



**Application Areas**

Perimeter: Global

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Service Function: -

Business Line: Enel Grids

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THE HEAD OF GLOBAL NETWORK COMPONENTS

**Fabrizio GASBARRI**

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**1. DOCUMENT AIMS AND APPLICATION AREA**

The purpose of this document is to provide technical and testing requirements for connection cables used between the protection and control equipment (UP, RGDM, QED) and the switchgears installed within Enel Grids MV/LV substations for remote control and automation.

*This document shall be implemented and applied to the extent possible within the Enel Grids Business Line, in compliance with any applicable laws, regulations and governance rules, including any stock exchange and unbundling-relevant provisions, which in any case prevail over the provisions contained in this document.*

**1.1 RELATED DOCUMENTS TO BE IMPLEMENTED AT COUNTRY LEVEL**

This document does not require implementation of further documents. Anyway, each Enel Grids Company can issue, under the supervision of Enel Grids Global Network Components detailed documents, according to the provisions of the present document and in case of specific needs.

**2. DOCUMENT VERSION MANAGEMENT**

Version	Date	Main changes description
1	10/01/2023	First issuing of Enel Grids "GSCM014 MV/LV Substation connection cables"

**3. UNITS IN CHARGE OF THE DOCUMENT**

Responsible for drawing up the document:

- Enel Grids: Engineering and Construction /Components and Devices Design/ Network Components/MV and LV Equipment unit.

Responsible for authorizing the document:

- Enel Grids: Head of Global Network Components unit;
- Enel Grids: Head of Quality unit.

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**4. REFERENCES**

- Integrated Policy for Quality, Health and Safety, Environment, anti-Bribery and Information security.
- ISO 9001:2015 - Quality Management System – Requirements.
- ISO 14001:2015 - Environmental Management System - Requirements with guidance for use.
- ISO 45001:2018 - Occupational Health and Safety Management System - Requirements with guidance for use.
- ISO 37001:2016 - Anti-bribery Management System - Requirements with guidance for use.
- ISO 27001:2017 - Information Security Management System – Requirements.
- GSTR002: Remote Terminal Unit for MV/LV substation – UP2020 Lite.
- GSCM004: MV RMU with circuit breaker.
- GSM001: MV RMU.
- GSCM005: Modular Medium Voltage Switchgears.

**Group Pillar References:**

- The Code of Ethics of Enel Group;
- The Enel Group Zero Corruption Tolerance Plan (ZTC);
- Human Rights Policy;
- Organization and Management Model as per Legislative Decree No. 231/2001;
- Enel Global Compliance Program (EGCP).

**5. ORGANIZATIONAL PROCESS POSITION IN THE PROCESS TAXONOMY**

- Value Chain /Process Area: Engineering and Construction
- Macro process: Devices and Components Development
- Process: Standard Catalog Management

**6. DEFINITIONS AND ACRONYMS**

Acronym and Key words	Description
<b>Circuit-Breaker (CB)</b>	Mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified duration and breaking currents under specified abnormal circuit conditions such as those of short circuit

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<b>Logic Selectivity Function (FSL)</b>	Set of operations allowing selective automation for fault detection on the MV network
<b>Medium Voltage (MV)</b>	System with a nominal operative voltage between the phases higher than 1 kV to 35 kV included. NOTE: The boundary value between medium voltage and high voltage depends on local and historical circumstances or on common usage. Nevertheless, for internal standardization purposes, medium voltage is defined as a system with a nominal operative voltage between the phases higher than 1 kV to 35 kV included”
<b>MV Ring Main Unit (RMU)</b>	Compact solution for MV switchboard
<b>MV/LV Substation</b>	Enel Secondary substation
<b>OdM</b>	Manoeuvring organ
Power supply Battery Charger (PSBC)	Power supply unit
<b>RIO - QED</b>	Remote Input/Output module for the Quantum Edge Device
<b>Self Healing Automation (SHA)</b>	System which allows automatic resolution of problems/faults
<b>Smart Fault Selection (SFS)</b>	Automation for automatic fault selection and isolation
<b>Switchgears</b>	A general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy

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**7. DESCRIPTION**

**7.1 LIST OF COMPONENTS**

The MV/LV substation connection cables described in this technical specification can be classified into different products, shown in:

Type Code	Description	Country	Country Code
GSCM014/1	UP Connection Cable	IT	140496
GSCM014/1	UP Connection Cable	RO	140217
GSCM014/2	FSL adapter for RGDM	IT	140497
GSCM014/3	RGDM cable	IT	140498
GSCM014/4	Y cable	IT	140499

**Table 1 – List of Components**

**7.2 CONSTRUCTIVE KITS**

Different solutions of connection cables depending on the control and protection devices installed in the MV/LV substation have been identified.

**7.2.1.1. KIT 1**

KIT 1 shall be used when the following equipment are installed within MV/LV substation:

- UP2020Lite (or old version).
- Switchgears with Switch-disconnector (SD) according to DY8XX series or GSM001 series.
- RGDM/RGDM (no advanced automation).

KIT 1 is composed by:

- GSCM014/1 (UP Connection Cable), to connect the RTU (UP) and the MV switchgear\*, according to par. 0.

\*For GSM001 series the GSCM014/1 is included in the supply

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**7.2.1.2. KIT 2:**

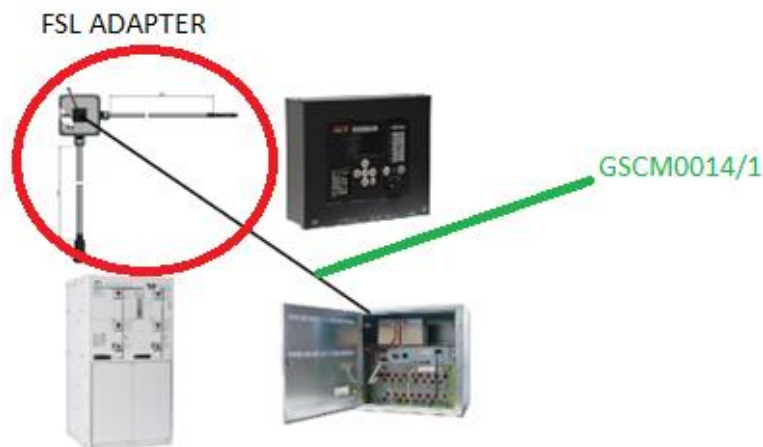
KIT 2 shall be used when the following equipment are installed within MV/LV substation.

- UP2020Lite (or old version).
- Switchgears according to DY800 and DY900 series.
- RGDM (FSL/SFS/SHA).

KIT 2 is composed by:

- GSCM014/1 (UP Connection Cable), to connect the RTU (UP) and the FSL adapter, according to par.0.
- GSCM014/2 (FSL adapter for RGDM) to connect the RGDM with the switchgear, according to par.7.5

In Figure 1 there is the representation of the connections between Switchgear-RGDM-UP



**Figure 1 - Kit 2 example, principle diagram of connections between Switchgears-RGDM-UP in according to DY800 and DY900**

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**7.2.1.3. KIT 3**

KIT 3 shall be used when the following equipment are installed within MV/LV substation.

- UP2020Lite (or old version).
- Switchgears according to GSCM004\* and GSCM005.
- RGDM (FSL/SFS/SHA).

KIT3 is composed by:

- GSCM014/1 (UP Connection Cable), to connect the RTU (UP) and the MV switchgear\*, according to par.0.
- GSCM014/3 (RGDM cable) to connect the RGDM with the terminal block within the switchgear, according to par.7.6.

\*For GSCM004 series GSCM014/1 is included in the supply

In Figure 2 there is the representation of same situation seen above, in according with the new revisions of GSCM004 and GSCM005.



**Figure 2 - Principle diagram of connections between Switchgears-RGDM-UP in according to GSCM004, GSCM005**

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**7.2.1.4. KIT 4.**

KIT 4 shall be used when the following equipment are installed within MV/LV substation.

- UP2020/QED;
- Switchgears with Circuit breaker functional unit.
- RGDM/RIO RGDM (FSL/SFS/SHA);

KIT 4 is composed by:

- GSCM014/4 (Y cable) used to connect UP2020/QED and RGDM/RIO RGDM with the switchgear according to par.7.7.

**7.3 OPERATING CONDITIONS**

<b>OPERATING VALUES</b>		
Rated supply voltage of SD and CB drives:	[V <sub>DC</sub> ]	24 -15% +20%
Maximum temperature	[°C]	40
Maximum average value of temperature, referring to a period of 24h:	[°C]	35
Minimum temperature for indoor installation:	[°C]	-15
Minimum temperature for outdoor installation:	[°C]	-25
Storage temperature:	[°C]	-25 +70
Relative humidity:	-	95%
Atmospheric pressure:	[kPa]	70 106

**Table 2 – Operating conditions**



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**7.4 GSCM014/1 - UP CABLE**

As indicated above such cable allows interface between the switchgear with the external remote terminal unit (UP).

GSCM014/1 technical characteristic shall be as follows:

- Rated voltage: 300/500 V.
- Flexible annealed, not tinned, copper conductor.
- Cable formation 11x1,5 mm<sup>2</sup>, signal cable type FS18OR18 or equivalent or upper class.
- Cable length 8 mt.
- Circular Plastic Connector male (see Figure 3).
- Square Grid Connector female (see Figure 3).

A belt-type marking device, made in PVC, shall be fitted at each end of the cable, to be used, during installation, to indicate the number and the name of the functional unit it relates to.

The coupling of the parts shall be ensured by means of a quick-release screw ring nut. The detachable part of the rectangular connector provided at the other end of the cable shall be of the type shown in Figure 3. Both the fixed and the detachable parts shall be made of insulating material with dielectric characteristics.

The cable shall have a circular terminal indicated in Figure 3, that is suitable for being inserted into the connector on the MV Switchgear.



**Figure 3 - UP Cable**

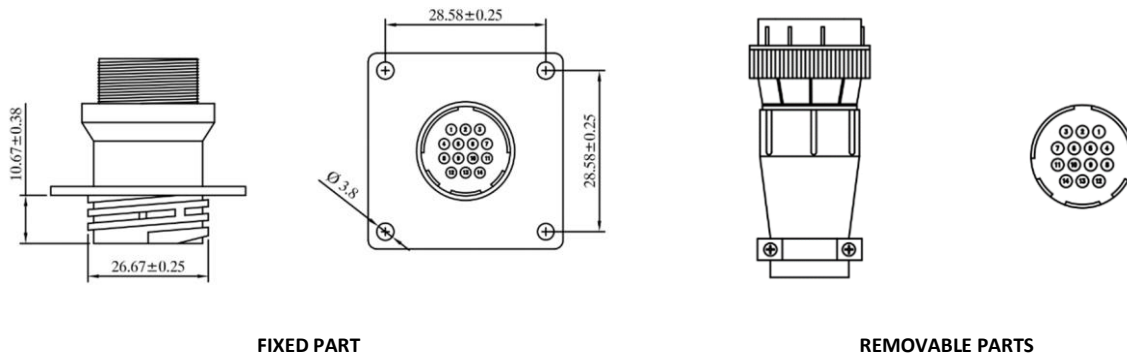
**Application Areas**

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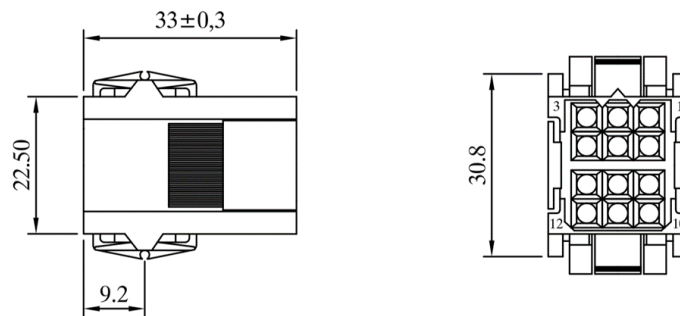
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FIXED PART

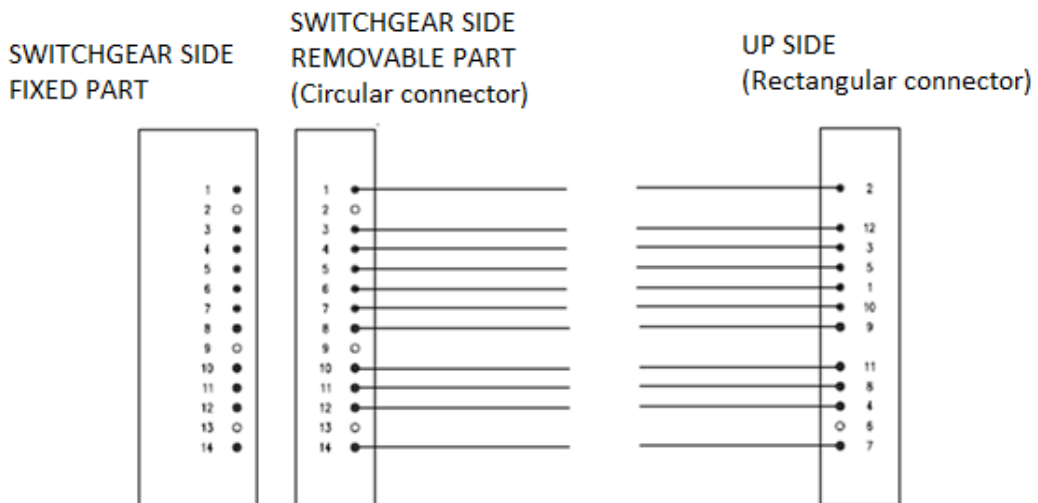
REMOVABLE PARTS

**Figure 4- Connectors on the Switchgear side (Circular Plastic Connector)**



**Figure 5- Connector on the Peripheral Unit side of the cable (Square Grid Connector)**

The wiring diagram of the cables should be as shown in Figure 6:



**Figure 6 - Wiring diagram between UP and equipment**

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In Table 3 the pin-out of both connectors (Switchgear side and UP side) is showed.

1	+M	Motor supply voltage (+24 Vcc)	8	89cax	Signal opening position switch-disconnector or circuit breaker
2		Not used	9		Not used
3	- A	Common (-24 Vcc) commands	10	- M	Motor supply voltage (-24 Vcc)
4	+ M	Motor supply voltage (+24 Vcc)	11	CH	Closing command
5	Com TS	Common position signals switch-disconnector or circuit breaker	12	89ccx	Signal closing position switch-disconnector or circuit breaker
6	+ L	Local commands supply (+24 Vcc)	13		Not used
7	- M	Power supply (-24 VDC) motor	14	AP	Opening command

**Table 3 - Circular connector pin-out (Switchgear side)**

1	+ L	Local commands supply (+24 Vcc)	7	AP	Opening command
2	+M	Motor supply voltage (+24 Vcc)	8	CH	Closing command
3	+M	Motor supply voltage (+24 Vcc)	9	89cax	Signal opening position switch-disconnector or circuit breaker
4	89ccx	Signal closing position switch-disconnector or circuit breaker	10	- M	Motor supply voltage (-24 Vcc)
5	Com TS	Common position signals switch-disconnector or circuit breaker	11	- M	Motor supply voltage (-24 Vcc)
6		Not used	12	- A	Common (-24 Vcc) commands

**Table 4 - Rectangular connector pin-out (UP Side)**

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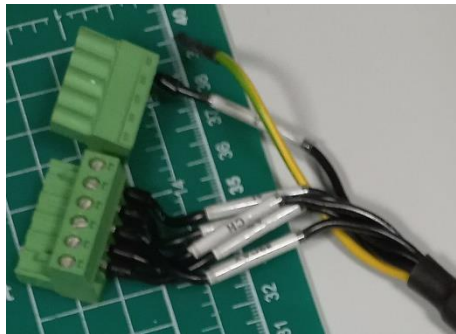
Service Function: -

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**7.5 GSCM014/2 - FSL Adapter for RGDM**

FSL adapter for RGDM (Figure 8) is used between the GSCM014/1 (UP connection cable) and the circuit breaker functional unit motorisation, to enable advanced automations (FSL/SFS/SHA) with RGDM (Directional Fault Detector and Measurement).

The FSL adapter must be equipped with circular connectors at the ends of the feed-through cables, and the branch cables to the RGDM must be insulated up to the connection with the RGDM terminal blocks (see Figure 7).



**Figure 7 – Insulated cables linked with RGDM terminal blocks**

GSCM014/2 shall be made with the following reference material list:

- An external junction box colored in light grey, with IP56 protection degree with dimensions 100x100x50mm. It shall be made in self-extinguishing plastic material with smooth walls (without holes and/or provision for holes) compliant with EN 60670-22.
- 2 grey colored cable glands compliant with standard IEC 62444, for cable formation same as 11x1,5mm<sup>2</sup> and 7x1,5 mm<sup>2</sup> to obtain at least a protection degree IP54.
- 1 circular female connector mounted on the cover of the box.
- 1 circular male connector mounted on the cable.
- 1 meter of grey flame-proof cable 11x1,5mm<sup>2</sup>, signal cable type FS18OR18 or equivalent or upper class, on the Circuit breaker functional unit side with circular connector and single female pins.
- 1 meter of grey flame-proof cable 7x1,5mm<sup>2</sup>, signal cable type FS18OR18 or equivalent or upper class on the RGDM side, with insulated ferrules;
- 3 spring terminals to make the RGDM connections inside the box.

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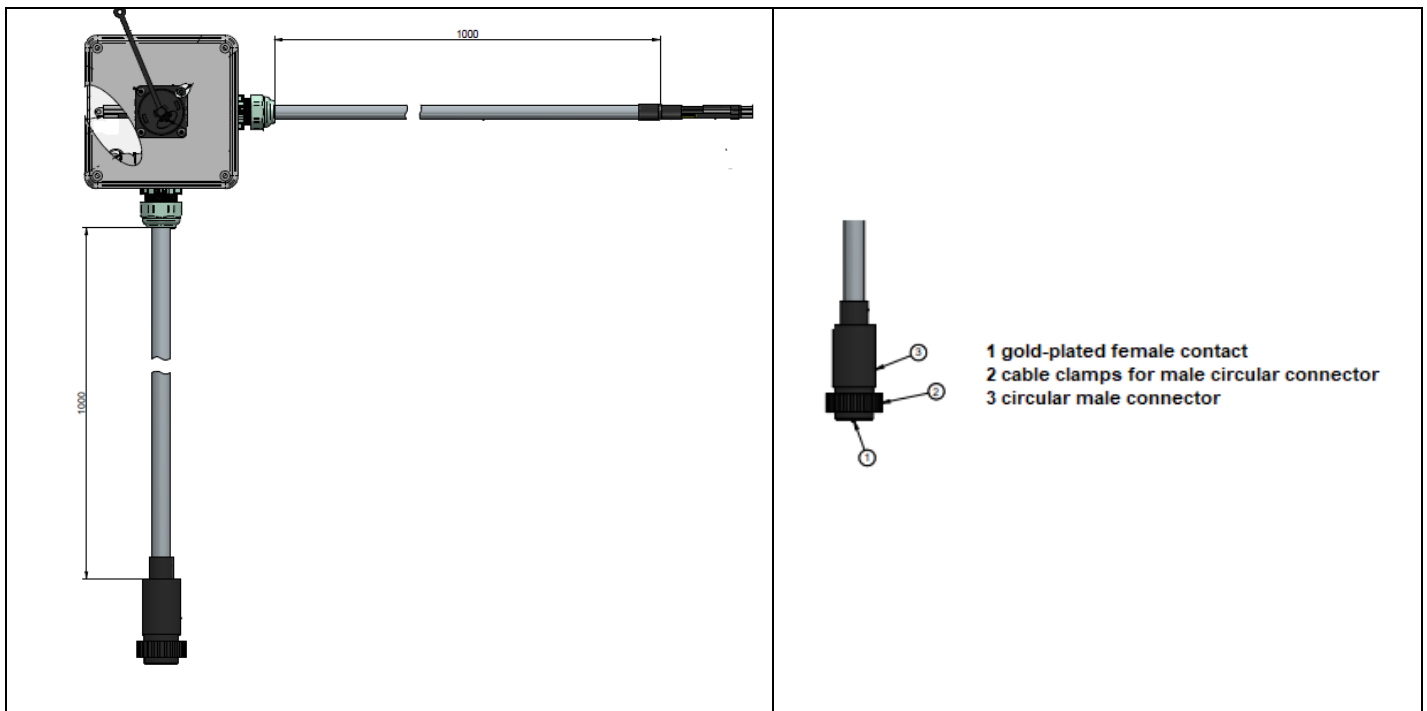
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- Conductor end sleeves, required for the ends of the RGDM side branch cable
- Indelible numbering of the individual conductors on the RGDM side with transparent sheath protection

For more clarity see also Figure 1, where is visible the configuration where this element is used (reported in Kit 2)



**Figure 8 - FSL adapter for RGDM**

The wiring diagram of the FSL adapter for RGDM is shown in Figure 9, where there are also the positions and wire numbering of the connectors:

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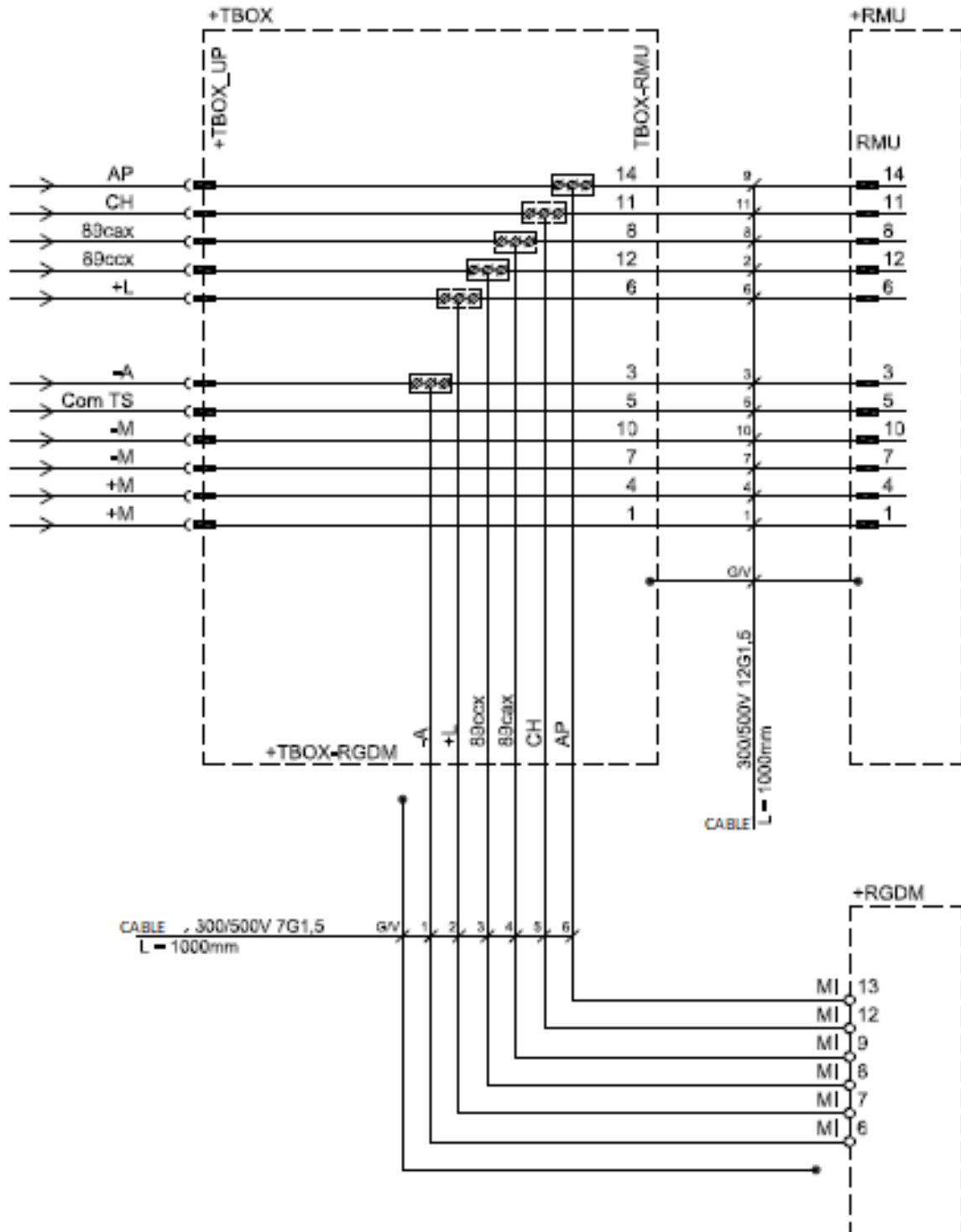


Figure 9 – FSL adapter Electrical scheme

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**7.6 GSCM014/3 - RGDM CABLE**

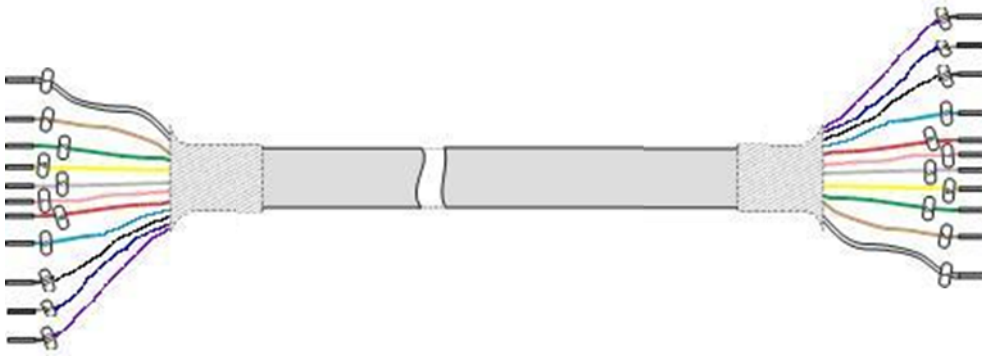
GSCM014/3 - RGDM cable (Figure 10) characteristics shall be as follows:

- Rated voltage: 300/500 V;
- 1 meter of flameproof cable 7x1,5mm<sup>2</sup>, signal cable type FS18OR18 or equivalent or upper class
- Flexible annealed, not tinned, copper conductors.

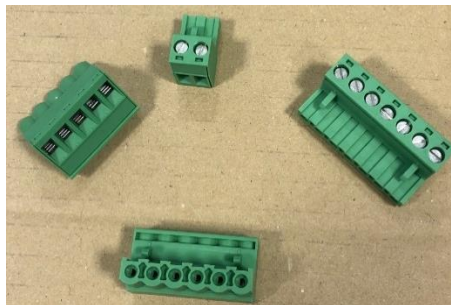
A belt-type marking device, made in PVC, shall be fitted at each end of the cable, to be used, during installation, to indicate the number and the name of the functional unit it relates to.

Cables must be preassembled by the supplier, with removable terminal boards (Figure 11).

For more clarity see Figure 2 where is visible the configuration where this element is used (reported in Kit 3)



**Figure 10 – Example of the connection cable between the MV Switchgear and RGDM**



**Figure 11 - Example of the removable part of the cable (Switchgear and RGDM side)**

The pinout of the cable is shown in Table 5. The correct marking (on each conductor inside the removable part of the terminal board) must be done at each end of the cable according to the following table.

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Switchgear terminal board side	RGDM terminal board side (called MI)	Signal	Description
1	6	-A	Common (- 24Vdc) commands
2	7	+L	Local commands (+24Vdc)
3	8	89ccx	Signal closing position switch-disconnector or circuit breaker
4	9	89cax	Signal opening position switch-disconnector or circuit breaker
5	12	CH	Closing command
6	13	AP	Opening command

**Table 5 - Connection Cable pinout**



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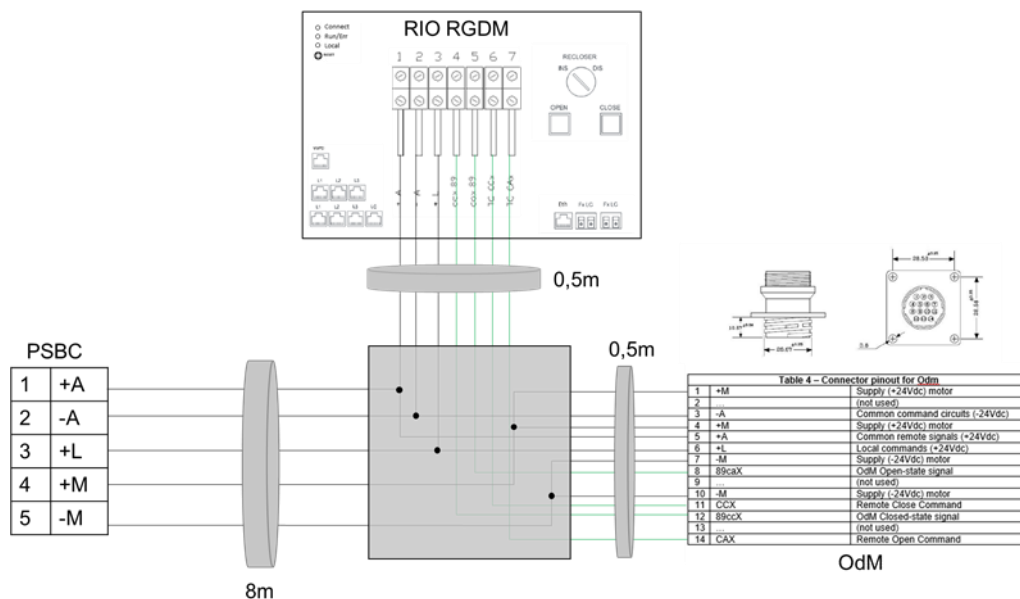
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**7.7 GSCM014/4 - Y CABLE**

It must be provided the connection cable between the PSBC, the RIO RGDM/RGDM device and the Switchgear (Figure 12). See also 7.2.1.4



**Figure 12 – Example of the technical solution for the "Y" cable**

As indicated in the figure, the cable must have at least, a length of 8 meters to the PSBC side and 0,5 meters each to the MI (installed on the RIO RGDM/RGDM) and switchgear side.

The connection cable must be realized with the following characteristics:

- 8 meters of flameproof cable; 5 conductors with section (2,5 mm<sup>2</sup> for ±M signal and 1,5 mm<sup>2</sup> for ±A, +L signal), on PSBC side;
- 0,5 meter of flameproof cable; 7 conductor with 1,5 mm<sup>2</sup> section on RIO-RGDM/RGDM side;
- 0,5 meter of flameproof cable; 11 conductor with 1,5 mm<sup>2</sup> section on switchgear side with circular connector and single female pins
- All the cables must be signal cables, type FS18OR18 or equivalent or upper class

The not fixed part of the cable, both on the PSBC side and MI side, must be preassembled by the supplier, with removable terminal boards (Figure 13).

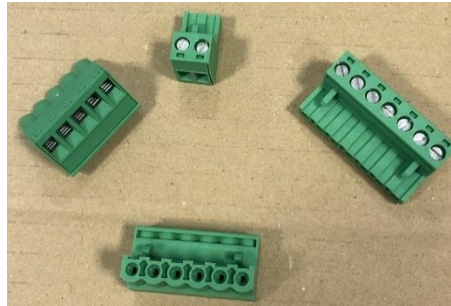
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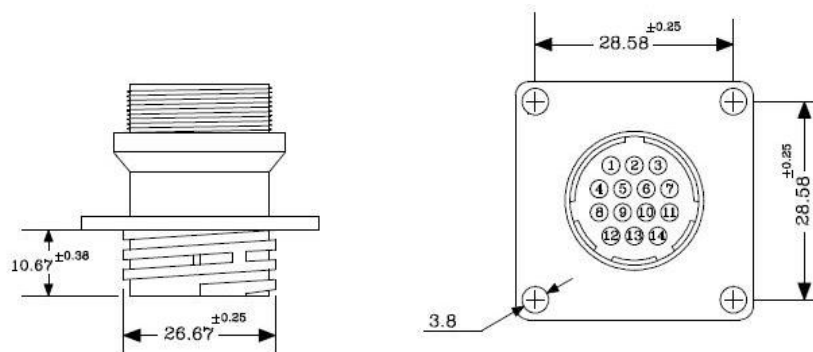
**Figure 13 - Example of the removable part of the cable (PSBC and MI side)**

The cable, on the switchgear side, must have the following electrical characteristics:

- Rated isolation voltage: 300/500 V
- Flexible annealed, not tinned, copper conductors
- R2 quality PVC insulation
- Outside diameter (of the insulation) of the cores:  $\varnothing$  3 mm
- Distinction of the cores by marked numbers (according to CENELEC HD 186 S2), connecting the marked numbers with the identifying numbers on the conductor's pins
- Rz quality PVC sheath

A belt-type marking device, made in PVC, shall be fitted at each end of the cable, to be used, during installation, to indicate the number and the name of the functional unit it relates to.

The cable, on the switchgear side, must have a terminal that is suitable for being inserted into the connector on the MV Switchgear. Both the fixed part installed on the MV Switchgear and the not fixed part of the cable, are shown below (respectively in Figure 14 and in Figure 15):



**Figure 14 – Fixed part installed on the MV Switchgear**

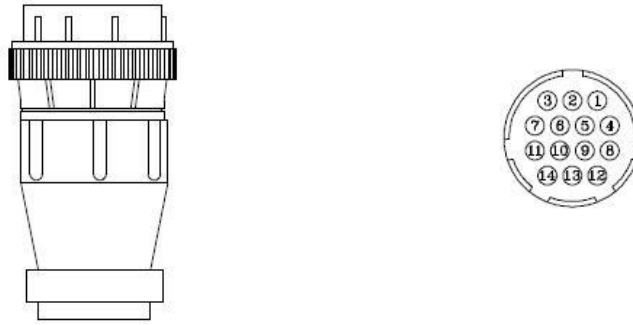
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**Figure 15 – Not fixed part installed on the cable**

The connector's pinout is shown in Table 6.

1	+M	Supply (+24Vdc) motor
2	...	(not used)
3	-A	Common command circuits (-24Vdc)
4	+M	Supply (+24Vdc) motor
5	+A	Common remote signals (+24Vdc)
6	+L	Local commands (+24Vdc)
7	-M	Supply (-24Vdc) motor
8	89caX	Switchgear: Open-state signal
9	...	(not used)
10	-M	Supply (-24Vdc) motor
11	CCX	Remote Close Command
12	89ccX	Switchgear: Closed-state signal
13	...	(not used)
14	CAX	Remote Open Command

**Table 6 - Connector pinout for switchgear**

**7.8 TESTING AND CERTIFICATIONS**

All the requirements from this chapter must be respected. These tests must be performed in the provider factory or third part's laboratories.

**7.8.1. Test documents**

Test documents must contain all drawings and tests for the manufacture and operation of the product from which the conformity of the product with all requirements of the technical specification can be verified, directly or indirectly.

**7.8.2.Type test list**

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- Verification of insulation tightness at industrial frequency
  - Verification of the connections and compliance with the wiring diagram
  - Functionality check with UP command simulator
  - Verification of IP protection degree
  - Verification of compliance of the individual components with the product standards

The supplier must retain all the documentation proving the successful results of the type tests and all data must be made available to the technical unit in real time.

At technical unit's discretion these tests may be completely or partially repeated during the lifetime of the contract as continuing evidence of type conformity.

**7.8.3. Routine and acceptance tests**

The routine tests are here reported:

- Verification of insulation tightness at industrial frequency
- Verification of compliance with the approved;
- Verification of connections and electrical diagram compliance;
- Verification of functionality with a command simulator;
- Verification of IP degree of protection;
- Functional test of the UP/QED connection cable with reference;
- Verification of compliance of individual components with product standards.

The acceptance tests shall be repeated by the supplier, under the Distribution Companies surveillance, on a sample chosen randomly among those ones of the batch that has already been successfully tested by the supplier. The tests shall be carried out on samples defined by the sampling plan below:

Single sampling plan for normal inspection - AQL = 2,5% - Level II (in case of negative result, in the new commissioning the sampling plan shall be ordinary).