS22540.189	225	3x75
1	MS25040.189	250	2x50+2x75
1	MS27540.189	275	50+3x75
1	MS30040.189	300	4x75
1	MS35040.189	350	50+4x75
1	MS37540.189	375	5x75
1	MS45040.189	450	6x75
1	MS52540.189	525	7x75
1	MS60040.189	600	8x75
1	MS67540.189	675	9x75
1	MS75040.189	750	10x75

With 189 Hz circuit breaker (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)	Circuit breaker rating (A)	Breaking capacity (kA)
1	MS7540.189/DISJ	75	25+50	160	25
1	MS10040.189/DISJ	100	2x25+50	250	36
1	MS12540.189/DISJ	125	25+2x50	250	36
1	MS15040.189/DISJ	150	3x50	400	36
1	MS20040.189/DISJ	200	50+2x75	400	36
1	MS22540.189/DISJ	225	3x75	630	36
1	MS25040.189/DISJ	250	2x50+2x75	630	36
1	MS27540.189/DISJ	275	50+3x75	630	36
1	MS30040.189/DISJ	300	4x75	630	36
1	MS35040.189/DISJ	350	50+4x75	1250	50
1	MS37540.189/DISJ	375	5x75	1250	50
1	MS45040.189/DISJ	450	6x75	1250	50
1	MS52540.189/DISJ	525	7x75	1250	70
1	MS60040.189/DISJ	600	8x75	1250	70

SAH type (continued)

Without 135 Hz circuit breaker (p = 14%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)
1	MS5240.135	52.5	3x17.5
1	MS7040.135	70	2x17.5+35
1	MS8740.135	87.5	17.5+2x35
1	MS10540.135	105	2x17.5+2x35
1	MS14040.135	140	2x35+70
1	MS17540.135	175	35+2x70
1	MS21040.135	210	2x35+2x70
1	MS24540.135	245	35+3x70
1	MS28040.135	280	2x35+3x70
1	MS31540.135	315	35+4x70
1	MS38540.135	385	35+5x70
1	MS42040.135	420	6x70
1	MS45540.135	455	35+6x70
1	MS49040.135	490	7x70
1	MS52540.135	525	35+7x70
1	MS56040.135	560	8x70
1	MS63040.135	630	9x70

With 135 Hz circuit breaker (p = 14%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)	Circuit breaker rating (A)	Breaking capacity (kA)
1	MS5240.135/DISJ	52.5	3x17.5	100	25
1	MS7040.135/DISJ	70	2x17.5+35	160	25
1	MS8740.135/DISJ	87.5	17.5+2x35	160	36
1	MS10540.135/DISJ	105	2x17.5+2x35	250	36
1	MS14040.135/DISJ	140	2x35+70	400	36
1	MS17540.135/DISJ	175	35+2x70	400	36
1	MS21040.135/DISJ	210	2x35+2x70	630	36
1	MS24540.135/DISJ	245	35+3x70	630	36
1	MS28040.135/DISJ	280	2x35+3x70	630	36
1	MS31540.135/DISJ	315	35+4x70	630	36
1	MS38540.135/DISJ	385	35+5x70	1250	50
1	MS42040.135/DISJ	420	6x70	1250	50
1	MS45540.135/DISJ	455	35+6x70	1250	50
1	MS49040.135/DISJ	490	7x70	1250	50
1	MS52540.135/DISJ	525	35+7x70	1250	70
1	MS56040.135/DISJ	560	8x70	1250	70

Alpimatic automatic capacitor banks with detuned reactor (continued)

MS.R28040.215

Technical characteristics **p. 30-31**

400 V - 50 Hz three-phase network
IP 30 - IK 10 enclosure
Fully modular design for ease of maintenance
Alpimatic with detuned reactor is made up of several enclosures, depending on the capacitor bank model and the nominal current
The contactors are controlled by the Alptec power controller with a simple commissioning procedure
Step control using CTX³ electromechanical contactors
Can be fitted with optional kits/combined units for supervision of capacitor banks (p. 36)
Capacitor banks without circuit breaker: connection via the bottom (or via the top on request)
Capacitor banks with circuit breaker: connection via the top
Grey enclosure (RAL 7035) with black base
Conforming to standard IEC 61921

Reinforced SAH type

Max. harmonic pollution level
THDU ≤ 8%, THDI ≤ 40%
With integrated smoke detection

Without 189 Hz circuit breaker (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)
1	MS.R12040.189	120	3x40
1	MS.R16040.189	160	2x40+80
1	MS.R20040.189	200	40+2x80
1	MS.R24040.189	240	3x80
1	MS.R28040.189	280	40+3x80
1	MS.R32040.189	320	4x80
1	MS.R36040.189	360	40+4x80
1	MS.R40040.189	400	5x80
1	MS.R44040.189	440	40+5x80
1	MS.R48040.189	480	6x80
1	MS.R52040.189	520	40+6x80
1	MS.R56040.189	560	7x80
1	MS.R60040.189	600	40+7x80
1	MS.R64040.189	640	8x80
1	MS.R72040.189	720	9x80
1	MS.R80040.189	800	10x80

With 189 Hz circuit breaker (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)	Circuit breaker rating (A)	Breaking capacity (kA)
1	MS.R12040.189/DISJ	120	3x40	250	36
1	MS.R16040.189/DISJ	160	2x40+80	400	36
1	MS.R20040.189/DISJ	200	40+2x80	400	36
1	MS.R24040.189/DISJ	240	3x80	630	36
1	MS.R28040.189/DISJ	280	40+3x80	630	36
1	MS.R32040.189/DISJ	320	4x80	630	36
1	MS.R36040.189/DISJ	360	40+4x80	1250	50
1	MS.R40040.189/DISJ	400	5x80	1250	50
1	MS.R44040.189/DISJ	440	40+5x80	1250	50
1	MS.R48040.189/DISJ	480	6x80	1250	50
1	MS.R52040.189/DISJ	520	40+6x80	1250	70
1	MS.R56040.189/DISJ	560	7x80	1250	70
1	MS.R60040.189/DISJ	600	40+7x80	1250	70

Extra-reinforced SAH type

Max. harmonic pollution level
THDU ≤ 11%, THDI ≤ 55%
With integrated smoke detection
At this level of harmonic pollution, we strongly recommend that you contact us to take measurements on site

Without 215 Hz circuit breaker (p = 5.41%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)
1	MS.RS14440.215	144	2x72
1	MS.RS21640.215	216	3x72
1	MS.RS28840.215	288	4x72
1	MS.RS36040.215	360	5x72
1	MS.RS43240.215	432	6x72
1	MS.RS50440.215	504	7x72
1	MS.RS57640.215	576	8x72
1	MS.RS64840.215	648	9x72
1	MS.RS72040.215	720	10x72
1	MS.RS79240.215	792	11x72
1	MS.RS86440.215	864	12x72

With 215 Hz circuit breaker (p = 5.41%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)	Circuit breaker rating (A)	Breaking capacity (kA)
1	MS.RS14440.215/DISJ	144	2x72	400	36
1	MS.RS21640.215/DISJ	216	3x72	630	36
1	MS.RS28840.215/DISJ	288	4x72	1250	50
1	MS.RS36040.215/DISJ	360	5x72	1250	50
1	MS.RS43240.215/DISJ	432	6x72	1250	70
1	MS.RS50440.215/DISJ	504	7x72	1250	70
1	MS.RS57640.215/DISJ	576	8x72	1600	70

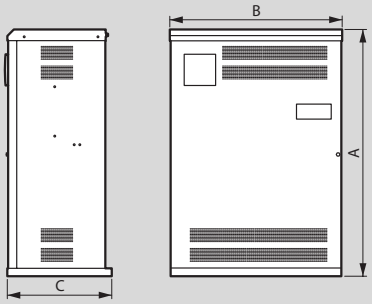
Optional kits for supervision of capacitor banks **p. 36**

For other power ratings, voltages, frequencies, air conditioning, IP 54, **please consult us**

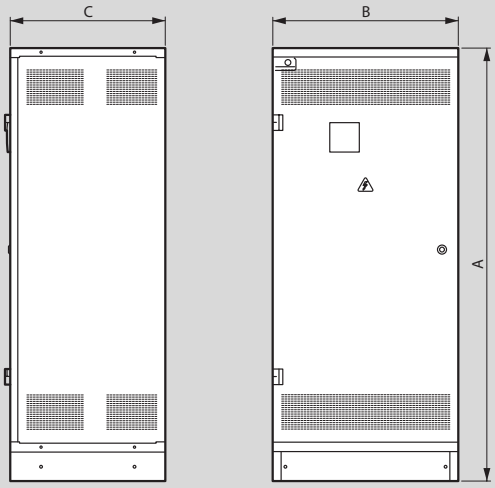
Alpimatic automatic capacitor banks

Dimensions

PL1 type cabinet with natural ventilation



PL2 type enclosure with natural ventilation and integrated smoke detection

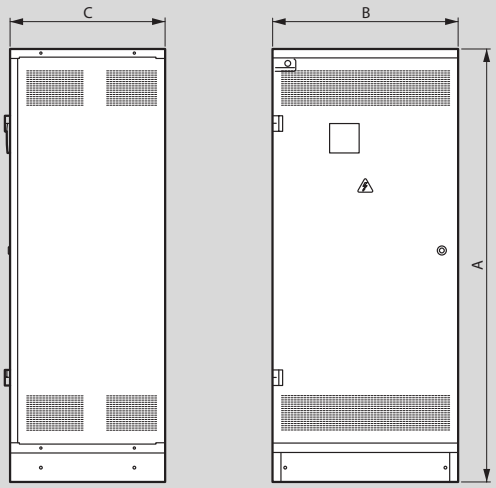


Tables of weights and dimensions
p. 31

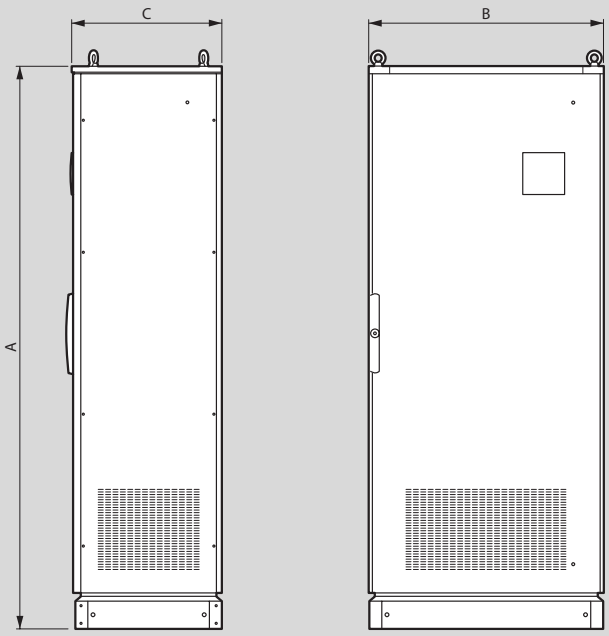
Alpimatic automatic capacitor banks with detuned reactor

Dimensions

PL2 type enclosure with natural ventilation and integrated smoke detection



AL type enclosure with forced ventilation and integrated smoke detection



Optional lifting rings

Tables of weights and dimensions
p. 32

Alpimatic automatic capacitor banks

Dimensions

H type - without circuit breaker

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MH7540	770	520	320	42	PL1	No
MH87.540-F	770	520	320	44	PL1	
MH87.540	770	520	320	44	PL1	
MH10040-F	770	520	320	44	PL1	
MH10040	770	520	320	45	PL1	
MH112.540	770	520	320	45	PL1	
MH12540	770	520	320	50	PL1	
MH15040	770	520	320	53	PL1	
MH17540	1400	600	500	110	PL2	Yes
MH20040	1400	600	500	115	PL2	
MH22540	1400	600	500	120	PL2	
MH25040	1400	600	500	125	PL2	
MH27540	1400	600	500	130	PL2	
MH30040	1400	600	500	135	PL2	
MH35040	1900	600	500	165	PL2	
MH40040	1900	600	500	175	PL2	
MH45040	1900	600	500	185	PL2	
MH50040	1900	1200	500	230	PL2	
MH55040	1900	1200	500	240	PL2	
MH60040	1900	1200	500	250	PL2	
MH67540	1900	1200	500	325	PL2	
MH75040	1900	1200	500	340	PL2	
MH82540	1900	1200	500	355	PL2	
MH90040	1900	1200	500	370	PL2	

H type - with circuit breaker

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MH1040/DISJ	770	260	320	23	PL1	No
MH12.540/DISJ	770	260	320	24	PL1	
MH1540/DISJ	770	260	320	25	PL1	
MH2040/DISJ	770	260	320	25	PL1	
MH2540/DISJ	770	260	320	25	PL1	
MH3040/DISJ	770	260	320	28	PL1	
MH3540/DISJ	770	260	320	28	PL1	
MH4040/DISJ	770	260	320	29	PL1	
MH47.540/DISJ	770	260	320	29	PL1	
MH5040/DISJ	770	260	320	31	PL1	
MH6040/DISJ	770	260	320	31	PL1	
MH67.540/DISJ	770	520	320	41	PL1	
MH7540-F/DISJ	770	260	320	33	PL1	
MH7540/DISJ	770	520	320	43	PL1	
MH87.540-F/DISJ	770	520	320	45	PL1	
MH87.540/DISJ	770	520	320	45	PL1	
MH10040-F/DISJ	770	520	320	45	PL1	
MH10040/DISJ	770	520	320	46	PL1	
MH112.540/DISJ	770	520	320	46	PL1	
MH12540/DISJ	770	520	320	53	PL1	
MH15040/DISJ	1400	600	500	110	PL2	Yes
MH17540/DISJ	1900	600	500	140	PL2	
MH20040/DISJ	1900	600	500	145	PL2	
MH22540/DISJ	1900	600	500	150	PL2	
MH25040/DISJ	1900	600	500	155	PL2	
MH27540/DISJ	1900	600	500	160	PL2	
MH30040/DISJ	1900	600	500	165	PL2	
MH35040/DISJ	1900	1200	500	250	PL2	
MH40040/DISJ	1900	1200	500	280	PL2	
MH45040/DISJ	1900	1200	500	290	PL2	
MH50040/DISJ	1900	1200	500	300	PL2	
MH55040/DISJ	1900	1200	500	310	PL2	
MH60040/DISJ	1900	1200	500	320	PL2	

Alpimatic automatic capacitor banks with detuned reactor

Dimensions (continued)

SAH type - without 189 Hz circuit breaker (p = 7%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MS7540.189	1400	600	500	124	PL2	Yes
MS10040.189	1400	600	500	158	PL2	
MS12540.189	1400	600	500	164	PL2	
MS15040.189	1400	600	500	170	PL2	
MS20040.189	2100	800	500	266	AL	
MS22540.189	2100	800	500	275	AL	
MS25040.189	2100	800	500	307	AL	
MS27540.189	2100	800	500	316	AL	
MS30040.189	2100	800	500	325	AL	
MS35040.189	2100	800	500	366	AL	
MS37540.189	2100	800	500	375	AL	
MS45040.189	2100	1600	500	525	AL	
MS52540.189	2100	1600	500	575	AL	
MS60040.189	2100	1600	500	625	AL	
MS67540.189	2100	1600	500	627	AL	
MS75040.189	2100	1600	500	725	AL	

SAH type - with 189 Hz circuit breaker (p = 7%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MS7540.189/DISJ	1900	600	500	164	PL2	Yes
MS10040.189/DISJ	2100	800	500	226	AL	
MS12540.189/DISJ	2100	800	500	236	AL	
MS15040.189/DISJ	2100	800	500	245	AL	
MS20040.189/DISJ	2100	800	500	286	AL	
MS22540.189/DISJ	2100	800	500	295	AL	
MS25040.189/DISJ	2100	800	500	327	AL	
MS27540.189/DISJ	2100	800	500	336	AL	
MS30040.189/DISJ	2100	800	500	345	AL	
MS35040.189/DISJ	2100	1600	500	486	AL	
MS37540.189/DISJ	2100	1600	500	495	AL	
MS45040.189/DISJ	2100	1600	500	545	AL	
MS52540.189/DISJ	2100	1600	500	595	AL	
MS60040.189/DISJ	2100	1600	500	645	AL	

SAH type - without 135 Hz circuit breaker (p = 14%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MS5240.135	1400	600	500	124	PL2	Yes
MS7040.135	1400	600	500	130	PL2	
MS8740.135	1400	600	500	164	PL2	
MS10540.135	2100	800	500	216	AL	
MS14040.135	2100	800	500	225	AL	
MS17540.135	2100	800	500	266	AL	
MS21040.135	2100	800	500	275	AL	
MS24540.135	2100	800	500	316	AL	
MS28040.135	2100	800	500	325	AL	
MS31540.135	2100	800	500	366	AL	
MS38540.135	2100	1600	500	516	AL	
MS42040.135	2100	1600	500	525	AL	
MS45540.135	2100	1600	500	566	AL	
MS49040.135	2100	1600	500	575	AL	
MS52540.135	2100	1600	500	616	AL	
MS56040.135	2100	1600	500	625	AL	
MS63040.135	2100	1600	500	675	AL	

SAH type - with 135 Hz circuit breaker (p = 14%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MS5240.135/DISJ	2100	800	500	221	AL	Yes
MS7040.135/DISJ	2100	800	500	227	AL	
MS8740.135/DISJ	2100	800	500	250	AL	
MS10540.135/DISJ	2100	800	500	236	AL	
MS14040.135/DISJ	2100	800	500	245	AL	
MS17540.135/DISJ	2100	800	500	286	AL	
MS21040.135/DISJ	2100	800	500	295	AL	
MS24540.135/DISJ	2100	800	500	336	AL	
MS28040.135/DISJ	2100	1600	500	445	AL	
MS31540.135/DISJ	2100	1600	500	486	AL	
MS38540.135/DISJ	2100	1600	500	536	AL	
MS42040.135/DISJ	2100	1600	500	545	AL	
MS45540.135/DISJ	2100	1600	500	586	AL	
MS49040.135/DISJ	2100	1600	500	595	AL	
MS52540.135/DISJ	2100	1600	500	636	AL	
MS56040.135/DISJ	2100	1600	500	645	AL	

Dimensions (continued)

Reinforced SAH type - without 189 Hz circuit breaker (p = 7%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MS.R12040.189	1400	600	500	191	PL2	Yes
MS.R16040.189	2100	800	500	299	AL	
MS.R20040.189	2100	800	500	328	AL	
MS.R24040.189	2100	800	500	359	AL	
MS.R28040.189	2100	800	500	407	AL	
MS.R32040.189	2100	800	500	437	AL	
MS.R36040.189	2100	800	500	485	AL	
MS.R40040.189	2100	800	500	515	AL	
MS.R44040.189	2100	1600	500	663	AL	
MS.R48040.189	2100	1600	500	693	AL	
MS.R52040.189	2100	1600	500	741	AL	
MS.R56040.189	2100	1600	500	771	AL	
MS.R60040.189	2100	1600	500	811	AL	
MS.R64040.189	2100	1600	500	849	AL	
MS.R72040.189	2100	1600	500	927	AL	
MS.R80040.189	2100	1600	500	1005	AL	

Reinforced SAH type - with 189 Hz circuit breaker (p = 7%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MS.R12040.189/DISJ	2100	800	500	289	AL	Yes
MS.R16040.189/DISJ	2100	800	500	319	AL	
MS.R20040.189/DISJ	2100	800	500	348	AL	
MS.R24040.189/DISJ	2100	800	500	379	AL	
MS.R28040.189/DISJ	2100	800	500	427	AL	
MS.R32040.189/DISJ	2100	800	500	457	AL	
MS.R36040.189/DISJ	2100	1600	500	605	AL	
MS.R40040.189/DISJ	2100	1600	500	635	AL	
MS.R44040.189/DISJ	2100	1600	500	683	AL	
MS.R48040.189/DISJ	2100	1600	500	713	AL	
MS.R52040.189/DISJ	2100	1600	500	761	AL	
MS.R56040.189/DISJ	2100	1600	500	791	AL	
MS.R60040.189/DISJ	2100	1600	500	831	AL	

Extra-reinforced SAH type - without 215 Hz circuit breaker (p = 5.41%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MS.RS14440.215	2100	1000	600	330	AL	Yes
MS.RS21640.215	2100	1000	600	420	AL	
MS.RS28840.215	2100	1000	600	510	AL	
MS.RS36040.215	2100	2000	600	725	AL	
MS.RS43240.215	2100	2000	600	815	AL	
MS.RS50440.215	2100	2000	600	905	AL	
MS.RS57640.215	2100	2000	600	995	AL	
MS.RS64840.215	2100	3000	600	1210	AL	
MS.RS72040.215	2100	3000	600	1300	AL	
MS.RS79240.215	2100	3000	600	1390	AL	
MS.RS86440.215	2100	3000	600	1480	AL	

Extra-reinforced SAH type - with 215 Hz circuit breaker (p = 5.41%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
MS.RS14440.215/DISJ	2100	1000	600	350	AL	Yes
MS.RS21640.215/DISJ	2100	1000	600	440	AL	
MS.RS28840.215/DISJ	2100	1600	600	610	AL	
MS.RS36040.215/DISJ	2100	2000	600	745	AL	
MS.RS43240.215/DISJ	2100	2000	600	915	AL	
MS.RS50440.215/DISJ	2100	2600	600	1025	AL	
MS.RS57640.215/DISJ	2100	2600	600	1115	AL	

Alpistatic automatic capacitor banks with detuned reactor

STS 25040.189/DISJ

Technical characteristics **p. 35**

400 V - 50 Hz three-phase network
IP 30 - IK 10 enclosure
Alpistatic with detuned reactor is a real-time compensation system, with a response time ≤ 40 ms
Step control using thyristor-controlled solid state contactors
It is specially designed for sites using rapidly-changing loads, or for processes sensitive to harmonics and transient currents.
All levels can be connected or disconnected at the same time, so as to correspond exactly to your demand for reactive energy.
Alpistatic with detuned reactor is made up of several static enclosures depending on the capacitor bank model and the nominal current
Can be fitted with optional kits/combined units for supervision of capacitor banks (p. 36)
Capacitor banks without circuit breaker: connection via the bottom (or via the top on request)
Capacitor banks with circuit breaker: connection via the top
Grey enclosure (RAL 7035) with black base
Conforming to standard IEC 61921

SAH type

Max. harmonic pollution level
THDU ≤ 6%, THDI ≤ 30%
With integrated smoke detection

Without 189 Hz circuit breaker (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)
1	STS10040.189	100	2x25+50
1	STS12540.189	125	25+2x50
1	STS15040.189	150	3x50
1	STS17540.189	175	2x50+75
1	STS20040.189	200	50+2x75
1	STS22540.189	225	25+50+2x75
1	STS25040.189	250	2x50+2x75
1	STS27540.189	275	50+3x75
1	STS30040.189	300	2x50+2x100
1	STS35040.189	350	50+3x100
1	STS40040.189	400	4x100
1	STS45040.189	450	75+3x125
1	STS50040.189	500	4x125
1	STS52540.189	525	2x75+3x125
1	STS57540.189	575	75+4x125
1	STS62540.189	625	5x125
1	STS70040.189	700	75+5x125
1	STS75040.189	750	6x125
1	STS82540.189	825	75+6x125
1	STS87540.189	875	7x125
1	STS95040.189	950	75+7x125
1	STS100040.189	1000	8x125
1	STS112540.189	1125	9x125
1	STS125040.189	1250	10x125
1	STS137540.189	1375	11x125
1	STS150040.189	1500	12x125

SAH type (continued)

With 189 Hz circuit breaker (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)	Circuit breaker rating (A)	Breaking capacity (kA)
1	STS10040.189/DISJ	100	2x25+50	250	36
1	STS12540.189/DISJ	125	25+2x50	250	36
1	STS15040.189/DISJ	150	3x50	400	36
1	STS17540.189/DISJ	175	2x50+75	400	36
1	STS20040.189/DISJ	200	50+2x75	400	36
1	STS22540.189/DISJ	225	25+50+2x75	630	36
1	STS25040.189/DISJ	250	2x50+2x75	630	36
1	STS27540.189/DISJ	275	50+3x75	630	36
1	STS30040.189/DISJ	300	2x50+2x100	630	36
1	STS35040.189/DISJ	350	50+3x100	1250	50
1	STS40040.189/DISJ	400	4x100	1250	50
1	STS45040.189/DISJ	450	75+3x125	1250	50
1	STS50040.189/DISJ	500	4x125	1250	50
1	STS52540.189/DISJ	525	2x75+3x125	1250	70
1	STS57540.189/DISJ	575	75+4x125	1250	70
1	STS62540.189/DISJ	625	5x125	1250	70
1	STS70040.189/DISJ	700	75+5x125	1250	70

For other power ratings, voltages, frequencies, air conditioning, IP 54 **please consult us**

Optional kits for supervision of capacitor banks **p. 36**

Alpistatic automatic capacitor banks with detuned reactor (continued)

STS.R28040.215

Technical characteristics **p. 35**

400 V - 50 Hz three-phase network. IP 30 - IK 10 enclosure
Alpistatic with detuned reactor is a real-time compensation system, with a response time ≤ 40 ms
Step control using thyristor-controlled solid state contactors. It is specially designed for sites using rapidly-changing loads, or for processes sensitive to harmonics and transient currents.
All levels can be connected or disconnected at the same time, so as to correspond exactly to your demand for reactive energy.
Alpistatic with detuned reactor is made up of several static enclosures depending on the capacitor bank model and the nominal current. Can be fitted with optional kits/combined units for supervision of capacitor banks (p. 36)
Capacitor banks without circuit breaker: connection via the bottom (or via the top on request). Capacitor banks with circuit breaker: connection via the top
Grey enclosure (RAL 7035) with black base. Conforming to standard IEC 61921

Reinforced SAH type

Max. harmonic pollution level
THDU ≤ 8%, THDI ≤ 40%
With integrated smoke detection

Without 189 Hz circuit breaker (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)
1	STS.R12040.189	120	40+80
1	STS.R16040.189	160	2x40+80
1	STS.R20040.189	200	40+2x80
1	STS.R24040.189	240	2x40+2x80
1	STS.R28040.189	280	40+3x80
1	STS.R32040.189	320	4x80
1	STS.R36040.189	360	40+4x80
1	STS.R40040.189	400	5x80
1	STS.R44040.189	440	80+3x120
1	STS.R48040.189	480	4x120
1	STS.R52040.189	520	2x80+3x120
1	STS.R56040.189	560	80+4x120
1	STS.R60040.189	600	5x120
1	STS.R68040.189	680	80+5x120
1	STS.R72040.189	720	6x120
1	STS.R80040.189	800	80+6x120
1	STS.R84040.189	840	7x120
1	STS.R92040.189	920	80+7x120
1	STS.R96040.189	960	8x120
1	STS.R108040.189	1080	9x120
1	STS.R120040.189	1200	10x120
1	STS.R132040.189	1320	11x120
1	STS.R144040.189	1440	12x120

With 189 Hz circuit breaker (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)	Circuit breaker rating (A)	Breaking capacity (kA)
1	STS.R12040.189/DISJ	120	40+80	250	36
1	STS.R16040.189/DISJ	160	2x40+80	400	36
1	STS.R20040.189/DISJ	200	40+2x80	400	36
1	STS.R24040.189/DISJ	240	2x40+2x80	630	36
1	STS.R28040.189/DISJ	280	40+3x80	630	36
1	STS.R32040.189/DISJ	320	4x80	630	36
1	STS.R36040.189/DISJ	360	40+4x80	1250	50
1	STS.R40040.189/DISJ	400	5x80	1250	50
1	STS.R44040.189/DISJ	440	80+3x120	1250	50
1	STS.R48040.189/DISJ	480	4x120	1250	50
1	STS.R52040.189/DISJ	520	2x80+3x120	1250	70
1	STS.R56040.189/DISJ	560	80+4x120	1250	70
1	STS.R60040.189/DISJ	600	5x120	1250	70
1	STS.R68040.189/DISJ	680	80+5x120	1250	70

Extra-reinforced SAH type

Max. harmonic pollution level
THDU ≤ 11%, THDI ≤ 55%
With integrated smoke detection
At this level of harmonic pollution, we strongly recommend that you contact us to take measurements on site

Without 215 Hz circuit breaker (p = 5.41%)

Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)
1	STS.RS14440.215	144	2x72
1	STS.RS21640.215	216	3x72
1	STS.RS28840.215	288	4x72
1	STS.RS36040.215	360	5x72
1	STS.RS43240.215	432	6x72
1	STS.RS50440.215	504	7x72
1	STS.RS57640.215	576	8x72
1	STS.RS64840.215	648	9x72
1	STS.RS72040.215	720	10x72
1	STS.RS79240.215	792	11x72
1	STS.RS86440.215	864	12x72

With 215 Hz circuit breaker (p = 5.41%)

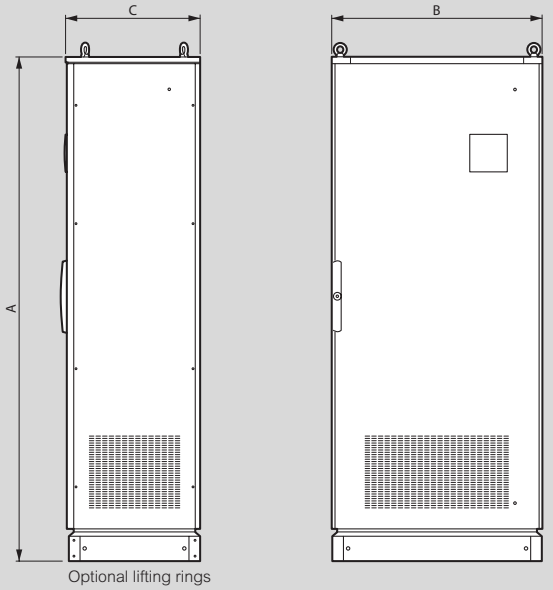
Pack	Cat.Nos	Nominal power (kVAr)	Steps (kVAr)	Circuit breaker rating (A)	Breaking capacity (kA)
1	STS.RS14440.215/DISJ	144	2x72	400	36
1	STS.RS21640.215/DISJ	216	3x72	630	36
1	STS.RS28840.215/DISJ	288	4x72	1250	50
1	STS.RS36040.215/DISJ	360	5x72	1250	50
1	STS.RS43240.215/DISJ	432	6x72	1250	70
1	STS.RS50440.215/DISJ	504	7x72	1250	70
1	STS.RS57640.215/DISJ	576	8x72	1600	70

Optional kits for supervision of capacitor banks **p. 36**

Alpistatic automatic capacitor banks with detuned reactor

Dimensions

AL type enclosures with forced ventilation and integrated smoke detection



SAH type - without 189 Hz circuit breaker (p = 7%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
STS10040.189	2100	800	500	195	AL	
STS12540.189	2100	800	500	215	AL	
STS15040.189	2100	800	500	235	AL	
STS17540.189	2100	800	500	255	AL	
STS20040.189	2100	800	500	275	AL	
STS22540.189	2100	800	500	295	AL	
STS25040.189	2100	800	500	315	AL	
STS27540.189	2100	800	500	335	AL	
STS30040.189	2100	1000	600	360	AL	
STS35040.189	2100	1000	600	395	AL	
STS40040.189	2100	1000	600	430	AL	
STS45040.189	2100	1000	600	470	AL	
STS50040.189	2100	1000	600	510	AL	
STS52540.189	2100	2000	600	640	AL	Yes
STS57540.189	2100	2000	600	680	AL	
STS62540.189	2100	2000	600	720	AL	
STS70040.189	2100	2000	600	780	AL	
STS75040.189	2100	2000	600	820	AL	
STS82540.189	2100	2000	600	880	AL	
STS87540.189	2100	2000	600	920	AL	
STS95040.189	2100	2000	600	980	AL	
STS100040.189	2100	2000	600	1020	AL	
STS112540.189	2100	3000	600	1190	AL	
STS125040.189	2100	3000	600	1360	AL	
STS137540.189	2100	3000	600	1530	AL	
STS150040.189	2100	3000	600	1700	AL	

SAH type - with 189 Hz circuit breaker (p = 7%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
STS10040.189/DISJ	2100	800	500	200	AL	
STS12540.189/DISJ	2100	800	500	220	AL	
STS15040.189/DISJ	2100	800	500	240	AL	
STS17540.189/DISJ	2100	800	500	260	AL	
STS20040.189/DISJ	2100	800	500	280	AL	
STS22540.189/DISJ	2100	1600	500	385	AL	
STS25040.189/DISJ	2100	1600	500	405	AL	
STS27540.189/DISJ	2100	1600	500	430	AL	
STS30040.189/DISJ	2100	2000	600	480	AL	Yes
STS35040.189/DISJ	2100	2000	600	515	AL	
STS40040.189/DISJ	2100	2000	600	550	AL	
STS45040.189/DISJ	2100	2000	600	590	AL	
STS50040.189/DISJ	2100	2000	600	630	AL	
STS52540.189/DISJ	2100	2000	600	650	AL	
STS57540.189/DISJ	2100	2000	600	690	AL	
STS62540.189/DISJ	2100	2000	600	730	AL	
STS70040.189/DISJ	2100	2600	600	790	AL	

Dimensions

Reinforced SAH type - without 215 Hz circuit breaker (p = 5.41%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
STS.R12040.215	2100	800	500	255	AL	
STS.R16040.215	2100	800	500	295	AL	
STS.R20040.215	2100	800	500	335	AL	
STS.R24040.215	2100	800	500	375	AL	
STS.R28040.215	2100	800	500	415	AL	
STS.R32040.215	2100	800	500	455	AL	
STS.R36040.215	2100	800	500	505	AL	
STS.R40040.215	2100	800	500	545	AL	
STS.R44040.215	2100	1000	600	600	AL	
STS.R48040.215	2100	1000	600	640	AL	
STS.R52040.215	2100	2000	600	805	AL	
STS.R56040.215	2100	2000	600	845	AL	Yes
STS.R60040.215	2100	2000	600	885	AL	
STS.R68040.215	2100	2000	600	965	AL	
STS.R72040.215	2100	2000	600	1005	AL	
STS.R80040.215	2100	2000	600	1085	AL	
STS.R84040.215	2100	2000	600	1125	AL	
STS.R92040.215	2100	2000	600	1245	AL	
STS.R96040.215	2100	2000	600	1285	AL	
STS.R108040.215	2100	3000	600	1475	AL	
STS.R120040.215	2100	3000	600	1595	AL	
STS.R132040.215	2100	3000	600	1715	AL	
STS.R144040.215	2100	3000	600	1835	AL	

Reinforced SAH type - with 215 Hz circuit breaker (p = 5.41%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
STS.R12040.215/DISJ	2100	800	500	260	AL	
STS.R16040.215/DISJ	2100	800	500	300	AL	
STS.R20040.215/DISJ	2100	800	500	340	AL	
STS.R24040.215/DISJ	2100	1600	500	465	AL	
STS.R28040.215/DISJ	2100	1600	500	505	AL	
STS.R32040.215/DISJ	2100	1600	500	545	AL	
STS.R36040.215/DISJ	2100	1600	500	585	AL	
STS.R40040.215/DISJ	2100	1600	500	625	AL	Yes
STS.R44040.215/DISJ	2100	2000	600	730	AL	
STS.R48040.215/DISJ	2100	2000	600	770	AL	
STS.R52040.215/DISJ	2100	2000	600	810	AL	
STS.R56040.215/DISJ	2100	2000	600	850	AL	
STS.R60040.215/DISJ	2100	2000	600	890	AL	
STS.R68040.215/DISJ	2100	2000	600	970	AL	

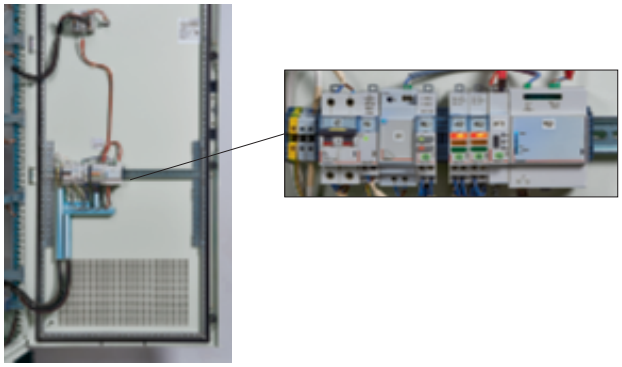
Extra-reinforced SAH type - without 215 Hz circuit breaker (p = 5.41%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
STS.RS14440.215	2100	1000	600	525	AL	
STS.RS21640.215	2100	1000	600	610	AL	
STS.RS28840.215	2100	1000	600	695	AL	
STS.RS36040.215	2100	2000	600	890	AL	
STS.RS43240.215	2100	2000	600	975	AL	
STS.RS50440.215	2100	2000	600	1060	AL	Yes
STS.RS57640.215	2100	2000	600	1145	AL	
STS.RS64840.215	2100	3000	600	1340	AL	
STS.RS72040.215	2100	3000	600	1425	AL	
STS.RS79240.215	2100	3000	600	1510	AL	
STS.RS86440.215	2100	3000	600	1595	AL	

Extra-reinforced SAH type - with 215 Hz circuit breaker (p = 5.41%)

Cat.Nos	Dimensions (mm)			Weight (kg)	Enclosure	Integrated smoke detection
	A	B	C			
STS.RS14440.215/DISJ	2100	1000	600	530	AL	
STS.RS21640.215/DISJ	2100	1000	600	615	AL	
STS.RS28840.215/DISJ	2100	1000	600	745	AL	
STS.RS36040.215/DISJ	2100	2000	600	895	AL	Yes
STS.RS43240.215/DISJ	2100	2000	600	980	AL	
STS.RS50440.215/DISJ	2100	2000	600	1120	AL	
STS.RS57640.215/DISJ	2100	2000	600	1205	AL	

Optional kits for supervision of capacitor banks



KPFNWS23

Technical characteristics **p. 37**

Can be used to make a new capacitor bank smart
Factory-wired and assembled (order with a new capacitor bank)
Can be used for remote control, status feedback and measurement of electrical values

Level 1 optional kits

Can be used to control the capacitor bank via the power factor controller which manages step control (ON/OFF)
If smoke is detected, the main circuit breaker trips automatically to switch off the capacitor bank power supply

For capacitor banks without a circuit breaker

Pack	Cat.Nos	Supply voltage (V)	Type of kit
1	KPFSWS23	230	with Web server
1	KPFSGT23	230	with IP interface
1	KPFSWS40	400	with Web server
1	KPFSGT40	400	with IP interface

For capacitor banks with integrated circuit breaker

Pack	Cat.Nos		
1	KPFSWSD23	230	with Web server
1	KPFSGTD23	230	with IP interface
1	KPFSWSD40	400	with Web server
1	KPFSGTD40	400	with IP interface

Level 2 optional kits

Can be used to control the capacitor bank via the power factor controller which manages step control (ON/OFF) and trip the circuit breaker remotely via Nemo SX supervision modules
If smoke is detected, the main circuit breaker trips automatically to switch off the capacitor bank power supply and send a dedicated email alert

For capacitor banks without a circuit breaker

Pack	Cat.Nos	Supply voltage (V)	Type of kit
1	KPFNWS23	230	with Web server
1	KPFNGT23	230	with IP interface
1	KPFNWS40	400	with Web server
1	KPFNGT40	400	with IP interface

For capacitor banks with integrated circuit breaker

Pack	Cat.Nos		
1	KPFNWSD23	230	with Web server
1	KPFNGTD23	230	with IP interface
1	KPFNWSD40	400	with Web server
1	KPFNGTD40	400	with IP interface

For additional web servers and IP interfaces
see opposite

Combined units for supervision of existing capacitor banks

KPFRWS23

KPFRGT23

Technical characteristics **p. 37**

Can be used to make a capacitor bank smart in an existing installation
Can be used for remote control, status feedback and measurement of electrical values
Ready-to-use Plexo³ prewired combined units

Level 2 combined units

Can be used to control the capacitor bank via the power factor controller which manages step control (ON/OFF) and trip the circuit breaker remotely via Nemo SX supervision modules
If smoke is detected, the circuit breaker trips automatically to switch off the capacitor bank power supply and send a dedicated email alert

For installation with 1 capacitor bank

For capacitor bank with or without a circuit breaker

Pack	Cat.Nos	Supply voltage (V)	Type of kit
1	KPFRWS23	230	with Web server

For installation with a number of capacitor banks

For capacitor bank with or without a circuit breaker

Pack	Cat.Nos	Supply voltage (V)	Type of kit
1	KPFRGT23	230	with IP interface

Additional products

For installations equipped with smart capacitor banks

Web servers

Enable remote viewing via a web browser on a number of PCs, smartphones, web screens, tablet computers etc, of values collected on protection, measurement and supervision devices

Pack	Cat.Nos	
1	SXWS10	For 10 MODBUS addresses
1	SXWS32	For 32 MODBUS addresses
1	SXWS255	For 255 MODBUS addresses

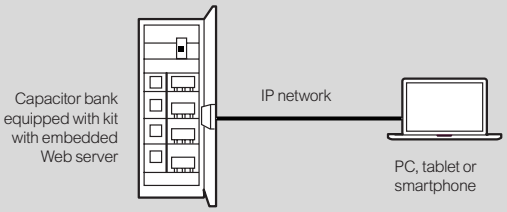
IP interface

Pack	Cat.Nos	
1	SXIIP	230 V RS485/IP communication interface

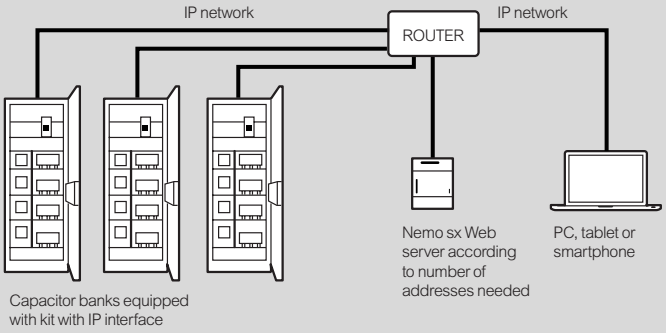
Optional kits for supervision of capacitor banks

Schematic diagram

Example for 1 capacitor bank in the installation



Example for a number of capacitor banks in the installation



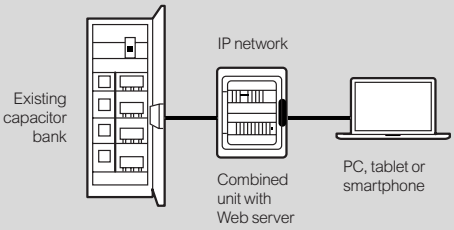
Compatibility of automatic capacitor banks

Type of capacitor bank	New capacitor bank with factory-wired/assembled kit	
	Level 1	Level 2
Alpistatic with detuned reactors	Yes	Please consult us
Alpimatic with detuned reactors	Yes	Yes
Alpimatic without detuned reactors with nominal power > 150 kVAr	Yes	-

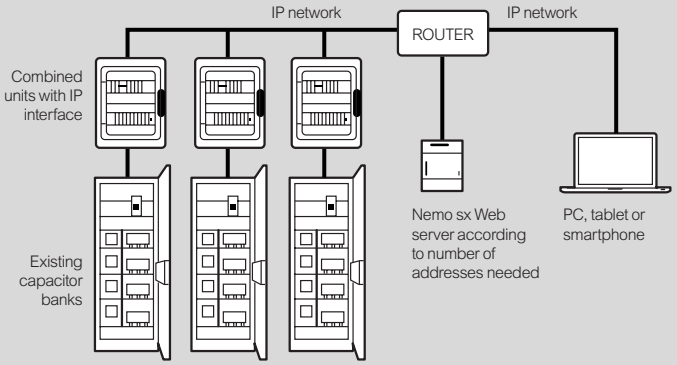
Combined units for supervision of existing capacitor banks

Schematic diagram

Example for 1 existing capacitor bank in the installation: cabinet with web server



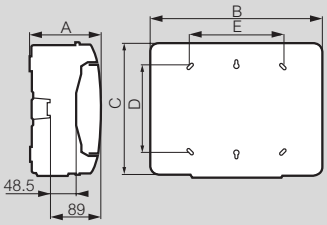
Example for a number of existing capacitor banks in the installation: cabinet with IP interface



Compatibility of automatic capacitor banks

Type of capacitor bank	Retrofit with combined unit
	Level 2
Alpistatic with detuned reactors	Yes
Alpimatic with detuned reactors	Yes
Alpimatic without detuned reactors with nominal power > 150 kVAr	Yes

Dimensions



Cat.Nos	Dimensions (mm)				
	A	B	C	D	E
KPFRWS23 KPFRGT23	161	340	432	330	180

Safety kits for existing capacitor banks (retrofit)

KSSNM

KSSVM

Technical characteristics **opposite**

Safety kits are used for enhanced capacitor bank monitoring in an existing installation as they check for presence of smoke inside the enclosure.
In the event of a fault, they:
- immediately disconnect the step power supply via the GE (generator) load-shedding contact
- switch off the ventilation in kits with forced ventilation
- signal the fault locally by means of an audible signal via an integrated buzzer
- signal the fault remotely by making available an NC contact on terminals to be connected to activate a technical alarm for example.

Pack	Cat.Nos	**Surface-mounted safety kits**
		For capacitor banks with forced ventilation IP20 Installed on the existing fan tray
1	KSSVM	Master kit Equipped with a integrated 80 dB buzzer + 1 NC contact on terminals to be connected by the customer
1	KSSVS	Slave kit
		For capacitor banks with natural ventilation IP30 Installed on the free cable gland plate: cable entry at the bottom
1	KSSNM	Master kit Equipped with a integrated 80 dB buzzer + 1 NC contact on terminals to be connected by the customer
1	KSSNS	Slave kit
		Rack-mounted safety kits
		For capacitor banks with natural ventilation IP 2X Installed in the enclosure when the cable gland plate is not available: cable entry at the top
1	KSRNM	Master kit Equipped with a integrated 80 dB buzzer + 1 NC contact on terminals to be connected by the customer
1	KSRNS	Slave kit

Enclosure compatibility

References	Mounting	Type of ventilation	Master/ Slave	IP	Alpimatic/Alpistatic enclosures		
					AL type (2100 mm)	PL2 type (1400/ 1900 mm)	PL1 type (770 mm)
KSSVM	Surface	Forced	Master	IP20	With and without circuit breaker	No	No
KSSVS			Slave				
KSSNM	Surface	Natural	Master	IP30	No	Supply via the bottom	No
KSSNS			Slave				
KSRNM	Rack	Natural	Master	IP2X	No	Supply via the top	No
KSRNS			Slave				

Natural ventilation

Number of cubicles in the enclosure to be protected	Master kit: KSSNM/KSRNM	Slave kit: KSSNS/KSRNS
1	1	-
2	1	1
3	1	2

Supply via the bottom

➔ Master surface-mounting kit
+ one Slave surface-mounting kit per cubicle

Each cubicle supplied via the top

➔ Master rack-mounting kit
+ one Slave rack-mounting kit per cubicle

A single cubicle supplied via the top

Eg: enclosure with standard circuit breaker

➔ Master rack-mounting kit
+ one Slave surface- or rack-mounting kit per cubicle

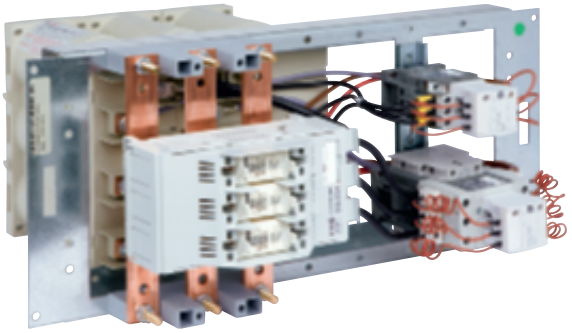
Surface-mounting forced ventilation

Number of cubicles in the enclosure to be protected	Master kit: KSSVM	Slave kit: KSSVS
1	1	-
2	1	1
3	1	2

Supply via the top or the bottom

➔ Master surface-mounting kit
+ one Slave surface-mounting kit per cubicle

Alpimatic racks



P255040

Technical characteristics **opposite**

400 V - 50 Hz three-phase network
Factory-connected units for integration in universal or distribution enclosures for automatic compensation systems
H type:
- 1 Alpivar 3 capacitor
- 1 or 2 CTX³ contactors with damping resistor suitable for capacitive currents for step control
- 1 set of 3 HRC fuses
- 1 set of modular copper busbars with junction bars for connecting several racks
- 1 steel frame on which the components are assembled and wired

Pack	Cat.Nos	H type Max. harmonic pollution level THDU ≤ 4%, THDI ≤ 15%	
		Nominal power (kVAr)	For enclosures width (mm)
1	PH12.540	12.5	600
1	PH12.512.540	12.5+12.5	600
1	PH2540	25	600
1	PH252540	25+25	600
1	PH5040	50	600
1	PH255040	25+50	600
1	PH7540	75	600

CTX³ contactors **p. 51**

Alpimatic racks

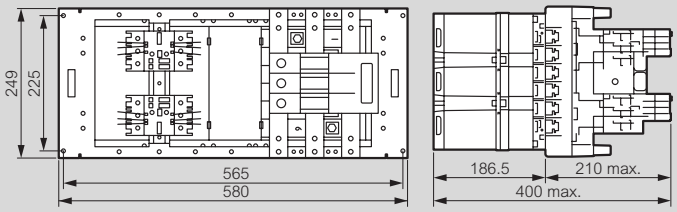
Technical specifications

Loss factor
H type Alpimatic racks have a loss factor of approximately 2 W/kVAr

Standards
Racks for integration in automatic compensation systems complying with standard IEC 61921

Temperature class
• operation: max. +45°C (average over 24 hours: 40°C)

Dimensions

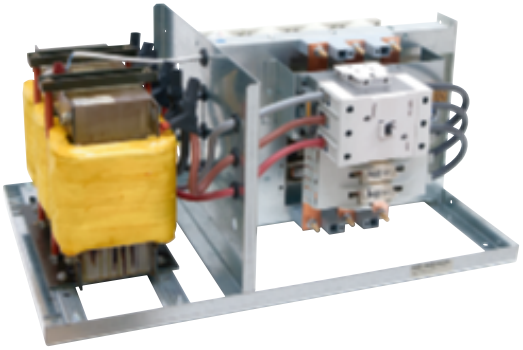


H type

	Weight (kg)
PH12.540	14
PH12.512.540	17
PH2540	14
PH252540	17
PH5040	17
PH255040	20
PH7540	20

Alpimatic racks with detuned reactor

Alpimatic racks with detuned reactor



R7.R8040.215

Technical characteristics **opposite**

400 V - 50 Hz three-phase network
Factory-connected units for integration in universal or distribution enclosures for automatic compensation systems
SAH versions (with detuned reactor):
- 1 Alpivar 3 capacitor
- 1 CTX³ electromechanical contactor for step control
- 1 detuned reactor with thermal protection
- 1 set of 3 HRC fuses
- 1 set of modular copper busbars with junction bars for connecting several racks
- 1 steel frame on which the components are assembled and wired

SAH type

Max. harmonic pollution level
THDU ≤ 6%, THDI ≤ 30%
189 Hz (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	For enclosures width (mm)
1	R5.12.540.189	12.5	600
1	R5.2540.189	25	600
1	R5.5040.189	50	600
1	R7.12.540.189	12.5	800
1	R7.2540.189	25	800
1	R7.5040.189	50	800
1	R7.7540.189	75	800

Reinforced SAH type

Max. harmonic pollution level
THDU ≤ 8%, THDI ≤ 40%
189 Hz (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	For enclosures width (mm)
1	R5.R2040.189	20	600
1	R5.R4040.189	40	600
1	R7.R2040.189	20	800
1	R7.R4040.189	40	800
1	R7.R8040.189	80	800

Extra-reinforced SAH type

Max. harmonic pollution level
THDU ≤ 11%, THDI ≤ 55%
215 Hz (p = 5.41%)
At this level of harmonic pollution, we strongly recommend that you contact us to take measurements on site

Pack	Cat.Nos	Nominal power (kVAr)	For enclosures width (mm)
1	R9.RS7240.215	72	1000

Technical specifications

Loss factor

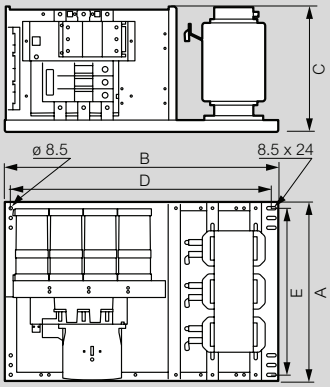
Alpimatic racks with detuned reactor have a loss factor of approximately 6 W/kVAr

Standards

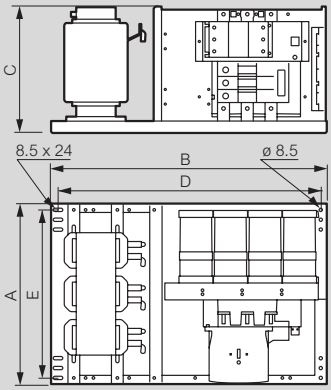
Racks for integration in automatic compensation systems complying with standard IEC 61921

Dimensions

Racks for 600 mm wide enclosures



Racks for 800 and 1000 mm wide enclosures



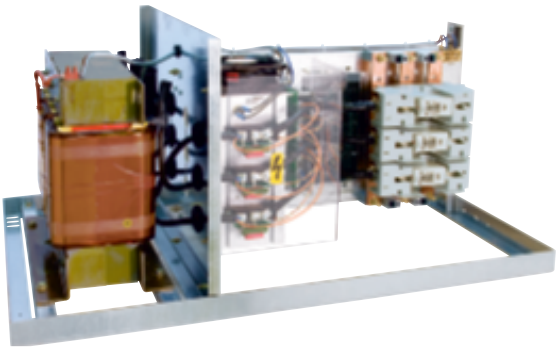
SAH type	Dimensions (mm)					
	A	B	C	D	E	Weight (kg)
R5.12.540.189	458	500	325	468	425	34
R5.2540.189	458	500	325	468	425	34
R5.5040.189	458	500	325	468	425	40
R7.12.540.189	458	700	325	665	425	35
R7.2540.189	458	700	325	665	425	35
R7.5040.189	458	700	325	665	425	41
R7.7540.189	458	700	325	665	425	50

Reinforced SAH type	Dimensions (mm)					
	A	B	C	D	E	Weight (kg)
R5.R2040.189	458	500	325	468	425	45
R5.R4040.189	458	500	325	468	425	47
R7.R2040.189	458	700	325	665	425	46
R7.R4040.189	458	700	325	665	425	48
R7.R8040.189	458	700	325	665	425	78

Extra-reinforced SAH type	Dimensions (mm)					
	A	B	C	D	E	Weight (kg)
R9.RS7240.215	558	900	400	865	425	90

Alpistatic racks with detuned reactor

Alpistatic racks with detuned reactor



RST7.2540.215

Technical characteristics **opposite**

400 V - 50 Hz three-phase network
Factory-connected units for integration in universal or distribution enclosures for automatic compensation systems
Comprise:
- 1 Alpivar 3 capacitor
- 1 thyristor-controlled solid state contactor for step control
- 1 detuned reactor
- 1 set of 3 HRC fuses
- 1 set of modular copper busbars with junction bars for connecting several racks
- 1 steel frame on which the components are assembled and wired

SAH type

Max. harmonic pollution level
THDU ≤ 6%, THDI ≤ 30%
189 Hz (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	For enclosures width (mm)
1	RST7.2540.189	25	800
1	RST7.5040.189	50	800
1	RST7.7540.189	75	800
1	RST9.10040.189	100	1000
1	RST9.12540.189	125	1000

Reinforced SAH type

Max. harmonic pollution level
THDU ≤ 8%, THDI ≤ 40%
189 Hz (p = 7%)

Pack	Cat.Nos	Nominal power (kVAr)	For enclosures width (mm)
1	RST7.R4040.189	40	800
1	RST7.R8040.189	80	800
1	RST9.R12040.189	120	1000

Extra-reinforced SAH type

Max. harmonic pollution level
THDU ≤ 11%, THDI ≤ 55%
215 Hz (p = 5.41%)
At this level of harmonic pollution, we strongly recommend that you contact us to take measurements on site

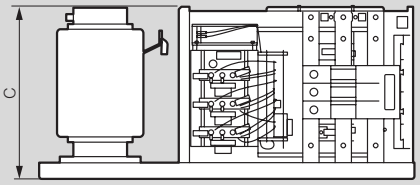
Pack	Cat.Nos	Nominal power (kVAr)	For enclosures width (mm)
1	RST9.RS7240.215	72	1000

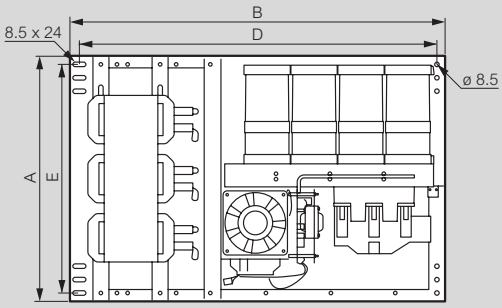
Technical specifications

Standards

Racks for integration in dynamic compensation systems complying with standard IEC 61921

Dimensions





SAH type	Dimensions (mm)					
	A	B	C	D	E	Weight (kg)
RST7.2540.189	458	700	325	665	425	49
RST7.5040.189	458	700	325	665	425	57
RST7.7540.189	458	700	325	665	425	62
RST9.10040.189	458	700	325	665	425	80
RST9.12540.189	458	700	325	665	425	90

SAH type Reinforced	Dimensions (mm)					
	A	B	C	D	E	Weight (kg)
RST7.R4040.189	458	700	325	665	425	62
RST7.R8040.189	458	700	325	665	425	82
RST9.R12040.189	458	700	325	665	425	90

Extra SAH type Reinforced	Dimensions (mm)					
	A	B	C	D	E	Weight (kg)
RST9.RS7240.215	558	900	400	865	425	95

Alptec 3.2/5.2/8.2 and Alptec 8 automatic power factor controllers

ALPTEC3.2

ALPTEC8.2

ALPTEC8

Technical characteristics **p. 44-47**

Pack	Cat.Nos	Alptec 3.2/5.2/8.2 automatic power factor controllers
		Control connection and disconnection of steps in order to maintain the target power factor Detect critical operating conditions and generate alarms for each type of fault. Connection on single and three-phase lines, three-phase lines with neutral control and cogeneration systems with operation in 4 quadrants. For use with medium voltage applications • Main functions: - setting the power factor adjustment range - automatic identification of the CT current direction - fewer switching operations - balancing of steps with similar nominal power - reactive power measurement for each installed step - recording the number of connections per step - “overcurrents and overloads” alarm - “temperature rise via the internal sensor” alarm - “undervoltage” alarm - analysis of harmonics and protection according to the level of THDU THDI - CT quick programming function • Equipped with: - optical USB port on the front for controller programming, diagnostics and downloading data - backlit LCD screen for easy data reading, including when the lighting conditions are poor (6 languages available) - USB and Wi-Fi communication interface for connection to a computer, smartphone or tablet Can be equipped with special extension modules to extend their functionality Conform to standards IEC 61010-1, IEC/EN 61000-6-2, IEC/EN 61000-6-3, UL508, CSA C22.2 no. 14
1	ALPTEC3.2	3 steps with possible extension to 6 steps; Takes 1 extension module
1	ALPTEC5.2	5 steps with possible extension to 8 steps; Takes 1 extension module
1	ALPTEC8.2	8 steps with possible extension to 14 steps; Takes up to 2 extension modules

Pack	Cat.Nos	Alptec 8 power factor controller
1	ALPTEC8	8 steps with possible extension to 18 steps maximum. Takes up to 4 extension modules. Controls connection and disconnection of steps in order to maintain the target power factor Detects critical operating conditions and generates alarms for each type of fault. Connection on single and three-phase lines, three-phase lines with neutral control and cogeneration systems with operation in 4 quadrants. For use with medium voltage applications • Main functions: - setting the power factor or tangent phi adjustment range - automatic identification of the CT current direction - fewer switching operations - balancing of steps with similar nominal power - reactive power measurement for each installed step - recording the number of connections per step - “overcurrents and overloads on all three phases” alarm - “temperature rise via the internal sensor” alarm - “undervoltage” alarm - analysis of current and voltage harmonics - analysis of current and voltage waveforms recorded for overload events - CT quick programming function • Equipped with: - optical USB port on the front for controller programming, diagnostics and downloading data - backlit LCD screen for easy data reading, including when the lighting conditions are poor (10 languages available) - USB and Wi-Fi communication interface for connection to a computer, smartphone or tablet Can be equipped with special extension modules to extend its functionality Conforms to standards IEC 61010-1, IEC/EN 61000-6-2, IEC/EN 61000-6-3, UL508, CSA C22.2 no. 14

Accessories for Alptec automatic power factor controllers

EXT2GR

Technical characteristics **p. 44-47**

Pack	Cat.Nos	Extension modules
		For mounting on the back of the power factor controller
		Output extension module for Alptec 8 and Alptec 3.2/5.2/8.2
1	EXT2GR	2 relay outputs Can be used to increase the number of steps
1	EXT3GR	3 relay outputs Can be used to increase the number of steps
		Output extension module for Alptec 8
1	EXT4GRS	4 solid state outputs - optically isolated. For applications using solid state contactors
1	EXTHARM	Protection against harmonics
		Communication module for Alptec 8 and Alptec 3.2/5.2/8.2
1	EXTRS485	Optically-isolated RS485 communication interface
		Communication module for Alptec 8 and Alptec 8.2
1	EXTETH	Optically-isolated Ethernet communication interface
1	EXTPROFI	Optically-isolated Profibus DP interface

Pack	Cat.Nos	Communication accessories
		These communication devices can be used to connect Alptec power factor controllers to a computer, smartphone or tablet
1	4 226 87[1]	**USB connection device** Computer connection cable with USB connector For Alptec 8 and Alptec 3.2/5.2/8.2 For programming, downloading data, diagnostics and upgrading the firmware The computer identifies the connection as a standard USB connection. There is no need to switch off the controller power supply
1	4 226 88[1]	**Wi-Fi connection device** Wi-Fi connection device compatible with computers, smartphones and tablets For Alptec 8 and Alptec 3.2/5.2/8.2 For programming, downloading data, diagnostics and upgrading the firmware

1: Configuration software available on request
Please consult us

Current transformers (CT)

4 121 62

Technical characteristics **p. 47**

Pack	Cat.Nos	Split core current transformers		
		Can be combined with ammeters, electricity meters, measurement control units or power factor controllers (for calculating the cos φ as well as the voltage reference) 5 A secondary current For fixing on a bar When used with power factor controllers, current transformers must be positioned on a different phase to the one for the voltage (L1 as standard) upstream of all the loads to be compensated Secondary connection by terminals, or by a lug Precision 0.5%		
		For 50 x 80 mm bar	Transformation ratio	Power (VA)
1	4 121 62		400/5	1.5
1	4 121 63		800/5	3
		For 80 x 120 mm bar		
1	4 121 64		1000/5	5
1	4 121 65		1500/5	8
		For 80 x 160 mm bar		
1	4 121 66		2000/5	15
1	4 121 67		2500/5	15
1	4 121 68		3000/5	20
1	4 121 69		4000/5	20

Alptec automatic power factor controllers: functionality

Technical characteristics

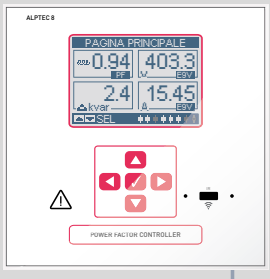
	Alptec 3.2/5.2/8.2	Alptec 8
Number of steps	**Alptec 3.2 (up to 6 with EXT2GR/ EXT3GR) Alptec 5.2 (up to 8 with EXT2GR/ EXT3GR) Alptec 8.2 (up to 14 with EXT2GR/ EXT3GR)**	**Alptec 8 (up to 18 with EXT2GR/EXT3GR)**
FRONT PANEL/CASING		
Screen	Backlit LCD with icons	Backlit graphic LCD 128 x 80 pixels
Languages	6 alarm codes (scrolling text) Italian, English, Spanish, French, German, Portuguese	10 Italian, English, Spanish, French, German, Czech, Polish, Russian, Portuguese and 1 customisable
IEC protection index	IP54	IP54
Extendable with modules EXT...	•	•
CONTROL/FUNCTIONS		
automatic identification of the current direction	•	•
Operation in 4 quadrants	•	•
Master/slave architecture		•
Separate input for the auxiliary power supply	•	•
Three-phase voltage control		•
Current inputs	1 (per CT, /5 A or /1 A)	3 (per CT, /5 A or /1 A)
Use of dynamic compensation (FAST)		• (with EXT4GRS)
Use with medium voltage	•	•
Separate compensation for each phase		•
Phase-neutral connection on three-phase system	•	•
Isolated RS485 communication interface	• (with EXTRS485)	• up to 16 solid state steps (with EXTRS485)
Quick current transformer programming	•	•
Configuration software and automatic distribution board test	•	•
Remote control software	•	•
Time and date (RTC) on battery for standalone operation		•
Event log: alarms, modification of settings, etc.		•
MEASUREMENT		
Rated measurement voltage	600 VAC max	600 VAC max
Voltage measurement range	50-720 VAC	50-720 VAC
Instantaneous cos ø (displacement factor)	•	•
Power factor - instantaneous and average weekly	•	•
Voltage and current	•	•
Reactive power to achieve the setpoint and total	•	•
Capacitor overload	•	•
Control panel temperature	•	•
Maximum voltage and current value	•	•
Maximum capacitor overload value	•	•
Maximum control panel temperature value	•	•
Active apparent power		•
Analysis of current and voltage harmonics	• up to 15th order	• up to 31st order
Measured value of each step, in VAr	•	•
Number of switching operations per step	•	•
ALARMS		
Voltage too high and too low	•	•
Current too high and too low	•	•
Overcompensation	•	•
Under-compensation	•	•
Capacitor overload	•	•
Capacitor overload on all 3 phases		•
Overheating	•	•
Micro-power cuts	•	•
Failure of a capacitor bank	•	•
Overshoot of maximum current harmonic distortion level	•	•
Programming alarm properties (activation, delay on tripping, relay excitation, etc)		•

Alptec automatic power factor controllers: functionality (continued)

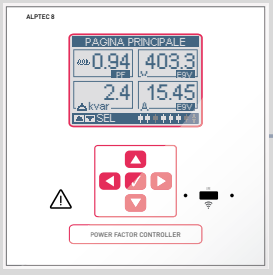
The Alptec 8 controller's basic functions can easily be extended:

- Optically-isolated solid state outputs for dynamic compensation
- Ethernet interface
- Optically-isolated Profibus-DP interface

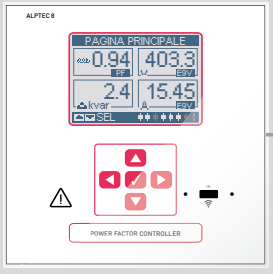
Master/slave function



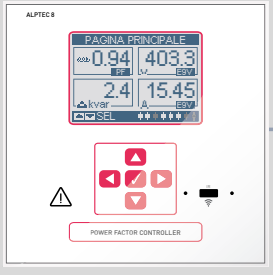
Master



Slave 1



Slave 2



Slave 8

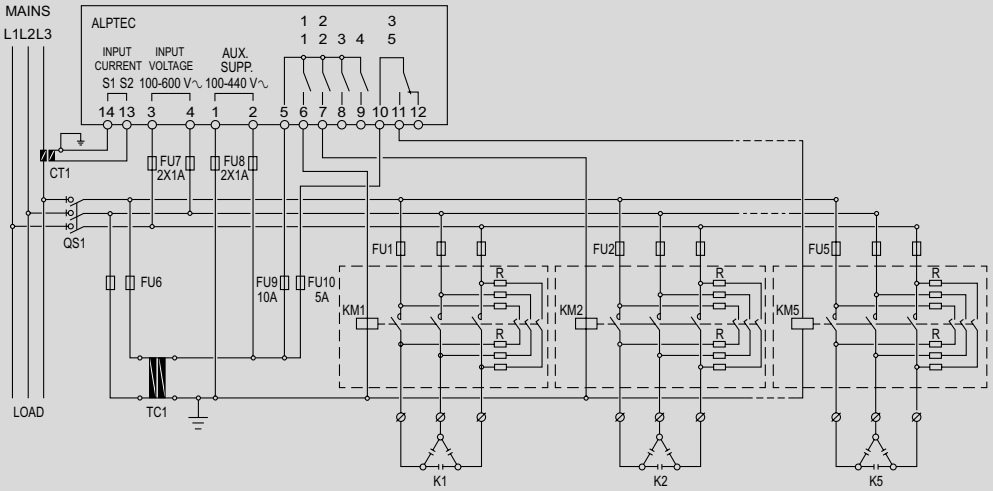
The Alptec 8 controller can be used to control the outputs of other analogue controllers as well its own steps. It therefore offers a master/slave architecture. Up to 8 slaves can be controlled, resulting in a system with a maximum of 32 steps.

Alptec 3.2/5.2/8.2 and Alptec 8 automatic power factor controllers

Technical characteristics

	ALPTEC 3.2/5.2/8.2	ALPTEC 8
AUXILIARY POWER SUPPLY CIRCUIT		
Nominal auxiliary voltage Us	100-440 VAC	100-415 VAC
Operating range	-10 to +10%	-10 to +10%
Nominal frequency	50 Hz or 60 Hz ∿ 10%	50 Hz or 60 Hz ∿ 10%
Maximum consumption	9.5 VA	27 VA
Maximum dissipation (excluding output contacts)	3.5 W	4.5 W
VOLTAGE CIRCUIT		
Control voltage	100-600 VAC	100-600 VAC
Operating range	50-720 VAC	50-720 VAC
Nominal frequency	50 or 60 Hz ∿ 10%	50 or 60 Hz ∿ 10%
Micro-cut immunity time	35 ms (110 VAC) - 80 ms (220-415 VAC)	35 ms (110 VAC) - 80 ms (220-415 VAC)
CURRENT CIRCUIT		
Nominal current Ie	Programmable 5 A/1 A	Programmable 5 A/1 A
Operating range	0.025-6 A for 5 A CT/0.025-1.2 A for 1 A CT	0.025-6 A for 5 A CT/0.025-1.2 A for 1 A CT
Constant overload	1.2 Ie	1.2 Ie
Rated short time withstand current	50 Ie for 1 s	50 Ie for 1 s
Current consumption	0.6 VA	0.6 VA
MEASUREMENT DATA		
Type of voltage/current measurement	TRMS	TRMS
Power factor adjustment	0.5 inductive to 0.5 capacitive	0.5 inductive to 0.5 capacitive
RELAY OUTPUTS		
Number of outputs	3, 5 or 8 (can be extended with EXT2GR/EXT3GR)	8 (up to 18 with EXT2GR/EXT3GR)
Contact layout	2/4 NO (SPST) + 1 throw (SPDT)	7 NO (SPST) + 1 throw (SPDT)
IEC nominal capacity	5 A 250 V (AC1)	5 A 250 V (AC1)
Maximum capacity of the common contact terminal	10 A	10 A
Maximum switching voltage	415 VAC	415 VAC
UL/CSA and IEC/EN 60947-5-1 designation	B300	B300
Electrical service life (at nominal load)	10^5 cycles	10^5 cycles
Mechanical life	30 x 10^6 cycles	30 x 10^6 cycles
SOLID STATE OUTPUTS		
Number of outputs	-	up to 16 with EXT4GRS
CONNECTIONS		
Terminal type	Removable/plug-in	Removable/plug-in
Conductor cross-section (min./max.)	0.2-2.5 mm² (24-12 AWG)	0.2-2.5 mm² (24-12 AWG)
AMBIENT CONDITIONS		
Working temperature	- 20... 60°C	- 20... 70°C
Storage temperature	- 30... 80°C	- 30... 80°C
CASING		
IEC protection index	IP 54	IP 54

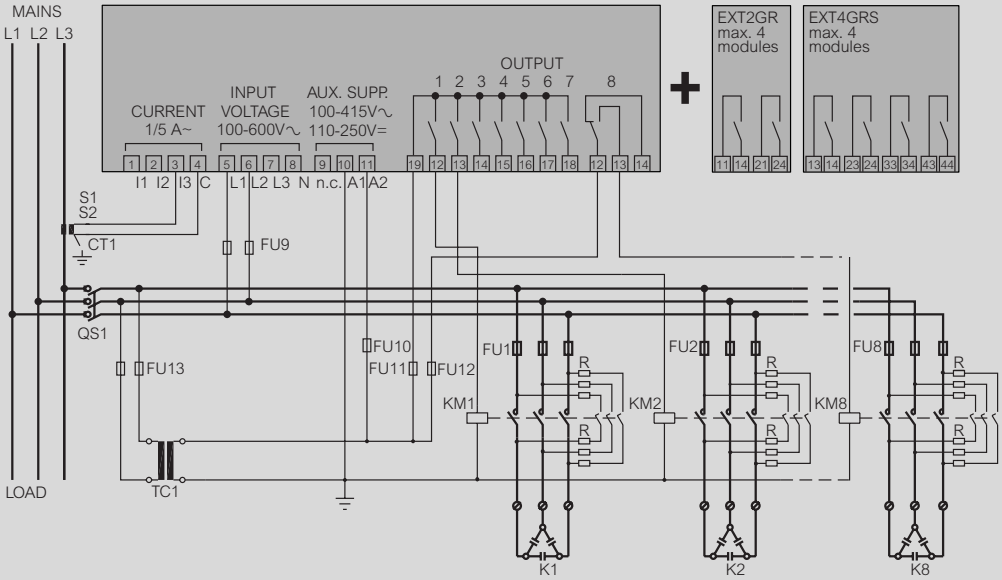
ALPTEC 3.2/5.2 standard three-phase wiring diagram



For ALPTEC 8.2 wiring diagram
please consult us

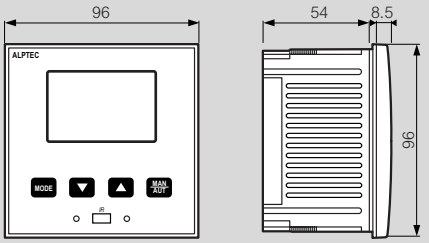
Alptec 3.2/5.2/8.2 and Alptec 8 automatic power factor controllers
Current transformers

ALPTEC 8 standard three-phase wiring diagram

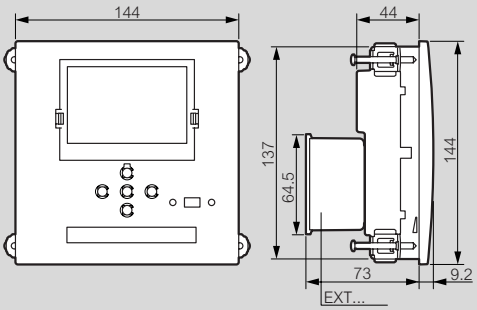


Alptec dimensions

Alptec 3.2/5.2

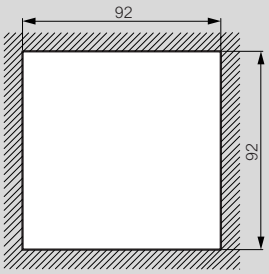


Alptec 8.2 and 8

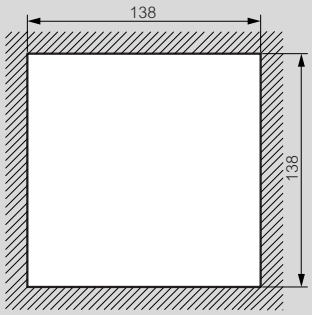


Alptec cut-out

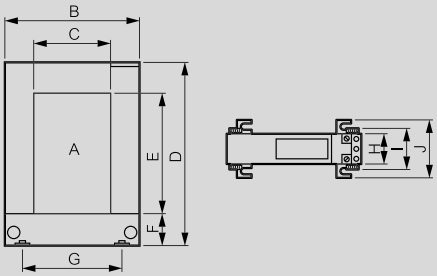
Alptec 3.2/5.2



Alptec 8.2 and 8



Current transformer dimensions



Cat.Nos	A	B	C	D	E	F	G	H	I	J
4 121 62/63	50 x 80	114	50	145	80	33	78	32	46	69
4 121 64/65	80 x 120	144	80	185	121	32	108	32	46	69
4 121/66/67/68/69	80 x 160	184	80	245	160	38	120	32	46	69

ALPES TECHNOLOGIES

Selection guide: cross-sections of conductors for supplying automatic capacitor banks without a main circuit breaker

Power (kVAr)	In (A)	Circuit breaker model recommended upstream	In rating (A)	Setting Ir (A)	COPPER			
					Single enclosure (1 connection point)		Double enclosure (2 connection points)	
					Recommended section[1] (mm²)	Maximum capacity[3] (mm²)	Recommended section[1] (mm²)	Maximum capacity[3] (mm²)
10	14	DPX³ 160	25	25	6	70	-	-
12.5	18		25	25	6	70	-	-
15	22		40	40	6	70	-	-
20	29		40	40	6	70	-	-
25	36		63	63	16	70	-	-
30	43		63	63	16	70	-	-
35	51		100	100	16	70	-	-
37.5	54		100	100	16	70	-	-
40	58		100	100	16	70	-	-
45	65		100	100	25	70	-	-
50	72		100	100	25	70	-	-
60	87		125	125	35	70	-	-
75	108		160	160	50	70	-	-
87.5	126	DPX³ 250	200	180	70	2 × 70	-	-
100	144		200	200	70	2 × 70	-	-
125	180		250	250	2 × 50	2 x 70	-	-
150	217	DPX³ 630	320	288	120	2 × 240	-	-
160	231		320	320	120	2 × 240	-	-
175	253		400	360	150	2 × 240	-	-
200	289		400	400	185	2 × 240	-	-
225	325		500	450	185	2 × 240	-	-
240	346		500	500	240	2 × 240	-	-
250	361		500	500	240	2 × 240	-	-
275	397		630	567	2 × 120	2 x 240	-	-
280	404		630	567	2 × 120	2 x 240	120 (x2)	2 x 240 (x2)
300	433		630	567	2 × 120	2 x 240	120 (x2)	2 x 240 (x2)
320	462		630	567	2 × 120	2 x 240	120 (x2)	2 x 240 (x2)
350	505	DPX³ 1600	800	720	2 × 150	2 x 240	150 (x2)	2 x 240 (x2)
360	520		800	720	2 × 150	2 x 240	150 (x2)	2 x 240 (x2)
400	577		800	800	2 × 185	2 x 240	185 (x2)	2 x 240 (x2)
440	635		1000	900	2 × 240	2 x 240	240 (x2)	2 x 240 (x2)
450	650		1000	900	2 × 240	2 x 240	240 (x2)	2 x 240 (x2)
480	693		1000	1000	-	-	240 (x2)	2 x 240 (x2)
500	722		1000	1000	-	-	240 (x2)	2 x 240 (x2)
520	751		1000	1000	-	-	240 (x2)	2 x 240 (x2)
550	794		1250	1125	-	-	2 x 120 (x2)	2 x 240 (x2)
560	808		1250	1125	-	-	2 x 120 (x2)	2 x 240 (x2)
600	866		1250	1250	-	-	2 x 120 (x2)	2 x 240 (x2)
640	924		1250	1250	-	-	2 x 120 (x2)	2 x 240 (x2)
675	974		1600	1267	-	-	2 x 120 (x2)	2 x 240 (x2)
720	1039		1600	1352	-	-	2 x 120 (x2)	2 x 240 (x2)
750	1083		1600	1408	-	-	2 x 150 (x2)	2 x 240 (x2)
800	1155		1600	1502	-	-	2 x 150 (x2)	2 x 240 (x2)
825	1191		1600	1549	-	-	2 x 150 (x2)	2 x 240 (x2)
900	1299		1600	1600	-	-	2 x 150 (x2)	2 x 240 (x2)

1: Indicative values based on standard IEC 60364 for conductors made of Copper.
2: Indicative values based on standard IEC 60364 for conductors made of Aluminium.
These cross-sections may vary according to local regulations, the ambient temperature around the conductor, the installation method, line lengths, etc.
3: The connection options vary according to the type of accessory and type of conductor used.

The recommended cross-sections indicated in the tables are given for information only and are calculated for single-pole cables with an ambient temperature of 30°C.
They do not take account of additional correction factors:
- Installation method: trunking or cable trough
- Very long lines to be used
- Ambient temperature around the cables

COPPER		ALUMINIUM					
Triple enclosure (3 connection points)		Single enclosure (1 connection point)		Double enclosure (2 connection points)		Triple enclosure (3 connection points)	
Recommended section[1] (mm²)	Maximum capacity[3] (mm²)	Recommended section[2] (mm²)	Maximum capacity[3] (mm²)	Recommended section[2] (mm²)	Maximum capacity[3] (mm²)	Recommended section[2] (mm²)	Maximum capacity[3] (mm²)
-	-	10	70	-	-	-	-
-	-	10	70	-	-	-	-
-	-	10	70	-	-	-	-
-	-	10	70	-	-	-	-
-	-	16	70	-	-	-	-
-	-	16	70	-	-	-	-
-	-	25	70	-	-	-	-
-	-	25	70	-	-	-	-
-	-	25	70	-	-	-	-
-	-	35	70	-	-	-	-
-	-	35	70	-	-	-	-
-	-	50	70	-	-	-	-
-	-	70	70	-	-	-	-
-	-	2 x 35	2 x 70	-	-	-	-
-	-	2 x 50	2 x 70	-	-	-	-
-	-	2 x 70	2 x 70	-	-	-	-
-	-	150	2 × 240	-	-	-	-
-	-	185	2 × 240	-	-	-	-
-	-	240	2 × 240	-	-	-	-
-	-	240	2 × 240	-	-	-	-
-	-	2 x 120	2 x 240	-	-	-	-
-	-	2 x 120	2 x 240	-	-	-	-
-	-	2 x 120	2 x 240	-	-	-	-
-	-	2 x 150	2 x 240	-	-	-	-
-	-	2 x 150	2 x 240	150 (x2)	2 x 240 (x2)	-	-
-	-	2 x 150	2 x 240	150 (x2)	2 x 240 (x2)	-	-
-	-	2 x 185	2 x 240	185 (x2)	2 x 240 (x2)	-	-
-	-	2 x 240	2 x 240	240 (x2)	2 x 240 (x2)	-	-
-	-	2 x 240	2 x 240	240 (x2)	2 x 240 (x2)	-	-
-	-	2 x 240	2 x 240	240 (x2)	2 x 240 (x2)	-	-
-	-	-	-	2 x 120 (x2)	2 x 240 (x2)	-	-
-	-	-	-	2 x 120 (x2)	2 x 240 (x2)	-	-
-	-	-	-	2 x 120 (x2)	2 x 240 (x2)	-	-
-	-	-	-	2 x 120 (x2)	2 x 240 (x2)	-	-
-	-	-	-	2 x 120 (x2)	2 x 240 (x2)	-	-
-	-	-	-	2 x 150 (x2)	2 x 240 (x2)	-	-
-	-	-	-	2 x 150 (x2)	2 x 240 (x2)	-	-
185 (x3)	2 x 240 (x3)	-	-	2 x 185 (x2)	2 x 240 (x2)	2 x 95 (x3)	2 x 240 (x3)
185 (x3)	2 x 240 (x3)	-	-	2 x 185 (x2)	2 x 240 (x2)	2 x 95 (x3)	2 x 240 (x3)
185 (x3)	2 x 240 (x3)	-	-	2 x 185 (x2)	2 x 240 (x2)	2 x 95 (x3)	2 x 240 (x3)
185 (x3)	2 x 240 (x3)	-	-	2 x 185 (x2)	2 x 240 (x2)	2 x 95 (x3)	2 x 240 (x3)
240 (x3)	2 x 240 (x3)	-	-	2 x 185 (x2)	2 x 240 (x2)	2 x 120 (x3)	2 x 240 (x3)
240 (x3)	2 x 240 (x3)	-	-	2 x 240 (x2)	2 x 240 (x2)	2 x 120 (x3)	2 x 240 (x3)
240 (x3)	2 x 240 (x3)	-	-	2 x 240 (x2)	2 x 240 (x2)	2 x 120 (x3)	2 x 240 (x3)
240 (x3)	2 x 240 (x3)	-	-	2 x 240 (x2)	2 x 240 (x2)	2 x 120 (x3)	2 x 240 (x3)

Selection guide: cross-sections of conductors for supplying automatic capacitor banks with a main circuit breaker

Power (kVAr)	In (A)	Main circuit breaker model	In rating (A)	Setting Ir (A)	COPPER		ALUMINIUM	
					Recommended section[1] (mm²)	Maximum capacity[3] (mm²)	Recommended section[2] (mm²)	Maximum capacity[3] (mm²)
10	14	DPX³ 160	25	25	6	70	10	120[4]
12.5	18		25	25	6	70	10	120[4]
15	22		40	40	6	70	10	120[4]
20	29		40	40	6	70	10	120[4]
25	36		63	63	16	70	16	120[4]
30	43		63	63	16	70	16	120[4]
35	51		100	100	16	70	25	120[4]
37.5	54		100	100	16	70	25	120[4]
40	58		100	100	16	70	25	120[4]
45	65		100	100	25	70	35	120[4]
50	72		100	100	25	70	35	120[4]
60	87		125	125	35	70	50	120[4]
75	108		160	160	50	70	70	120[4]
87.5	126	DPX³ 250	250	200	70	95	2 × 35	2 x 70
100	144		250	200	70	95	2 × 50	2 x 70
125	180		250	250	2 × 50	95	2 × 70	2 x 70
150	217	DPX³ 630	400	320	120	2 × 240	150	2 × 240
160	231		400	320	120	2 × 240	185	2 × 240
175	253		400	320	150	2 × 240	240	2 × 240
200	289		400	400	185	2 × 240	240	2 × 240
225	325		630	630	185	2 × 240	2 x 120	2 x 240
240	346		630	630	240	2 × 240	2 x 120	2 x 240
250	361		630	630	240	2 × 240	2 x 120	2 x 240
275	397		630	630	2 × 120	2 x 240	2 x 150	2 x 240
280	404		630	630	2 × 120	2 x 240	2 x 150	2 x 240
300	433		630	630	2 × 120	2 x 240	2 x 150	2 x 240
320	462		630	630	2 × 120	2 x 240	2 x 185	2 x 240
350	505	DPX³ 1600	800	640	2 × 150	4 x 240	2 x 240	4 x 240
360	520		800	720	2 × 150	4 x 240	2 x 240	4 x 240
400	577		800	800	2 × 185	4 x 240	2 x 240	4 x 240
440	635		1000	880	2 × 240	4 x 240	3 x 185	4 x 240
450	650		1000	880	2 × 240	4 x 240	3 x 185	4 x 240
480	693		1000	960	2 × 240	4 x 240	3 x 185	4 x 240
500	722		1250	1000	2 × 240	4 x 240	3 x 185	4 x 240
520	751		1250	1040	3 × 150	4 x 240	3 x 240	4 x 240
550	794		1250	1250	3 × 150	4 x 240	3 x 240	4 x 240
560	808		1250	1120	3 × 150	4 x 240	3 x 240	4 x 240
600	866		1250	1250	3 × 185	4 x 240	4 x 185	4 x 240

1: Indicative values based on standard IEC 60364 for conductors made of Copper.
2: Indicative values based on standard IEC 60364 for conductors made of Aluminium.
These cross-sections may vary according to local regulations, the ambient temperature around the conductor, the installation method, line lengths, etc.
3: The connection options vary according to the type of accessory and type of conductor used.
4: Large-capacity connection terminals compulsory (Cat.No 421006 or 421007).

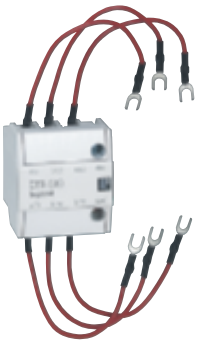
The recommended cross-sections indicated in the tables are given for information only and are calculated for single-pole cables with an ambient temperature of 30°C.
They do not take account of additional correction factors:
- Installation method: trunking or cable trough
- Very long lines to be used
- Ambient temperature around the cables

CTX³ power contactors - 3-pole

for maintenance of Alpimatic racks and enclosures

4 161 39

4 161 59



4 168 74

Technical characteristics **opposite**
Dimensions **p. 52-53**

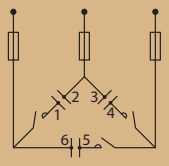
Conform to standards IEC 60947-1, IEC 60947-4-1 AC6b

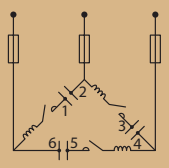
Pack	Cat.Nos	CTX³ contactors			
		With built-in auxiliary contacts For maintenance of capacitor banks without a detuned reactor, CTX³ contactors should be equipped with damping resistors			
		CTX³ 40 - connection via screw terminals			
		Max. operating current AC 3	Control voltage	Built-in auxiliary contacts	Damping resistor to be added
1	4 161 29	32 A	415 V~	2 NO + 2 NC	4 168 74
1	4 161 39	40 A	415 V~	2 NO + 2 NC	4 168 74
		CTX³ 65 - connection via cage terminals			
1	4 161 59	50 A	415 V~	2 NO + 2 NC	4 168 76
1	4 161 79	65 A	415 V~	2 NO + 2 NC	4 168 76
		CTX³ 100 - connection via cage terminals			
1	4 161 99	75 A	415 V~	2 NO + 2 NC	4 168 76
1	4 162 39	100 A	415 V~	2 NO + 2 NC	4 168 76
		CTX³ 150 - connection via cage terminals			
1	4 162 59	130 A	400-440 V~	2 NO + 2 NC	-
		CTX³ switching units for capacitor banks without detuned reactor			
1	4 168 74	AC-6b For CTX³ contactors - 3 poles from 32 to 40 A			
1	4 168 76	For CTX³ contactors - 3 poles from 50 to 100 A with cage terminals			

CTX³ power contactors - 3-pole

for maintenance of Alpimatic racks and enclosures

Contactor selection according to the step power rating

Step power rating at 400 V (kVAr)	Capacitor banks without detuned reactor With Alpivar 3 capacitors (△ configuration) 	
	Screw terminals	Cage terminals
5	4 161 29 + 4 168 74	-
10		
12.5		
15		
20		
25		
30	-	4 161 59 + 4 168 76
35		
40		
45		
50		
60	-	4 161 99 + 4 168 76
70		
75		
80	-	4 162 39 + 4168 76

Step power rating at 400 V (kVAr)	Capacitor banks with detuned reactor With Alpivar 3 capacitors (△ configuration) 	
	Screw terminals	Cage terminals
5	4 161 29	4 161 59
10		
12.5		
15		
20		
25		
30	4 161 39	4 161 59
35		
40		
45		
50		
60	-	4 161 79
70		
75		
80	-	4 162 59

For direct control of Alpivar 3 capacitors with 3 terminals or other power ratings, please consult us

CTX³ switching units for capacitor banks without detuned reactor- Cat.Nos 4 168 74 and 4 168 76

Damping resistors are connected to the contactor terminals in order to reduce the high inrush current. IEC 60947-4-1 AC 6b

Contactor		Discharge resistor	
		CTX³ screw terminals	CTX³ cage terminals
CTX³ 40	32 A	4 168 74	-
CTX³ 40	40 A	4 168 74	-
CTX³ 65	50 A	-	4 168 76
CTX³ 65	65 A	-	4 168 76
CTX³ 100	75 A	-	4 168 76
CTX³ 100	100 A	-	4 168 76

Characteristics of the switching units

- Switching units can limit the inrush current to 60 x In by closing before the main contactor contacts
- Eliminate switching voltage surges
- Improve the capacitor system performance

Operating sequence

Switching units: OFF
Contactor: OFF

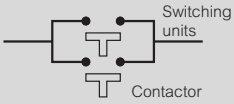


Fig. 1

Switching units: ON
Contactor: OFF

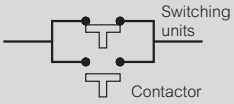


Fig. 2

Switching units: OFF
Contactor: ON

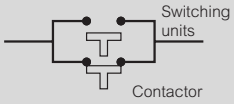
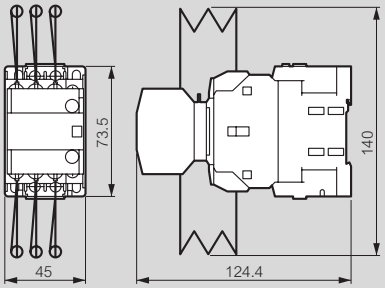


Fig. 3

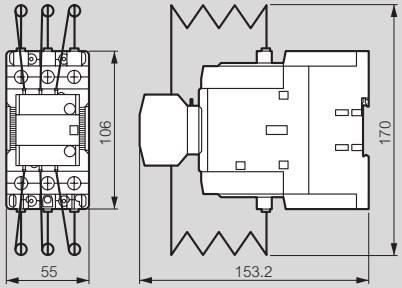
Note - Closing sequence: Fig.1 => Fig.2 => Fig.3
Opening sequence: Fig.3 => Fig.1

Dimensions of CTX³ contactors equipped with switching units

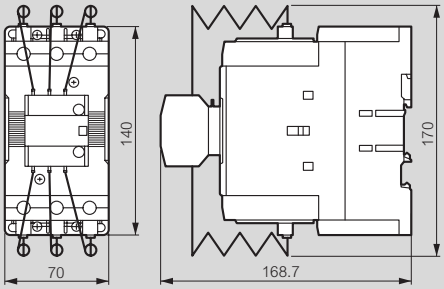
Cat.No 4 168 74 on CTX³ 40 (Cat.No 4 161 29)



Cat.No 4 168 76 on CTX³ 65 (Cat.Nos 4 161 59/79)



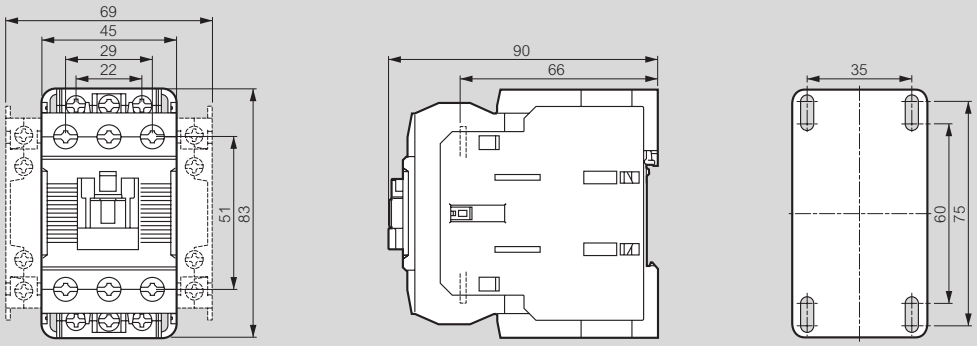
Cat.No 4 168 76 on CTX³ 100 (Cat.Nos 4 161 99 and 4 162 39)



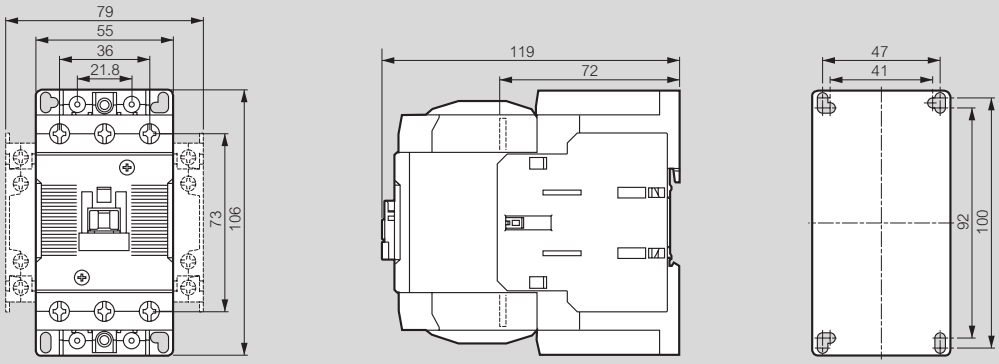
CTX³ power contactors - 3-pole

dimensions

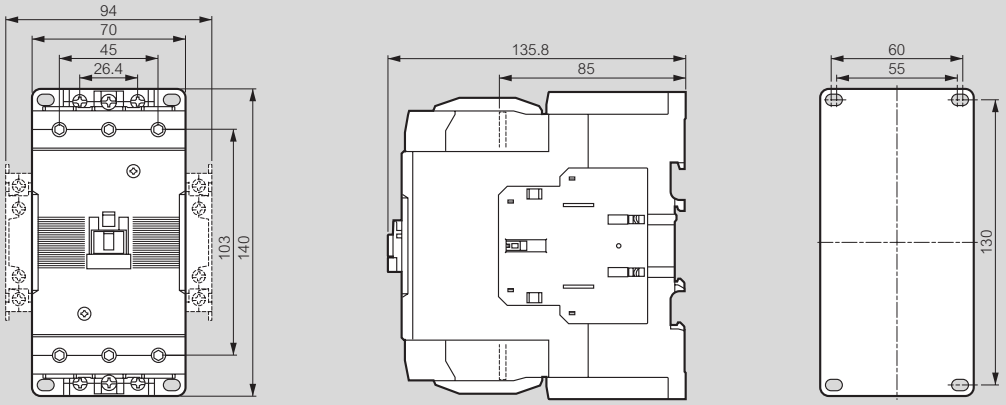
CTX³ 40 - Cat.Nos 4 161 29/39



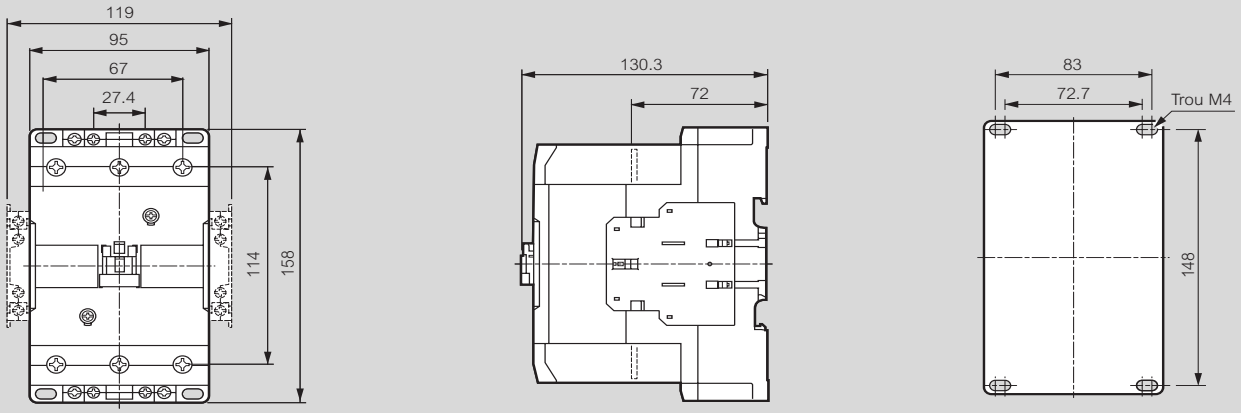
CTX³ 65 - Cat.Nos 4 161 59/79



CTX³ 100 - Cat.Nos 4 161 99 and 4 162 39



CTX³ 150 - 4 162 59

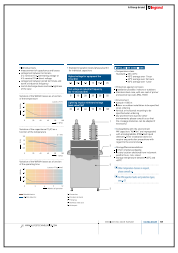


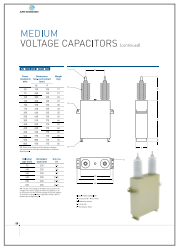
MEDIUM VOLTAGE RANGE

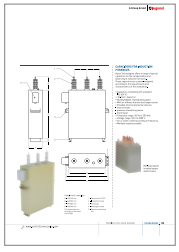
SEE THE PRODUCTS

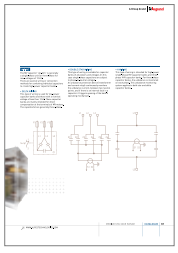
"All-film" medium voltage capacitors
(p. 56)

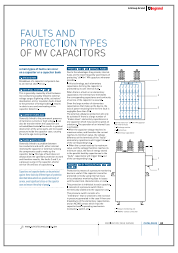
Medium voltage capacitor banks
(p. 60)

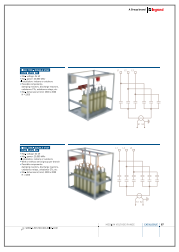


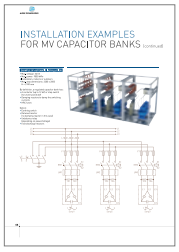












MEDIUM VOLTAGE CAPACITORS

"All-film"

"All-film" medium voltage capacitors are made up of elementary or partial capacitances, usually connected in several series-parallel groups, providing the required electrical characteristics for the unit.

ADVANTAGES OF THE RANGE

- The nominal voltage of a capacitor depends on the number of groups in series
- The nominal power of a capacitor depends on the number of partial capacitances in parallel per group

Each elementary capacitance is made of two sheets of aluminium foil forming the reinforcements or the electrodes, and special high-quality polypropylene film which is rough to assist impregnation, forming part of the insulation.
This wired capacitance assembly, referred to as the
"active part", is positioned in a stainless steel case, which has insulated porcelain terminals or bushings at the top for connecting the device.
After this "active part" has been dried and treated, it is vacuum-impregnated with a liquid dielectric of the following type:
- non-chlorinated
- non-toxic
- biodegradable.

With the polypropylene film, this liquid dielectric, which has a remarkably high chemical stability, a high gas absorption capacity and a high partial discharge extinction capacity (discharges for which the flash point is approximately 150°C), ensures total insulation between electrodes. This "all-film" capacitor technology has the following main characteristics:

- Excellent resistance to strong electrical fields
- Very low power losses, leading to considerable savings for high power capacitor banks.

ELECTRICAL CHARACTERISTICS

Capacitors with synthetic "all-film" type dielectric, compared with the previous generation of capacitors with "mixed" (paper + film) type dielectric, have a much longer service life, due to:

- Their excellent thermal stability related to very low power losses, due to the removal of the paper
- The remarkable chemical stability of the liquid dielectric, giving:

- high partial discharge absorption capacity
- high dielectric resistance to transient overcurrents and overvoltages
- very low variation of capacitance as a function of temperature.

- Average loss factor:
- 0.15 W/kVAr at power-up
- 0.1 W/kVAr after 500 hours' operation

- Variation of the capacitance as a function of the temperature:
- average: 2 x 10-4/°C

- Internal discharge device :
- internal discharge resistors reducing the residual voltage to 75 V in 10 minutes after disconnection of the supply

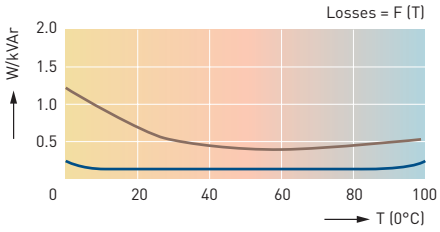
- Frequency:
- standard: 50 Hz (60 Hz on request)

- Reference standards:
- French: C 54 102
- international:
  IEC 60 871.1 and 2 (supply capacitors)
  IEC 60 110 (capacitors for air or water-cooled induction furnaces)
- German: VDE 0560/4
  VDE 0560/9
- British: BS 1650
- other standards on request

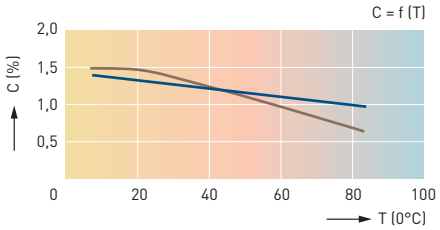
- Permissible overloads
- current: up to 1.3 In
- voltage (between terminals):
  1.1 Un 12 hrs/24 hrs
  1.15 Un 30 minutes/24 hrs
  1.2 Un 5 minutes/24 hrs
  1.3 Un 1 minute/24 hrs

- Individual tests
- measurement of capacitance and losses
- voltage test between terminals:
  2 U nominal 10 s. alternating voltage or
  4 U nominal 10 s. direct voltage
- voltage test between joined terminals and earth at industrial frequency
- test of discharge device and seal-tightness of the case

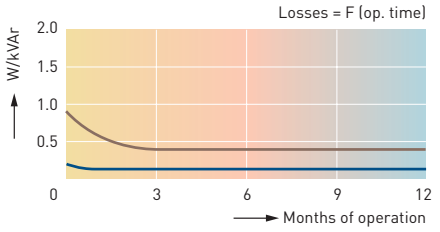
Variation of the W/kVAr losses as a function of the temperature



Variation of the capacitance C (µF) as a function of the temperature



Variation of the W/kVAr losses as a function of the operating time



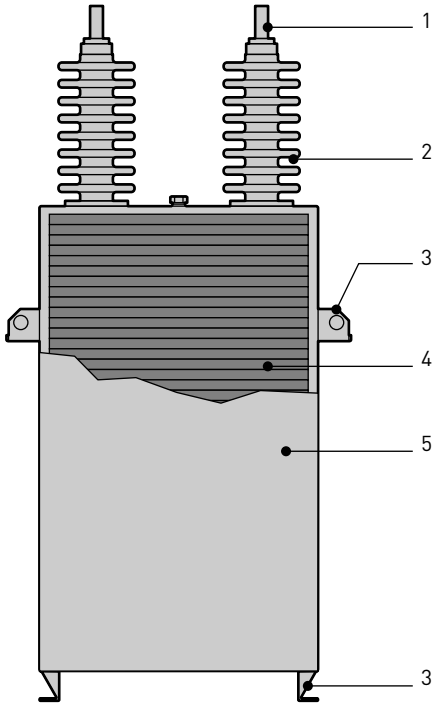
Mixed dielectric
All-film dielectric

- Standard insulation levels (phases/earth) for individual capacitors

Highest voltage for equipment Um (rms) (kV)					
2.4	3.6	7.2	12	17.5	24

Test voltage at industrial frequency (for 10 seconds) (kV)					
8	10	20	28	38	50

Lightning impulse withstand voltage (peak value) (kV)					
35	40	60	75	95	125



1 – Connection
2 – Porcelain terminal
3 – Fixing lug
4 – Stainless steel case
5 – Active part

INSTALLATION CONDITIONS

- Temperature class
  Standard: - 25/+ 45°C:
  - 45°C average over 1 hour
  - 40°C average over 24 hours
  - 30°C average over 1 year

- Protection against corrosion
- Installation possible: indoors or outdoors
- Stainless steel case, with one coat of primer and several top coats (RAL 7033)

- Environment
- Altitude <1000 m
- Indoor or outdoor installation to be specified when ordering
- Vertical or horizontal mounting to be specified when ordering
- Dry and free from dust (for other environments please consult us so that the creepage distances can be adapted if necessary)

- Compatibility with the environment
  MV capacitors "All-film" are impregnated with a biodegradable (PCB-free) liquid dielectric. Their installation does not require any particular precautions with regard to the environment.

- Storage/Recommendations
- In their original packaging
- In a dry location sheltered from inclement weather (sun, rain, snow)
- Storage temperature between -40°C and +60°C

⊕ Other temperature classes on request, please consult us.

⊕ For MV capacitor faults and protection types, see p. 63

MEDIUM VOLTAGE CAPACITORS (continued)

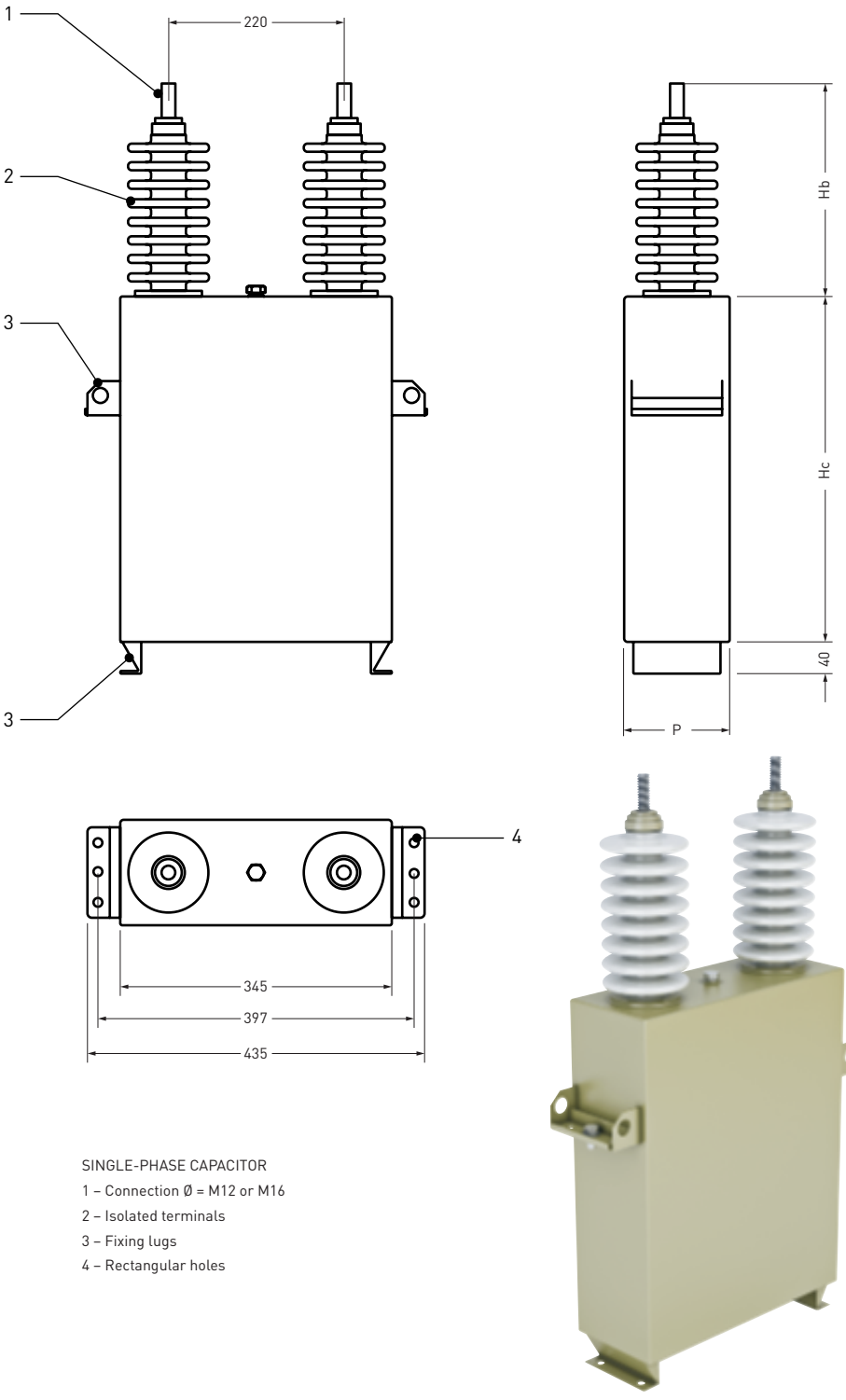
WEIGHTS AND DIMENSIONS

Power (standard) kVAr	Dimensions (non-contractual) (mm)		Weight (kg)
	Hc	P	
50	190	135	17
75	250	135	21
100	280	135	23
125	350	135	27
150	370	135	30
175	450	135	33
200	460	135	35
250	460	135	42
300	510	175	46
350	590	175	53
400	650	175	60
450	730	175	65
500	790	175	70
550	880	175	76
800	950	175	82

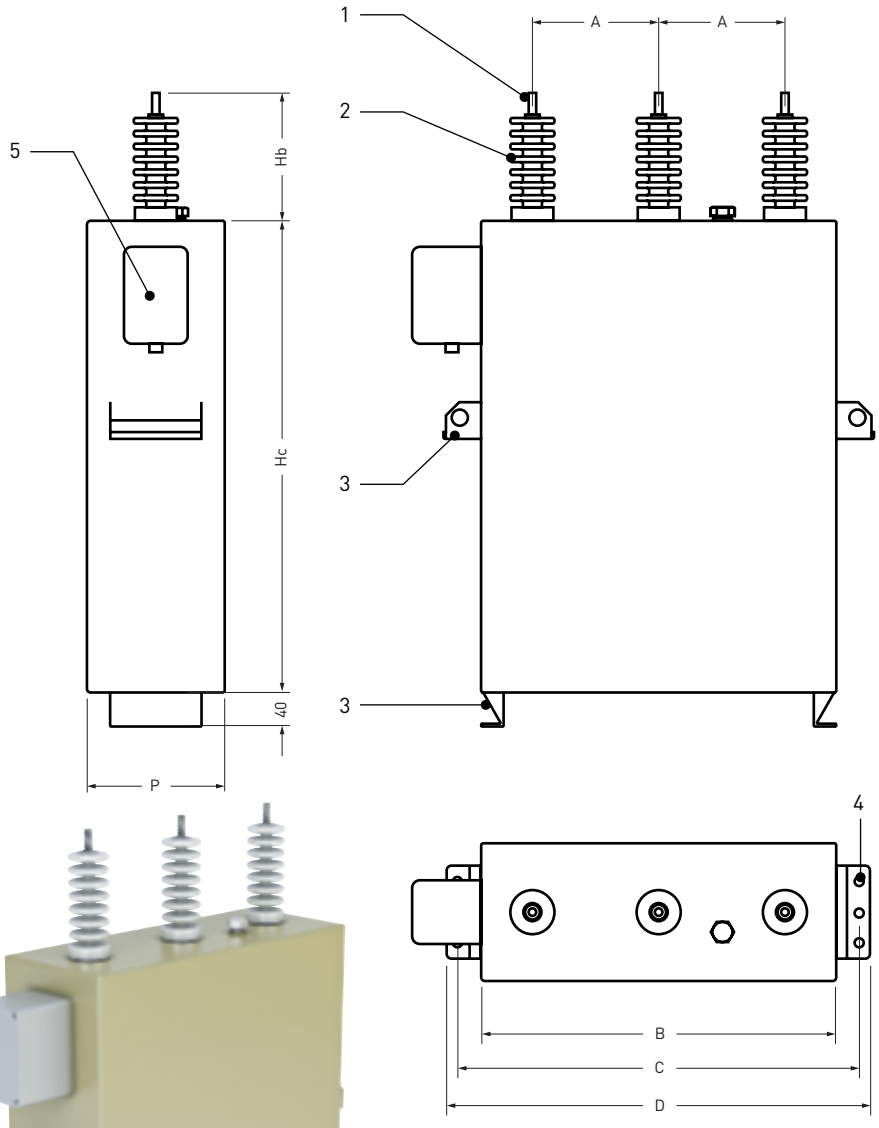
NB: Given the multiplicity of MV capacitor voltages, these dimensions must be confirmed by our technical departments.

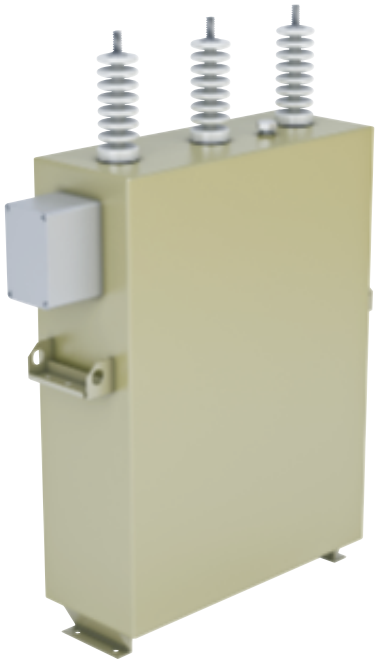
Hb Indoor type (mm)	Hb Outdoor type (mm)	Um rms kV
75	235	2.4
160	235	3.6
160	235	7.2
160	235	12.0
235	235	17.5
265	265	24.0

NB: The Um rms voltage to be taken into account is the voltage of the mains supply to which the capacitor is to be connected, not the nominal voltage of the unit (applies in particular to single-phase capacitors wired in star or double star configurations).



SINGLE-PHASE CAPACITOR
1 – Connection Ø = M12 or M16
2 – Isolated terminals
3 – Fixing lugs
4 – Rectangular holes





THREE-PHASE CAPACITOR

A – 123/160 mm
B – 345/450 mm
C – 397/502 mm
D – 430/540 mm
The dimensions vary according to the power and voltage

1 – Connection Ø = M12
2 – Isolated terminals
3 – Fixing lugs
4 – Rectangular holes
5 – Pressure monitoring unit

CAPACITORS FOR INDUCTION FURNACES

Alpes Technologies offers a range of special capacitors for the compensation and balancing of induction furnaces.
These capacitors are custom-designed according to the requirements and characteristics of the installation.

- Capacitors complying with standard IEC 60110
- "All-film" dielectric
- Biodegradable impregnating agent
- With or without internal discharge resistor
- Possible internal protection devices:
- internal fuses
- pressure monitoring device
- thermostat
- Frequency range: 50 Hz to 200 kHz
- Voltage range: 50 V to 3000 V
- Air or water cooled according to frequency
- Multiple outputs possible

Water-cooled capacitor for medium frequency induction furnaces

CAPACITOR BANKS

Medium Voltage

Alpes Technologies offers you bespoke solutions in order to adapt to your installation and your requirements.

CAPACITOR BANK TYPE

A capacitor bank is generally made up of several individual single or three-phase capacitors, assembled together and interconnected to create high-power assemblies called "capacitor banks".

ALPES TECHNOLOGIES designs and manufactures various different types of capacitor bank, defined by:

- The total reactive power to be installed
- The nominal supply voltage
- The altitude and ambient temperatures
- Electrical constraints:
  - presence of harmonics
  - automatic capacitor banks with power factor controller
- Installation
  - indoors (in an electrical room)
  - outdoors (in a substation)
  - dusty environments
- Operator safety
  - IP 00 open rack
  - IP 21 cubicle (indoor installation)
  - IP 23 cubicle (outdoor installation)
  - double overhanging roof
  - IP 54 cubicle
  - other degrees of protection on request

COMPOSITION

A capacitor bank can be made up of the following components:

- Additional accessories (discharge reactors, damping reactors and detuned reactors) see p. 65
- Built-in electrical protection devices (HRC fuses, unbalance protection devices, etc) see p. 64
- Switching appliances (earthing switch, switches, contactors, etc)
- Power factor controllers for automatic capacitor banks see p. 65

WIRING

The MV capacitor "all-film" is generally a single-phase unit (or three-phase for max. voltages of 12 kV).
There are several wiring or connection methods for combining individual capacitors to create high-power capacitor banks.

• DELTA WIRING

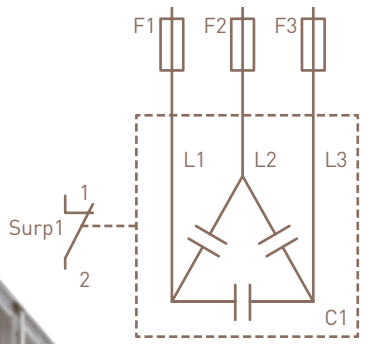
This type of wiring is used for low-power capacitor banks and those with a nominal voltage of less than 12 kV. These capacitor banks are mainly intended for direct compensation at the terminals of MV motors. The capacitor(s) are generally three-phase.

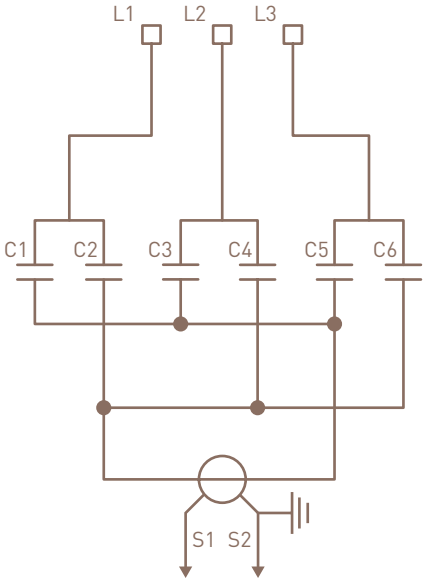
• DOUBLE STAR WIRING

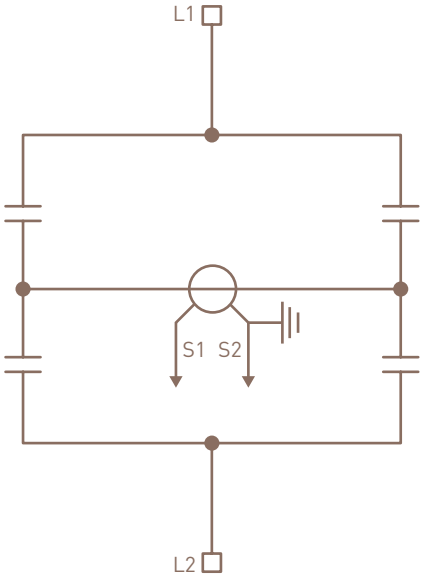
This type of wiring is suitable for capacitor banks of all powers and voltages (in this case single-phase capacitors are subject to phase-to-neutral voltage).
An unbalance protection device (transformer and current relay) continuously monitors the unbalance current, between two neutral points, and if there is an internal fault in a capacitor it triggers opening of the bank's operating mechanism.

• H WIRING

This type of wiring is intended for high-power single-phase MV capacitor banks and three-phase VHV capacitor banks. For three-phase capacitor banks, the unbalance is monitored on each phase. This unbalance monitoring system applies to both star and delta capacitor banks.







GENERAL CHARACTERISTICS OF MV COMPONENTS

Alpes Technologies offers a complete range of components for making up medium voltage capacitor banks.

SERVICE CONDITIONS

- Ambient air temperature
  ⩽ 40°C
  ⩽ 30°C on average over 24 hours
  ⩾ -25°C
- Altitude
  ⩽ 1000 m
- Environment
  Clean indoor industrial air (no dust, smoke, corrosive or inflammable gases or vapours, nor salt).
- Humidity
  Average relative humidity value, over 24 hours < 95%

SPECIFIC SERVICE CONDITIONS
(please consult us)

Alpes Technologies develops solutions for the following specific conditions:

- Temperature from -40°C to +50°C (derating, ventilation).
- Corrosive atmospheres, vibrations (adaptations may be available)
- Altitude > 1000 m (derating)

STORAGE CONDITIONS

To preserve all the qualities of the functional unit during prolonged storage, we recommend keeping the equipment in its original packaging, in a dry location sheltered from the rain and sun at a temperature between -25°C and +55°C.

STANDARDS

The equipment offered in this catalogue is designed, manufactured and tested in accordance with the requirements of the standards and the following recommendations:

- Medium Voltage capacitors: IEC 60871-1&2, BS 1650, VDE 0560, C22-2 No. 190-M1985, NEMA CP1
- Medium Voltage circuit breakers: IEC 56
- Current transformers: IEC 60044
- Earthing switch: IEC 129C
- Relays, Power factor controller: IEC 60010
- Fast discharge reactor, Damping inductances: IEC 60076-6
- Post insulators: IEC 168 - 273 - 815
- Medium Voltage contactors: IEC 420/IEC 470
- Medium Voltage fuses: IEC 282.1/IEC 787

COMMON ELECTRICAL CHARACTERISTICS

- Tolerance on capacitor bank rated power: 0/+10% (0/+5% for power > 3 MVAr)
- Relative variation of capacitance as a function of the temperature: -3.5.10-4/°C

INSULATION COORDINATION

Highest voltage for equipment U_m (kV)	Power frequency withstand (kVrms, 50 Hz-1 min)	Impulse withstand (kV peak, 1.2/50 µs)
7.2	20	60
12	28	75
17.5	38	95
24	50	125
36	70	170

FAULTS AND PROTECTION TYPES OF MV CAPACITORS

4 main types of faults can occur on a capacitor or a capacitor bank

1. BREAKDOWN

Breakdown of a capacitor component due to an internal short-circuit.

2. EXTERNAL SHORT-CIRCUIT

This is generally caused by a fault between live conductors possibly linked to external voltage surges (lightning strike, activation/deactivation, etc) or insulation faults linked to the presence of foreign bodies. It results in electric arcs and overheating of the capacitor dielectric.

3. CURRENT OVERLOAD

Generally linked to the permanent presence of harmonic currents or high voltage. It can also be transient when the capacitors are activated/deactivated. This results in gradual destruction of the active parts and increased pressure inside the capacitor case, causing the unit to age more quickly.

4. PHASE-EARTH FAULT

Generally linked to a problem between live conductors and earth, either internal involving the capacitor or external involving the components used to make up the capacitor bank. This type of fault does not always allow the upstream protection to work and therefore results, like faults 2 and 3, in a pressure surge in the capacitor, shorter service life and loss of capacitance.

Capacitors and capacitor banks can be protected against these faults by different types of protection described below which can provide continuity of service, avoid significant stress on the capacitor case and ensure the safety of people.

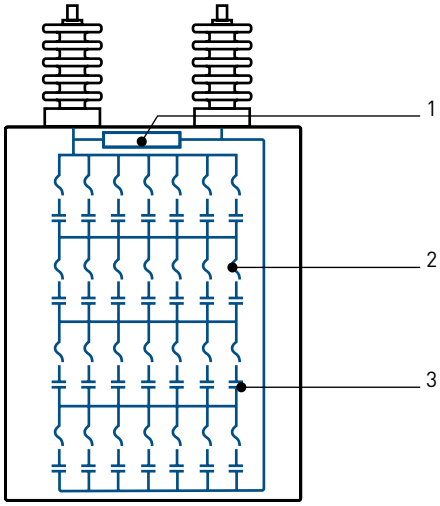
PROTECTION USING INTERNAL FUSES

Due to the advantages they provide, internal fuses are the most frequently used means of protecting "all-film" MV capacitors wherever possible.

In this technology, each elementary capacitance forming the capacitor is protected by its own internal fuse.

When there is a fault on an elementary capacitance, the internal fuse eliminates the corresponding capacitance and continuity of service of the capacitor is assured.

Given the large number of elementary capacitances that make up the device, the loss of power resulting from the first fault is negligible (less than 2%).
The external unbalance protection will only be activated if there is a large number of "broken down" elementary capacitances in one capacitor which may cause too great an unbalance. The operation of an internal fuse is activated:
- When the capacitor voltage reaches its maximum value, and therefore the current reaches its minimum value, the voltage difference at the terminals of the "faulty" elementary capacitance will trigger blow-out of the corresponding fuse.
- When the current reaches its maximum value, and the voltage therefore reaches its minimum value, the flow of energy stored in the parallel healthy capacitances to the "faulty" capacitance will trigger blow-out of the corresponding fuse.



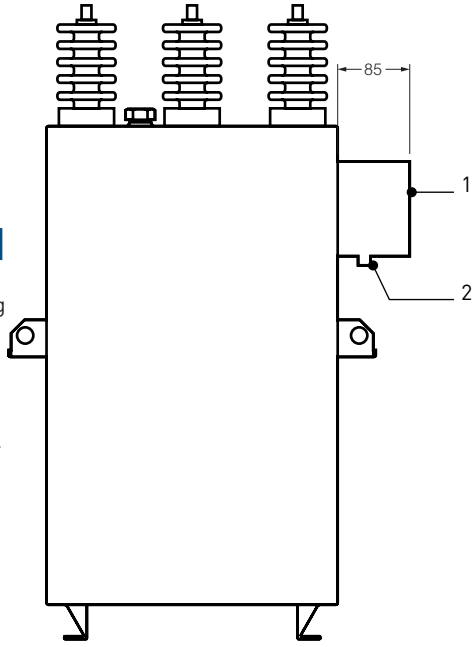
Internal view of an "all-film" MV capacitor with internal fuses
1 – Discharge resistor
2 – Internal fuse
3 - Elementary capacitance

PROTECTION BY PRESSURE MONITORING DEVICE

Protection by means of a pressure monitoring device is useful if the capacitor cannot be protected correctly using internal fuses or by unbalance monitoring (due to issues with the electrical characteristics or cost).

This protection is individual to each capacitor. It consists of a pressure switch that is hermetically sealed onto the capacitor case.

This pressure switch consists of a "membrane" that is sensitive to the increase in pressure generated in the case if there are breakdowns of the elementary capacitances, and an NC/NO contact which trips the capacitor bank's operating mechanism (contactor - switch, etc).



1 – Pressure monitoring unit
2 – "NO/NC" contact connection

EXTERNAL PROTECTION DEVICES USED WITH MV CAPACITORS

In addition to the protection devices specific to each capacitor (internal fuses or pressure monitoring devices), other accessories must be used and an associated external protection device incorporated in the capacitor bank. The most commonly used external protection devices are:
HRC fuses and unbalance protection.

The choice between these various options is dependent on the following criteria:
- Electrical characteristics of the capacitor (power, voltage, connection)
- Customer's requirements concerning the sensitivity of the protection device

There are four protection options for MV capacitors "all-film":
- Without internal fuses and external protection by unbalance monitoring
- With internal fuses and external protection by unbalance monitoring
- Without pressure monitoring device and external protection by HRC fuses
- With pressure monitoring device and external protection by HRC fuses

HRC FUSES

Protection using HRC fuses integrated in the capacitor bank is ideal (technically and economically) for capacitor banks with the following characteristics:
- low power (< 1200 kVAr)
- those equipped with three-phase connection capacitors (see delta wiring p. 63)
- supply voltage less than 12 kV

The HRC fuse rating should be selected to have a value between 1.7 and 2.2 times the nominal current of the capacitor bank.
HRC fuse blow-outs are generally caused by a dead short inside the capacitor. Operation of the fuses will depend on the number of groups in series that are damaged inside the capacitor.

As an option, it is possible to add blown-fuse contacts to feed back information or trip an operating mechanism (circuit breaker, switch, contactor, etc).

UNBALANCE OR DIFFERENTIAL PROTECTION

This protection generally applies to capacitor banks with the following characteristics:
- Medium or high power (> 1000 kVAr)
- Those with single-phase connection capacitors - Mains voltage greater than 12 kV

Unbalance or differential protection is sensitive, capable of detecting and reacting to a partial fault in a capacitor.
It consists of a current transformer connected between the 2 neutral points of the double star, combined with a current relay. When there is a fault in a capacitor there is an unbalance and therefore a current circulating in the current transformer which will cause, by means of the relay, the bank's operating mechanism (circuit breaker, switch, contactor, etc) to open.

⚠ This protection does not apply to three-phase capacitors.

The table opposite determines the possible type of protection for the capacitor and its advantages, according to the above criteria.

Capacitor power and voltage	Capacitor connection	Capacitor protection	Associated external protection	Advantages
All powers and all voltages	Single-ph.	Without internal fuse	Unbalance	
P ≥ 200 kVAr and U ≤ 13 kV	Single-ph.	Without internal fuses	Unbalance	• Does not trip on 1st fault • Assured continuity of service
All powers and U ≤ 12 kV	Three-ph.	Without pressure monitoring device	HRC fuses	
All powers and U ≤ 12 kV	Three-ph.	With pressure monitoring device	HRC fuses	• No risk of case rupturing

OPERATING AND PROTECTION COMPONENTS AND MECHANISMS

DAMPING REACTORS

Damping switching currents

Installing single-phase damping reactors in series on each phase of the capacitor bank makes it possible to reduce the switching currents to values that are acceptable for the corresponding operating mechanism. These are necessary in the following situations:

- step capacitor banks
- mains short-circuit power very high in relation to the power of the capacitor bank to be connected
- frequent control operations of the capacitor bank

DETUNED REACTORS

Protecting capacitors against harmonics

For mains supplies with a high level of harmonic interference, installing a detuned reactor, generally three-phase and connected in series with the capacitor bank, is the only effective protection. The detuned reactor performs a dual role:

- Increasing the impedance of the capacitor in relation to the harmonic currents.
- Shifting the parallel resonance frequency of the source and the capacitor to below the main frequencies of the harmonic currents that are causing interference. This prevents amplification of the harmonic voltages already present on the network.

The detuned reactor also acts as a damping reactor.

There are 3 main types of detuned reactor:

"resin-impregnated"
- Installation indoors
- IP 00
- Max. voltage 24 kV
- Connection on copper lug
- Three-phase
- Optional rollers for easier installation

"oil-immersed"
- Installation indoors or outdoors
- IP 00 or IP 55
- Max. voltage 36 kV
- Connection on porcelain terminals or plug-in terminals
- Three-phase
- Protection by DGPT2 type relay
- Rollers for easier installation

"resin-impregnated air reactors" (this type is mainly for use on VHV supplies)
- Installation outdoors
- IP 00
- Max. voltage 170 kV
- Single-phase

FAST DISCHARGE REACTORS

Operator protection

Installing two fast discharge reactors or voltage transformers between the phases of the capacitor bank reduces the capacitor discharge time from 10 minutes to approximately 10 seconds.
This reduced discharge time:

- Provides safety for staff when carrying out work
- Reduces waiting time before earthing (closing of the earthing switch)
- Makes it possible to reactivate the capacitor banks in steps more quickly after breaking, although a minimum time of 15 minutes between two discharges is essential, to ensure correct cooling of the reactors.

OTHER POSSIBLE COMPONENTS

- Unbalance relay – Protection of capacitors wired in double star configuration
- Earthing switch
- Switch (optionally motorised)
- Circuit breaker (optionally motorised)
- Power factor controller to control automatic capacitor banks

ALPTEC power factor controllers – Control of capacitor steps, see p. 42

The operating and protection equipment (circuit breaker, fuse, switch, contactor) of a medium voltage capacitor bank must take the following three requirements into account:

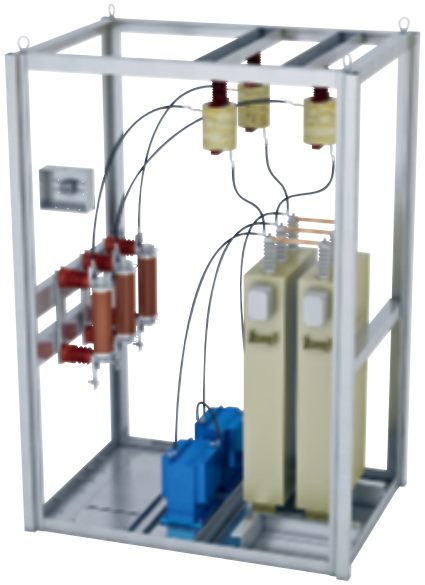
- Capacity to withstand high transient currents when activated
- Capacity to ensure breaking on opening without restrike (at the moment of breaking, the capacitor bank may be loaded at full voltage)
- Capacity to withstand a permanent rms current corresponding to at least 1.43 times the nominal 50 Hz current of the capacitor bank in steady state. Vacuum-break operating mechanisms, or those in SF6, are ideal for operating and protecting capacitor banks.

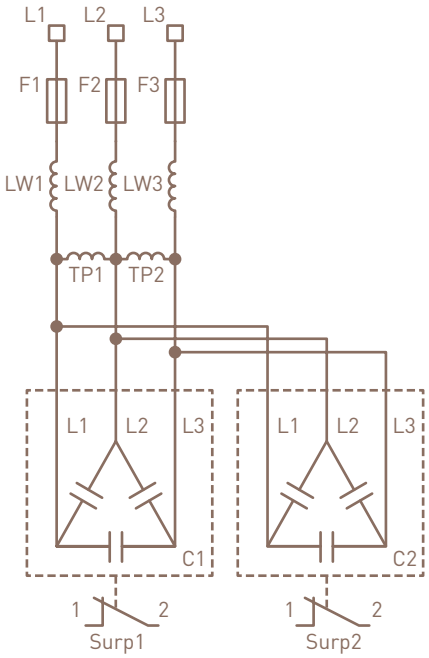
The ALPES TECHNOLOGIES Technical Departments can advise you on the selection of a suitable operating and protection device for your capacitor bank.

INSTALLATION EXAMPLES FOR MV CAPACITOR BANKS

FIXED TYPE - DOUBLE DELTA CONFIGURATION

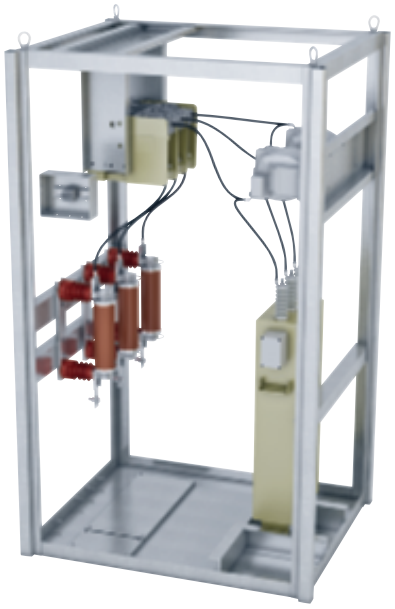
- Max. voltage: 12 kV
- Max. power: 1500 kVAr
- Installation: indoors or outdoors
- Possible components:
  damping reactors, discharge reactors, HRC fuses, earthing switch, detuned reactor, etc
- Max. dimensions (mm): 2000 x 2000
  H = 2200

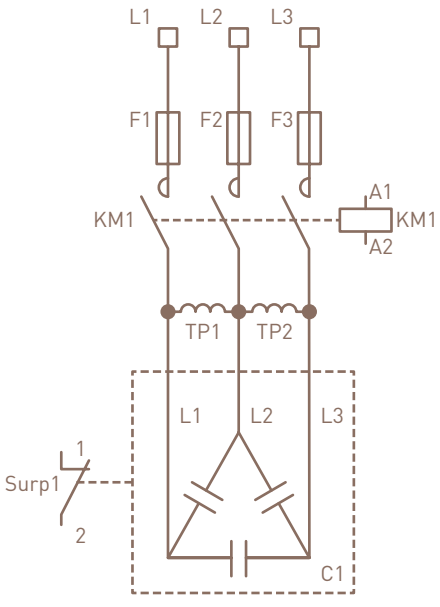




FIXED TYPE WITH CONTACTORS - DELTA CONFIGURATION

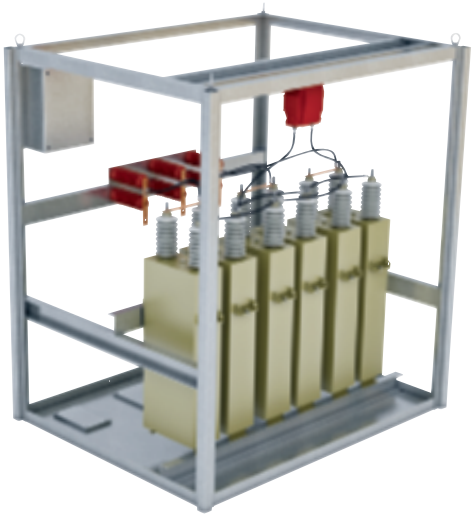
- Max. voltage: 12 kV
- Max. power: 1500 kVAr
- Installation: indoors or outdoors
- Possible components:
  damping reactors, discharge reactors, contactors, HRC fuses, power factor relay, detuned reactor, etc
- Max. dimensions (mm): 2000 x 2000
  H = 2200

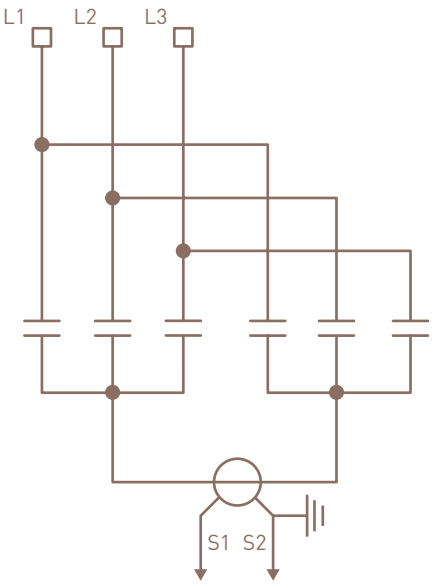




FIXED TYPE - DOUBLE STAR CONFIGURATION

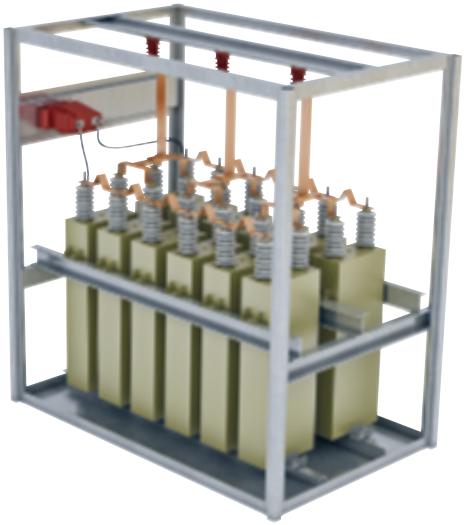
- Max. voltage: 24 kV
- Max. power: 20,000 kVAr
- Installation: indoors or outdoors
- Possible components:
  damping reactors, discharge reactors,
  unbalance CTs, unbalance relays, etc
- Max. dimensions (mm): 2500 x 2000
  H = 2200

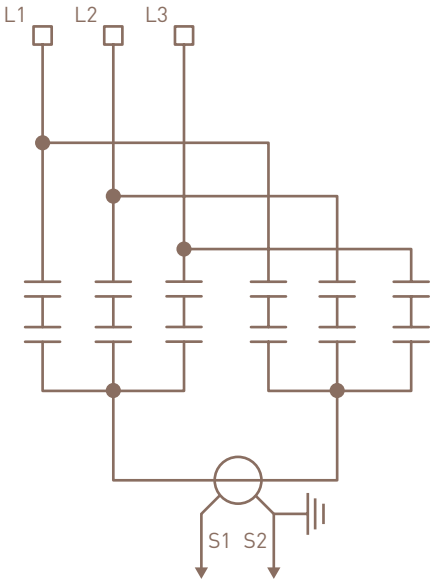




FIXED TYPE - DOUBLE STAR CONFIGURATION

- Max. voltage: 36 kV
- Max. power: 20,000 kVAr
- Installation: indoors or outdoors
- With or without serial group per branch
- Possible components:
  damping reactors, discharge reactors,
  unbalance relays, unbalance CTs, etc
- Max. dimensions (mm): 3500 x 2000
  H = 4000





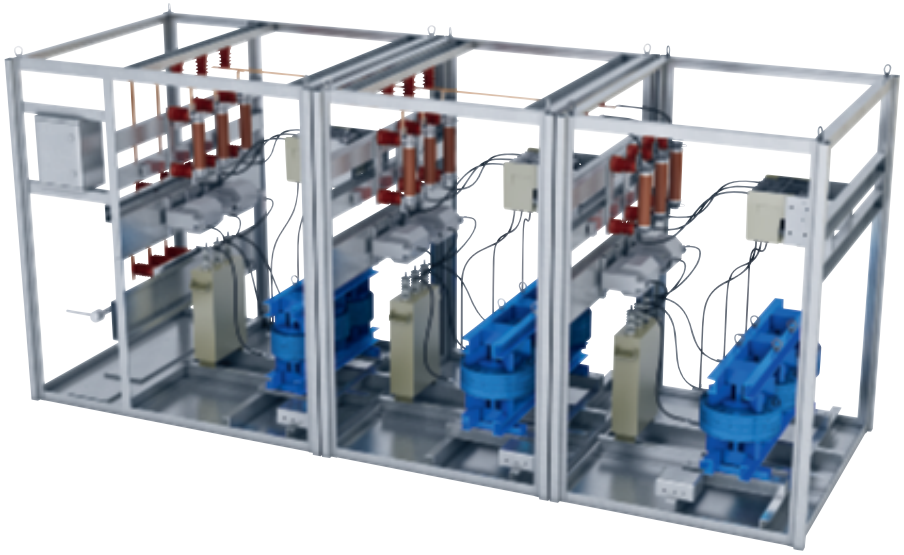
INSTALLATION EXAMPLES FOR MV CAPACITOR BANKS (continued)

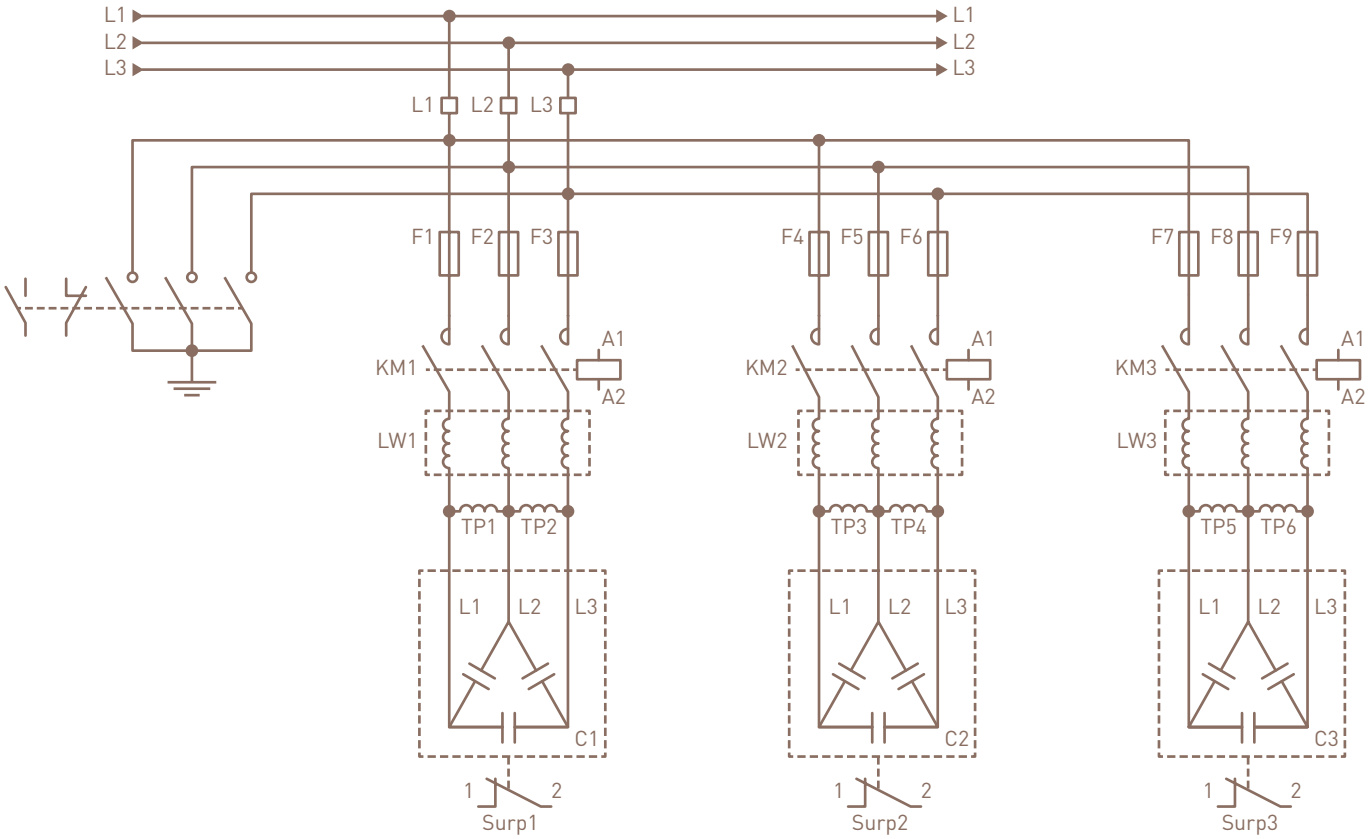
EXAMPLE OF AUTOMATIC INSTALLATION

- Max. voltage: 36 kV
- Max. power: 9000 kVAr
- Installation: indoors or outdoors
- Max. step dimensions: 3200 x 2000 H = 2100 mm

By definition, a regulated capacitor bank has:
- A contactor (up to 12 kV) or step switch (for 24 kV and 36 kV)
- Damping reactors to damp the switching currents
- HRC fuses

Option:
- Earthing switch
- Detuned reactor (no damping reactor in this case)
- Unbalance relay (depending on power/voltage)
- Fast discharge reactors

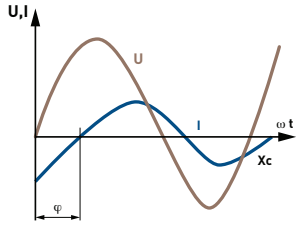




PHASE SHIFT - LOAD TYPES

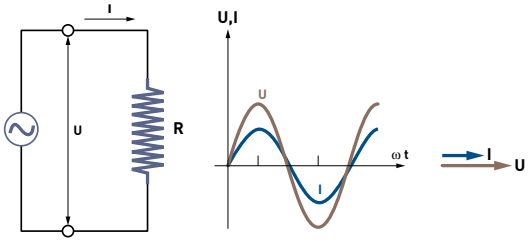
PHASE SHIFT

In an AC electrical installation, depending on the type of electrical load (resistive, inductive, capacitive), a phase shift of varying size occurs between the current and the voltage.
The symbol for this phase shift is "φ".

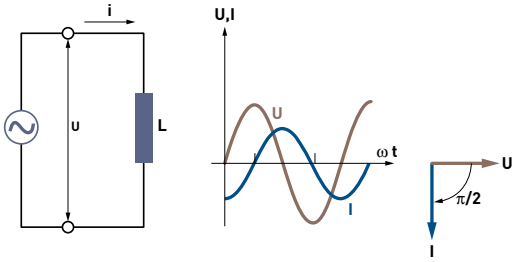


LOAD TYPES

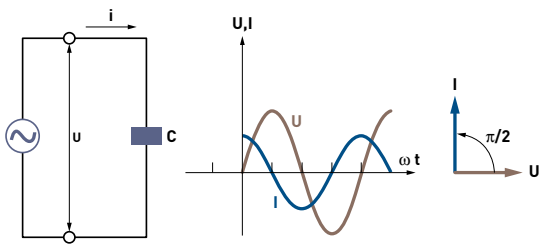
Resistive loads consist of pure R resistors. For this type of load, the current generated is in phase with the voltage.



Inductive loads consist of inductances, such as asynchronous motors and ballasts in fluorescent tubes. If we consider a purely inductive load L, the current generated always lags 90° behind the voltage.

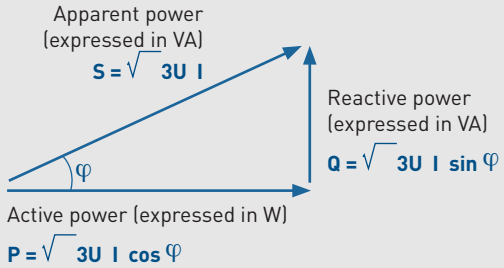


Capacitive loads consist of capacitors, mainly capacitor banks.
If we consider a purely capacitive load C, the current generated always leads the voltage by 90°.



ACTIVE, REACTIVE AND APPARENT POWERS

Electrical powers are made up as follows:



φ: voltage/current displacement angle

POWER FACTOR

This corresponds to the active power/apparent power ratio, therefore if we assume that the current and the voltage are perfectly sinusoidal without interference, it equals
PF = cos (φ).

ACTIVE POWER

This is what causes, for example, a movement in the case of a motor, or a release of heat in the case of a resistive load; it could be termed "useful" power. The unique property of active power is to make work. A load draws active power when the current is in phase with the voltage.
Active power is expressed in watts (W).

REACTIVE POWER

This is not strictly speaking a power, since work cannot be obtained from it as it can with active power.
Reactive power Q is defined compared to active power P.

$$P = \sqrt{3}\,U\,I\cos\varphi$$
$$Q = \sqrt{3}\,U\,I\sin\varphi$$

For a single phase supply the $\sqrt{3}$ disappears

Purely resistive devices are the only ones that do not consume reactive energy.

ACTIVE ENERGY

In physics, this represents the ability of a system to produce work, which could involve movement, light, heat or even electricity.
Energy is expressed in joules (SI unit), but often in kilowatts per hour (kWh).
Energy is therefore the consumption of a system producing work for one hour.
Active energy = Ea = consumption = active power x time

APPENDICES

APPENDICES

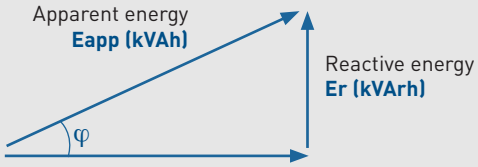
ACTIVE, REACTIVE AND APPARENT POWERS (CONTINUED)

REACTIVE ENERGY

This is used in particular in the windings of motors and transformers to create the magnetic field without which they would not be able to operate. It corresponds to the reactive power Q (kVAr).
Energy is expressed in kilovar per hours (kVArh).
Unlike active energy, reactive energy is said to be "unproductive" for the user.
Reactive energy = Er = reactive power x time

APPARENT ENERGY

This is the resultant vector of the active and reactive energy.



POWER FACTOR OF THE MAIN RECEIVERS

The following receivers consume the most reactive energy:
- Motors at low load
- Welding machines
- Arc and induction furnaces
- Power rectifiers

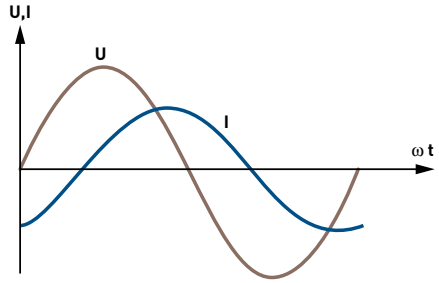
RECEIVER		COS φ	TG φ
Asynchronous motors ordinary loaded at	0%	0.17	5.80
	25%	0.55	1.52
	50%	0.73	0.94
	75%	0.80	0.75
	100%	0.85	0.62
Incandescent lamps		approx. 1	approx. 0
Fluorescent lamps		approx. 0.5	approx. 1.73
Discharge lamps		0.4 to 0.6	approx. 2.29 to 1.33
Resistance furnaces		approx. 1	approx. 0
Compensated induction furnaces		approx. 0.85	approx. 0.62
Dielectric heating furnaces		approx. 0.85	approx. 0.62
Resistance welding machines		0.8 to 0.9	0.75 to 0.48
Single-phase static arc welding stations		approx. 0.5	approx. 1.73
Arc welding transformers-rectifiers		0.7 to 0.9	1.02 to 0.48
		0.7 to 0.8	1.02 to 0.75
Arc furnaces		0.8	0.75
Thyristor power rectifiers		0.4 to 0.8	2.25 to 0.75

HARMONICS

In recent years, the modernisation of industrial processes and the sophistication of electrical machines and equipment have led to major developments in power electronics.
These systems represent "non-linear" loads for electrical supplies.

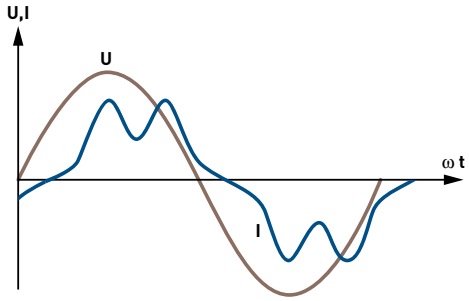
LINEAR LOADS

A load is said to be "linear" if the current it draws is sinusoidal when it is powered by a sinusoidal voltage.
This type of receiver does not generate harmonics.



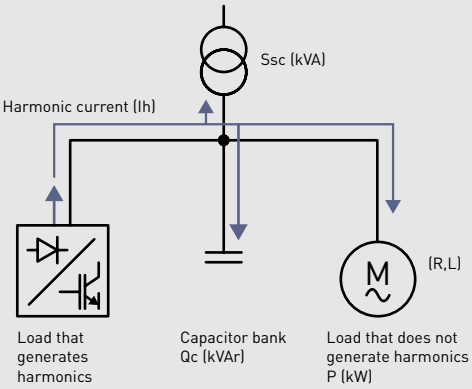
NON-LINEAR LOADS

A load is said to be "non-linear" if the current it draws is not sinusoidal when it is powered by a sinusoidal voltage.
Non-linear loads distort the electrical signals of the current and the voltage.
This type of receiver does generate harmonic currents.



Type of non-linear loads:
- Examples of single-phase loads:
  Low-voltage or energy-saving lamps, fluorescent tubes, electronic ballast, medical equipment, televisions, computers, printers, photocopiers, UPS, etc
- Examples of three-phase loads:
  Variable speed drives for motors, rectifier (AC/DC converter), welding machine, arc furnace used in metallurgy, battery charger, PLC, UPS, etc

These non-linear loads inject currents with a non-sinusoidal waveform onto the supply. These currents are formed by a fundamental component of the supply frequency, plus a series of superimposed currents, multiple frequencies of the fundamental which are known as harmonics.



EFFECTS OF HARMONICS

The immediate effects of harmonics (losses due to Joule effect):
- Deterioration of the power factor
- Reduction in the motor power
- Cable, transformer, motor overloads
- Increased noise in the motors
- Recording error in the meters
- Oversizing of the supply capacitance cables
- Contactors not working correctly
- Interference in the electronic systems
- Etc

Medium and long-term effects:
- Shorter life of motors and transformers
- Deterioration of capacitor banks
- Accelerating ageing of insulation and dielectrics
- Derating of transformers and motors
- Etc

APPENDICES

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HARMONIC ORDERS

The FOURIER decomposition (harmonic analysis) of the current consumption of a non-linear receiver shows:
- The fundamental, a sinusoidal term at the 50 Hz mains supply frequency
- The harmonics, sinusoidal terms whose frequencies are multiples of the fundamental frequency

According to the equation:

$$I_{rms} = \sqrt{I_1^2 + \sum_{h=2}^{n} I_h^2}$$

Σ: sum of all the harmonic currents from harmonic 2 (50 Hz x 2) at the last harmonic order n (50 Hz x n)

These harmonic currents circulate in the source. The harmonic impedances of this source then give rise to harmonic voltages, according to the equation:

$$Uh = Zh \times Ih$$

The harmonic currents induce most of the harmonic voltages causing the overall harmonic distortion of the supply voltage.

$$V_{rms} = \sqrt{U_1^2 + \sum_{h=2}^{n} U_h^2}$$

Note: The harmonic distortion of the voltage generated by construction defects in the windings of alternators and transformers is generally negligible

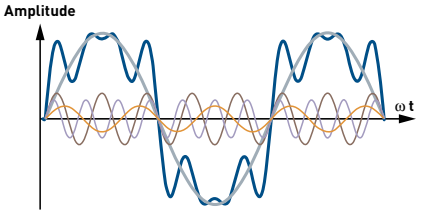
The electricity supply frequencies are 50 Hz or 60 Hz, called the fundamental frequency (f1).
For example: in France f1 = 50 Hz.

Harmonic components have a frequency (fn) which is a multiple of the fundamental frequency (f1).

$$f_n = n \times f_1$$

where n is the harmonic order

The FOURIER decomposition (harmonic analysis) of the current consumption of a non-linear receiver shows:
- The fundamental, a sinusoidal term at the 50 Hz mains supply frequency
- The harmonics, sinusoidal terms whose frequencies are multiples of the fundamental frequency



- Resultant.
- Fundamental.
- Order 3: additional current of 150 Hz (3 x 50 Hz).
- Order 5: additional current of 250 Hz (5 x 50 Hz).
- Order 7: additional current of 350 Hz (7 x 50 Hz).
- Etc
- Order n: additional current of xxx Hz (n x 50 Hz).

SPECIAL CASE OF 3RD ORDER HARMONICS

The main loads generating 3rd order harmonics are single-phase diode rectifiers with capacitive filtering.

Three-phase, non-linear, symmetrical, balanced loads, with no connection to the neutral do not generate any 3rd order harmonics, nor any harmonic orders that are multiples of 3.

Three-phase, non-linear, symmetrical, balanced loads, with connection to the neutral, generate 3rd order harmonic currents and harmonic currents in orders that are multiples of 3 in this neutral conductor. Single-phase loads such as high-power lighting (stadium lighting power, for example) also generate 3rd order harmonics.

IMPORTANT: The rms value of the neutral current can be greater than that of the phase current, which on average means that the neutral conductor cross-section must be twice that of the phase conductor cross-section.
- The design of Legrand's isolating transformers with low losses prevents 3rd order harmonics (see Legrand catalogue).
- SAH type – 135 Hz capacitor banks are sized to operate in conditions with high levels of 3rd order harmonics (see page 7).

TOTAL HARMONIC DISTORTION

The total harmonic distortion is used to quantify the distorted global sinusoidal signal using the following theoretical formulas:

individual THD

$$\sigma_n\,(\%) = \frac{X_n}{X_1} \times 100$$

X_n = rms value of the fundamental (voltages or current)
X_1 = rms value of the nth harmonic order (voltages or current)

global THD

$$\text{THD-U}(\%) = \frac{\sqrt{\sum_{n=2}^{n} U_n^2}}{U_1} \times 100$$

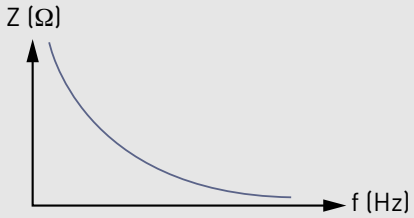
$$\text{THD-I}(\%) = \frac{\sqrt{\sum_{n=2}^{n} I_n^2}}{I_1} \times 100$$

- Nemo measurement control units provide you with optimum monitoring of your installation, see the IME catalogue.
- The "Measurement" Audit (see page 16-17) allows you to carry out complete diagnostics of the various phenomena in your installation.

IMPACT OF HARMONICS ON CAPACITORS

The capacitor bank reactance is inversely proportional to the frequency, and its ability to cancel out harmonic currents decreases significantly when the frequency increases. This leads to an increase in the current drawn by the capacitors and causes a temperature rise which accelerates capacitor ageing and can even lead to their destruction in extreme cases.

$$Z_c = \frac{1}{C\omega} = \frac{1}{C\ 2\pi\ f}$$

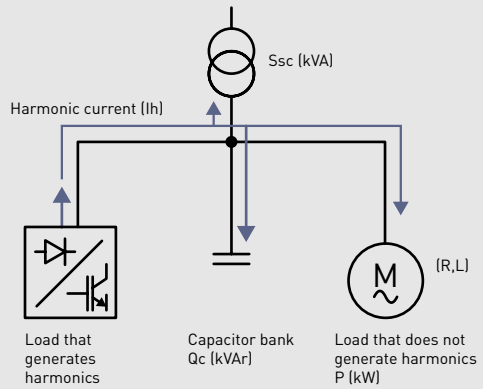


Alpivar 3 capacitors have the capacity to resist harmonics exceeding the requirements of standards IEC 60831-1 & 2
- permissible overvoltage up to 1.5*Un 12/24 hrs
- permissible overvoltage up to 2*In

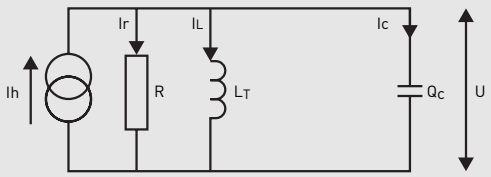
APPENDICES

THE PHENOMENON OF RESONANCE

The phenomenon of electrical resonance between the capacitor banks and the electricity supply corresponds to amplification of the existing voltage and current harmonics (increase in the THDu % and THDi %) due to electrical resonance between the capacitor banks and inductances in the system upstream.



This outline diagram of an electrical installation with capacitor bank and a load that generates harmonics can be drawn as below:

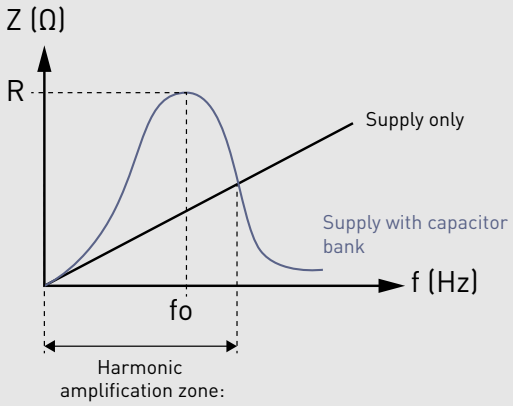


Ssc: transformer short-circuit power
LT: transformer short-circuit inductance, because the influence of the load inductances and the short-circuit inductance of the distribution network seen from the upstream terminals of an MV/LV transformer is negligible.

Hence the supply impedance seen from the main LV distribution board

$$Z = \frac{1}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{L_T\omega} - C\omega\right)^2}}$$

$$f_o = \frac{1}{2\pi\sqrt{L_T C}}$$



At frequency far, corresponding harmonic currents are generated. Circulating across the various impedances of the installation they generate an increase in the harmonic voltages and therefore in the level of THDu %.

Amplification is seen through the typical curve of impedances in the system as a function of the frequency. It shows the amplified value compared to the initial supply value without capacitors.
At resonance f_0 all the nth order current Io generated by the circuit that is causing interference passes into the resistor R, thus meaning that nearly all this current is drawn by loads consuming active power.
The direct consequence of this resonance is an increase in the harmonic voltages, and therefore in the level of THDi.

ESTIMATE OF PARALLEL RESONANCE BETWEEN THE CAPACITORS AND THE SOURCE

To find out the harmonic frequency (Fn) of order n with a risk of resonance in the system le and the amplification factor (Fa) of the harmonic currents in the capacitors and in the source (transformers), use the equations below:

$$S_{SC} = \frac{S_T}{U_{SC}}$$

$$F_n = f_1 \times \sqrt{\frac{S_{SC}}{Q_C}} \qquad F_a = \frac{\sqrt{S_{SC} \times Q_C}}{S}$$

Ssc: transformer short-circuit power
Usc: MV/LV transformer short-circuit voltage
Qc: capacitor bank reactive power
f1: fundamental frequency (50 Hz in France)
ST: power in kVA of the MV/LV transformer (or MV/LV transformers if there are two or more transformers in parallel)
S: active power of loads that do not generate harmonics (non-polluting)

The higher the source short-circuit power (SSC) the further the resonance frequency is from dangerous harmonic frequencies.
The higher the power (P) of non-polluting loads, the lower the harmonic current amplification factor.

EXAMPLE
Transformer power: ST = 1000 kVA where USC = 6%
Load power: S = 750 kW
Capacitor bank power: QC = 350 kVAr
Thus:

Transformer short-circuit power:

$$S_{SC} = \frac{1000}{6} \times 100 = 16{,}666 \text{ kVA}$$

Risk of resonance frequency:

$$F_n = 50 \times \sqrt{\frac{16{,}666}{350}} \text{ Hz} \approx 50 \times 6.90 \text{ Hz} \approx 354 \text{ Hz}$$

Level of amplification of harmonics:

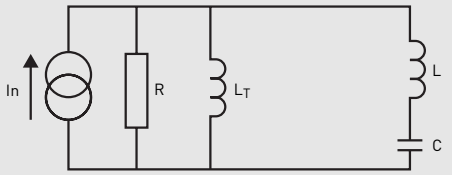
$$F_a = \frac{\sqrt{16{,}666 \times 350}}{750} \approx 3.22$$

IMPORTANT: In this example, the installation demonstrates a risk of resonance with the 7th order harmonic. To avoid this risk, use a capacitor bank with detuned reactor. See next section.

PROTECTING CAPACITORS USING DETUNED REACTORS

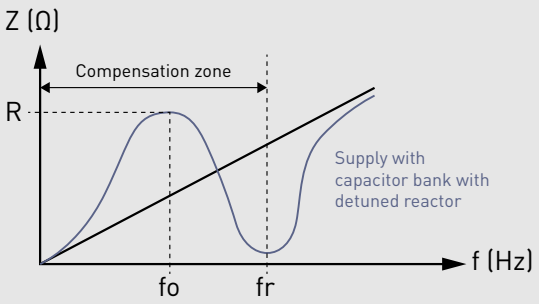
The detuned reactor performs a dual role:
- Increasing the capacitor impedance in relation to the harmonic currents
- Shifting the parallel resonance frequency of the source and the capacitor to below the main frequencies of the harmonic currents that are causing interference

Adding the reactor impedance



$$f_o = \frac{1}{2\pi\sqrt{(L_T + L)C}} \qquad f_r = \frac{1}{2\pi\sqrt{LC}}$$

fo: Parallel resonance frequency (anti-resonance)
fr: Serial resonance frequency for the branch between the capacitors and the detuned reactor



- The detuned reactor and capacitor assembly is capacitive for frequencies below fr, so allows reactive energy compensation.
- The detuned reactor and capacitor assembly is inductive, so prevents amplification of the harmonics.

NOTE: The serial frequency (fr) chosen must be below the first harmonic order present in the circuit.

APPENDICES

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PHYSICAL STEPS AND ELECTRICAL STEPS

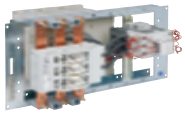
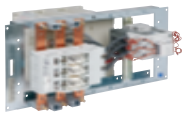
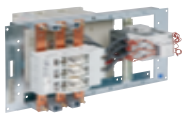
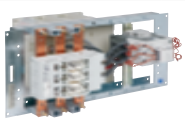
DEFINITION

Physical steps equivalent to the kVAr powers of the various capacitors which make up an automatic or dynamic capacitor bank (Alpimatic/Alpistatic range) and tripped individually by the contactors.
Electrical steps = total power/smallest physical step and represents the power kVAr seen by the electrical installation.

The design of Alpimatic and Alpistatic racks and the latest generation of Alptec 3.2/5.2/8.2 and Alptec 8 power factor controllers with sophisticated regulation ensures optimal, accurate, fast regulation with the least possible number of capacitors, alternating the steps required as a function of the reactive power needed.

This type of regulation:
- increases the capacitor bank service life
- ensures that all components which make up the capacitor bank steps (capacitors, contactors, etc) age uniformly and
- allows a smaller enclosure and hence lower purchase and maintenance costs of the enclosure.

EXAMPLE OF AN ALPIMATIC 225 KVAR CAPACITOR BANK

Cat.No	Capacitor bank power	Physical steps
MH22540	**225**	**(25+50)+2x75**
		 25 kVAr
		 50 kVAr
		 75 kVAr
		 75 kVAr

Number of electrical steps:
225/25 = 9 steps of 25 kVAr

OPERATING CYCLE

9 ELECTRICAL STEPS	4 PHYSICAL STEPS			
Power kVAr	**25**	**50**	**75**	**75**
25	1	0	0	0
50	0	1	0	0
75	0	0	1	0
100	1	0	0	1
125	0	1	1	0
150	1	1	0	1
175	1	0	1	1
200	0	1	1	1
225	1	1	1	1

0 = step disconnected
1 = step activated

⊕ ALPTEC power factor controllers – Control of capacitor steps, see p. 42

ESTIMATING THE CAPACITOR BANK POWER BASED ON ENERGY BILLS

Energy metering devices record active and reactive energy consumption. Electricity suppliers generally use the term tg φ on their bills.

The tg φ is the ratio between the reactive energy Er (kVArh) and the active energy Ea (kWh) consumed during the same period.. Unlike the cos φ, it is easy to see that the value of tg φ must be as small as possible in order to have the minimum reactive energy consumption.

CALCULATING THE TG φ

$$\text{tg } \varphi = \frac{\text{Er (kVArh)}}{\text{Ea (kWh)}}$$

The reactive energy billing threshold is set at:
- Tg φ = 0.4 or cos φ = 0.928: at the primary
- Tg φ = 0.31 or cos φ = 0.955: at the secondary

CALCULATION

To calculate the capacitor banks to be installed, use the following method:
- Analyse the monthly electricity bills
- Select the month in which the bill is highest (kVArh to be billed)

$$Qc = \frac{\text{kVArh to be billed (monthly)}}{\text{No. of hours' operation (monthly)}}$$

- Assess the number of hours the installation operates each month during high-load times and peak times (generally 6 hours to 22 hours excluding Sunday)
- Calculate the capacitor power Qc to be installed
- When calculating the kVArh to be billed, electricity suppliers generally introduce fixed transformer consumption by applying a coefficient of 0.09 to the calculated secondary tg φ to obtain the primary tg φ.

EXAMPLE FOR THE SUBSCRIBER[1]

REACTIVE ENERGY P + HP	ACTIVE ENERGY P + HP as recorded on the meter	TANGENT phi secondary	TANGENT phi primary	kVArh free	kVArh as consumed	kVArh to be discounted	kVArh to be billed
120,000	125,000		0 96		12,000		70,000

SUBSCRIBED DEMAND P1	P2	P3	P4	P5	POWER RATINGS CHOSEN TO CALCULATE THE PRM P1	P2	P3	P4	P5	PR	PRM	Excess amount to be billed
525	590	590	590	590						560	1	

- Highest reactive energy bill: December
- Number of kVArh to be billed: 70,000
- Monthly operating times: high-load + peak times = 350 hours

$$Qc \text{ (bank to be installed)} = \frac{70{,}000}{350} = 200 \text{ kVAr}$$

1: Example for information purposes only.
The way in which reactive energy is billed and any penalties is specific to each country/electricity supplier.

APPENDICES

ALPES TECHNOLOGIES

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