



Merus[®] HPQ

– Hybrid Power Quality Solution

All-in-one power quality product for active harmonic mitigation
and power factor correction combined

TECHNICAL



Power quality

and its solutions

Power quality is becoming a critical issue in electrical environments as industry, automation, and machinery are constantly increasing. Every day, more variable frequency drives (VFD) and other non-linear loads are being connected to electrical networks. They get more sensitive to poor power quality issues that they often generate themselves. Poor power quality can cause severe economic and technical issues.

Typical power quality problems are:

- **Overheating of equipment**
- **Poor performance and malfunctions**
- **Decreased lifespan of devices**
- **System heat losses**
- **Overdimensioning of the electrical feeder**
- **Power cuts**

Most of the countries worldwide have power quality standards and recommendations in place, such as IEEE519, G5/5 and EN 50160. These require the power quality to be always kept within the prescribed range in order for electrical systems to function in their intended manner without any issues.

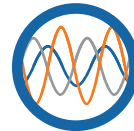
Basically, power quality issues can be divided into **three main categories**:



HARMONICS



REACTIVE POWER



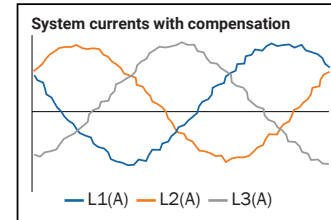
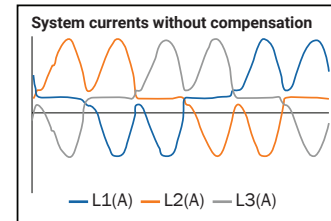
UNBALANCE

Harmonics

Current harmonics in the network (multiples of fundamental current e.g., 5th 250 Hz, 7th 350 Hz) create:

- **Voltage distortion when going through the feeding transformer**
- **Heating of electrical components such as transformers and motors**
- **Causes Tripping of the protection and control devices**
- **Abnormal amount of neutral currents**
- **Heat losses**

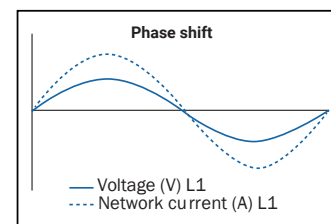
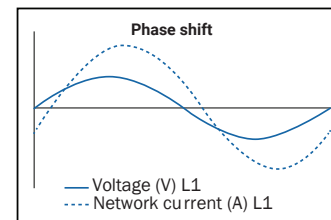
Both current and voltage harmonics are often required to be within suitable ranges according to electrical standards and recommendations. Harmonic voltage also improves via mitigating harmonic currents.



Reactive power

- **Reactive power consumes electrical network capacity**
- **Rapid changes create voltage flicker and voltage fluctuations**
- **Excess amount of reactive power might result in an unnecessarily-sized electrical feeder or generators**

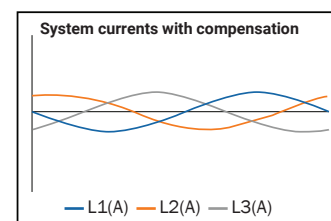
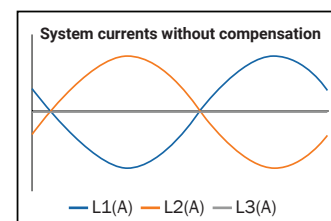
Excessive amount of reactive power can be penalized from the customer depending on local regulations.



Unbalance

Main current unbalance creates:

- **Current imbalance creates voltage unbalance**
- **Can lead to overdimensioning of the transformer or force a redesign of the existing network**
- **Overheating of the electrical devices**



Merus Power

Electrify your Future

Merus Power is a global technology company headquartered in the city of Ylöjärvi, Finland where we design and manufacture Finnish innovative battery energy storage systems and power quality solutions. Scalable and modular power electronics, intelligent software technologies and electrical engineering expertise are the base of our business.

The fruit of our 15-year operating experience and continuous product development is an extensive and specialized product portfolio that meets the increased demand of megatrends. Our solutions are based on scalable technology, which enables the use of our products and services in a wide range of different application needs.

2008

Merus Power was founded to meet the challenges of industrial power quality and connecting wind power to the electrical grid. Our operations focused on power electronics, advanced software technologies, and electrical engineering expertise, as well as their application to energy savings and productivity improvements in industry and real estate.

2010

We launched our very first delivery in the fall of 2010, delivering Merus® Active Filters to a large domestic industrial operator.

2011

We completed our first international customer deliveries to Taiwan, China, and the United Kingdom.

2018

We launched our brand new Merus® HPQ solution, an all-in-one power quality product for active harmonic mitigation and power factor correction combined.

2021

We became a publicly listed company. Trading of our shares began on the Nasdaq First Growth Market Finland on June 8, 2021.

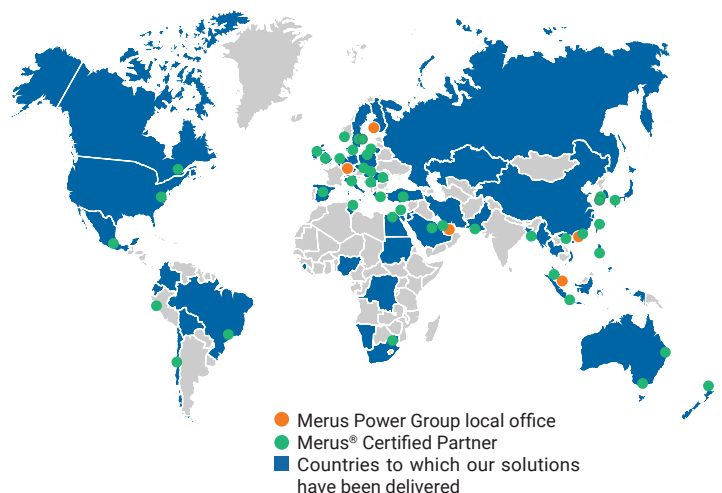
We hold a profound local and global presence as well as a strong industrial order backlog in power quality solutions. Over the years, we have delivered our innovative solutions to over 70 countries around the world to various customers and successfully mitigated all sorts of power quality issues.

Our values

- Passion for technology
- Appreciation and trust
- Meeting customer needs
- Clean future

Why choose Merus Power?

- Over 15 years of experience in power quality and engineering
- Profound local and global presence with strong industrial order backlog
- Strong investment in software development and substantial Merus® Software portfolio
- Cost-effective and top-quality scalable solutions made with Nordic excellence in Finland
- Customer-oriented approach and support
- Unique opportunity to simulate various real situations in laboratory conditions
- Trusted company – Publicly listed on NASDAQ OMX First North since June 2021

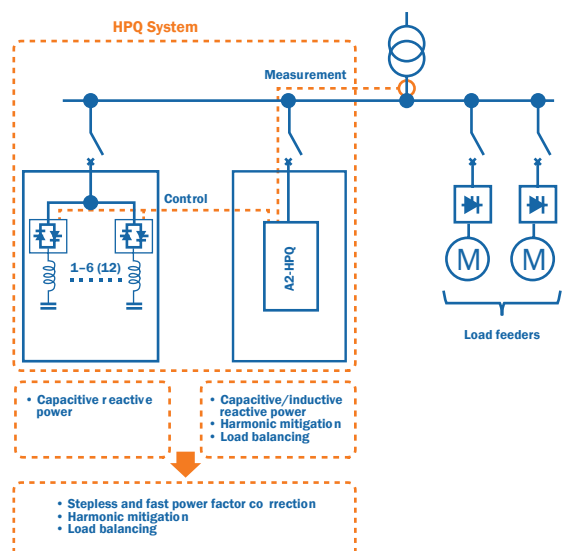




Merus® HPQ

a cost-efficient solution for dynamic reactive power compensation and harmonic mitigation

Merus® HPQ is a hybrid power quality compensator. Its operation is based on two main components: a detuned capacitor bank and an active harmonic filter. In Merus® HPQ all-in-one solution, the Merus® A2-series Active Harmonic Filter operates as a power factor correction (PFC) controller for the detuned capacitor bank and utilizes detuned capacitor steps to fulfill most capacitive reactive power needs. Simultaneously, the Merus® A2 module handles the smaller fluctuating requirement for reactive power, whilst filtering the harmonic currents and balancing unbalanced load currents.



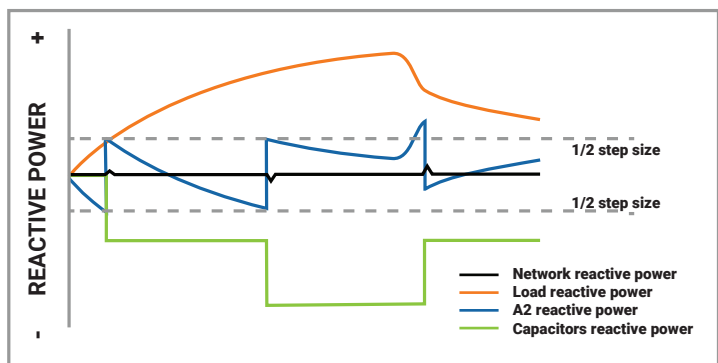


Merus[®] HPQ

How does it operate?

Merus[®] HPQ system is connected in parallel with the loads, where the detuned capacitor bank will feed the capacitive reactive power need. Merus[®] HPQ can use a standardized and cost-efficient detuned capacitor bank step ratio (1:1:1:1:1), because the Merus[®] A2 module will take care of the intermediate steps.

Merus[®] A2-module controls the capacitor bank and receives measurement data from the current transformer, which can be installed to measure network or load side current (depending on the operation mode). Simultaneously, Merus[®] HPQ mitigates harmonics, compensates reactive power, and balances unbalanced currents. The HPQ entirety solves all major power quality problems, even in demanding environments.



Merus[®] HPQ Operating modes

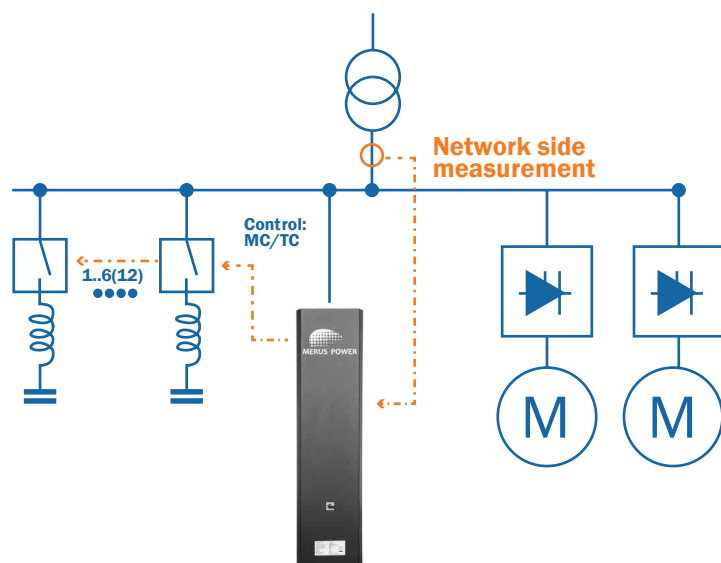
Power Factor Correction (PFC) -mode

For gradually fluctuating loads in closed-Loop configurations (Traditional PFC-control).

- Based on the traditional capacitor-application style, where the measurements are on the network side and the system can accommodate multiple loads. The switching speed for the capacitors is < 1 s and the contactor or the thyristors can be used as switches.

Example Industries

printing, manufacturing, and water treatment.



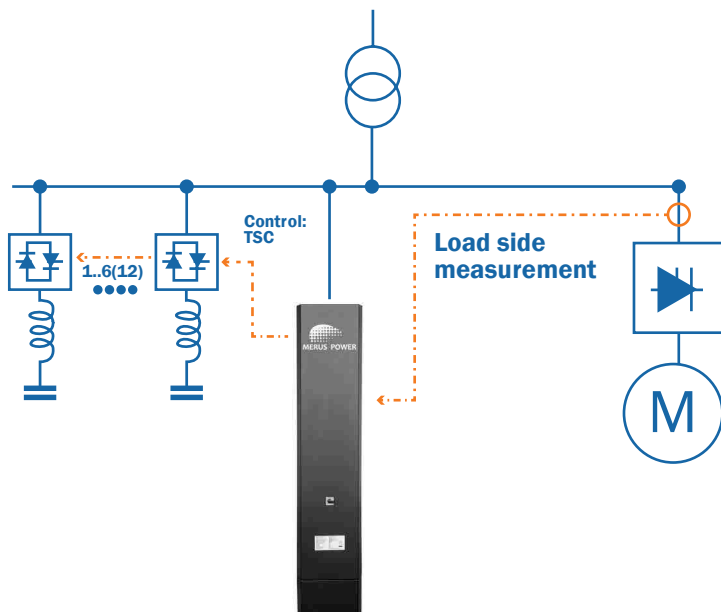
Ultra-Fast (UF) -mode

For rapidly fluctuating loads in Open-Loop configurations.

- Mainly for the individual loads which are changing fast. In UF-mode, the capacitors are connected to the thyristors due to the required fast switching speed < 20 ms. Typical applications for UF-mode are cranes or lifts.

Example Industries

cranes and plastics.



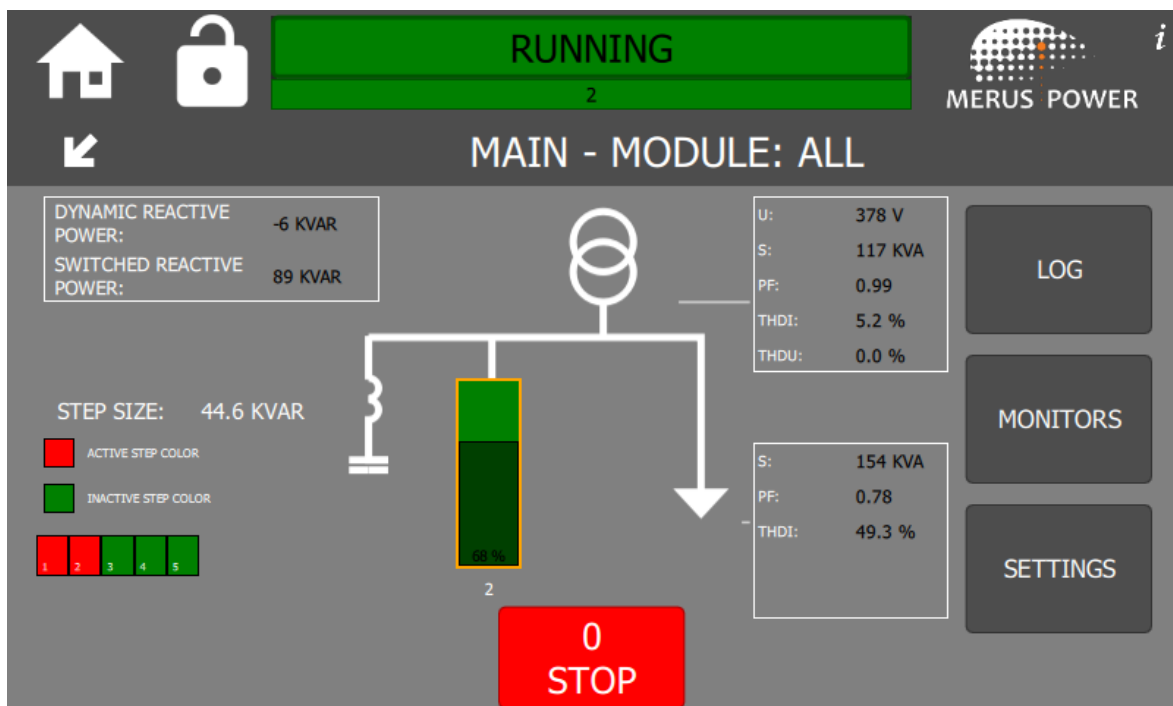
Merus® HPQ

HMI and software

Merus® HPQ uses just one software and is equipped with an advanced 7" Human Machine Interface (HMI), that is used to manage the whole system, including the capacitor banks. Merus® HMI comes with advanced and user-friendly monitoring and reporting features, is multilingual with over 8 languages, supports USB connectivity, and provides clear error and trip messages without cryptic codes.

Modern and user-friendly interface

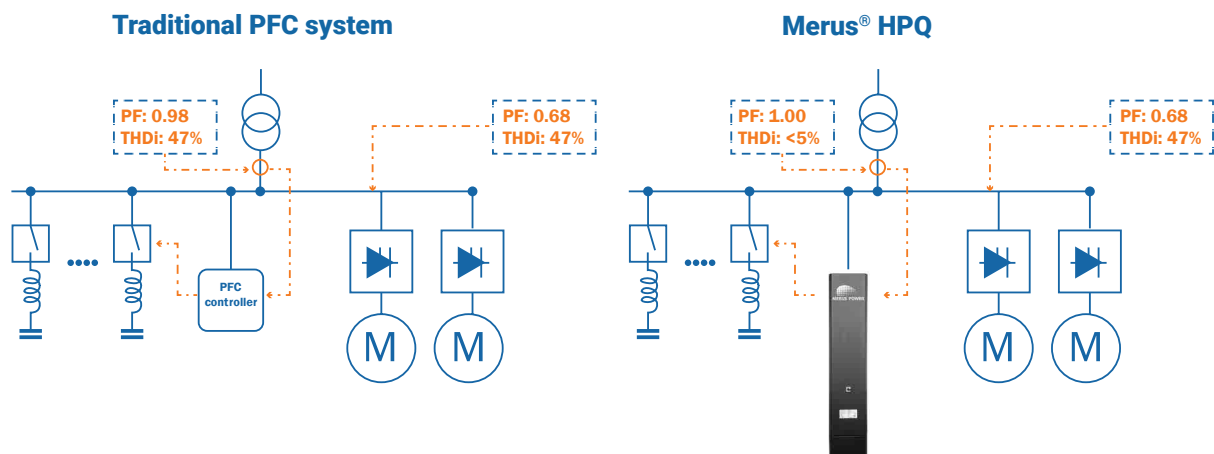
- Easy-to-use HMI
- Provides additional information about system status
- Trend recordings give more value and understanding
- Remote monitoring over TCP as standard
- Commissioning wizard
- Same user interface for HPQ and detuned capacitor banks



Merus[®] HPQ

Customer benefits

- Performance exceeds existing technologies
- Can often be retrofitted to existing detuned PFC
- Active filter is not disturbing the PFC-controller (no hunting)
- Enables simultaneous operation of traditional power factor correction and active harmonic filtering in the same PCC
- No additional CTs or PFC-controller required
- No unnecessary small steps to capacitor banks
- Higher effective compensation compared to traditional separate compensation systems
- Optimization of capacitor banks usage (FIFO)



Compared to traditional PFC systems, Merus[®] HPQ reduces harmonics, balances unbalanced loads, and eliminates the need to use different capacitor steps. This leads to higher power density and reduction in the number of required switching operations. In addition, Merus[®] HPQ ensures longer lifetime of capacitor banks, Merus[®] HPQ is the ultimate all-in-one solution for improving power quality. In addition, Merus[®] HPQ extends the lifetime of the capacitor banks since no harmonic current passes through them.

Merus® HPQ

Made to be integrated

Merus® HPQ solution is easy to integrate into a standard capacitor cubicle and well-suited for OEM cabinet builders.

Good power quality measurements that properly quantify the compensable parameters are strongly recommended as the first step when sizing and dimensioning.

If survey data is not available, a desktop study can be performed.

Dimensioning

All Merus® HPQ modules have nominal output capacity. This nominal current can be divided into fundamental current and harmonic current in a way that the following equation is true.

$$I_{nominal} = \sqrt{I_{fundamental}^2 + I_{harmonic}^2}$$

In the equation above, $I_{fundamental}$ is current for reactive power and $I_{harmonic}$ equals current for harmonics.

From the equation above, the following can be seen: Even when e.g., 50 % of the total nominal current of Merus® HPQ-module is used for harmonics, there is still 86 % of the nominal current capacity left for fundamental compensation. This is one of the biggest advantages of Merus® HPQ.

The rule of thumbs for dimensioning

Dimensioning of the capacitor

- Minimum capacitor system size:
 - Maximum reactive power demand – HPQ-module reactive power capacity
- Step size:
 - Depending on the installation network, Merus® HPQ module(s) capacity and the load reactive power profile
 - Most common unit size between 50...100kvar

Dimensioning of Merus® HPQ module(s)

- Based on step size: Merus® HPQ module ~1 step size (or higher if dQ/dt is high)
- Based on inductive side reactive power needs (if higher than one step)
- Add harmonics and unbalance needs for the total I_{rms} needs

Merus Power has developed a sizing tool for Merus® HPQ-systems. Please contact our Sales team for more information at sales@meruspower.com.

Merus[®] HPQ

Reference cases

Malting company with a 3 million tonnes production capacity

Industry: Food & beverage

The malting company produces and sells barley malts for smaller and bigger breweries as well as distilleries around the world. The production of malt requires a lot of heat which is covered with a 6 MW CHP unit in the factory with a 4 MW load.

The local grid operator has a requirement for good power factor and low harmonics before granting an export license for excess generation.

After the required measurements, 6 Merus[®] HPQ systems were installed across key areas by Merus Power's official partner, totaling 900 A and 1500 kVAr. After installation, compliance was achieved with the power quality standard, and the grid operator granted the export license to the malting company.



Key treatment site providing wastewater treatment services

Industry: Water and wastewater treatment

Water and wastewater treatment are energy-intensive processes that improve water and wastewater quality to make it suitable for a specific end-use. They are key infrastructure elements, and securing their continuous operation is crucial to sustaining safety and sanitation in modern society.

Complicated requirements for both reactive power control and harmonic current mitigation were met by Merus[®] HPQ system with specific additional customer requirements involved. Merus[®] HPQ solution was sized by a desktop study. Its performance was verified during commissioning.



Advanced surface technology that extends the life of critical components

Industry: Process industry

Sensitive and critical equipment and manufacturing processes require high-quality electricity and high process continuity in order to avoid serious losses and dangerous malfunctions.

Specification compliance was met with Merus[®] HPQ system by mitigating harmonics.

Reduction in reactive power demand supported the installation of additional load without requiring network reinforcement.

Flexibility of technology means an upgrade from 100A & 200kVAr to 200A & 400kVAr is now possible without detrimental effects.



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Merus® Solutions can be easily tailored to a variety of applications and can meet small and large-scale customer needs with their modular structures. Their compact size, design, and scalability allow simple and cost-effective integration into many electrical systems.

Over the years we have worked with various customers in industry, utility, infrastructure, and renewable energy applications in over 70 different countries.



Send us an email to sales@meruspowers.com.
One of our sales reps will be in touch with you as soon as possible.

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Configuration	PFC-mode	UF-mode
Max step number (pcs)	6/12*	6/12*
Maximum number of parallel modules	2 modules	2 modules
Acceptable module ratings	ALL	ALL
3W/4W configuration	3W/4W	3W/4W
CT-signals	Closed-Loop (System side)	Open-Loop (Load side)
Load balancing	0..100% *In of the module (configurable)	0..100% *In of the module (configurable)
Reactive power	0..100% *In of the module (configurable)	0..100% *In of the module (configurable)
Harmonic compensation	0..100% *In of the module (configurable)	0..100% *In of the module (configurable)
Harmonic compensation range	2nd to 50th harmonics. Fully selectable and programmable up to 25th harmonic order in 'selectable' mode (standard deliveries).	2nd to 50th harmonics. Fully selectable and programmable up to 25th harmonic order in 'selectable' mode (standard deliveries).
Compensation mode	Selectable/All but not fundamental	Selectable/All but not fundamental
Reactive power response time	<20ms	<20ms
Voltage range	200..690 VAC	200..690 VAC
Frequency	50 Hz / 60 Hz	50 Hz / 60 Hz
Minimum time between step changes	1s	<20 ms (thyristor delay)
Programmable turn off time	30..999s	N/A
Capacitor selection	Cyclic with RTC counter	FIL0
Hysteresis limit	0..50%	0..50%
(Target?) Power factor range	-0.7..0.7	-0.7..0.7
Overvoltage protection	Selectable 10%, 15%, 20%	Selectable 10%, 15%, 20%
Programmable priority between harmonics and fundamental compensation in the A2-module	Yes	Yes
HMI	User friendly 7" touch screen.	
	Step states, ON-time recorder, Switch time recorder	
HPQ AUX relay type: Mechanical (Included)	24VDC/2A or 277VAC/6A	
	5/12ms	
HPQ AUX relay type: SSR (Optional)	24VDC/2A or 240VAC/2A	
	0.1/0.6ms	

* Up to 12 steps with secondary module, 5/11 if one output is selected for TRIP-state.

TECHNICAL DATA FOR CAPACITOR STEPS

Configuration	The Power Factor Correction mode	The Ultra-fast compensation mode
Capacitor size per step (kvar)	10...200kVAr*	10...200kVAr*
Possible step-ratios	1:1:1:1:1	1:1:1:1:1
Series reactor (%)	6..20%	6..20%
Switch type	Thyristor Switch or magnetic switch	Thyristor Switch (TC) only
Capacitor type	Three-phase	Three-phase

* The maximum step size depending the nominal current level, voltage level and hysteresis.

* Multiple capacitor packs can be used as one step. e.g. 2*35kvar steps together to have 70kvar steps. Relay characteristics must be taken into account.