# BENEFITS OF INNOVATIVE MV INTERCONNECTOR SYSTEM

Venanzio FERRARO
Schneider-Electric – France
venanzio.ferraro@schneider-electric.com

Jean-Michel BONFILS
Schneider-Electric – France
jean-michel.bonfils@schneider-electric.com

Sebastien BRUNET
Schneider-Electric – France
sebastien.brunet@schneider-electric.com

## *ABSTRACT*

*The purpose of this paper is to describe a technical solution able to simplify the connections between Medium Voltage products and/or equipment. The connection devices consist of a conducting insert in a compressible insulating elastomer or silicone moulded from casting, which is coated with a shielding, and of a flat interface termination. The interconnector system has many advantages in terms of speed, flexibility and reliability of connections. In particular, the arrangements between electrical apparatuses are simplified by a positioning tolerance enabling an easy alignment of the pole-unit to be connected. The shielding also provides the benefit of full insensitivity to environmental conditions.*

## INTRODUCTION

Traditionally, the connections between functional units or inside of them are made with bare conductors or insulated conductors. Sometimes, these insulated conductors are screened with cone type terminations.

The AIS interconnectors ensure simplicity and flexibility of installation but the withstanding to harsh environment is not optimal. In order to improve this behaviour, some deflectors may be introduced but the distances between the live parts are increased and some manufacturers have developed airtight with high IP, waterproof or gas insulated cubicles. This technical approach brings an additional complexity to the installation and important increase of cost of the cubicle.

The installation of screened interconnectors imposes a reduced tolerance between the functional units or products to be connected together. Moreover, the overall dimensions of the connectors, together with complex procedures of installation that require a significant space for the execution, reduce the possibility of use.

More and more the MV users require modular, flexible and upgradeable solutions able to better withstand harsh environments in order to increase the availability of the grid.

It is why a new concept of an MV interconnector system has been designed with a significant breakthrough combining the advantages of both approaches existing on the market.

## AN ORIGINAL INTERCONNECTOR ARCHITECTURE

The interconnector product is a Screened Solid Insulation System (2SIS) and it is constituted by three concentric layers:
- a main conductor;
- an insulating elastomer or silicone layer;
- a conductive elastomer or silicone layer.

### Main conductor

The main conductor is permanently connected to the MV network and it is, therefore, subject to all current and voltage variations (i.e. fault, overload…)
It may be in aluminium for electrical application or copper. It may be flexible or rigid and obtained through different technologies.

### Insulating elastomer or silicone layer

An intermediate insulating layer wraps the conductor in very close contact and is covered by a conductive elastomer or silicone layer that is connected to the earth.
The purpose of the insulating layer is to ensure the insulation function in all the operating conditions during the whole life expectancy of the MV equipment.
Elastomer or silicone are well known high quality materials and therefore widely used for MV insulation applications.

### Conductive elastomer or silicone layer

An external conductive elastomer or silicone layer closely wraps the insulating elastomer or silicone layer on all the accessible surfaces of the installed product. The interconnector product of protection grade PA according to IEC 62271-201 [1] can be accidentally or inadvertently touched by persons (i.e. during maintenance operations).
The conductive layer has a relatively low resistance in order to ensure the electrical continuity and an effective earth connection.

## A LARGE VARIETY OF INTERFACES

In order to satisfy the large variety of the MV connection systems available on the market, the interconnector system is very open. The original interface principle allows fitting the interconnector system with many existing types of MV connections.

The connector may include:
- a conical interface complying with EN 50181 standard [2] and with its next evolution for connection with other products existing on the market. The standard EN 50181 is currently under revision and some new types of connectors are being defined. The interconnector system already includes the possibiliy to be linked with these additional types of connectors;
- a conical interface complying with other national standards (i.e. ANSI/IEEE);
- a conical interface in accordance with particular user or manufacturer specifications;

In addition, Schneider Electric has developed a specific flat interface covered by patent improving the performances of the MV connections.

## INNOVATIVE FLAT INTERFACE

The flat interface is an evolution of the conical interface, keeping the strong points of the insulated and screened connections and adding simplicity of installation, compactness, flexibility and increasing safety.

The flat interface (Figure 1) consists of a conducting insert in a compressible insulating elastomer or silicone which is coated with a shielding. The connecting surface of the conducting insert is recessed from the connection surface of the insulating support.

When connection is performed, the insulating surfaces come into contact. Compression is then performed enabling the interface to become air-tight, while at the same time bringing the conducting surfaces into contact. The assembly is kept compressed by means of a central screw.

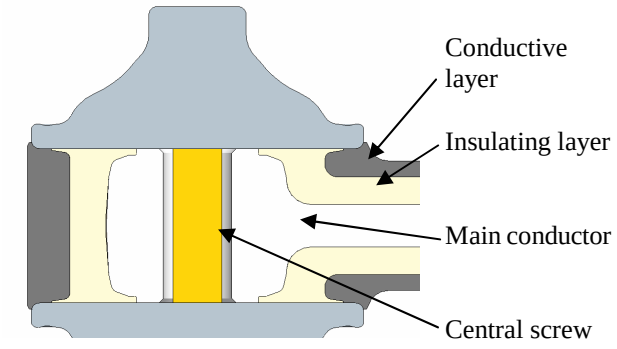


Figure 1: cross-section of flat interface

Mechanical functions and electrical performances have been optimized by high technical 3D design and validated by many tests.
All the external surfaces of the installed interconnector system are screened and connected to the earth. The electrical field is totally included and fixed in the insulating layer without affecting the surface of the interconnector ,avoiding any electrical superficial aging. Figure 2 shows that all equipotential lines are maintained inside the connector with an sufficiently low level of stress with respect to the properties of the insulating materials to ensure a long life time.
High quality insulation materials and industrial process allow reaching a long life expectation even in harsh environmental conditions.
The flat interface interconnector products are submitted to partial discharge measurements as individual tests to ensure constant and very high performances.

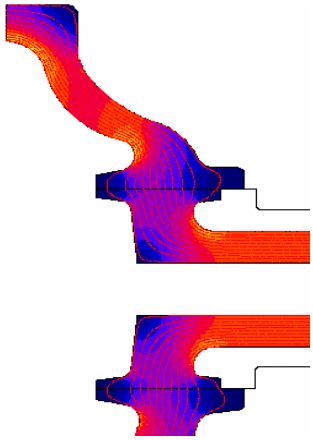

Figure 2: electrical field calculation in the flat interface (the equipotential lines are plotted).

The assembly procedure is simple due to the reduced number of components and dielectric interfaces. The sequence of assembly is intuitive with simple visual controls easy to make (i.e. cleanliness of both contact and insulating surfaces...).

The flat interface is more compact compared to the conical interface and the space needed to make the installation is extremely reduced. This is bringing an important advantage in case of compact units that are more and more used in the MV substations.

The earth continuity is automatically obtained when tighting the interconnectors having flat interface without the need of any additional components, dedicated tooling or specific sequences of assembly.

The flat interface interconnector system ensures more reliable assembly and, therefore, increases the safety of the installation.

## ADVANTAGES OF FLAT INTERFACE INTERCONNECTOR SYSTEM

The flat interface including 2SIS technology has several advantages:
- harsh environment withstand;
- simple operations of installation and positioning of the switchgear;
- simple operation of installation of the interconnector products;
- flexibility of architecture of the MV switchgear;
- easy implementation of Smart Grid and metering solution;
- easy up-grade and adaptation.

### Harsh environment withstand

The 2SIS technology ensures the most efficient harsh environment withstand because the insulating performances are not affected by any possible electrical field variation.
Long service operation is ensured in all possible indoor harsh environment conditions (dust, pollution, humidity, temperature changes, etc…)

### Simple operations of installation and positioning of the switchgear.

The arrangements between functional units are simplified thanks to a three dimensional positioning tolerance. In particular, the alignment of the pole-units to be connected is less sensitive to the floor flatness.

### Simple operation of installation of the interconnector products

The installation procedure is simple and it does not need any specific procedures, training or dedicated tools.
With flat interface interconnector products, the physical efforts to install or disassemble the connection are very low. In comparison, for conical interface, the physical efforts to properly position parts for the assembly or to remove them when disassembling are very high and may damage the connector or the switchgear itself.

### Flexibility of architecture of the MV switchgear

The compact size and the reduced space needed for assembly allow installing the interconnector system inside a compact functional unit.

The MV switchgear becomes very modular and it is possible to configure it in numerous configurations.
The cable interface location may include:
- bottom, rear, top or side entry
- front, or lateral connection

The busbars arrangement inside the cubicle may be bottom, top or vertical.

### Easy implementation of Smart Grid and metering solution.

The possibility to install compact size ring CTs, screened VTs or low power stand-alone sensors (LPCS, LPVS) allows metering, monitoring and protection flexible solution with reduced impact.

### Easy up-grade and adaptation

The extension and/or the up-grade of the installed switchgear is simple and without strong impacts on the installed switchboard. It is possible to install additional cubicles, to interchange or to integrate additional instrument transformers or capacitive sensors supplying VPIS/VDS devices without heavy interventions on the existing switchgear of the substation.

Figures 3 and 4 show some configurations of an MV switchboard, achievable thanks to the flexibility obtained with the flat interface interconnector system.

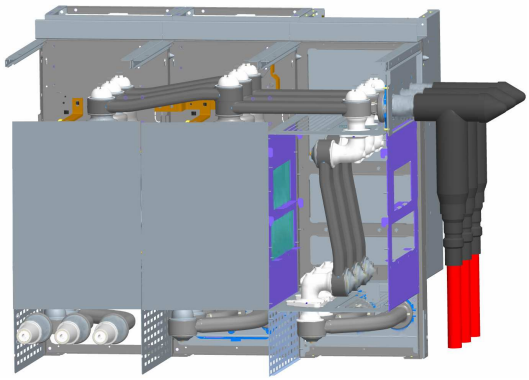

Figure 3: example of top busbar installation of flat interface interconnector system in MV switchgear

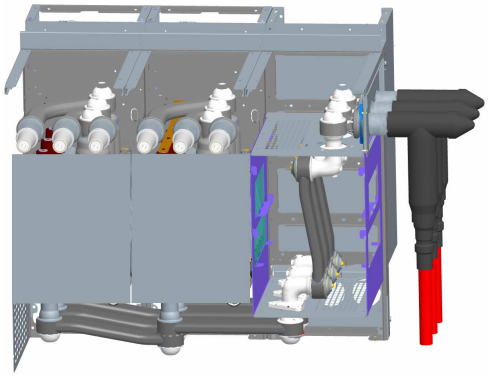

Figure 4: example of bottom busbar installation of flat interface interconnector system in MV switchgear

## CONCLUSION

The flat interface inteconnector system allows modular, flexible and upgradeable solutions able to better withstand harsh environments.
It is an open solution as a large variety of MV cable connectors can be used.
It combines installation simplicity, modularity and flexibility of the AIS connectors with the compact size and safety of the insulated and screened connectors.
This is a factor that increases the availability of the MV network and the easiness to upgrade and adapt the switchboard for any evolution (i.e. new smartgrid needs).

## REFERENCES

[1] IEC 62271-201, 2006 Ed. 1.0, High-voltage switchgear and controlgear – Part 201: AC insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

[2] EN 50181, May 1997: Plug-in type bushings above 1 kV up to 36 kV and from 250 A to 1,25 kA for equipment other than liquid filled transformers