Customized pre-assembled equipment for electrical installations

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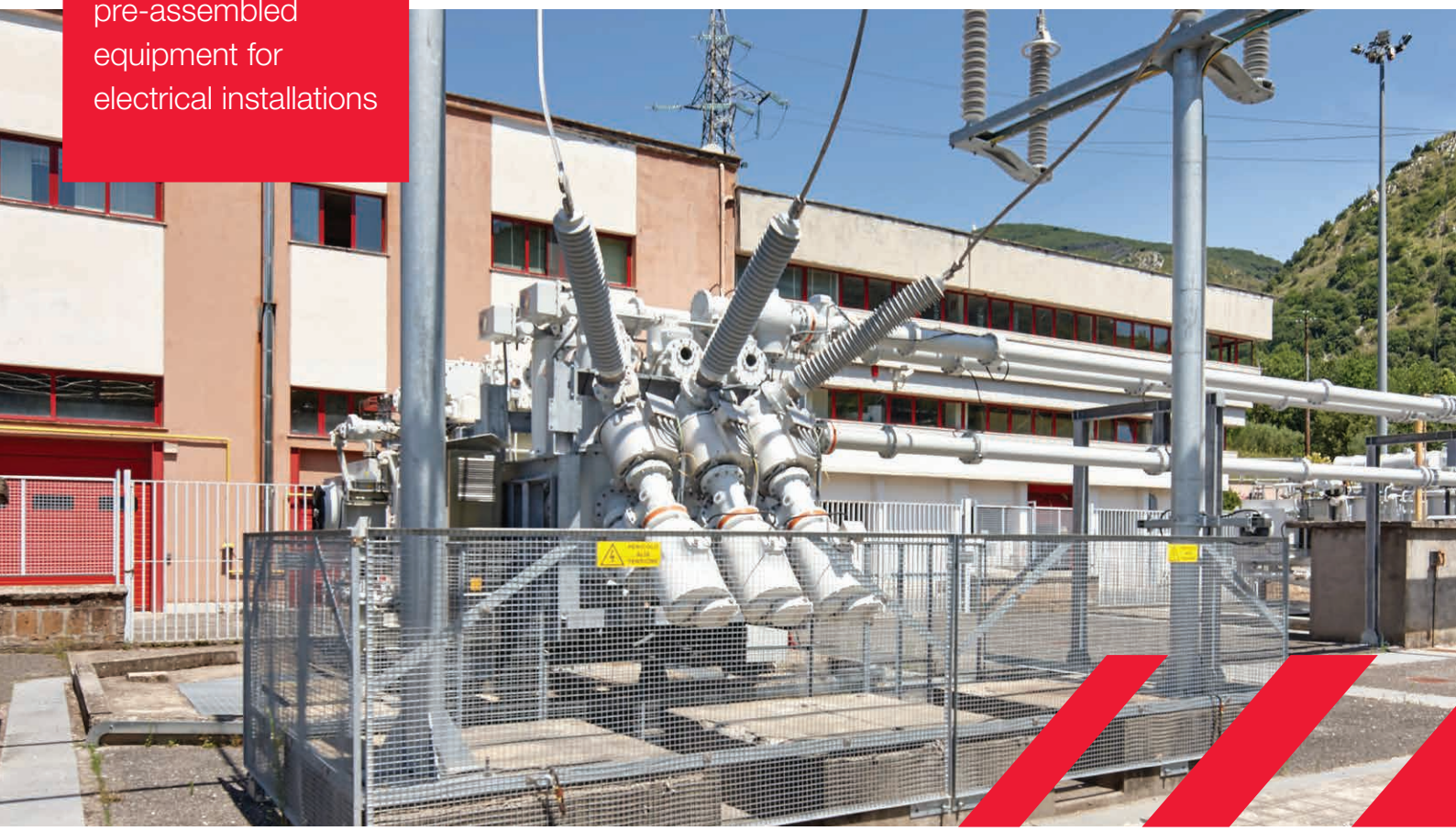


High-Voltage Products | Integrated Multifunctional Products

MFM – Multifunctional Modules

Hitachi Energy

Hitachi Energy's experience

Global technology leader that is advancing a sustainable energy future for all

We serve customers in the utility, industry and infrastructure sectors with innovative solutions and services across the value chain. Together with customers and partners, we pioneer technologies and enable the digital transformation required to accelerate the energy transition towards a carbon-neutral future. We are advancing the world's energy system to become more sustainable, flexible and secure whilst balancing social, environmental and economic value. We operate in more than 90 countries with about 38,000 employees.

A complete range of Multifunctional Modules (MFMs)
Utility companies face the challenge of rapidly connecting an ever-increasing number of energy sources to the electrical network, without compromising the overall quality of transmission and distribution.

To meet this need, Hitachi Energy has designed the MFM solutions: integrated and compact modules, made according to the customer's needs. MFM is transportable and easy to install, so that it is the ideal solution for connecting renewable sources or providing power supply infrastructures for disaster recovery.

Hitachi Energy offers the widest range of MFM solutions currently available on the market. Our portfolio of solutions runs from 72.5 kV to 420 kV.

The electrical installations of the future

Hitachi Energy's response to the new requirements of the high- and medium-voltage electrical distribution market is provided in the form of innovative and compact MFMs (Multifunctional Modules) capable of intelligently combining, in a single product, the functions of a high-voltage module, power transformer, medium-voltage switchgear and control and protection.

New challenges for the world of electrical distribution

- Continually changing demands
- Reduced installation and commissioning times
- Increasing reliability requirements
- Increasing space constraints

Generation from renewable sources

Energy efficiency

Dispersed and unpredictable generation

Increased network responsiveness to growing demand

Reliability & availability

- Aging of existing infrastructures
- Safety
- Fast-recovery plan

Impact on the efficiency and stability of electrical networks

The networks of the future shall be different from those of the past. In particular:

- They should be open to all types of distribution and generation
- They should interact with users, modifying their set-up according to the requirements of the network

Excellent transportability

With commercial vehicles and lifting equipment

145 kV MFM (PASS M0H) with lifting system

220/11 kV – 60 MVA MFM on trailer ready for transport

170 kV MFM on-site

132/33 kV – 45 MVA MFM on-site

Components

High-voltage

The high-voltage part of the MFM is based on the PASS (Plug and Switch System), a family of hybrid modules. The term “hybrid” indicates the combination of traditional air-insulated switchgear (AIS) and SF_6 gas-insulated module (GIS), therefore taking advantage of both of these different technologies.

This hybrid solution uses already existing and tested, gas-insulated switching devices, but also utilizes a conventional and very reliable AIS busbar. All functions (with the exception of ring-core current transformers) are integrated into a single SF_6 gas-insulated enclosure:

- Circuit-breaker
- Disconnector
- Earthing switch
- Cable terminals
- Voltage transformer

This compact design can save up to 70 percent of the space necessary for an equivalent AIS bay. The module is also completely prefabricated, prewired and tested at the factory. The flexibility of the PASS is unmatched in the field of high-voltage switchgear and this important characteristic has enabled modular integration of the PASS with the power transformer which led to the MFM concept.

Technical data of the PASS

		 **M00 PASS**		 **M0 PASS**		 **M0S PASS**	
Rated voltage	kV	72.5	100	145	170	252	420
Frequency	Hz	50/60	50	50/60	50/60	50/60	50/60
Rated current	A	2,000	2,000	3,150	3,150	4,000	5,000
Rated breaking current	kA	40	31.5	63	50	50/40	63
Test voltage (AC)	kV	140	185	275	325	460	650
Impulse withstand voltage (BIL)	kV	350	450	650	750	1,050	1,425
Operational impulse withstand voltage	kV	-	-	-	-	-	1,050
Altitude above sea level	m	≤1,000	≤1,000	≤1,000	≤1,000	≤1,000	≤1,000
Max. air temperature	°C	+40 [1]	+40 [1]	+40 [1]	+40 [1]	+40 [1]	+40 [1]
Min. air temperature	°C	-40 [1]	-30 [1]	-30 [1]	-30 [1]	-25 [1]	-25 [1]
Relative humidity	%	100	100	100	100	100	100
Wind pressure	Pa	700	700	700	700	700	700
Seismic protection (IEC 1166)	g	0.5	0.5	0.5	0.5	0.5	0.5
Pollution level (IEC 60815)		III High [2]	III High [2]	IV Very high	IV Very high	IV Very high	IV Very high

[1] Other temperatures are available on request. | [2] Level IV (very high) on request.

Components

Medium-voltage

The MFM unit includes a medium-voltage section complete of a switchgear with IED relays for protection and control of all the elements.

Typically, the medium voltage section is a metal enclosed type, suitable for indoor installations delivered completely pre-assembled and tested into a dedicated environmentally controlled housing. Outdoor executions are available as well.

Metal partitions segregate the compartments, and the live parts may be either air-insulated or gas insulated. Each functional unit as well as the complete assembly is guaranteed arc proof in accordance with the applicable standard.

All the installation, operation and maintenance operations can be carried out from the front of the unit. The switchgear and the earthing switches are operated from the front with the door closed. Whenever the selected switchgear requires rear access, dedicated openings are foreseen in the enclosure to ensure easiness of use.

The range of available apparatus is unlimited, including:

- Withdrawable or fixed vacuum circuit-breakers
- Withdrawable gas circuit-breakers
- Withdrawable vacuum contactors with fuses
- Earthing switches/disconnectors
- Instrument transformers or sensors for current and voltage measurement and protection
- Any type of protection and control unit

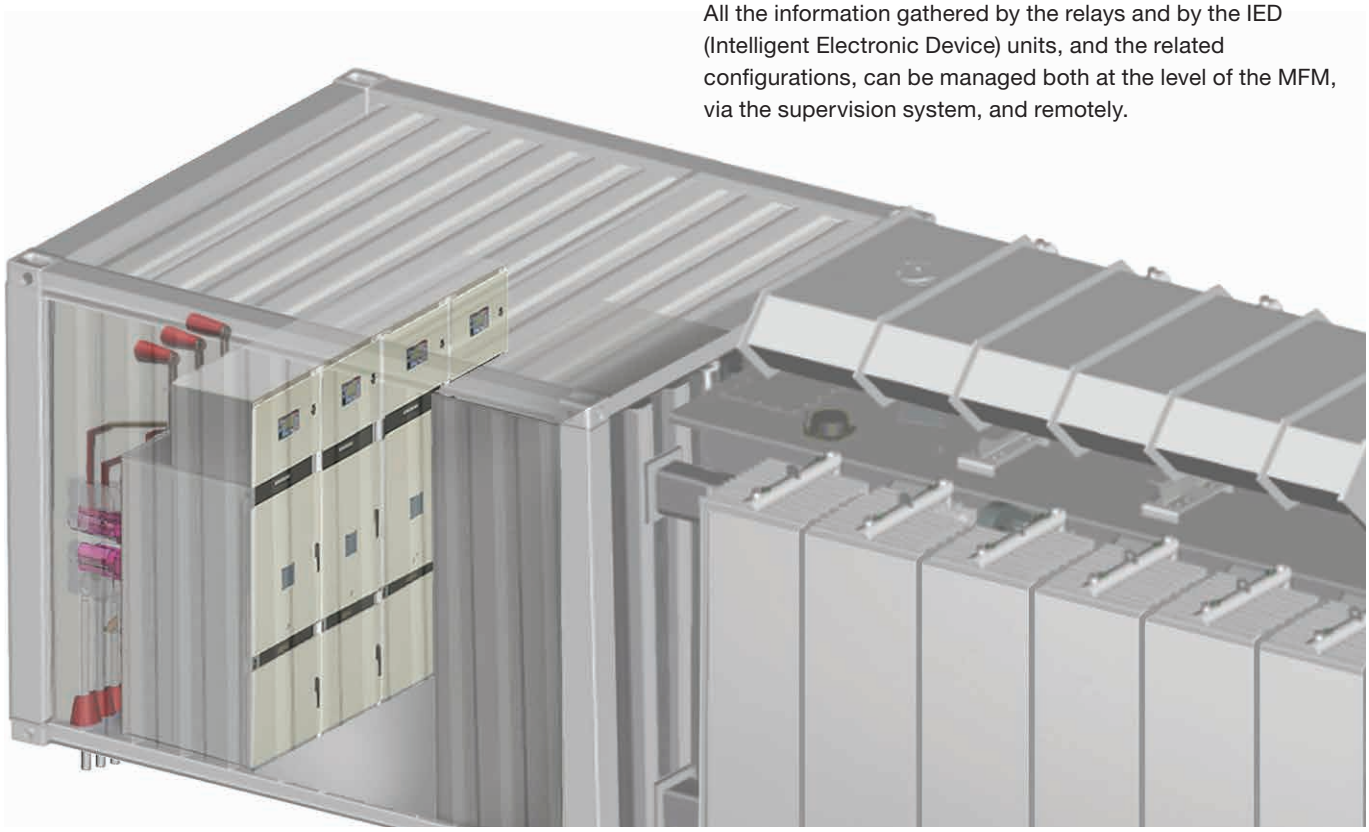
The safety mechanical interlocks are standard equipment.

With regards to busbars or switchgear layout, single level-single busbar arrangement, Double-level single busbar and Double Busbar Systems are all available.

UPS, back up batteries and the relevant charging system as well as other apparatuses can be included according to project specific requirements.

The protection system makes keep monitored the status of all the switchgear and control gear and guarantees complete protection of the MFM.

All the information gathered by the relays and by the IED (Intelligent Electronic Device) units, and the related configurations, can be managed both at the level of the MFM, via the supervision system, and remotely.



MV section of an MFM

Components

Power transformer

The MFM unit is fitted with a power transformer which, depending on the configurations, can be the central and supporting structure of the entire module, integrating both the high- and medium-voltage switchgear and controlgear. Hitachi Energy's power transformers continuously undergo research, thus making it possible to offer constantly to its customers the highest quality and technological standards.

The range

The Range of transformers available for the MFM unit have power ratings between 10 and 63 MVA and voltages up to 420 kV, offering ideal solutions for all applications, including traditional ones.

Cutting-edge design and simulation techniques make it possible to optimize the design of the transformer guaranteeing both its performance (for example low losses, low noise levels, etc.) and the limits of its weight and dimensions, fundamental aspects for easy road transport of the entire MFM unit.

Cutting-edge components and materials

When requested, in transformer production, new solid insulating materials such as hybrid insulation is used, or fluid insulators such as MIDEL or natural esters, which are safer and eco-compatible.

The use of such insulating materials, enables the transformer to withstand higher operating temperatures, offering a higher overload capacity and at the same time reduced dimensions, thus opening the way for new applications including very safe transformers destined for urban substations, petrochemical plants, and offshore platforms.

The range of transformers for MFMs is completed with all the accessories normally required on the machine, such as insulating bushings in ceramic or silicon resin, on- and off-load ratio changers, Buchholz relays, oil-level indicators, and dehumidifiers. Besides the traditional electromechanical components, versions are available with electronic solutions that enable remote monitoring and management, and reduction of maintenance costs.

More complex designs, such as transformers with three or more windings, single-phase devices, auto-transformers, and special cooling systems, are made on the basis of the requests and the design needs.

23 MVA 130 kV 50Hz

45 MVA 132 kV 50Hz

Components

Control module

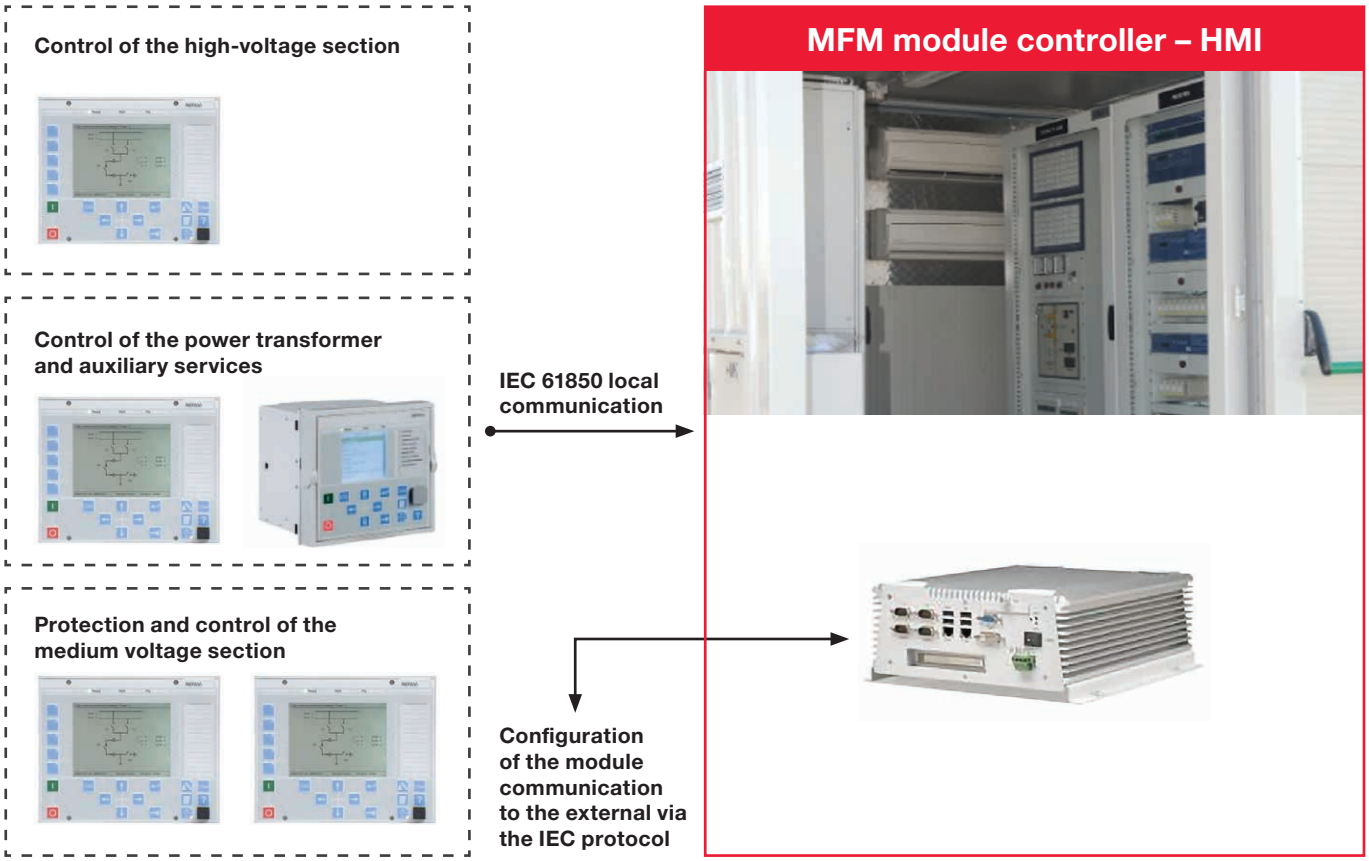
Importance of the need for diverse protection equipment and philosophies that meet local legislation, safety requirements and engineering practice is fully understood.

Using mature devices and available technologies, MFM is complete of a power protection philosophy that not only serves the specific needs and requirements of diverse power systems, but also creates confidence for both the power system owners and users. The main purpose of a protection and control system is to operate and monitor every power equipment and to recognize any abnormal power system condition, or abnormally operating system component. Based on the information gathered, the protection system will initiate corrective actions that, at first, provides dedicated alarms and isolates the affected portion, allowing the system to be restored and therefore to return into its normal operating state. This provides a fully safe environment.

Since protection and control devices do not prevent network faults from arising, selecting the right functions and methods improves the performance and the reliability of the equipment, thus minimizing the effects of network faults and preventing the disturbance from spreading to the healthy parts of the network. Close attention shall be paid to operating speed, sensitivity, selectivity and as there is a strong correlation between the protective device operating speed and the damage and danger caused by a fault. Also, a reliable selectivity is essential to limit the loss of power supply to the smaller part of the network, and to allow the faulted part of the network to be easily located and restored.

Including control and monitoring capabilities, it puts the operator in complete control of the substation both locally and remotely with all the benefits of digital technology.

Metering functions can be integrated in the IEDs as well and in case revenue metering is required, dedicated devices can be included.



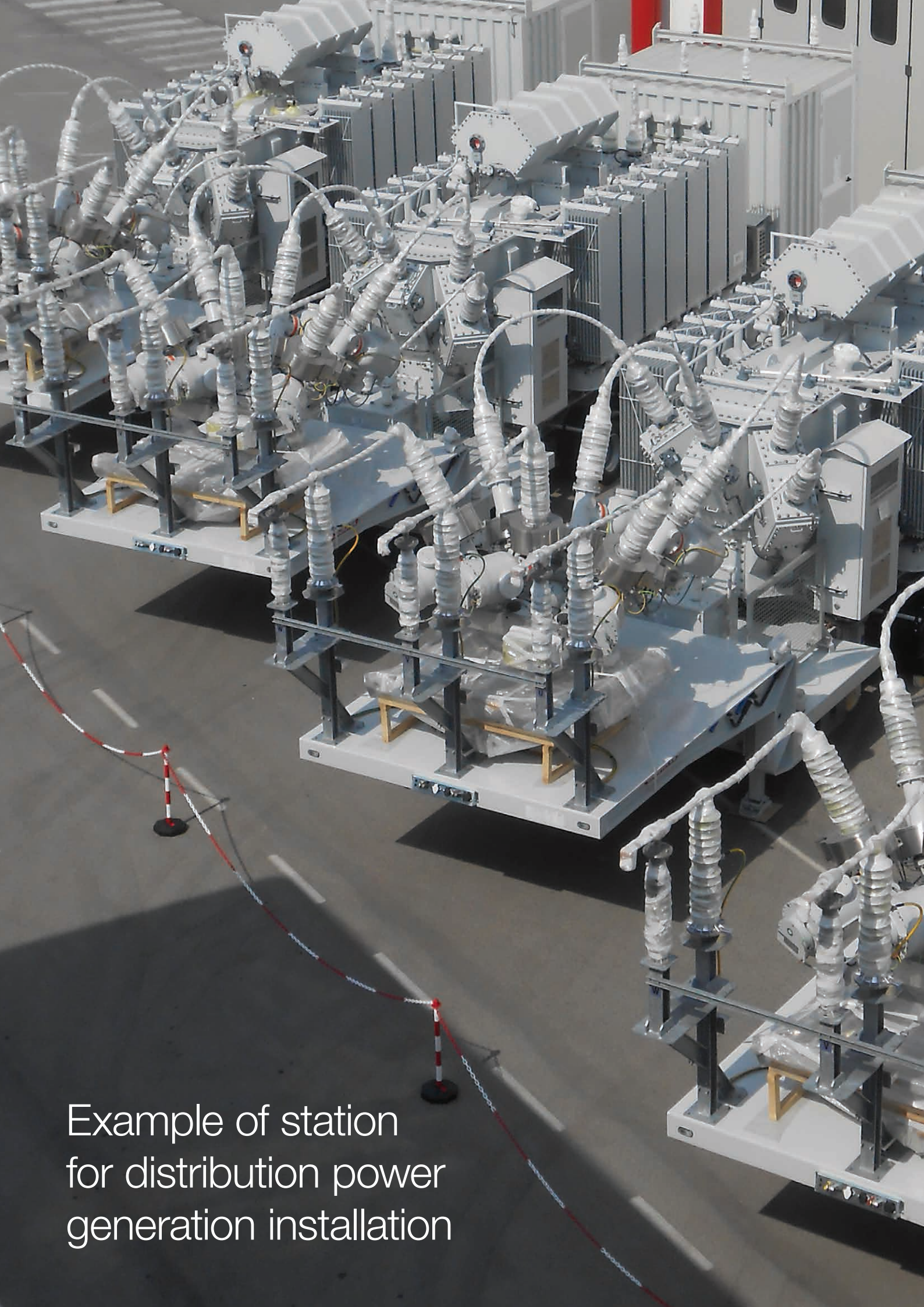
Typical configuration of the control of the MFM module with the use of HMI interface

Electrical characteristics

Multifunctional modules from 72.5 kV to 420 kV

High-voltage (primary) section	Rated voltage	kV		**72.5**	**145**	**170**	**245**	**420**
	Rated frequency	Hz		50 - 60	50 - 60	50 - 60	50 - 60	50 - 60
	Power frequency withstand voltage	kV	up to	140	175	325	460	650
	BIL	kV	up to	325	650	750	1,050	1,425
	Rated current	A	up to	2,000	2,500	2,500	4,000	5,000
	Rated making and breaking capacity	kA	up to	40	63	50	50	63
Medium/High voltage (secondary) section	Rated voltage	kV		12	17.5	24	36	72.5
	Rated frequency	Hz		50 - 60	50 - 60	50 - 60	50 - 60	50 - 60
	Power frequency withstand voltage	kV	up to	28	38	50	70	140
	BIL	kV	up to	75	75	125	170	325
	Rated current	A	up to	2,500	2,500	2,500	2,500	2,500
	Rated making and breaking capacity	kA	up to	50	50	31.5	31.5	40
Power transformer	Rated power	kVA	up to	60,000	60,000	60,000	60,000	60,000
Auxiliary services transformer	Rated power	kVA	up to	250	250	250	250	250

The data are not limiting values. Additional data on request.



Example of station
for distribution power
generation installation

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