ORTEA NEXT

Innovative solutions for sustainable power quality since 1969

ORTEA BY ORTEA NEXT

MV POWER CAPACITOR AND BANKS

ORTEA NEXT

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GENERAL
SALES
CONDITIONS

OUR BRANDS:

ORTEA BY ORTEA NEXT
VOLTAGE STABILIZERS
SAG COMPENSATORS
LV TRANSFORMERS AND REACTORS

ICAR BY ORTEA NEXT
POWER FACTOR CORRECTION SYSTEMS
ACTIVE HARMONIC FILTERS

ENERSOLVE BY ORTEA NEXT
ENERGY EFFICIENCY SMART DEVICES

PowerSines BY ORTEA NEXT
ENERGY SAVING VOLTAGE OPTIMIZERS

ABOUT US

Innovative solutions for sustainable power quality since 1969

Founded in 1969, Ortea is a leader in the design and manufacture of innovative products and customised solutions for power quality and energy efficiency.

Thanks to a network of offices and dealers on all continents, Ortea products are now installed, maintained and operating in more than 100 countries worldwide.

In line with the strategy of creating a global pole of excellence, the new brand Ortea Next is created in 2019, bringing together the 3 historical product brands - Ortea, Icar and Enersolve - in a single concept of integrated technological offer.

Alongside the standard production, Ortea Next develops and produces equipment that can be customised according to the client's specific requirements with extreme flexibility.

The process of renewal and continuous improvement strengthens Ortea Next's leadership as your ideal partner to meet the challenge of the global energy transition.

GLOBAL PRESENCE

Ortea Next solutions are already present in a large number of countries with positive, long-lasting results

Thanks to a network of offices and distributors that are strategically distributed, local, fast, and competent assistance is guaranteed.

ORTEA NEXT

MADE IN ITALY

Production quality, attention to details, design, and reliability represent the added value of Made in Italy. All the Ortea Next solutions are devised, designed, produced, and assembled in Italy.

EXPERIENCE

Founded in 1969, Ortea Next has accumulated experience and expertise that have contributed to continuous growth over time, until becoming an authoritative and innovative company in designing and producing power quality solutions on an international scale.

RELIABILITY

The certified Company Quality System of Ortea Next guarantees the reliability and longevity of the whole range of products, each of which is strictly controlled and tested.

CUSTOMIZED SOLUTIONS

In addition to standard production, Ortea Next is able to develop and produce complete and integrated solutions based on the specific needs of each client with extreme flexibility.
Ortea Next is always at your service to evaluate projects and study customised solutions, assisting and supporting the client at each stage of development.

QUALITY

Ortea Next's certified Company Quality System guarantees that all the production stages are controlled, from the verification of components to the choice of the most suitable packaging depending on the kind of transport.

RESEARCH & DEVELOPMENT

To ensure innovative solutions, Ortea Next continuously collaborates with universities, institutions, and technological partners in researching and developing new products and reliable technologies.

EXPERTISE

The experience and expertise of the Ortea Next technicians assist the customer both in the design and service stage, ensuring solidity and reliability in researching the best solution.

CUSTOMER CENTRIC

Listening to the customer and their requirements allows Ortea Next to continuously improve the service level offered.

LRQA CERTIFIED
ISO 9001 · ISO 14001
ISO 45001

CERTIFIED QUALITY

The conviction that product quality and customer satisfaction must be the main requirements of a modern company has led to the adoption of a certified Company Quality System

After having obtained the first ISO 9001 certification in 1996, today our Company Quality System is certified by Lloyd's Register in compliance with the main standards:

ISO9001	Quality management system
ISO14001	Environmental management system
ISO45001	Occupational health and safety management system

This means that Ortea Next guarantees optimised performance in terms of the internal management of processes, engagement on environmental issues, and attention to occupational health and safety

POWER QUALITY SOLUTIONS

Paying little attention to the issue of power quality causes problems and damage to equipment and production processes

Ortea Next offers a complete range of integrated products and solutions for power quality and energy efficiency, thanks to the synergy between the Ortea Next brands, Ortea, Icar, Enersolve, and Powersines.

VOLTAGE VARIATION	ORTEA BY ORTEA NEXT	VOLTAGE STABILIZERS
SAGs / DIPs	ORTEA BY ORTEA NEXT	SAG COMPENSATORS
UNPROTECTED LOADS	ORTEA BY ORTEA NEXT	LV TRANSFORMERS AND REACTORS
EXCESSIVE REACTIVE POWER	ICAR BY ORTEA NEXT	PFC SYSTEMS
HARMONIC POLLUTION	ICAR BY ORTEA NEXT	ACTIVE HARMONIC FILTERS
WASTE OF ENERGY	ENERSOLVE BY ORTEA NEXT	ENERGY EFFICIENCY SMART DEVICES
WASTE OF ENERGY	PowerSines BY ORTEA NEXT	ENERGY SAVING VOLTAGE OPTIMIZERS

HOW TO UPGRADE ELECTRICAL NETWORK AND IMPROVE ENERGY EFFICIENCY?

POWER FACTOR CORRECTION

Power Factor Correction solutions modify and control the reactive power to avoid utility penalties, and reduce overall kVA demand

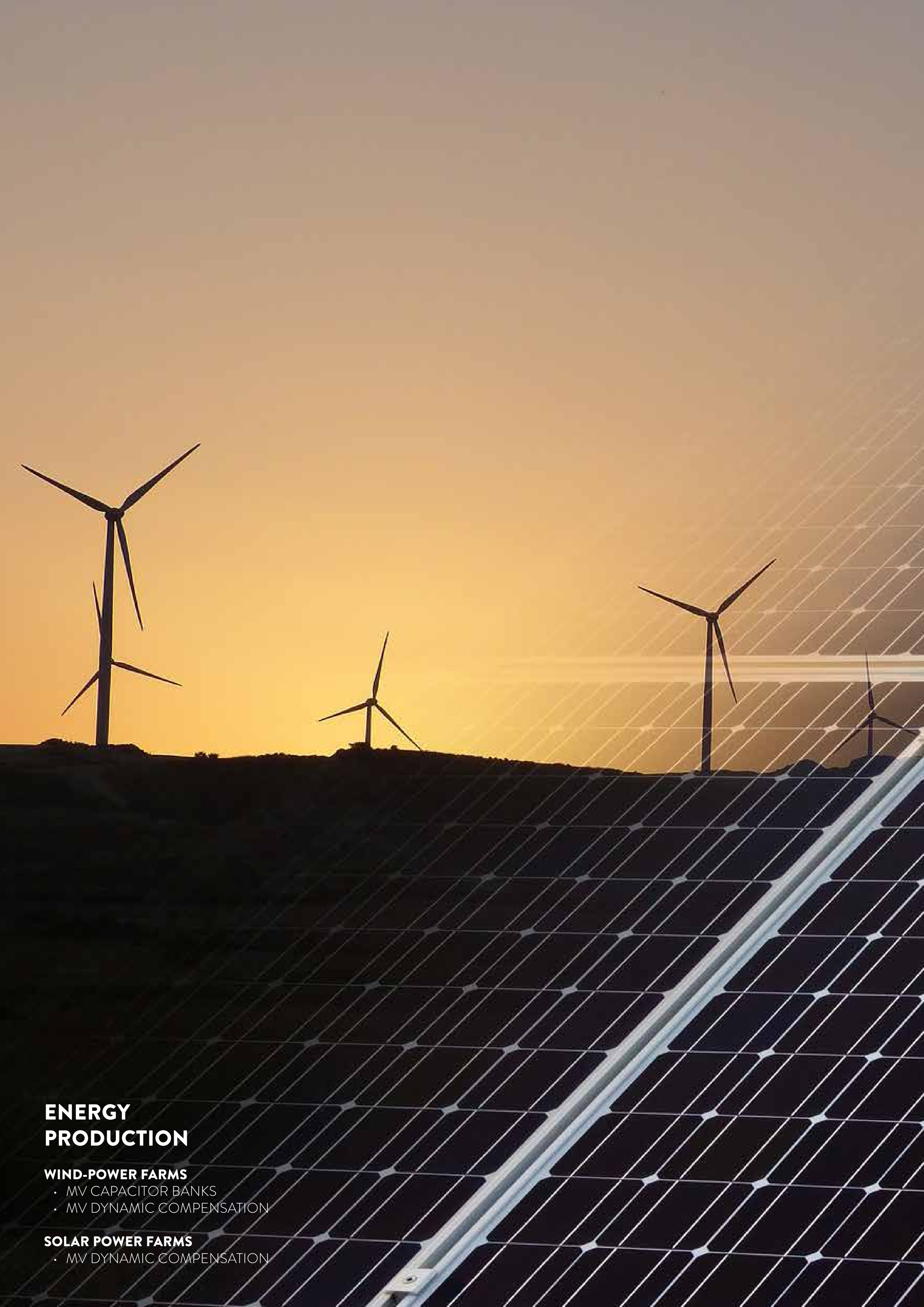
Most utilities have specific policies for billing reactive energy.
Price penalties are applied if the active power / apparent power ratio is not within the guidelines.
Every electric machine needs active and reactive power to operate.
Power factor is used to identify the level of reactive energy.
If the power factor drops below the limit set by the utility, then power factor correction equipment can be installed in order to avoid penalties.
By correcting a poor power factor, these solutions also reduce kVA demand.
The results are a 5 to 10% lower electricity bill, cooler equipment operation and longer equipment life.
In addition proper power factor correction helps optimize electrical network loading and improves reliability.

HARMONIC FILTERING

Harmonic Filtering solutions are a means to mitigate the harmonics.They increase the service life of equipment

Harmonics stress the electrical network and potentially damage equipment.
Equipment such as drives, inverters, UPS, arc furnaces, transformers during energization and discharge lamps generate harmonic currents and voltage distortion.
These harmonics stress the network, overload cables and transformers, cause outages and disturb many types of equipment such as computers, telephones, and rotating machines.
The life of equipment can be greatly reduced.

ENERGY QUALITY WITH POWER FACTOR CORRECTION AND HARMONIC FILTERING



ENERGY PRODUCTION

WIND-POWER FARMS

- MV CAPACITOR BANKS
- MV DYNAMIC COMPENSATION

SOLAR POWER FARMS

- MV DYNAMIC COMPENSATION

APPLICATIONS

The following table shows the typical solutions proposed for installations in various sectors of activity.

ACTIVITY	Fixed banks	Automatic banks	Passive filters	Surge suppressors
Energy				
Transmission	x		x	
Distribution	x	x	x	
Wind farm		x		
Solar farm				
Infrastructure				
Water		x		
Tunnels		x		
Airports		x		
Industry				
Paper		x		x
Chemicals	x	x		x
Plastics		x		x
Glass		x		x
Iron and steel	x	x	x	x
Metallurgy	x	x		x
Automotive		x		x
Cement	x	x		x
Mines	x	x		x
Refineries	x	x		x

POWER FACTOR CORRECTION

REDUCE YOUR ELECTRICITY BILL
by reducing your reactive energy consumption

OPTIMIZE THE SIZE OF YOUR ELECTRICAL INSTALLATION
by increasing the available capacity and reducing the dimensions of your equipment (transformer, cables, etc.)

IMPROVE ENERGY QUALITY
and the service life of your equipment

CONTRIBUTE
to environmental conservation by reducing losses in transmission and distribution networks

ENERGY TRANSMISSION

EHV/HV SUBSTATION

- HV CAPACITOR BANKS
- HV PASSIVE FILTERS

ENERGY PRODUCTION

Wind-power farms
- MV capacitor banks
- MV dynamic compensation

Solar power farms
- MV dynamic compensation

ENERGY TRANSMISSION

EHV/HV Substation
- HV capacitor banks
- HV passive filters

ENERGY DISTRIBUTION MV/MV

Substation
- MV capacitor banks
- MV passive filters

INDUSTRY MV/MV

Substations
- MV capacitor banks
- MV passive filters
- MV dynamic compensation
- Surge suppressors

INFRASTRUCTURE MV/LV

Substations
- MV capacitor banks

HARMONIC FILTERING

INCREASE CONTINUITY OF SERVICE
by eliminating risks of stoppages due to nuisance tripping

ELIMINATE MALFUNCTIONS
of your electrical equipment by reducing overheating, increasing its lifetime by up to 30%

BENEFIT FROM THE ASSURANCE PROVIDED BY STANDARDIZATION
by anticipating the requirements of regulations currently being prepared, deploying environmentally friendly solutions

INDUSTRY MV/MV

SUBSTATIONS

- MV CAPACITOR BANKS
- MV PASSIVE FILTERS
- MV DYNAMIC COMPENSATION
- SURGE SUPPRESSORS

ORTEA'S MV AND HV SOLUTIONS

ORTEA BIORIF SINGLE PHASE MV CAPACITORS

- Unit power up to 950kvar
- Nominal voltages up to 24kV
- Frequency of 50 or 60Hz

ORTEA BIORIF THREE-PHASE MV CAPACITORS

- Nominal unit power up to 850kvar
- Nominal voltages up to 12kV
- Frequency of 50 or 60Hz

SPECIAL CAPACITORS FOR CUSTOMIZED APPLICATIONS

- Three-phase capacitors with neutral brought out
- Split-phase capacitor
- Overvoltage protection capacitors (typically used in protection of large electrical machines)
- Caps for applications in aggressive environments, such as high or very low temperature, salty atmosphere, altitude above 1000 m, etc.

MV AND HV POWER-FACTOR CORRECTION CAPACITORS BANKS

Contact us.

TUNED CAPACITOR BANKS

Contact us.

MV AND HV SPECIAL FILTERS

Such as high pass, second order filters with double tuning frequency, damping resistor, etc.
Contact us.

MV POWER CAPACITORS

General Features

ORTEA BIORIF Capacitors series is complete range of solutions for MV and HV power-factor correction.
They are designed and manufactured using the most modern technologies, ensuring long expected life and high reliability.
The ORTEA BIORIF series is designed in full compliance with applicable standards (IEC 60871, ANSI, IEEE 18, NEMA CP-1, etc.): they are therefore suitable for installation in any environment or conditions in adherence with the above standards.

Classification

The various models are identified by:

- series name
- power
- voltage
- typology
- single-phase: with or without internal fuses, with single or double isolator;
- three-phase: with delta or star connection with neutral brought out

Examples
BIORIF 200/12: single-phase capacitor of 200kvar at 12kV
BIORIF 200/12/E: as above, but with only one bushing
BIORIF 200/12/T: three-phase capacitor of 200kvar at 12kV

All capacitors are uniquely identified by the relevant rating plate as required by the IEC Standard 60871-1, with the following information:

- Name of manufacturer
- Serial number/year
- Nominal power
- Nominal voltage
- Nominal frequency
- Temperature category
- Insulation level
- Internal discharge device
- Connection symbol
- Name of the impregnating fluid
- Indication of the presence of internal fuses (if included)

Capacitor construction

Dielectric

Dielectric and electrodes constitute the most important parts of the capacitor, which determines the electrical characteristics (capacity, losses) and affects the durability and reliability over the time.
The dielectric of ORTEA BIORIF capacitors is composed of several layers of rough BOPP film (Biaxial Oriented Polypropylene) of very high quality.

Aluminum electrodes

The electrodes of BIORIF capacitors are made of a thin sheet of purest aluminum to ensure the best performance and greatest reliability.
The winding with the extended foils provides high withstand capacity at current peaks consequent to the transients of the capacitors switching or during the transients relating to network fluctuations.

Impregnation oil

BIORIF capacitors are vacuum impregnated with dielectric fluid and are sealed without an air head.
The oil impregnates all the individual capacitive elements of which the capacitor is composed, and it fills the entire free volume, ensuring perfect isolation and absence of partial discharges.
Special attention is paid to the various stages of treatment. Drying is carried out with the capacitor placed in a vacuum autoclave at a high temperature.
At the end of the drying process, the interior of the capacitors reaches the molecular vacuum.
JARYLEC® is used for the impregnation of ORTEA BIORIF capacitors: it is a biodegradable, environmentally friendly synthetic oil (free of PCBs and other substances harmful to the environment) and it is non-toxic. The high quality oil, produced by leading chemical companies, is further in house refined through vacuum degasification chemical purification. Rigorous controls of its physical and chemical properties are made prior to impregnation.

Dielectric losses and total losses

Dielectric losses in ORTEA BIORIF are very low, initially below 0,07 W/kvar, reducing in less than 400 hours of work to a value in the range between 0.02 to 0.05 W/kvar.
Dielectric losses must be added to those of the discharge resistances built into the capacitors.
ORTEA BIORIF total losses, dielectric losses + loss of discharge resistance are:

- less than 0.15 W/kvar for models with discharge resistance designed to ensure a residual voltage less than at 75V within 10 minutes (IEC standards)
- less than 0.20 W/kvar for models with discharge resistance designed to ensure a residual voltage less than 50 V within 5 minutes (IEEE standards).

Housing

The hermetically sealed housing protects the active part (electrodes and dielectric), ensuring preservation and good function over time.
The housing of ORTEA BIORIF capacitors is made of AISI 409 stainless steel sheet, very thick, bent and T.I.G. welded. The completely automated process guarantees the highest welding quality and thus the robustness and hermetic sealing of the capacitor.
The elasticity of the larger surfaces of the housing ensures that it follows the thermal expansion of oil due to the variation of room temperatures.
At low temperatures the elasticity of the housing must ensure that there will not be an inner depression that reduces the dielectric strength of the oil and the voltage of partial discharges.
At high temperatures, conversely, the elasticity of the housing must ensure that the internal overpressure be limited.
Whenever there is any other electrical protection, the overpressure gauge is provided as standard feature.
The housing is protected with two layers of synthetic paint suitable for outdoor service and having a high mechanical strength and excellent performance in an environment polluted by industrial fumes and fog.
The blue-gray color, RAL 7031, allows for efficient transmission heat within the environment.
For applications exposed to high solar radiation, a lighter gray color, RAL 7035, is used which provides for an increased reflection of solar radiation, limiting internal overheating.
The housing also has two handles for lifting and fixing the capacitor. For specific needs, the positioning of the handles can be changed on request, or additional handles can be included.

Bushing
The bushing of the ORTEA BIORIF capacitors are made of the highest quality porcelain, brown in color; for large lots and upon request, it is possible to provide bushing in a light gray color.
The porcelain bushings have a high resistance to electrical arcs and to tracking (especially dangerous in highly polluted industrial environments); they are resistant to chemicals, atmospheric agents, heat, fungi and bacteria and are mechanically very robust.
The porcelain bushings are, therefore, a quality choice for ORTEA BIORIF capacitors.
Before assembling, all the bushings are subjected to strict controls.
The bushings of standardized models are suitable for installation in places with moderate fog or industrial fumes. For exceptionally polluted (salty or desert-like environments), special bushings are provided with creepage distance of up to 31 mm/kV.
The ORTEA BIORIF capacitors are supplied with 1 or 2 bushing; the three-phase version are with 3 bushings or 4 (in the latter case, the internal connection of the capacitor is star with neutral brought out).

Discharge resistance
When the capacitors are disconnected from the network, they remain charged, and the stored energy would be fatal in case of accidental contact, so the power-factor correction capacitors have an incorporated discharge resistor which ensures capacitor discharge in a fixed time.
In accordance with IEC standards, the incorporated discharge resistor in BIORIF series ensures a reduction of the residual voltage to 75V in less than 10 minutes.
On request, in accordance with IEEE standards, discharge resistance at 50V in less than 5 minutes can be provided.
Important Safety Notice: notwithstanding the presence of the discharge resistor, it is mandatory to short circuit and earthing terminals of the capacitors before any possible contact or handling.
Capacitors shall be also stored with short circuited terminals.

ROUTINE TESTS, TYPE TEST AND SPECIAL TEST

All ORTEA BIORIF capacitors undergo routine tests as required by IEC standards 60871 and relevant certificates are available upon request

ROUTINE TESTS:

- Capacitance measurement (IEC 60871-1)
- Measurement of the tangent of the loss angle (tan δ) of test capacitor (IEC 60871-1)
- Voltage test between terminals (IEC 60871-1)
- AC voltage test between terminals and container (IEC 60871-1)
- Test of internal discharge device (IEC 60871-1)
- Sealing test (IEC 60871-1)
- Discharge test on internal fuses (IEC 60871-4)

TYPE TESTS:

- Thermal stability test (IEC 60871-1)
- Measurement of the tangent of the loss angle (tanδ) of the capacitor at elevated temperature (IEC 60871-1)
- AC voltage test between terminals and container (IEC 60871-1)
- Lightning impulse voltage test between terminals and container (IEC 60871-1)
- Short circuit discharge test (IEC 60871-1)
- Disconnecting test on internal fuses (IEC 60871-4)

SPECIAL TESTS:

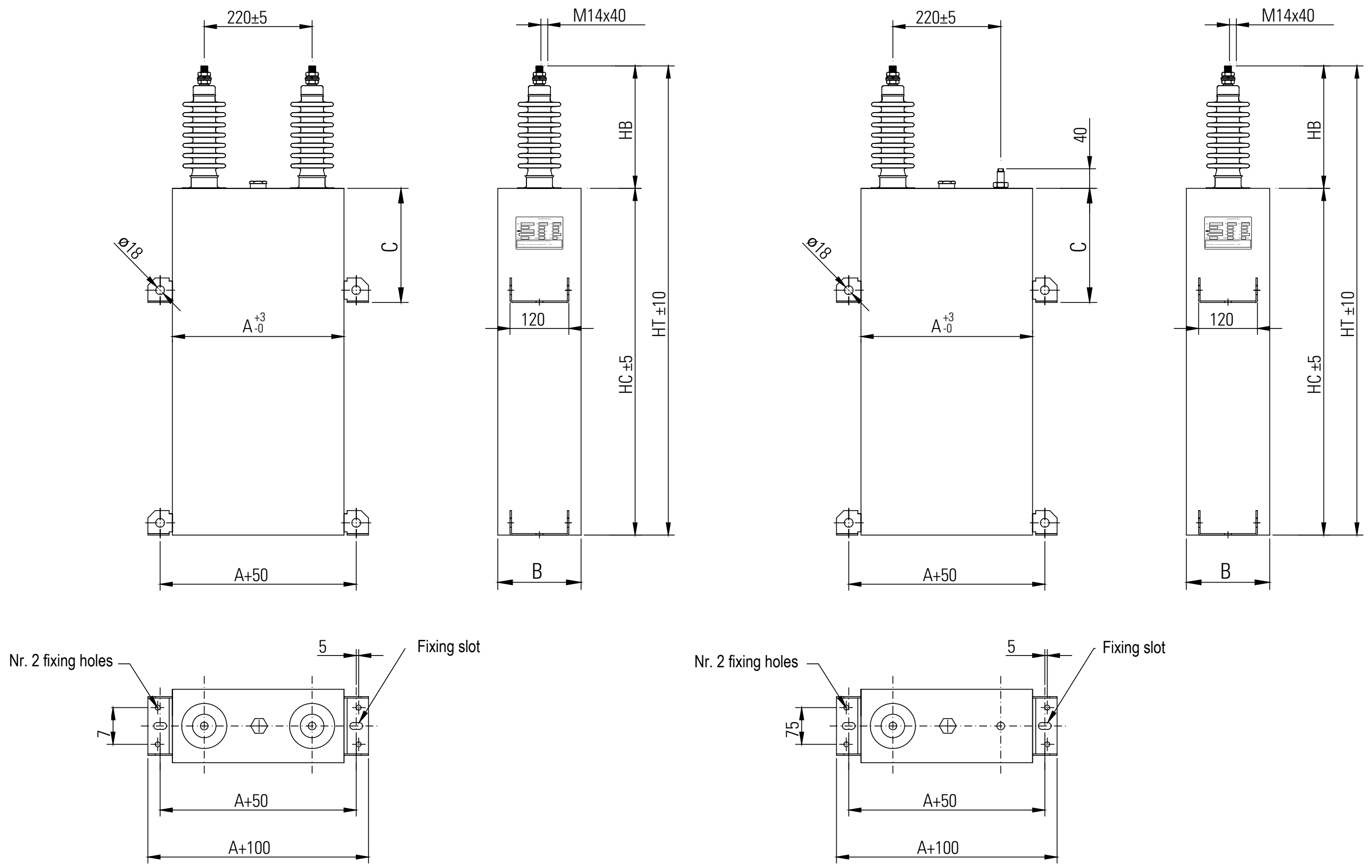
- Ageing test (IEC 60871-2)
- Overvoltage cycling test (IEC 60871-2)

ORTEA BIORIF SINGLE-PHASE MV CAPACITORS

ORTEA makes two types of single-phase capacitors:

- without internal fuses
- with internal fuses.

MV capacitors are internally made by connecting in series a number of parallel element groups.
In the capacitors with internal fuses, there is a fuse in series to each element which melts and isolates the same in case of dielectric perforation: so capacitors can keep on service with a small output reduction.
In case of capacitors without internal fuses the element perforation short circuits the entire series group at which it belongs, and the capacitors keep on service with an inner fault.
The choice of capacitors types depends on bank designer choice and on its power and rated voltage.



ORTEA BIORIF Single-Phase MV capacitors without internal fuses

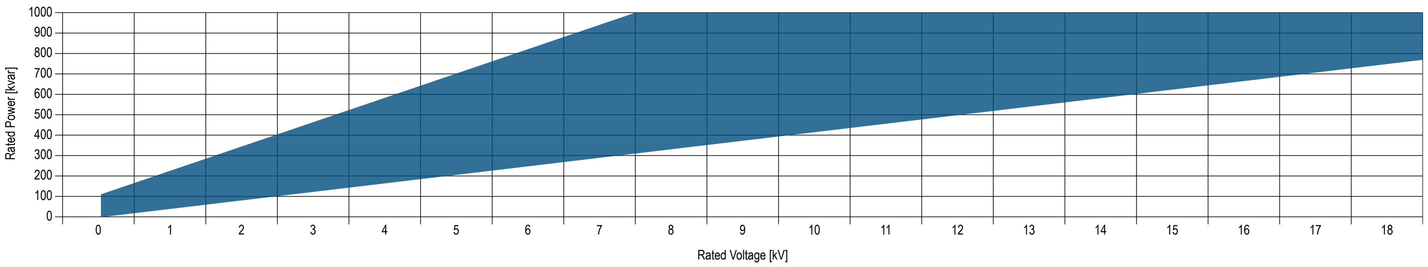
Small capacitors banks are made with single phase capacitors without internal fuses, they are connected in delta and protected by means of HRC limiting current fuses.
Capacitors banks of higher power are made up of at least six single phase capacitors or three split-phase, without internal fuses, with capacitor bank connected in insulated double star and unbalance protection.
In case of capacitors without internal fuses, higher power capacitor banks use one single external expulsion fuse for each capacitor; this fuse, which is specific for power capacitors, is very easy and effective, and it allows an immediate evidence of faulty capacitor.
In these type of banks the number of capacitors is chosen so to allow the bank to keep on service even in the case one capacitor has been insulated by its fuse melting.
An unbalance protection, which works out a lower priority protection, will provide the capacitor bank disconnection after a certain number of capacitors are out of order.
Capacitors without internal fuses, which have smaller losses than those with internal fuses, are designed to lower dielectric withstand and are so much more robust and reliable.

Rated Power	Container dimensions			Capacitor dimensions					
	A	B	HC	Ui=12kV (28/75kV)		Ui=17,5kV (38/95kV)		Ui=24kV (50/125kV)	
[kvar]	[mm]	[mm]	[mm]	HT [mm]	Weight [kg]	HT [mm]	Weight [kg]	HT [mm]	Weight [kg]
50	350	140	175	355	15	425	17	475	18
75	350	150	190	370	18	440	20	490	21
100	350	150	230	410	21	480	23	530	24
150	350	150	310	490	27	560	29	610	30
200	350	150	390	570	33	640	35	690	36
250	350	150	470	650	39	720	41	770	42
300	350	150	540	720	44	790	46	840	47
350	350	175	530	710	51	780	53	830	54
400	350	175	590	770	56	840	58	890	59
450	350	175	660	840	62	910	64	960	65
500	350	175	720	900	67	970	69	1020	70
550	350	175	790	970	72	1040	74	1090	75
600	350	175	850	1030	78	1100	80	1150	81
650	350	175	910	1090	83	1160	85	1210	86
700	350	175	980	1160	89	1230	91	1280	92
750	350	190	1000	1180	92	1250	94	1300	95
800	350	190	1060	1240	97	1310	99	1360	100
850	350	190	1120	1300	102	1370	104	1420	105
900	350	190	1150	1330	105	1400	106	1450	108
950	350	190	1180	1360	107	1430	108	1480	110

Other characteristics and sizes on request.
The above dimensions are not to be considered binding in relation to the continual development, product research and production of capacitors with or without internal fuses.

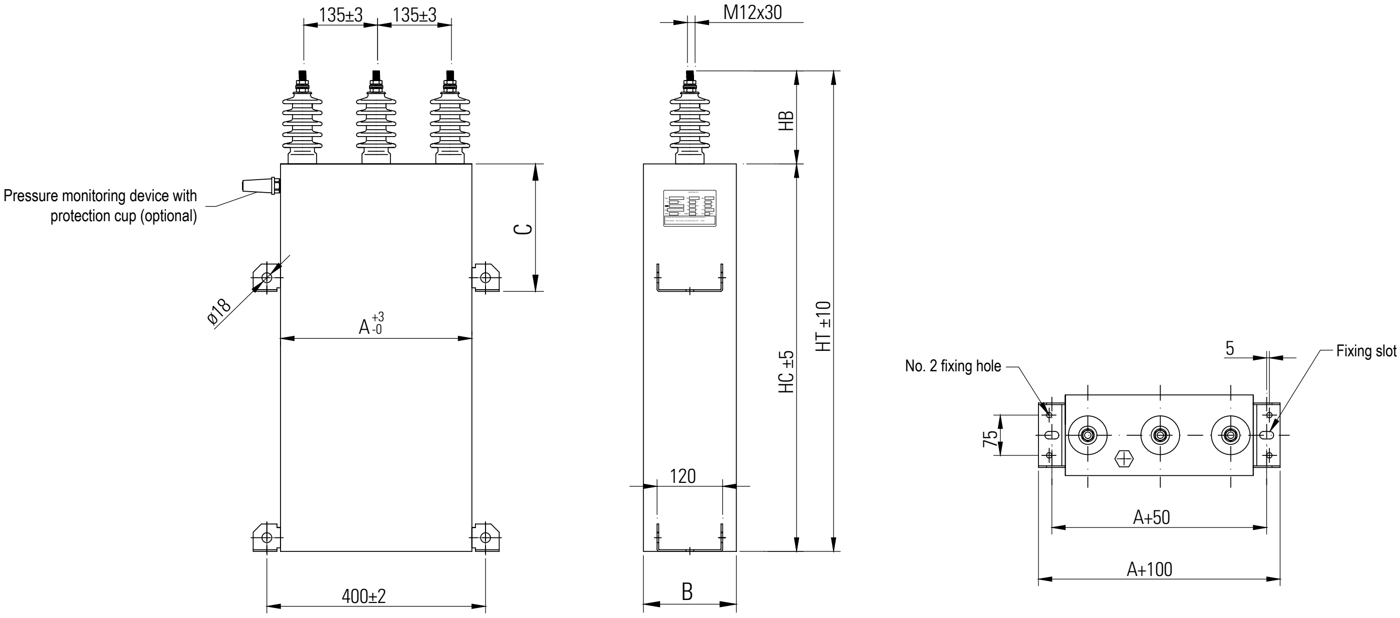
ORTEA BIORIF Single-Phase MV capacitors with internal fuses

As mentioned earlier in these capacitors each capacitive element inside the capacitor has an internal fuse in series.
In the event that an element has a fault, the fuse intervenes to exclude the damaged element, without removing the parallel elements from service. The break of the fuse is very fast (tens of milliseconds) due to energy stored in parallel elements. Doing so other protection can't operate and capacitor can stay in service with a small capacitance reduction. The high reliability of these solutions allows to design capacitors with an higher dielectric stress and so units of reduced volume and higher reactive power per volume unity. ORTEA available capacitor range which can be equipped with internal fuses is shown in the following table 2 (blue zone). It is clear that small power capacitors and those of high voltage are excluded. The reason of this choice are strictly related to the criterion of good design of these type of capacitors and they are briefly described below.
A well made design of internally fused capacitors requires indeed that each series group stored energy, while the sinusoidal voltage reaches its peak value, is sufficient to assure an immediate fusion of the fuses in the even of one element fault.
With a lower stored energy the fusion time would be uncertain, it would indeed happen for the capacitor current and within a time equal to several cycles of the fundamental frequency.
Each element disconnection due to its fuse melting, causes a voltage increase across the other elements of the same series group. This voltage increase is in reverse proportion to the number of group elements.
A good internally fused capacitor design requires that the number of parallel elements is chosen to limit such rise: it is necessary at least 10 elements to ensure the voltage rise is less than 10%.
Usually the series group parallel elements are not less than 14-16.
Series group stored energy limitations and minimum number of parallel elements, along with the limitations voltage per element, lead to make not convenient to make internally fused capacitors of small power and high voltage or big power and low voltage.
The following table could be used as an indication device showing the constructional feasibility of internal fuses in relation to the output and voltage of capacitors.



ORTEA BIORIF THREE-PHASE MV CAPACITORS

The three-phase capacitors are a simple and cheap solution to create groups of three-phase power factor up to 850 kvar.
They are normally used for power factor correction of motors or no load MV/LV transformers. Inside the three-phase capacitors are composed of three single phase units connected in delta or star or star with neutral brought out.
The three-phase capacitors for voltages up to 12 kV are usually delta connected and protected with current-limiting type fuses (HRC fuses with a high switching capacity). It's important to use this type of fuses to prevent the explosion of the capacitor that in case of short circuit will absorb the phase to phase short-circuit system current. Capacitors with internal star connection or with neutral brought out are provided on request.



Rated Power	Container dimensions			Capacitor dimensions					
				Ui=3,6kV (10/40kV)		Ui=7,2kV (20/60kV)		Ui=12kV (28/75kV)	
[kvar]	A [mm]	B [mm]	HC [mm]	HT [mm]	Weight [kg]	HT [mm]	Weight [kg]	HT [mm]	Weight [kg]
50	350	140	185	275	14	315	15	355	16
75	350	150	200	290	17	330	18	370	19
100	350	150	240	330	20	370	21	410	22
150	350	150	330	420	26	460	27	500	28
200	350	150	410	500	32	540	33	580	34
250	350	150	490	580	38	620	39	660	40
300	350	150	560	650	43	690	44	730	45
350	350	175	560	650	50	690	51	730	52
400	350	175	620	710	55	750	56	790	57
450	350	175	690	780	61	820	62	860	63
500	350	175	760	850	66	890	67	930	68
550	350	175	820	910	71	950	72	990	73
600	350	175	890	980	77	1020	78	1060	79
650	350	175	960	1050	82	1090	83	1130	84
700	350	175	1030	1120	88	1160	89	1200	90
750	350	190	1030	1120	93	1160	94	1200	95
800	350	190	1060	1150	98	1190	99	1230	100
850	350	190	1090	1180	102	1220	103	1260	104

Other characteristics and sizes on request.
The above dimensions are not to be considered binding in relation to the continual development, product research and production of capacitors with or without internal fuses.

CAPACITOR BANKS

ORTEA proposes Medium Voltage capacitor banks by assembling ORTEA BIORIF capacitors along with other components in order to make integrated and completed solutions

Capacitor banks can be suitable for indoor or outdoor use, with damping reactors, tuned or detuned reactors for harmonic blocking or absorption.
The most adopted scheme is double insulated star with unbalance protection between the two stars, which allows to spot a single capacitor fault.
The bank, depending on type of capacitor, could be also equipped with the following protection means:

- Expulsion or HRC fuses
- Capacitor inner fuses

Damping reactors

Transient overcurrent of high amplitude and high frequency may occur when capacitors are switched on and especially when a step of a capacitor bank is switched in parallel with other steps which are already energized.
The peak value of the inrush current should be limited to a maximum of 100 times the r.m.s. value (see IEC 60871-1).
For MV or HV capacitor banks when the natural values of the inductance of the network, in the case of a single bank, or inductance between the batteries in the case of multiple batteries in parallel, is not sufficient to limit the inrush current, damping reactors are installed in series with the capacitor banks that aim to limit this current.
The reactors are installed directly on the capacitor bank and remain in service throughout the operating time of capacitor banks. The damping reactors are made of an air core, dry insulation and winding copper or aluminum.
The design of the damping reactor must consider both, the maximum continuous current as well as the inrush current and its frequency.
An accurate assessment of the switching on transient is necessary for the correct sizing of the reactor and its internal insulation (insulation between turns).
Because the damping reactors are air core, during the installation of the capacitor bank the isolation distances and the magnetic distances from metal and from closed turns must be respected.

MV Detuned and Tuned filters

MV Detuned filters

In case of capacitor banks to be installed inside harmonic current polluted networks, which are generated by no linear loads such as frequency converters, drivers a specific study of the network impedance should be done at the point of capacitor bank connection.
The switching of a capacitor bank can indeed trip resonance phenomenon which amplifies harmonic currents and generates overloads and higher distortions.
In the simpler case of a shunted capacitor bank, which is in parallel to harmonic current generating loads, the parallel resonance frequency between the capacitor bank capacitance and the line inductance could be close to the several harmonic current frequency and so to magnify them and to over charge both the distribution transformer and the capacitor bank itself, further than lead to a very high distortion of the voltage waveform that could compromise the proper working of all other electrical devices which are wired to the same distribution system.
Whenever harmonic generating loads are a small part of the whole and harmonic absorption filters are not required, detuned capacitor banks are used; they are made up of pure capacitor banks which are in series to properly sized reactors to generate low pass filter having a detuning frequency which is below the lower existing harmonic current frequency.
This way the bank behaves as a pure capacitor below such frequency and as a pure reactor above such frequency.
The resonance parallel frequency is so shifted below all no linear loads generated harmonic current frequencies and any amplification phenomenon is avoided.
While the detuned capacitor bank will be working at a frequency above the blocking, it will turn to be as big impedance and the load generated harmonic currents will partially flow either on the mains or inside the capacitor banks, depending on the specific frequency.
For capacitor bank power lower than 1-2 MVAR capacitor bank absorbed harmonic currents are small, the higher the capacitor bank reactive power the bigger the capacitor bank absorbed harmonic currents is; for big banks the absorbed fifth harmonic current by a 4,1 times the fundamental detuned bank might reach as much as 40-50% of the no linear load absorbed currents, which turns the detuned filter a low efficiency absorption filter.
In MV networks the most common detuning frequency is 4,1 times the 50Hz or 60Hz fundamental frequency (XL%=6%), or seldom 3.8 (XL%=7%) or 2.7 (XL%=14%).
As far as small capacitor banks are concerned, iron multiair gaps linearized core reactors are recommended.
On the contrary for higher power capacitor banks air core reactors are more adequate.
At capacitor bank design a higher actual voltage level shall be considered, this is for the series reactors voltage increased effect and for the absorbed harmonic current contribution (see IEC 60871-1 appendix B).

MV Tuned filters

As far as harmonic generating loads are prevailing among the others, typically in plants such as steel mills, arc furnaces, it is likely that substantial current and voltage harmonic pollution levels are flowing through the network, and so it turns to be required to adopt harmonic absorption filters to reduce such distortions and to compensate for the most relevant harmonics.
MV harmonic absorption filters are of passive type, and they are made by capacitor banks which are wired in series to properly design reactor to create absorption targeted harmonic resonance circuits.
Below the tuning frequency the filter capacitor bank behaves as capacitor and it cater for power factor correction as well.
At the tuning frequency the capacitive reactance and the inductive reactance are mutually compensated and the cap bank impedance is made by the resistive part only, so it becomes a low impendence path for the harmonic current to be erased.
Above the tuning frequency the inductive reactance will prevail and the filter will be an inductance.
Tuned harmonic filters shall always be tuned to the lower harmonic current present, in other words, if the aim is to reduce or erase a determined harmonic current, lower frequency harmonics shall be compensated as well, otherwise they would be amplified by the parallel resonance between network impendence and filters of higher order.
For example if in a plant 5, 7, 11, 13 harmonic currents are found, even if the 11th would be the most relevant, it wouldn't be enough to install 11th harmonic filter, but 5th and 7th harmonic filter shall be there as well.

INDUSTRY MV/MV

SUBSTATIONS

- MV CAPACITOR BANKS
- MV PASSIVE FILTERS
- MV DYNAMIC COMPENSATION
- SURGE SUPPRESSORS

In special cases also attenuating filters and high pass filters are used.
MV tuned filter reactors are generally air core and the most disadvantageous and heavy harmonic conditions load shall be considered at their design stage.
At capacitor bank design a higher actual voltage level shall be considered, this is for the series reactors voltage increased effect and for the absorbed harmonic current contribution (see IEC 60871-1 appendix B).

Unbalance protection
Capacitor banks are usually protected by means of unbalance protection which ensures the phase balance.
The most common protection scheme foresee an insulated double star capacitor bank connection, where the two start points are connected via an unbalance protection CT which supplies secondary current to an homopolar over current relay.
In normal working conditions star points are balanced and no current flows into the CT. As soon as one capacitor is faulty, its star becomes unbalanced and an unbalance current flows into the CT.
In fact CT connection between the two star points, ensure their equipotential status, hence if any of the two stars is unbalanced a homopolar current is generates and it closes the loop through the CT.

Open rack banks
They are made of capacitors which are mounted on hot deep galvanized steel rack; they are usually complete of aluminum connecting banks, unbalance protection CT, stacking insulators, damping resistors and expulsion fuses.
ORTEA delivers complete open rack banks suitable for network voltage from 1 kV to 220 kV and power up to 100 MVAr.

METAL ENCLOSED CAPACITOR BANKS

ORTEA proposes metal enclosed capacitors banks in many different versions (fixed or automatic, with damping, blocking and absorption reactors).

Fix capacitor banks (with or without main breaker)

The fix banks are mainly adopted for the compensation of steady loads or for fixed portions of the plant required reactive power.
Typical example of the first case is compensation of large MV motors, which are used for large pumping stations, cement or chemical plants.
In this case the bank is placed close to the motor and it is wired downstream its main Circuit Breaker, so it is switched on and off along with its motor (for this connecting scheme see Technical Remarks within this catalogue).
In the second case the capacitor bank is directly connect to the distribution system bus bars.

Typical scheme of these capacitor banks is as follows:

Incoming Compartment can be equipped with options:
- Bus bars only and earthing switch (for the safety earthing of the cap bank and so to make inspection and maintenance inside the cell);
- no load line disconnector, earth switch;
- line disconnector or fixed CB;
- withdrawable CB;

Capacitor Step Compartment:
- Capacitors and Unbalance CT;
- Damping reactors, Capacitors and Unbalance CT;
- Blocking reactors, Capacitors and Unbalance CT;

For small power banks more essential solution may be provided, such as a single compartment with Incoming busbars, HRC current liming fuses, three phase delta connection capacitors, earthing switch.
Fixed enclosed capacitor banks are available as standard for power up to 5 MVAR and voltage up to 12 kV, both for indoor and outdoor use.

Automatic capacitor banks

These types of MV banks are normally divided in two or three or more steps of regulation of the total reactive bank power and they are operated automatically by a power factor correction controller.
Each single step is switched by MV vacuum contactors or Circuit Breaker.

Typical scheme of these capacitor banks is as follows:

Incoming Compartment can be equipped with options:
- bus bars only;
- no load line disconnector;
- line disconnector or fixed circuit breaker;
- withdrawable circuit breaker;

Capacitor step compartment:
- MV vacuum contactor with HRC current limiting fuses or Circuit Breaker;
- Damping or blocking reactors;
- Fast discharge resistors;
- Capacitors;
- Unbalance protection CT;
- Each step earthing switch (optional).

In order to reduce dimensions of these banks, withdrawable vacuum contactor solutions are also available.
These contactor metal clad cells are placed in the upper part of the compartment.
This solution perfectly segregates the capacitor bank compartment while the contactor is withdrawn, and it is so possible to make step maintenance while the others are live.
As option, each capacitor bank step can be equipped with a harmonic overload protection, which is made up of a high current three phase relay integrated inside a multifunction protection relay, along with unbalance protection function.
Automatic capacitor banks are available as standard for power up to 5 MVAR and voltage up to 12 kV, both for indoor and outdoor use, and steps from 500kvar to 2000 kvar.

TECHNICAL REMARKS

Voltage

Nominal voltage of a capacitor is the value of the alternating voltage for which the capacitor has been designed and that test voltage are referred. The proper and safe use of power capacitors impose that working voltage does not overcome nominal voltage.
In special and particular conditions, capacitor units shall be suitable for operation at voltage levels according to table below (long lasting voltage levels, extract of IEC 60871-1).

TYPE	Voltage Factor x Un	Max duration	Remarks
Rated frequency	1	Continue	Highest average value during any period of capacitor energization
Rated frequency	1.1	12h every 24h	System voltage regulation and fluctuations
Rated frequency	1.15	30min every 24h	System voltage regulation and fluctuations
Rated frequency	1.2	5min	Voltage rise at light load
Rated frequency	1.3	1min	

In any case capacitors and other power factor correction devices while they are working in overload leads to a reduction of their expected life. Nominal voltage choice is then influenced by the following facts:

- On some networks working voltage could be very different from nominal voltage
- Power factor correction equipment in parallel could cause an increase of the voltage at the connection point
- The voltage increases with the presence of harmonics on the network and/or cosphi of in advance (leading).
- Voltage at capacitor terminals is likely to be especially high
- Under low-load conditions.

When a capacitor is permanently connected to a motor, difficulties may arise after disconnecting the motor from the supply.
The motor, while still rotating, may act as a generator by self-excitation and may give cause to voltages considerably in excess of the system voltage. This, however, can usually be prevented by ensuring that the capacitor current is less than the no-load magnetizing current of the motor; a value of about 90 % is suggested. As a precaution, live parts of a motor to which a capacitor is permanently connected should not be handled before the motor stops.

Working temperature

Working temperature of capacitor is a fundamental parameter for safe operation. As a consequence it is very important that heat generated is dissipated correctly and that the ventilation is such that the heat losses in the capacitors do not exceed the ambient temperature limits. The capacitor temperature must not exceed the temperature limits hereinafter tabled.
Ambient air temperature categories (60871-1) The lower ambient air temperature at which the capacitor may be operated should be chosen from the five preferred values +5 -5 -25 -40 -50 °C.

AMBIENT TEMPERATURE °C

Symbol	Max value	Highest mean over any period of	
		24h	1 year
A	40	30	20
B	45	35	25
C	50	40	30
D	55	45	35

SAFETY AND STORAGE INSTRUCTIONS

Capacitor disposal

The capacitor and its impregnant oil should be disposed of in a manner consistent with the laws in force in the country where they are installed.
Loss of the impregnant in the environment should be avoided or minimized. Consult the Material Safety Data Sheet for further information.

Safety instructions

Power must be switched off before doing any work on capacitors or equipment and accidental access has to be prevented.
To be certain that the capacitors have been disconnected from the power source, it is necessary to make a visual check for an open-contact disconnect.
After being disconnected, the capacitors or equipment should then be shorted and grounded.
The capacitors have built-in discharge resistors which are designed to reduce the voltage, after the power is switched off, to 75 Vdc or less in 10 minutes.
After the indicated time, the capacitors or equipment should be shorted and grounded by utilizing and insulated grounding stick or equivalent and then the capacitor terminals should be connected together and to the case and grounded before handling.
Remove the shorting connection only just before the unit is reconnected in the circuit.
A failed capacitor should be handled very carefully.
It should be shorted with suitable insulated shorting sticks to discharge any residual charge.
Particular attention has to be paid to the internal pressure from gassing, which is reduced if the capacitor is permitted to cool before handling. In handling capacitors which have liquid leaking out, avoid contact with the skin and prevent entry into sensitive areas such as the eyes.
Close-fitting protecting goggles should be worn when handling units which are leaking or might suddenly squirt impregnant while being handled.
Contact with the skin is taken care of by simply washing off thoroughly with soap and water as soon as possible.
The eyes can be quite irritated by the impregnant and so they should be flushed with large amounts of water as soon as possible and the examined by a physician.

Storage

Power must be switched off before doing any work on Capacitors can be stored at temperatures between -40°C and +75°C and they are not affected by humidity variation.
Take care of the terminals by protecting them against accidental impacts which might damage them.
Shelter the capacitors from dust and aggressive or polluting substances.

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