



Subject: **GSTP102** - Global Infrastructure and Networks Global Standard
Protection and control device for HV/MV substation – Remote
Input/Output module (RIO)

Application Areas

Perimeter: *Global*
Staff Function: -
Service Function: -
Business Line: *Infrastructure & Networks*

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THE HEAD OF TECHNOLOGY DEVELOPMENT
Gianni Ceneri



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1. DOCUMENT AIMS AND APPLICATION AREA

This global standard defines the characteristics of Remote Input / Output module (RIO) for HV/MV distribution substations at declared fundamental frequency of 50 Hz or 60 Hz.

1.1 RELATED ORGANIZATIONAL DOCUMENTS TO BE IMPLEMENTED AT COUNTRY LEVEL

This document applies to both Enel Global Infrastructure and Networks Srl Company and to Infrastructure and Networks Business Line perimeter, when each Company does not have to issue further documents.

2. DOCUMENT VERSION MANAGEMENT

Version	Date	Main changes description
2	[13/07/2021]	Issuing of Global Infrastructure and Networks Global Standard – Protection and control device for HV/MV substation – Remote Input/Output module (RIO)

3. UNITS IN CHARGE OF THE DOCUMENT

Responsible for drawing up the document:

- Global Infrastructure and Networks: Innovation and Industrialization/ Technology Development/ Grid Solutions Factory unit;

Responsible for authorizing the document:

- Global Infrastructure and Networks: Head of Technology Development unit;
- Global Infrastructure and Networks: Head of Health, Safety, Environment and Quality unit;

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4. REFERENCES

- Enel Group Code of Ethics;
- The Enel Group Zero Corruption Tolerance (ZCT) Plan;
- Organizational and management model as per Italian Legislative Decree no. 231/2001 or equivalent documents adopted in the Countries;
- Enel Human Rights Policy;
- Stop Work Policy;
- Enel Global Compliance Program (EGCP);
- Global Infrastructure and Networks RACI Handbook;
- IEC 61850 series: Communication protocols for IED at electrical substation
- IEC 60529: Classification of degrees of protection provided by enclosures for electrical equipment
- IEC 60255 series: Measuring relays and protection equipment
- IEC 61000 series: Electromagnetic compatibility
- IEC 60068 series: Environmental testing
- IEEE 802.3u: Physical layer and data link layer's media access control of wired Ethernet
- IEEE 802.1q: System of VLAN tagging for Ethernet frames
- GSCG002: Technical Conformity Assessment
- GSTP10X series: Protection and control device for HV/MV substation – Multifunctional feeder protection (MFP)
- GSTP901: Cybersecurity requirements for protection and control devices
- EN 55011: Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement
- EN 50160: Voltage characteristics of electricity supplied by public distribution systems.
- EU directive 2004/108/CEE: EMC directive
- EU directive 2006/95/CEE: Low Voltage directive
- EU directive 93/68/CEE: CE marking directive



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- NTC-2050: Código eléctrico colombiano
- RETIE: Reglamento técnico de instalaciones eléctricas



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5. ORGANIZATIONAL PROCESS POSITION IN THE PROCESS TAXONOMY

Value Chain /Process Area: Networks Management

Macro process: Materials management

Process: Network components standardization

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6. DEFINITIONS AND ACRONYMS

Acronym and Key words	Description
Global Standard (GS)	Enel Group Technical Specification
Intelligent Electronic Devices (IED)	Devices that perform one or more of functions of protection, measurement, fault recording and control
Multifunctional Feeder Protection (MFP)	Multifunctional feeder protection
HV/MV Substation	Electric power substation supplied in HV, equipped with at least one HV/MV power transformer dedicated to the MV distribution network.
Remote Terminal Unit (RTU)	Remote Terminal Unit for the remote control and automation functions

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7. DESCRIPTION

7.1 List of components, product family or solutions to which the gs applies

The RIO module described in this GS is a product of GSTP10X series, as shown in Table 1:

GSTP10X type	Product family code	Description
GSTP102-RIO	GSTP10X	Remote I/O module

Table 1 – GSTP10X product family and description

The RIO is equipped with the accessories (Small Form-factor Pluggable: SFP) provided in Table 2:

Accessories	Connected Device	Description	Reference Global Standard	Included in the Supply
SFP RJ45		SFP module for the characterization of SFP port with RJ45 connector output		Yes
SFP LC		SFP module for the characterization of SFP port with LC fiber optical connector output		Yes

Table 2 – Accessories of the RIO device

7.2 Application field

This document standardizes the functional and construction requirements of the Remote I/O modules (RIO) used in the ENEL's HV/MV distribution substation. This device accomplishes to the definition of IED, by according to IEC 61850 series.

The RIO use the protocols from the IEC 61850 to communicate with the RTU, the communication profiles are defined in the GSTP103 and GSTP104.

The Remote I/O Modules (RIO) allows reducing the required wiring for IEDs constituted by an integrated protection in a controlled system.

The RIO equipment shall meet the following physical general features:

- a. Reduced size
- b. Easy installation
- c. Strength

Security by design is mandatory for any devices developed to be installed in the ENEL premises. The requirements from GSTP901 must be adopted.

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7.3 General requirements

7.3.1 Enclosure

The RIO module must be in boxed version suitable for mounting on DIN rail (Omega type). The RIO type module can be realized in two different ways, horizontally and vertically. In case of horizontal layout, it must have following maximum dimensions (Figure 1):

- a. W = 150mm
- b. H = 120mm
- c. D = 60mm

In case of vertical layout, it must have following maximum dimensions (Figure 2):

- d. W = 120mm
- e. H = 150mm
- f. D = 60mm

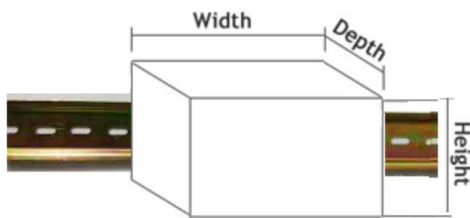


Figure 1 – RIO horizontal dimensions

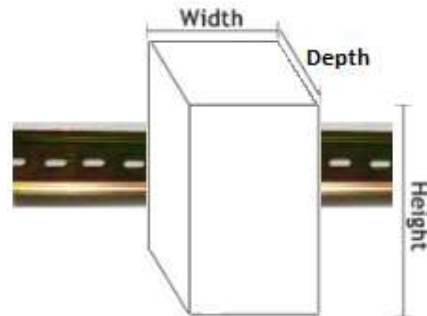


Figure 2 – RIO vertical dimensions

In the next figures (Figure 3 - Figure 4) an example of possible frontal layout for both the vertical and the horizontal configuration of the RIO device is showed.

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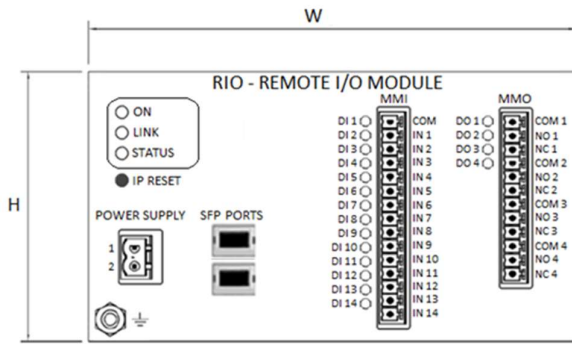


Figure 3 – RIO frontal layout (horizontal)

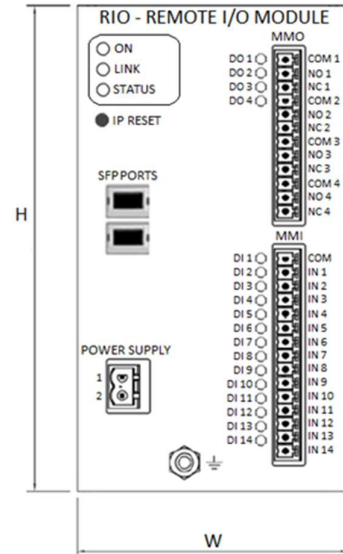


Figure 4 – RIO frontal layout (vertical)

The container must be made of hot-galvanized steel sheet or equivalent material from the point of view of electromagnetic compatibility, of the structure's stiffness and resistance to atmospheric agents (plastic solutions with metallization are excluded).

The following degrees of protection, according to the IEC 60529 must be guaranteed:

- IP-34 for the enclosure;
- IP-2x to meet health and safety requirements; therefore, the terminals must be completely covered with protection caps.

The choice of RIO enclosure type, i.e. whether horizontal or vertical, will be made during the procurement phase (par.7.5.2).

Different enclosure characteristics may be approved by ENEL during the procurement process (par.7.5.2).

7.3.2 Environmental requirements

The device shall operate accurately in the following conditions:

- | | |
|---|-------------|
| a. operating temperature: | -25 ÷ 70°C |
| b. relative humidity (without condensation or ice): | ≤ 95% |
| c. atmospheric pressure: | 67 ÷ 106kPa |
| d. altitude level: | 0 ÷ 3000 m. |

7.3.3 Electrical safety

The insulation properties must be compliant with the standards on electrical safety referred in Table 3.

The RIO must be equipped with an M6 type screw terminal with a double washer made of copper alloy, copper-washed or made of material with equivalent electrical conductivity for the grounding connection.

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IEC 60255-26	Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements
IEC 60255-27	Measuring relays and protection equipment - Part 27: Product safety requirements
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
IEC 61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60664-1	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests
IEC 61810-1	Electromechanical elementary relays - Part 1: General and safety requirements
IEEE C37.2	IEEE Standard Electrical Power System Device Function Numbers and Contact Designations

Table 3 – Standards for the Electrical Safety
7.3.4 Electromagnetic (EMC) requirements

The remote input/output module (RIO) must comply with all the EMC standards referred in Table 4.

IEC 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
IEC 61000-6-5	Electromagnetic compatibility (EMC) - Part 6-5: Generic standards - Immunity for equipment used in power station and substation environment
EN 55011	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement

Table 4 – Standards for the Electromagnetic compatibility (EMC)

By according to the IEC 61000-4-30 and IEC 62749 and EN 50160, the RIO is called to work also in presence of power quality disturbances affecting also the power supply.

The following tables (Table 5 - Table 6 - Table 7 - Table 8) list the levels of immunity to electromagnetic disturbances, as defined in the relevant standards, the device must comply.

Power frequency magnetic field	IEC 61000-4-8	Test Level 5
Damped oscillatory magnetic field	IEC 61000-4-10	Test Level 5
Radiated, radiofrequency, electromagnetic field (including digital radio telephones)	IEC 61000-4-3	Test Level 3 (up to 2 GHz)
Electrostatic discharges	IEC 61000-4-2	Test Level 4

Table 5 – EMC levels for the Enclosure Port

Electrical fast transient/burst	IEC 61000-4-4	Test Level 4
Conducted disturbances, induced by radio-frequency fields	IEC 61000-4-6	Test Level 3

Table 6 – EMC levels for the Grounding Port

Power frequency voltage	IEC 61000-4-16	Test Level 4
Conducted disturbances in the frequency range 0 Hz to 150 kHz	IEC 61000-4-16	Test Level 3
Voltage surges 1.2/50ms – Current surges 8/20ms	IEC 61000-4-5	Test Level 3
Damped oscillatory waves	IEC 61000-4-18	Test Level 3
Ring wave	IEC 61000-4-12	Test Level 3

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Electrical fast transient/burst	IEC 61000-4-4	Test Level 4
Conducted disturbances, induced by radio-frequency fields	IEC 61000-4-6	Test Level 3

Table 7 – EMC levels for the Communication Port

Power frequency voltage	IEC 61000-4-16	Test Level 4
Conducted disturbances in the frequency range 0 Hz to 150 kHz	IEC 61000-4-16	Test Level 3
Voltage surges 1.2/50ms – Current surges 8/20ms	IEC 61000-4-5	Test Level 4
non-repetitive damped oscillatory transients	IEC 61000-4-12	Test Level 3
Electrical fast transient/burst	IEC 61000-4-4	Test Level 4
Conducted disturbances, induced by radio-frequency fields	IEC 61000-4-6	Test Level 3
Voltage dips	IEC 61000-4-29	50% for 0,1 s
Short interruptions	IEC 61000-4-29	100% for 0,05 s
Voltage variations	IEC 61000-4-29	Un + 20% - 40%
Ripple on d.c. input power port	IEC 61000-4-17	10%

Table 8 – EMC levels for the In and Out Port of the d.c. supply
7.3.5 Leds

The inclusion of any kind of display will be rejected. Visual indications must be reduced to the following LEDs:

- a. LED “Power”: to indicate the status of power supply
- b. LED to indicate device status (self-diagnosis):
 - This LED keeps green if no problem is detected.
 - This LED turns red, or turns off, when an internal hardware fault is detected.
- c. Communication LEDs:
 - LEDs to indicate transmission and reception (connection to IED/protection)
- d. LED of each input and output:
 - RIO module must have LEDs to indicate the state of each input and output.

7.3.6 Module power supply

The connector for the power supply must be 2 poles, pitch 5.08 (MMP Connector, see Table 12).

The power supply unit of the device must comply with the requirements in Table 9.

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Auxiliary Voltage (Vaux)	110V (+30%, -60%) - 125V (+30%,-30%) - 220V (+10%,-60%) d.c. Auxiliary Power depends from installation site, during the procurement process (par 7.5.2), the information about the operating conditions will be shared.
Ripple rate for DC power supply	10%
Temperature at maximum load	Max ϑ = Envir. temp. + 25 K
residual ripple at maximum deliverable current	10%
Insensitivity to micro-interruptions	Vaux 0V per 100 ms
Overload 1 s	2 Vn
Maximum RIO consumption	25 W
Starting current	<10A 10ms
Environmental temperature	Par 7.3.2
Cooling	Natural ventilation

Table 9 – Electrical characteristics of the power supply

A self-diagnosis function must be provided in order to continuously check the general efficiency of the power supply and any anomaly or failure detection must be signaled by switching off the "STATUS" LED on the front panel and sending an alarm to the RTU of the HV/MV Substation.

The supply stage must be protected against polarity inversion.

7.3.7 Module Digital Inputs

The connector for the Programmable Digital Inputs must be 15 poles, pitch 3.81 with common polarization as a part of the MMI (Table 12).

The sampling of digital signals must allow the processing of the digital signals as well as the corresponding output on the disturbance-recording file with 1 ms resolution. While typically a change in the status of the Digital Inputs is detected on the rising edge of the signal, it must be possible via programmable functions to detect the variation also on the falling edge of the signal.

The default parameters that must be set in the RIO are in Table 10.

Vaux	ref to par 7.3.6
Voltage Level HI	$\geq 0,75$ Vaux
Voltage Level LO	$\leq 0,6$ Vaux
Input Resistance to Vn	12 k Ω \div 40 k Ω
Power Consumption	$\leq 3,6$ W

Table 10 – Summary of the electrical characteristics of the Digital Inputs
7.3.8 Module Digital Outputs

The connector for the Programmable Digital Outputs must be 12 poles, pitch 3.81, with common polarization; as a part of the MMO (Table 12).

These digital outputs are needed to send commands to other devices.

The relays driving the Digital Outputs must comply with the IEC 61810-1, and must have the electrical characteristics shown in Table 11.

DC supply voltage	Vaux
Permanent current	5 A

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Current breaking capacity L/R=40ms	0,5 A
Number of electric maneuvers	100000
Number of mechanical maneuvers	1000000
Minimum command duration	100 ms (setting)
Maximum command dropout	150 ms (setting)

Table 11 – Summary of electrical characteristics of the Digital Output
7.3.9 RIO Module Pin-Out

In Table 12 the characteristics of the module output pins are shown.

Type	Clamps	Terminal	Function	Voltage
MMP Connector – 2 poles – pitch 5.08				
Power Supply	MMP	1	Power supply	+Vaux
Power Supply	MMP	2	Power supply	-Vaux
MMI Connector – 15 poles – pitch 3.81				
Dig-IN	MMI	1	Programmable	+Vaux
Dig-IN	MMI	2	Programmable	+Vaux
Dig-IN	MMI	3	Programmable	+Vaux
Dig-IN	MMI	4	Programmable	+Vaux
Dig-IN	MMI	5	Programmable	+Vaux
Dig-IN	MMI	6	Programmable	+Vaux
Dig-IN	MMI	7	Programmable	+Vaux
Dig-IN	MMI	8	Programmable	+Vaux
Dig-IN	MMI	9	Programmable	+Vaux
Dig-IN	MMI	10	Programmable	+Vaux
Dig-IN	MMI	11	Programmable	+Vaux
Dig-IN	MMI	12	Programmable	+Vaux
Dig-IN	MMI	13	Programmable	+Vaux
Dig-IN	MMI	14	Programmable	+Vaux
Dig-IN	MMI	15	Common	-Vaux
MMO Connector – 12 poles – pitch 3.81				
Polarization Dig-OUT	MMO	1	Common	+Vaux
Dig-OUT 1	MMO	2	Programmable NO	+Vaux
	MMO	3	Programmable NC	+Vaux
Polarization Dig-OUT	MMO	4	Common	+Vaux
Dig-OUT 2	MMO	5	Programmable NO	+Vaux
	MMO	6	Programmable NC	+Vaux
Polarization Dig-OUT	MMO	7	Common	+Vaux
Dig-OUT 3	MMO	8	Programmable NO	+Vaux
	MMO	9	Programmable NC	+Vaux
Polarization Dig-OUT	MMO	10	Common	+Vaux
Dig-OUT 4	MMO	11	Programmable NO	+Vaux
	MMO	12	Programmable NC	+Vaux

Table 12 – Pin out Remote Module

In the above table, NO is used for Normally Open, instead NC for Normally Closed

7.3.10 Interface for local connection and configuration

The module must be equipped with two SFP ports that will be configured in switch mode.

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In addition, the supplier must provide two SFP modules required to characterize the outputs of the SFP ports. The module must comply the ethernet standard IEEE802.3u. They must be predisposed to have as outputs:

- a. or 100 BASE FX on the LC connector (1310 nm);
- b. or 100 BASE TX on the RJ45 connector with auto-negotiation.

The choice of the SFP modules, whether if with the RJ45 connector or the LC connector will be made according to the specific needs of each country, to cover the following possible configurations:

- a. 2 LC fiber optical outputs;
- b. 1 RJ 45 output and 1 LC fiber optical output.

The choice about the SFP module types will be made during the procurement process (par 7.5.2).

The protocols to be provided for the communication between the MFP panel (Client) and the remote modules (server) are:

- a. IEC61850 (the communication profiles is defined in GSTP104), in which case the module must become an IED of the BUS process network;
- b. The MODBUS (TCP/IP) protocol.

Since the interchangeability (not the only interoperability) between modules and panels must be guaranteed, even between the different manufacturers, no solutions or configurations for the panel-module communication outside or limiting the standard dictated by the protocol in question shall be implemented.

Moreover, the module must be equipped with an IP reset button to return the device to its default conditions.

7.3.10.1 SFTP interface

The RIO module must be able to access uploading/downloading files following SFTP protocol. This service should allow the following services for a user:

- a. Get CID file
- b. Send CID file
- c. Get Events text file
- d. Update firmware

7.3.10.2 Synchronization

Its synchronization will be able to be configured via NTP. It will be a main NTP server IP address. The equipment must have a backup NTP server IP address in case of failure of the main IP address.

7.3.10.3 Sampling and filtering the inputs

The sampling of each digital input will be performed in a frequency equal or greater than 1 KHz (one sample/1ms).

The digital RIO module inputs will have filtering systems that allow balancing the acquisition speed and the stability threshold against transients and electromagnetic disturbances.

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This filtering feature must be user-settable, allowing the configuration of the number of consecutive samples with the same state to stamp a value as “valid”. It must be possible to deactivate this filtering mode.

7.3.11 PLC Function

The PLC logic (16 variables) presented in Figure 5 must be available.

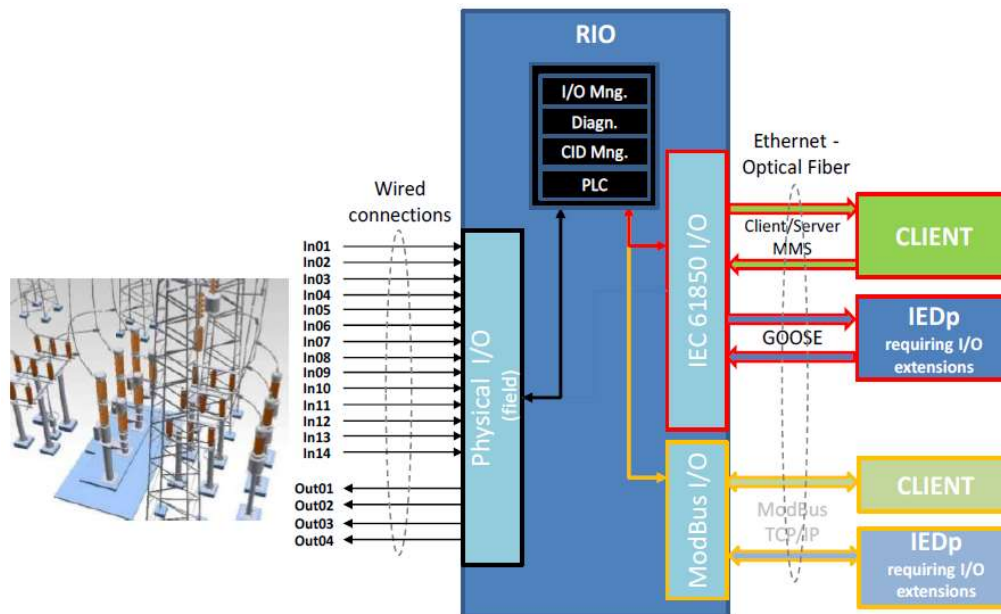


Figure 5 – RIO connectivity, functions and communication

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7.4 Technical conformity assessment

All the requirements stated in this chapter must be respected. ENEL has the right to ask a prototype for any kind of verification testing. These tests must be performed in the provider factory or third-party laboratories (by according to ENEL or relevant standards provision), with no cost participation by ENEL

7.4.1 Overview Technical Conformity Assessment (TCA) Process

The information of this paragraph is only indicative and may change by according with ENEL TCA management; final TCA organization will be discussed during the TCA kick off meeting.

7.4.2 TCA documents

The ENEL technical organization unit in charge of the Technical Conformity Assessment of the equipment will supervise the technical documentation and the execution of the tests required to receive the “Statement of Conformity”, according to GSCG002 prescriptions.

All the technical documentation required during that process shall be in English or in the local language of ENEL technical organization unit in charge of the TCA.

The TCA documents that shall be delivered include:

- a. Type A documentation (Not confidential documents used for product manufacturing and management from which it is possible to verify the product conformity to all technical specification requirements, directly or indirectly);
- b. Type B documentation (Confidential documents used for product manufacturing and management where all product project details are described, in order to uniquely identify the product object of the TCA). This type of documentation must be delivered **only to the ENEL technical organization unit in charge of the TCA**;
- c. TCA dossier (Set of final documents delivered by the Supplier for the TCA);
- d. The supplier shall provide the TCA Dossier on digital support.

7.4.3 Quality

During the TCA, the supplier shall provide the technical documentation listed in ENEL Quality Specification for Electronic Assemblies.

7.4.4 Safety warnings on Plate

The safety warnings required in the plate of the equipment and its components must be written in the local language of the device destination Countries.

7.4.5 Tests required to complete the TCA

This process consists of the following tests cases:

- a. static accuracy/precision tests;
- b. real-world tests cases (in COMTRADE format, supplied by ENEL);
- c. approximately 300 laboratory tests cases.

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The manufacturer must have a valid and product specific homologation before he may supply devices to ENEL. In compliance with this technical specification, the manufacturer must satisfactorily pass, within a maximum period of 6 months after contract award, all the tests described in the following sections.

Once these tests have been successfully completed, an approved manufacturer's RIO will be subject to ad-hoc reception tests.

In addition, ENEL reserves the right to request the repetition of the type tests at any time to ensure that the devices continue to meet the standards achieved by the initial testing and certification programs at the time the contract was awarded.

Type tests will be carried out in Official Laboratories or Laboratories recognized by ENEL, or in the workshops of the manufacturer. ENEL reserves the right to attend any or all of these tests and must be kept informed of the manufacturer's testing programs, schedules and result.

The manufacturer will bear the cost for type tests and for pilot installation tests.

7.4.6 Type test list

- a. Visual examination and control of geometric characteristics,
- b. Out of range power supply tests,
- c. Electromagnetic compatibility tests,
- d. Mechanical compatibility tests,
- e. Climate compatibility tests,
- f. Thermal behavior tests
- g. Performance test
- h. Functional final test.

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

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

7.4.7 Type test level

The test level for each requested environmental compatibility test and the relevant standard, where applicable, is shown in Table 13.

Type	Description	Test Level/Note	Standard
Insulation and EMC	Impulse withstand voltage	Overtoltage category IV	IEC 60664-1
	Dielectric strength	Test Voltage = 2 kV for the circuits in a.c.	IEC 60255-27
	Insulation resistance	≥100 MΩ a 500 V d.c.	IEC 60255-27
	Electrostatic discharges	Contact discharge level 3 Air discharge level 3	IEC 61000-4-2 IEC 60255-26
	Ring wave	Test level 3	IEC 61000-4-12
	Damped oscillatory wave	Test level 3	IEC 61000-4-18 IEC 60255-26
	Electrical fast transient/burst	Test level 4	IEC 61000-4-4

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			IEC 60255-26
	Voltage surges 1.2/50ms – Current surges 8/20ms	Test level 3	IEC 61000-4-5 IEC 61000-4-5/A1
	Power frequency Magnetic field	Test level 5	IEC 61000-4-8
	Damped oscillatory magnetic field	Test level 5	IEC 61000-4-10
	Radiated, radio-frequency, electromagnetic field	Test level 3	IEC 61000-4-3 IEC 60255-26
	Radiated, radio-frequency, electromagnetic field from digital radio telephones	Test level 3	
	Short interruptions on d.c. input power port	level 0% t = 0,05 s	
	Voltage dips on d.c. input power port	level 50% t = 0,1 s	
	Voltage variations on d.c. input power port	Un ± 20%; t = 10 s	
	Power frequency voltage	Test level 3	IEC 61000-4-16
	Conducted disturbances in the frequency range 0 Hz to 150 kHz	Test level 3	IEC 60255-26
	Conducted disturbances, induced by radio-frequency fields	Test level 3	IEC 61000-4-6 IEC 60255-26
Environment	Non powered equipment	Dry heat	(+70 ± 2)°C; duration 16 hour IEC 60068-2-2
		Damp heat	(40±2)°C; (93±3)% RH; duration 4 days IEC 60068-2-78
		Cold	(-25 ± 3)°C; duration 16 hours IEC 60068-2-1
		Change of temperature	TA = -25°C; TB =70°C; duration 3 hour + 3 hour IEC 60068-2-14
	Powered equipment	Dry heat	(+70 ± 2)°C; duration 16 h IEC 60068-2-2
		Damp heat	(40±2)°C; (93±3)% RH; duration 4 days IEC 60068-2-78
		Cold	(-25 ± 3)°C; duration 16 hour IEC 60068-2-1
		Change of temperature	TA = -25°C; TB =70°C; duration 3 hour + 3 hour IEC 60068-2-14
Mechanical	Vibration immunity	Inf. limit 10 Hz Sup.limit 500 Hz Acceleration 10 m/s ² Displacement amplitude 0,075 mm IEC 60068-2-6	
	Broadband random Vibrations	IEC 60068-2-64	

Table 13 – Tests Levels
7.4.8 Acceptance tests

The acceptance tests are those indicated in par.7.4.6 clause a, b and g.

Each device must be accompanied by a report stating that all ATS tests have been concluded successfully. ATS could be certified from a third-party laboratory but must be considered as part of the Technical Conformity Assessment, as described in the GSTX001 Global Standard.

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7.4.9 Visual inspection

It is mandatory to verify the absence of visible manufacturing defects, the highest build-quality and precision of manufacture, the compliance of the enclosure dimensions with those indicated in the present specification, as well as the required degree of IP protection.

7.4.10 Out of range power supply tests

It shall be verified that RIO module is inhibited by feeding the device with the values of the supply voltage that don't provide the proper function.

7.4.11 Immunity tests (electromagnetic compatibility)

The objective of the tests is to verify the correct functioning of RIO module subject to the application of various electromagnetic disturbances.

The interferences shall be applied on the terminal board, with reference to digital inputs.

The procedure for verifying the correct functioning of RIO module during these tests shall be agreed with ENEL.

7.4.12 Component Operating Margin

The thermal behaviour of the RIO device is tested by means of climatic tests. In particular, the temperature used in the dry heat test considers all possible thermal stresses encountered by the device in various installation and operating configurations, including installation at high altitudes (3000 m).

When carrying out climatic tests, the supplier must identify at least 3 to 5 components that are thermally critical. During the tests it must acquire the temperature on the case of these components in order to verify that the maximum temperature prescribed by the manufacturer of the individual component is never exceeded.

It is good practice to place conductive paste between the thermocouple and the component case.

7.4.13 Mechanical tests

The mechanical behavior tests are expressed by the requirements in the following Table 14:

TEST	DESCRIPTION	REMARKS
STATIONARY VIBRATION (SINUSOIDAL)	<ul style="list-style-type: none"> Displacement amplitude (mm): 0,75; Acceleration amplitude (m/s²): 10; Frequency range (Hz): 10-500; Duration: 5 cycles per axis; Fixing points: those of the standard mounting structure, Acceptance criteria: Correct operation of the device during the test. 	<p>Reference standard:</p> <p>EN 60068-2-6 (method Fc)</p>

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STATIONARY VIBRATION (RANDOM)	<ul style="list-style-type: none"> IEC 60068-2-64 (random vibration): Spectrum A.1 "Transportation" – Tab.A2 – Category 2 (IEC 60068-2-64); Duration: 0.5 hours per axis (3 axis); Fixing points: as in standard shipping position without package; Acceptance criteria: No damage of the device. 	Reference Standard: IEC 60068-2-64 (method Fh) Category: 2 (transportation-water, trailers, lorries, in areas with well-developed road systems)										
SHOCK	<ul style="list-style-type: none"> 3 positive impulses and 3 negative impulses for each axis, equal to 15g for 11 ms; Acceptance criteria: <ul style="list-style-type: none"> No damage of the device Correct operation of the device after the test 	Reference Standard: IEC 60068-2-27 Test Ea and guidance: Shock IEC 60721-4-2, table 6 class 2M2 of the standard.										
FREE FALL	<ul style="list-style-type: none"> Test to be performed on the same specimen that passed the SHOCK test; Applied to the [product + packaging]; 2 free falls on a concrete floor height of the fall along the axis perpendicular to the pallet (Z axis) varies in function of the total mass under test: <table border="1" data-bbox="548 1234 1068 1423"> <thead> <tr> <th>Total mass exceeding [Kg]:</th> <th>Height of the fall [cm]¹:</th> </tr> </thead> <tbody> <tr> <td>>30</td> <td>50</td> </tr> <tr> <td>>40</td> <td>40</td> </tr> <tr> <td>>50</td> <td>30</td> </tr> <tr> <td>>100</td> <td>20</td> </tr> </tbody> </table> <p>Acceptance criteria¹:</p> <ul style="list-style-type: none"> No damage of the device; Correct operation of the device after the test. 	Total mass exceeding [Kg]:	Height of the fall [cm] ¹ :	>30	50	>40	40	>50	30	>100	20	Reference Standard: IEC 60068-2-32 Test Ed: Free Fall (procedure 1) IEC 60721-4-2, table 6 class 2M2 of the standard.
Total mass exceeding [Kg]:	Height of the fall [cm] ¹ :											
>30	50											
>40	40											
>50	30											
>100	20											

Table 14 – Mechanical tests
7.4.14 Climatic Tests

The referring levels of the single group of tests are indicated in the Table 13.

The procedures for verifying the correct operation of RIO module during these tests shall be agreed with ENEL

¹ An annex document will be provided for a detailed description of the acceptance methods for SHOCK and FREE FALL tests.

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7.4.15 Performance system

Performance system must be tested getting times acceptable for control and protection system.

The figure below represents an example of test environment to get minimum time for required performance.

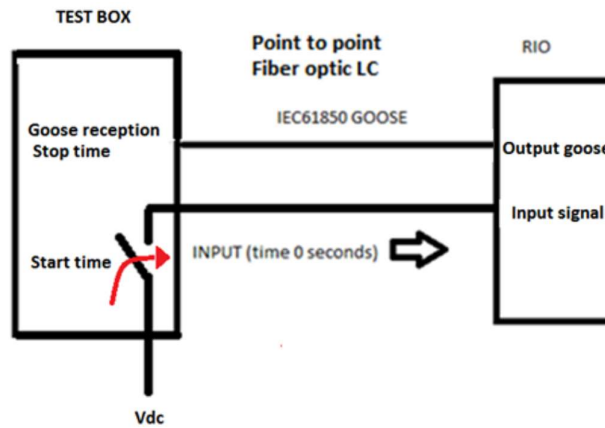


Figure 6 – Performance System

A test document will be issued. Time performance must be less or equal to 20 ms. This time must not be higher in any case.

The same behavior is required in reverse mode:

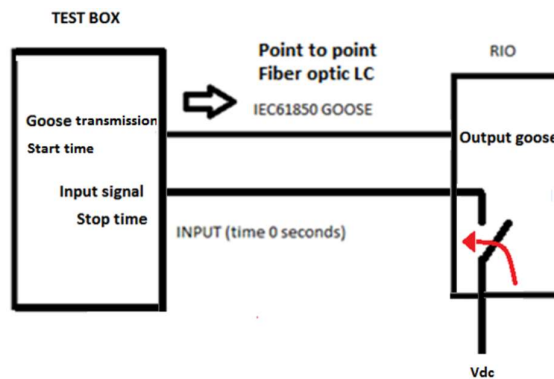


Figure 7 – Performance System (reverse mode)

The same requirement must be required within a LAN connection through switch, shared with other equipments that are using IEC61850 or other protocols. The same tests and the same time performance must be obtained, despite the traffic generated.

Traffic generator consists of 3 RIO modules connected to the LAN, with a continuous change of 1 input signal every 15 ms in everyone.

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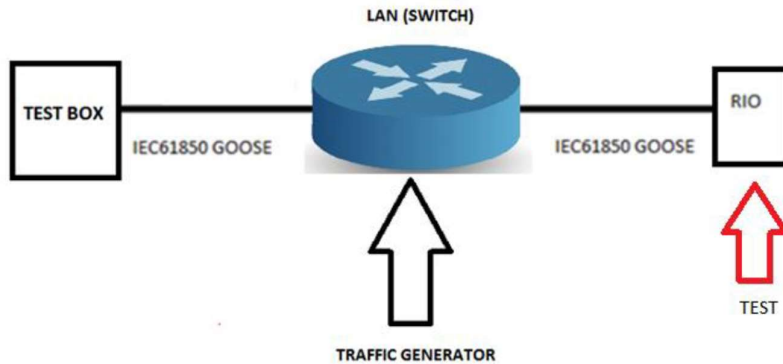


Figure 8 – Performance System (traffic generator)

The same behavior is required within a RIO LAN connection. The RIO module won't have any more connections. The same tests and the same time performance must be obtained.

The RIO LAN will have a continuous change of 1 input signal every 15 ms.

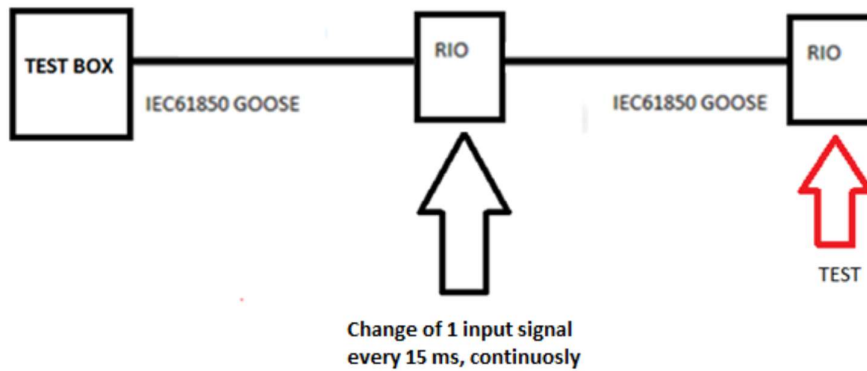


Figure 9 – Performance System (RO LAN)

7.4.16 Functional final test

In order to check that RIO module operates regularly after the execution of all the prescribed type tests, they shall be repeated, with the characteristics of the acceptance tests, those indicated in Par.7.4.6. clause a, b and g.

7.4.17 Pilot installation tests

In a substation chosen by ENEL will be installed one RIO guaranteed by the manufacturer in order to evaluate its behavior and stability in a real environment.

The manufacturer will configure the device and will collaborate in the commissioning with all the necessary modifications to enable all the required functionalities and completely integrate the RIO in the substation.

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7.4.18 Individual tests

These tests will consist of the visual checking of:

- a. Terminal blocks for the power supply, Digital Inputs and Outputs, Current and Voltage Inputs, communication ports/channels, etc.. For these tests it will be necessary to provide:
 - a) Photo(s) of the front panel of the device,
 - b) Photo(s) of the rear of the device.
- b. Identification label with the characteristics of the device (including complete model and firmware version).

The device will also be powered on to verify (via its keyboard/display) that the information about its identifying characteristics match those registered in the homologation process.

7.4.19 Certifications and self-certifications

About the compliance of all the requirements/standards recalled in this GS, a certificate or selfcertificate must be provided.

Regional laws or standards may require additional certifications or self-certifications.

Certifications and self-certifications must be made according to the relevant standards or laws (including the template format).

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7.5 Miscellaneous

This chapter include further requirements, recommendations and additional information.

7.5.1 Required documentation

The following documents (in pdf format) must be provided:

- a. RIO data sheet with snapshots;
- b. installation, operation and maintenance manuals, with instructions on the installation and interfacing procedures;
- c. administrator's manual, for proper integration of RIO into communication and IT networks (this document should describe any network service the RIO is supplying);
- d. list of pre-installation checks to ensure that the components have been delivered correctly;
- e. quick installation and set-up guide;
- f. installation and one-wire diagrams (also in DWG/DXF formats);
- g. all software need to RIO operation;
- h. parts list;
- i. required but not included parts list;
- j. recommended Tool List;
- k. electrical schematics;
- l. mechanical drawings;
- m. spare parts list;
- n. maintenance procedures;
- o. troubleshooting guide;
- p. component specification literature.

This document must be made according to IEC 61010-1 and they must be approved by ENEL.

7.5.2 Clarification during procurement process

By summarizing, during the procurement process the following clarification will be provided to the supplier:

- a. Choice about the enclosure (par. 6.2);
- b. Choice about the STP modules (par 7.3.10);
- c. Information about the auxiliary power supply level (Table 9);
- d. Language for embedded sw and documentations;
- e. Details about unique serial identifier, serial code and other labeling.

7.5.3 Procurement management

The information of this paragraph are only indicative and may change by according with ENEL procurement management; entrusted ENEL units will issue final procurement approach.

Within 30 days of receiving the present specification, the manufacturer must send the following documentation, in English, along with the technical proposal:

- a. Dimensions and weight of the RIO,

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- b. General description of functions, functional schema, wiring diagrams, power consumption requirements, errors limit, etc. The description must also include the algorithms used for the treating and filtering signals and the number of samples per cycle,
- c. Photos or detailed drawings of the RIO,
- d. Lists of references,
- e. Exceptions to this specification,
- f. Instructions for the installation, adjustment and commissioning of the RIO,
- g. Examples of adjustment and configuration,
- h. Instructions for checking and maintenance.

If the manufacturer fails to provide any or all of the above information within 30 days of receipt of this specification, he will be disqualified as supplier, for ENEL, of the product standardized in this Technical Specification.

7.5.4 Receipt of material

The information of this paragraph are only indicative and may change by according with ENEL product management; final procurement approach will be issued by entrusted ENEL units.

7.5.5 Reception tests

Part of the process of accepting delivery of a manufacturer's devices will include the proof of having successfully passed previously performed acceptance tests (Par. 8.1.7).

Then, the reception tests will be carried out in Official Laboratories or Laboratories accredited by ENEL, or in the workshops of the manufacturer. ENEL reserves the right to attend any or all of these tests and must be kept informed of the manufacturer's testing programs, schedules and results. If the assistance of an ENEL representative is not available, the provisional reception procedure will be conducted when tests protocols are received.

The reception will be deemed as completed once the reception tests have been carried out and the material has been delivered with the associated tests protocols. The tests are the ones mentioned in Par.8.3 and will be performed before any order is delivered; the associated testing protocols will be presented to ENEL for approval. The results obtained in these individual tests must be indicated in a report; every device must be accompanied by this report.

In the event the documentation has undergone modifications with reference to the actual devices delivered, the manufacturer must provide the updated documentation before the reception procedure will be deemed to have been completed.

7.5.6 Warranty

The manufacturer will commit to providing a guarantee of the IEDs for a minimum period of 24 months, which will commence immediately following a successful reception; final procurement approach will be issued by entrusted ENEL units.

The guarantee will be legally binding for any device/component faults and/or defects that occur within the guarantee period: accordingly, the devices and/or components will be replaced. Further, the manufacturer will undertake to continue, free of charge, the software and firmware development and provide the updates to ENEL for the lifetime of the devices.



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If during the contract term the manufacturer fails to address in a prompt and timely manner any functional anomalies or defects in the device behavior or manufacture (hardware or firmware), ENEL reserves the right to block the necessary positions on the contract, staged payments and/or alter the payment schedules as necessary until the anomalies have been resolved to the complete satisfaction of ENEL.

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8. ANNEX

8.1 RIO GOOSE message sent by the RIO module

The GOOSE messages sent by the RIO module will have the following information, to set in the device:

- a. Destination address GOOSE: 01-0C-CD-01-XX-YY
- b. VLAN-PRIORITY
- c. VLAN-ID
- d. Control Block Reference
- e. Time Allowed to Live (msec)
- f. (T0): It is considered that the default repetition time must be 2000 ms, when there is no change (it is a GOOSE setting).
- g. Dataset Reference:
- h. GOOSEID

If no GOOSE message is received within a three seconds period, all its signals will be set to zero and after that, the subscription will be deactivated until the GOOSE is available again.

The general criterion for sending data will consist in sending two variables, first its state and second its quality.

Any change in the state or the quality of a signal will cause the sending of a new GOOSE.

There are two types of data to be sent by the RIO module:

- i. Its internal state.
- j. The state of its inputs and outputs.

The following table presents the structure of the message body including its data and its possible values:



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General state of the RIO	STATE	BOOLEAN:	TRUE/FALSE	TRUE- correct RIO state FALSE- alarm RIO state
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 1	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 2	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 3	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 4	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 5	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 6	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 7	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 8	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 9	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 10	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 11	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 12	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 13	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
INPUT 14	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated input FALSE- Disabled input

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	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
OUTPUT 1	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated output FALSE- Disabled output
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
OUTPUT 2	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated output FALSE- Disabled output
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
OUTPUT 3	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated output FALSE- Disabled output
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
OUTPUT 4	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated output FALSE- Disabled output
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850

Table 15 – Message body (message sent by the RIO)

Each RIO module will send a GOOSE message with its internal state and the state of its inputs and outputs.

Activation and deactivation of the RIO digital outputs will be done by subscription to GOOSE messages sent by the IED of the system subscribed to a particular RIO.

When a signal from a GOOSE message arrives with a bad quality, it will be rejected and treated as if the signal was turned off, regardless of the state of arrival.

The structure of the message body must be the following:

OUTPUT 1	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated output FALSE- Disabled output
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
OUTPUT 2	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated output FALSE- Disabled output
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
OUTPUT 3	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated output FALSE- Disabled output
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850
OUTPUT 4	STATE	BOOLEAN:	TRUE/FALSE	TRUE- Activated output FALSE- Disabled output
	QUALITY	BITSTRING:	0000000000000000	Quality defined in IEC 61850

Table 16 – Message body (message sent by the RIO)