High voltage products

MFM - Multi Functional Modules
Customized pre-assembled equipment for electrical installations
ABB's experience

ABB (www.abb.com) is a leader in power and automation technologies that enable utility and industry customers to improve their performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs about 150,000 people.

A complete range of Multi Functional 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, ABB 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.

ABB 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

ABB's response to the new requirements of the high- and medium-voltage electrical distribution market is provided in the form of innovative and compact MFM (Multi Functional Module) 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

Reliability & availability
- Aging of existing infrastructures
- Safety
- Fast-recovery plan

Generation from renewable sources
Energy efficiency
Dispersed and unpredictable generation
Increased network responsiveness to growing demand

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
MFM - Multi Functional Module

MFMs cover a range of equipment for electrical installations, completely assembled and tested at the factory, easy to transport and install. Combining the modules makes it possible to create any type of mobile or fixed stations.

Example of 40 MVA 72.5/12 kV or 72.5/17.5 kV MFM module

Version ready for connection to the high-voltage network by means of cables fitted with couplings. The module is also available fitted with a medium-voltage switchgear up to 24 kV.

Typical single-line diagram

Medium-Voltage section

Transformer

High-Voltage section
The easy loading and unloading from the semitrailer without the use of a crane, facilitates positioning even in narrow areas near to high-voltage lines.

MFMs are customizable via software and hardware applications. They can be fitted with accessories such as wheels for road transport, hydraulic lifting and leveling system, remote monitoring and control system, etc.

Example of 40 MVA 145/12 kV or 145/17.5 kV or 170/12 kV or 170/17.5 kV MFM module

Version ready for connection to the high-voltage network by means of aluminum cords. Available also in a version ready for connection to the high-voltage network by means of cables fitted with couplings. The couplings make it possible to limit the dimensions of the module. The module is also available fitted with a medium-voltage switchgear up to 24 kV.

Typical single-line diagram
Example of 40 MVA 145/170 kV MFM Double Circuit Breaker module

Version ready for connection to the high-voltage network by means of cables fitted with couplings. The module is fitted with a double high-voltage circuit breaker and inductive voltage transformers (HV side).

Typical single-line diagram
Application example of MFMs to create an H-configuration station

The example shows how it is possible to create an H station using only two MFMs. There are many elements of this solution that differ from a traditional solution: it occupies a very small area, needs less design engineering, requires minimum civil works, offers logistical simplicity owing to its easy transport and installation, meaning less labor and a reduced commitment for assembly and testing on site.
MFMs offer excellent transportability. The overall dimensions are such as to allow transport with normal commercial vehicles, and thanks to the availability of a lifting system it is possible to perform the loading and unloading and positioning operations on site without the aid of a crane or lifting equipment.

MFM lifted utilizing its own hydraulic jacks.  
Inserting the trailer ready for transport.

220 kV MFM on trailer ready for transport.
High-voltage section
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 SF₆ 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 SF₆ 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

<table>
<thead>
<tr>
<th></th>
<th>M00 PASS</th>
<th>M0 PASS</th>
<th>M0S PASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>kV 72.5</td>
<td>145</td>
<td>170</td>
</tr>
<tr>
<td>Frequency</td>
<td>Hz 50/60</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>Rated current</td>
<td>A 3150</td>
<td>3150</td>
<td>3150</td>
</tr>
<tr>
<td>Interruption current</td>
<td>kA 40</td>
<td>31.5</td>
<td>50</td>
</tr>
<tr>
<td>Test voltage - AC</td>
<td>kV 160</td>
<td>185</td>
<td>275</td>
</tr>
<tr>
<td>Impulse withstand voltage - BIL</td>
<td>kV 350</td>
<td>450</td>
<td>650</td>
</tr>
<tr>
<td>Operational impulse withstand voltage</td>
<td>kV -</td>
<td>-</td>
<td>1050</td>
</tr>
<tr>
<td>Altitude above sea level</td>
<td>m ≤ 1000</td>
<td>≤ 1000</td>
<td>≤ 1000</td>
</tr>
<tr>
<td>Max. air temperature</td>
<td>°C + 40 (1)</td>
<td>+ 40 (1)</td>
<td>+ 40 (1)</td>
</tr>
<tr>
<td>Min. air temperature</td>
<td>°C - 40 (1)</td>
<td>- 30 (1)</td>
<td>- 30 (1)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>% 100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Wind pressure Pa</td>
<td>Pa 700</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>Seismic protection (IEC 1166)</td>
<td>g 0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Pollution level (IEC 60815)</td>
<td>III High (2)</td>
<td>III High (2)</td>
<td>IV Very high</td>
</tr>
</tbody>
</table>

(1) Other temperatures are available on request.
(2) Level IV (very high) on request.
Medium voltage section
The MFM unit is complete with a medium-voltage switchgear with relays for protection and control of all elements. The back up batteries and the charging system are also in the MV section.

The connection between the transformer and the medium-voltage switchgear can be made by cable or directly by busbar according to the type of configuration.

The protection and control system uses ABB relays of the Relion® family. The protection system makes it possible to monitor the statuses of all the switchgear and controlgear 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.
Power transformer section
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. ABB’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 245 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 Nomex® are 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.

Nomex® is a trademark of DuPont de Nemours.
MFM - Multi Functional Module

Components

**MFM control module**
Control of the MFM module is obtained by the usage of ABB Relion® IEDs, family, collecting all status and interlocking logics from all equipment. The same IED, for the medium voltage section, is simultaneously performing the protection and metering functions. ABB Relion® units are designed in accordance with the international standard IEC61850, which allows easy integration of all control, monitoring, metering and protection functions. The integration between the Relion® units and the COM600 module perfectly meets all specifications with modern Smart Grid, through the use of IEC standard communication protocols and the simple and intuitive use of the HMI interface.

Typical configuration of the control of the MFM module with the use of HMI interface.
Example of station for distribution power generation installation

The figure shows how it is possible to make a connection to the high-voltage electrical network using two MFMs. One module is positioned in the areas near the high-voltage line and connected in series to the line itself. The second MFM is used to make the transformation and distribution in medium voltage.

The modules are equipped with a protection and control system.
In exactly the same way it is possible to connect generation installations of the "dispersed" type (for example on-shore wind farms and photovoltaic farms) directly to the high-voltage line.
MFM - Multi Functional Module

Electrical characteristics

Main electrical characteristics of MFMs

<table>
<thead>
<tr>
<th>High-voltage (primary) section</th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>[kV]</td>
<td>72.5</td>
<td>145</td>
<td>170</td>
<td>245</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>[Hz]</td>
<td>50 - 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power frequency withstand voltage</td>
<td>up to [kV]</td>
<td>140</td>
<td>175</td>
<td>325</td>
<td>460</td>
</tr>
<tr>
<td>BIL</td>
<td>up to [kV]</td>
<td>325</td>
<td>650</td>
<td>750</td>
<td>1050</td>
</tr>
<tr>
<td>Rated current</td>
<td>up to [A]</td>
<td>2000</td>
<td>2500</td>
<td>2500</td>
<td>4000</td>
</tr>
<tr>
<td>Rated making and breaking capacity</td>
<td>up to [kA]</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>

| Power transformer             |  |  |  |  |  |
| Rated Power                   | up to [kVA] | 60000 |  |

| Auxiliary services transformer |  |  |  |  |  |
| Rated power                   | up to [kVA] | 100 |  |

| Medium/High voltage (secondary) section |  |  |  |  |  |
| Rated Voltage                   | [kV] | 12 | 17.5 | 24 | 36 | 72.5 |  |
| Rated frequency                 | [Hz] | 50 - 60 |  |
| Power frequency withstand voltage | up to [kV] | 28 | 38 | 50 | 70 | 140 |  |
| BIL                            | up to [kV] | 75 | 75 | 125 | 170 | 325 |  |
| Rated current                  | up to [A] | 2500 |  |
| Rated making and breaking capacity | up to [kA] | 31.5 | 31.5 | 25 | 31.5 | 40 |  |