

Subject: Global Infrastructure and Networks - GSCH014 Link Boxes for High Voltage Cable Systems.

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

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THE HEAD OF NETWORK COMPONENTS
Maurizio Mazzotti

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1. DOCUMENT AIMS AND APPLICATION AREA

The aim of this document is to provide technical requirements for the supply of link boxes for high voltage cable systems to be used on transmission lines of the Enel Group Companies listed below:

Country	Distribution Company
Argentina	Edesur
Brasil	Enel Distribuição Rio Enel Distribuição Ceará Enel Distribuição Goiás Enel Distribuição São Paulo
Chile	Enel Distribución Chile
Colombia	Codensa
España	e-distribución redes digitales
Italia	e-distribuzione
Perú	Enel Distribución Perú
Romania	Enel Distributie Banat Enel Distributie Dobrogea Enel Distributie Muntenia

Table 1 - Distribution Companies

1.1 RELATED 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
1	22/12/2021	Issuing of "Global Infrastructure and Networks - GSCH014 Link Boxes for High Voltage Cable systems" technical specification

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3. UNITS IN CHARGE OF THE DOCUMENT

Responsible for drawing up the document:

- Global Infrastructure and Networks: Engineering and Construction / Components and Devices Design / Network Components.

Responsible for authorizing the document:

- Global Infrastructure and Networks: Head of Network Components unit.
- Global Infrastructure and Networks: Head of Quality unit.

4. REFERENCES

- Code of Ethics of Enel Group;
- Enel Human Right Policy;
- The Enel Group Zero Tolerance of Corruption (ZTC) Plan;
- Organization and management model as per Legislative Decree No. 231/2001;
- RACI Handbook Infrastructure and Networks no. 06;
- Enel Global Compliance Program (EGCP);
- Integrated Policy of Quality, Health and Safety, Environment and anti-Bribery;
- Policy n. 332 Global Infrastructure and Networks Design and construction HV lines guidelines ;
- ISO 9001:2015 - Quality Management System - Requirements;
- ISO 14001:2015 - Environmental Management System - Requirements and user guide;
- ISO 45001:2018 - Occupational Health and Safety Management System - Requirements and user guide;
- ISO 50001:2018 - Energy management systems - Requirements with guidance for use;
- ISO 37001:2016 - Anti-bribery Management System - Requirements with guidance for use;
- ISO 7000 - Graphical symbols for use on equipment;
- IEC 60417 - Graphical symbols for use on equipment;
- IEC 60840 - Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um=36kV) up to 150kV (Um=170kV) test method and requirements
- IEC 62067 - Power cables with extruded insulation and their accessories for rated voltages above 150 kV (Um=170 kV) up to 500 kV (Um=550 kV) - Test methods and requirements
- IEC 60230 - Impulse tests on cables and their accessories
- IEC 60068-2-75 - Environmental testing - Part 2-75: Tests - Test Eh: Hammer tests

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- IEC 60099-4 - Surge arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems
- IEC 60529 - Degrees of protection provided by enclosures (IP Code)
- EN 50102 - Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK Code)

5. ORGANIZATIONAL PROCESS POSITION IN THE PROCESS TAXONOMY

Value Chain/Process Area: Engineering & Construction

Macro Process: Devices and Components Development

Process: Standard Catalog Management

6. DEFINITIONS AND ACRONYMS

Acronym and Key words	Description
Technical Conformity Assessment (TCA)	A “conformity assessment” ^a with respect to “specified requirements” ^b consists in functional, dimensional, constructional and test characteristics required for a product (or a series of products) and quoted in technical specifications and quality requirements issued by Enel Group distribution companies. This also includes the verification of conformity with respect to local applicable regulation and laws and possession of relevant requested certifications

7. DESCRIPTION

This standard specifies the functional and construction characteristics and test requirements that must be accomplished by the three-phase sectioning boxes to be used for grounding the screens of the high voltage cables at the sectioned joints and terminations installed in the system. It applies to the boxes used for the earth connection, directly or via arrester, of the cable systems with rated voltage above 36 kV and in detail for U_m^c equals to 52 kV, 72,5 kV, 145 kV, 170 kV and 245 kV.

^a Definition 2.1 of ISO/IEC 17000

^b Definition 3.1 of ISO/IEC 17000

^c U_m : maximum r.m.s. power-frequency voltage between any two conductors for which cables and accessories are designed. It is the highest voltage that can be sustained under normal operating conditions at any time and at any

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This standard replaces all the local standards used up to now by all the Distribution Companies, as long as local regulation allows it.

7.1 LIST OF COMPONENTS

This standard includes link boxes for the earthing of bonding cables arriving from joints and terminals of high voltage cable systems. The list of link boxes with the main requirements, which is an integral part of the present document, is reported in the GS Type Code Lists on Annex B, and their relationship with country codes is reported on the Common List on Annex C. In **Table 2** the list of link boxes is shown.

GSCH014 Type Code	For use with	Bonding cables	Type of installation	Electrical scheme
GSCH014/01	Terminals	3 Single-core cables	Indoor / outdoor	Scheme 1: Direct grounding
GSCH014/02	Terminals	3 Single-core cables	Indoor / outdoor	Scheme 2: Grounded with SVL
GSCH014/03	Joint	3 Coaxial-core cables	Underground	Scheme 3: Direct grounding
GSCH014/04	Joint	3 Coaxial-core cables	Underground	Scheme 4: Grounded with SVL
GSCH014/05	Joint	3 Coaxial-core cables	Underground	Scheme 5: Direct grounded and SVL
GSCH014/06	Joint	3 Coaxial-core cables	Underground	Scheme 6: Cross bonded
GSCH014/07	Joint	3 Single-core cables	Underground	Scheme 1: Direct grounding
GSCH014/08	Joint	3 Single-core cables	Underground	Scheme 2: Grounded with SVL

Table 2 – List of GSCH014 Type Codes for link boxes

7.2 DESIGN AND MANUFACTURE

Link boxes will be designed for installation in pits or vaults and on structures or poles.

They will have an enclosure prepared to house the shield connections, the bonding cables, the earthing cable, and the sheath voltage limiters (SVL). All type of link boxes will receive three bonding cables (single core or coaxial core) and one single core grounding cable, and all of them must be sealed to prevent the ingress of water inside the link box.

Link boxes will be accessible by means of a specific tool to allow the performance of test and measurement associated to the commissioning and periodic maintenance of the cable system. To facilitate these operations, they will not contain any type of fillings and the connections of bonding cables with each other and with the earthing cable will be made with removable plates.

point in a system. It excludes temporary voltage variations due to fault conditions and the sudden disconnection of large loads

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The design of the enclosure for outdoor use should also incorporate an interlock system that provides entry only with an appropriate key to prevent inadvertent or improper connection settings.

They will be provided with an insulating and transparent screen that prevents accidental contacts to live elements when the link box is open, so that the class protection is IP2X with the lid open according to IEC 60529.

In a visible place, they will have a label showing the identification of the line to which they belong and the connection scheme. On the outside, they will be identified by the voltage danger symbol according to IEC 60417 or ISO 7000.

7.2.1. Enclosure

The enclosure will be made of stainless steel with its exterior protected with anticorrosive paint to provide a life expectancy greater than ten years without sign of deterioration due to corrosion.

It may contain the effects of thermal or electrical failure of any of the elements housed in them without causing damage to nearby external elements.

In addition, it must always be connected to ground by means of a connection independent of the grounding of the elements contained within.

Protection class against mechanical impacts will be IK10 according to EN 50102

Link boxes designed for underground use will fulfill the requirements of IP68 class protection according to IEC 60529, and the lid must be fixed to the body of the enclosure with stainless steel screws.

Those designed for indoor or outdoor use will fulfill IP55 class protection and the lid has to be a practicable cover closed with a security padlock.

Maximum dimension of the enclosures will be 850 x 680 x 400 mm.

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7.2.1. Electrical schemes

Electrical schemes of link boxes will be one of the indicated on **Table 3** below:

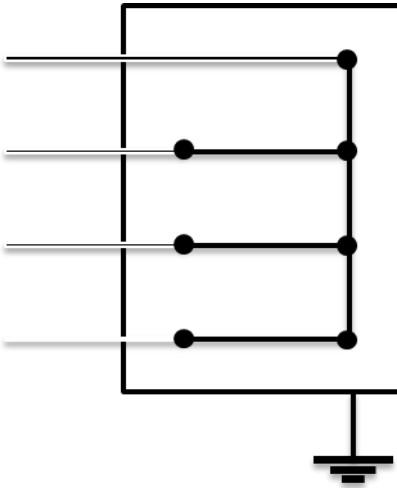
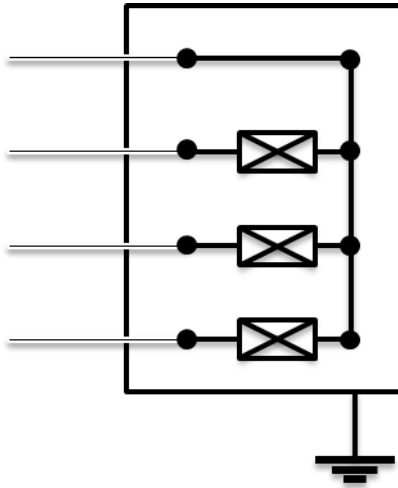
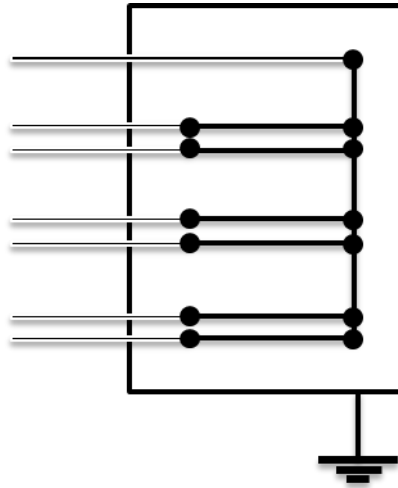
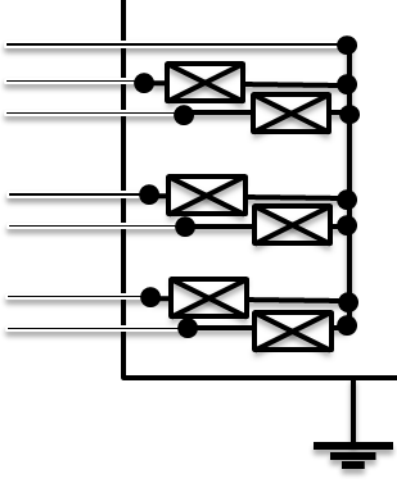
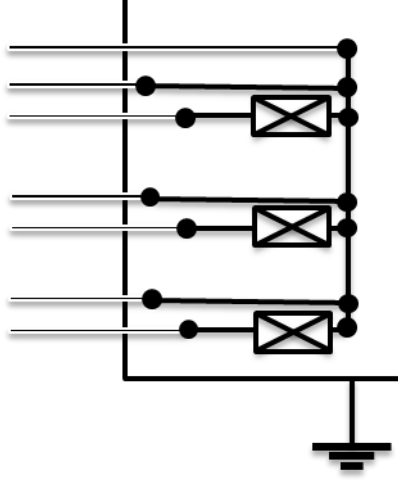
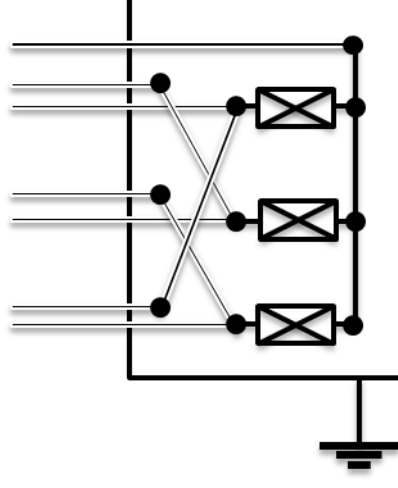
 <p>Scheme 1: DG Direct grounding of three single-core cables</p>	 <p>Scheme 2: 3SVL Three single-core cables grounded with SVL</p>	 <p>Scheme 3: DG Direct grounding of three coaxial-core cables</p>
 <p>Scheme 4: 6SVL Three coaxial-core cables grounded with SVL</p>	 <p>Scheme 5: DG+3SVL Three coaxial-core cables, direct grounded and with SVL</p>	 <p>Scheme 6: CB Three coaxial-core cables cross bonded</p>

Table 3 Electrical schemes

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7.2.2. Electrical specifications

The insulation between the links in all link boxes, including those without SVLs, shall be capable of withstanding the following voltages:

- 25 kV DC withstand voltage for 1 minute.
- 10 kV power frequency withstand voltage for 1 minute.
- 37,5 kV lighting impulse withstand voltage from links to earth.
- 75 kV lighting impulse withstand voltage between links.

All the elements that could be subject to current transportation shall be capable of withstanding a shorth circuit current of 63 kV for 1 seg.

7.2.3. Sheath Voltage Limiters

Sheath voltage limiters included on link boxes must be metal-oxide surge arrester with polymeric housing according to IEC 60099-4 with the appropriate rated voltage up to 10 kV according with the requirements of the cable system.

They will fulfill the following characteristic:

Residual voltage: ≤ 20 kV

Rated discharge current (8/20 μ s): ≥ 10 kA

Any other requirements according to Enel Standard GSCC016.

7.2.4. Cable ranges

Link boxes will be suitable to be used with bonding and earthing cables with the following minimum dimensional ranges:

- Single core cable cross section: from 50 mm² up to 400 mm²
- Coaxial core cable cross section: from 50+50 mm² up to 400+400mm²

Nevertheless, other cross sections than those indicated herein could be specified on specific orders.

7.3 LINK BOX DESIGNATION

Designation of the link box is formed by the following terms:

- “ENEL GSCH014”
- the code “LB-” indicating Link Box.
- a character representing the type of installation (U: for underground; O: for outdoor),
- a character representing the type of bonding cables (-SC: for single core cables; -CC: for coaxial core cable),

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- a character representing the type of grounding scheme as indicated on **Table 3**.

Designation example for joint GSCH014/01 is:

ENEL GSCH014 – LB – O-SC-DG

7.4 CONDITIONS OF SUPPLY

The supply of the link boxes will include the sheath voltage limiters and all the small material necessary for their correct installation.

They shall be provided with a complete set of assembly instructions together with drawings of the box.

The instructions should include lists of all the components of the link box including consumable materials, the specified assembly tools and the health and safety precautions.

For every step of the assembly instructions there must be available a video where it is shown that assemble step. Those videos could be storage on-line on the website of the supplier and referenced by a QR Code.

All documentation must be provided in the language of the country destiny of the supply.

Link boxes shall be securely packaged to prevent any damage during loading, transport, storage and installation.

The packaged shall be suitable for sea transportation.

On the packing there must be marked the following information:

- a) GS Type Code and reference of this standard.
- b) Manufacturer or brand.
- c) Supplier product designation as indicated on TCA.
- d) Order number or purchase order.
- e) Year and month of manufacture.
- f) Weights, tare and net.

7.5 TESTS

These tests shall be accomplished according to the requirements of this standard and those of Technical Conformity Assessment (TCA) procedures.

7.5.1. Routine Tests

i) Visual inspection

It will be checked that the link box is that indicated on TCA documentation, that does not present any defects to the naked eye, that its dimensions correspond to those indicated in the drawings and that the plates and arresters can be properly assembled and disassembled.

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It will be verified that the enclosure finish and thickness are right.

ii) Power frequency voltage routine test

Test method: A voltage of 10 kV will be applied for 1 minute to each of the cable entry terminals, with the other terminals connected to ground.

Requirements: No breakdown of the insulation nor superficial discharge shall occur.

iii) Contact resistance measurement

Test method: Measurements of the contact resistances of the different elements of the box will be made with a digital micrometer.

Requirements: < 10 $\mu\Omega$

7.5.2.Type Tests

Type tests indicated below will be carried out successively on the same link box that will be completely assembled including plates, sheath voltage limiters and connection cables. The assembly will be carried out following the manufacturer's assembly instructions supplied with the equipment and the use of any element not indicated in those instructions is not allowed.

Some plates or voltage limiters will be disassembled just to carry out the tests that explicitly indicate it.

i) Hammer test

Requirements: Protection class IK10 according to EN 50102 against mechanical impacts

Test method: vertical hammer test according to IEC 60068-2-75 clause 7

Impact energy value: 20 J

Number of impacts: 5 impacts distributed uniformly along the side of the enclosure on every side of the enclosure

Acceptance criteria: After the test, there is not a detectable deformation of the enclosure.

ii) Test for protection against access to hazardous parts (link box open)

Requirements: IEC 60529 clause 12 for protection class IP2X.

Test method: IEC 60529 clause 12.

iii) Test for protection against access to hazardous parts (link box closed)

Requirements: IEC 60529 clause 12 for protection class IP5X or IP6X according link to box type

Test method: IEC 60529 clause 12.

iv) Dust test

Requirements: IEC 60529 clause 13 for protection class IP5X or IP6X according to link box type

Test method: IEC 60529 clause 13.4

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v) Test for protection against water

Requirements: IEC 60529 clause 14 for protection class IPX5 or IPX8 according to link box type

Test method:

Water jets test according IEC 60529 clause 14.2.5 for link boxes IP55

Water immersion test according IEC 60529 clause 14.2.8 for link boxes IP68

Test condition for water immersion test (link boxes IP68):

Highest point of the enclosure has to be placed 1 m below the water surface.

The temperature of water will follow 20 cycles of 24 hour each like the one depicted on **Figure**

1 with the following requirements:

Maximum temperature: 45 (-0/+5) °C

Minimum temperature: 10 (-5/+0) °C

Difference between maximum temperature and minimum temperature: $\geq 20^{\circ}\text{C}$

Time at maximum temperature: ≥ 8 hours

Time to change temperature from maximum to minimum and vice versa: ≤ 2 h.

Time at minimum temperature: ≥ 8 hours

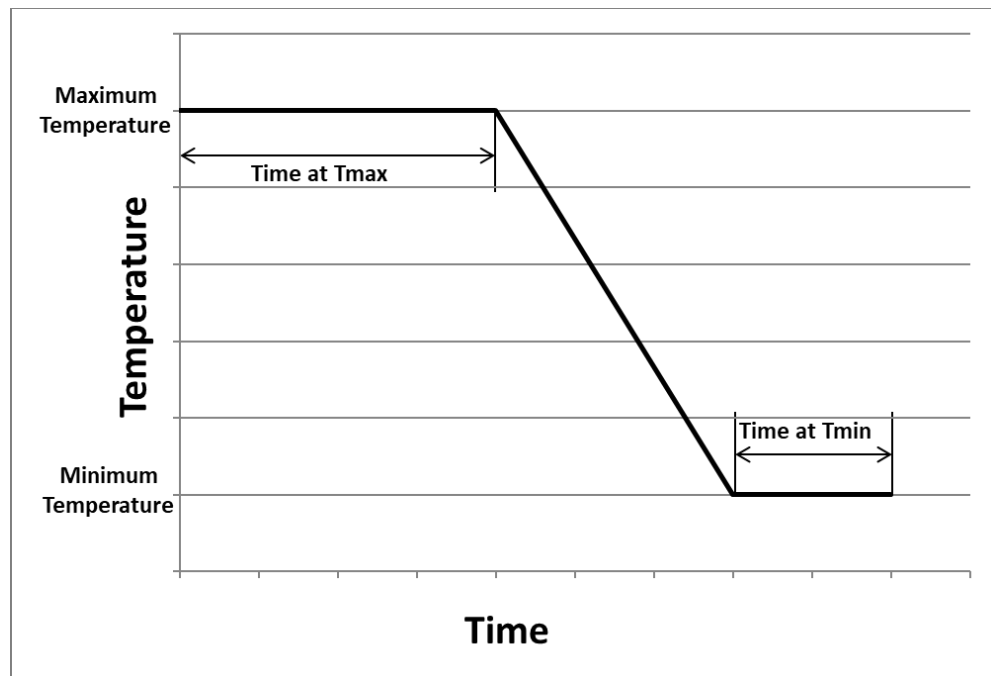


Figure 1 Water immersion test cycle

Acceptance criteria: After the test, there is not water presence inside the box. This condition could be verified after the CD withstand voltage test in point vi)

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vi) DC withstand voltage test

To be performed with a minimum delay after the test for protection against water. For link boxes with IP68 with the link box immersed in water at ambient temperature, if possible. In any case following recommendations from IEC60840 Annex H.3.

Requirements: Withstand without failure or flashover.

Test method: 25 kV applied during 1 minute between every bonding cable terminal and all the other cable terminals and the enclosure of the link box. When necessary connection plates will be dismantled.

vii) Lightning impulse voltage test

Requirements: Withstand without failure or flashover

Test method: With SVL removed, 10 positive and 10 negative voltage impulses according to IEC60230 applied between every bonding cable terminal and all the other cable terminals and the enclosure of the link box. Values of peak voltage are:

- Bonding cable terminals against grounding cable terminal and earth: 37.5 kV
- Bonding cable terminals against each other: 75 kV

viii) Short circuit test

Requirements: No signs of deterioration inside the link box.

Test method: With the box in the operating configuration, each plate and each connection to earth (excluding the SVL if provided) must be crossed by a current of 63 kA during 1 second.

ix) Test under conditions of arcing due to internal fault

Just in link boxes including SVLs (GS type codes: GSCH014/02, GSCH014/04, GSCH014/05, GSCH014/06 and GSCH014/08).

With the box fully mounted in the operating configuration, including cables and SVL.

Requirements: There are no projections of parts of the link box nor holes on the external enclosure.

Test method:

Link box prestressed by the short circuit test described in point viii).

Arc initiation by a copper wire with diameter 0.5 mm between the central cable and earth.

Fault current: 40 kA during 0.1 second

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8. ANNEX

ANNEX A – TECHNICAL CHECK LIST

The following chart indicates the minimum technical information that suppliers shall provide in technical offer during tenders and as part of the TCA Type A documentation:

Item	Description	Unit	Required values	Offered values
1	GENERAL INFORMATION			
1.1	Supplier Name	-		
1.2	Supplier CUI			
1.3	Factory	-		
1.4	Location of factory	-		
2	MAIN FEATURES			
2.1	ENEL Distribution Company and Country of supply	-		
2.2	Country Code	-		
2.3	GS Type Code	-		
2.4	Enel designation	-		
2.5	Type of installation (underground / outdoor)	-		
2.6	Type of mounting	-		
2.7	IP Code (link box closed)	-		
2.8	IP Code (link box open)	-		
2.9	IK Code	-		
2.10	Supplier product designation	-		
3	ELECTRICAL CHARACTERISTIC			
3.1	Reference scheme	-		
3.2	DC voltage test (1 min)	-		
3.3	Power frequency voltage test (1 min.)	-		
3.4	Lighting impulse voltage test links to earth	[kV]		
3.5	Lighting impulse voltage test between links	[kV]		
3.6	Maximum short circuit withstand current in links (1 s)	[kA]		
3.7	Internal power arcing test (0,1 s)	[kA]		
3.8	Contact resistance	[μΩ]		
3.9	Surge arrester rating	[kV]		
4	ENCLOSURE			
4.1	Type			
4.2	Material			

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Item	Description	Unit	Required values	Offered values
4.3	Dimensions (Hight - Width - Depth)	[mm]		
4.4	Thickness of housing	[mm]		
4.5	Thickness of cover	[mm]		
4.6	Material of insulating screen	-		
4.7	Thickness of insulating screen	[mm]		
4.8	Surface treatment	-		
4.9	Type of sealing for cables entries	-		
4.10	Type of insulation support	-		
5	BONDING CABLES			
5.1	Type of bonding cable	-		
5.2	Maximum cross section	-		
5.3	Minimum conductor diameter	-		
5.4	Minimum conductor diameter	[mm]		
5.5	Minimum overall diameter of bonding cable	[mm]		
5.6	Maximum overall diameter of bonding cable	[mm]		
6	EARTHING CABLE			
6.1	Type of earthing cable	-		
6.2	Maximum cross section	-		
6.3	Minimum conductor diameter	-		
6.4	Minimum conductor diameter	[mm]		
6.5	Minimum overall diameter of earthing cable	[mm]		
6.6	Maximum overall diameter of earthing cable	[mm]		
7	ADDITIONAL FEATURES			
7.1	Total weight	[kg]		
7.2	Maximum storage time	[months]		
7.3	Estimated time of installation	[h]		
7.4	Expected service life after installation	[years]		
8	TCA INFORMATION			
8.1	TCA Available	[Yes/No]	Informative	
8.2	TCA Code	-	Informative	
9	OBSERVATION			
9.1	Any exception to what is required on GSCH014	-		
9.2	Additional comments	-		

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ANNEX B – GLOBAL TYPE CODES FOR LINK BOXES

GS Type Code	Denomination	Type of installation	IP Code (close/open)	Electrical scheme
GSCH014/01	LB-O-SC-DG	Indoor / outdoor	IP55/IP2X	Scheme 1: Direct grounding
GSCH014/02	LB-O-SC-3SVL	Indoor / outdoor	IP55/IP2X	Scheme 2: Grounded with SVL
GSCH014/03	LB-U-CC-DG	Underground	IP68/IP2X	Scheme 3: Direct grounding
GSCH014/04	LB-U-CC-6SVL	Underground	IP68/IP2X	Scheme 4: Grounded with SVL
GSCH014/05	LB-U-CC-DG+3SVL	Underground	IP68/IP2X	Scheme 5: Direct grounded and SVL
GSCH014/06	LB-U-CC-CB	Underground	IP68/IP2X	Scheme 6: Cross bonded
GSCH014/07	LB-U-SC-DG	Underground	IP68/IP2X	Scheme 1: Direct grounding
GSCH014/08	LB-U-SC-3SVL	Underground	IP68/IP2X	Scheme 2: Grounded with SVL

ANNEX C – COMMON LIST

COMMON LIST				22/12/2021
GS Type Code	Designation	Distribution Company and Country	Country Code	TAM Description
GSCH014/01	LB-O-SC-DG	Enel Argentina		
GSCH014/02	LB-O-SC-3SVL	Enel Argentina		
GSCH014/03	LB-U-CC-DG	Enel Argentina		
GSCH014/04	LB-U-CC-6SVL	Enel Argentina		
GSCH014/05	LB-U-CC-DG+3SVL	Enel Argentina		
GSCH014/06	LB-U-CC-CB	Enel Argentina		
GSCH014/07	LB-U-SC-DG	Enel Argentina		
GSCH014/08	LB-U-SC-3SVL	Enel Argentina		
GSCH014/01	LB-O-SC-DG	EDI Italy		
GSCH014/02	LB-O-SC-3SVL	EDI Italy		
GSCH014/03	LB-U-CC-DG	EDI Italy		
GSCH014/04	LB-U-CC-6SVL	EDI Italy		
GSCH014/05	LB-U-CC-DG+3SVL	EDI Italy		
GSCH014/06	LB-U-CC-CB	EDI Italy		
GSCH014/01	LB-O-SC-DG	Enel Romania		
GSCH014/02	LB-O-SC-3SVL	Enel Romania		
GSCH014/03	LB-U-CC-DG	Enel Romania		
GSCH014/04	LB-U-CC-6SVL	Enel Romania		
GSCH014/05	LB-U-CC-DG+3SVL	Enel Romania		
GSCH014/06	LB-U-CC-CB	Enel Romania		
GSCH014/01	LB-O-SC-DG	EDRD España		
GSCH014/02	LB-O-SC-3SVL	EDRD España		
GSCH014/03	LB-U-CC-DG	EDRD España		
GSCH014/04	LB-U-CC-6SVL	EDRD España		
GSCH014/05	LB-U-CC-DG+3SVL	EDRD España		

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COMMON LIST				22/12/2021
GS Type Code	Designation	Distribution Company and Country	Country Code	TAM Description
GSCH014/06	LB-U-CC-CB	EDRD España		
GSCH014/01	LB-O-SC-DG	Enel Brazil		
GSCH014/02	LB-O-SC-3SVL	Enel Brazil		
GSCH014/03	LB-U-CC-DG	Enel Brazil		
GSCH014/04	LB-U-CC-6SVL	Enel Brazil		
GSCH014/05	LB-U-CC-DG+3SVL	Enel Brazil		
GSCH014/06	LB-U-CC-CB	Enel Brazil		
GSCH014/01	LB-O-SC-DG	Enel Chile		
GSCH014/02	LB-O-SC-3SVL	Enel Chile		
GSCH014/03	LB-U-CC-DG	Enel Chile		
GSCH014/04	LB-U-CC-6SVL	Enel Chile		
GSCH014/05	LB-U-CC-DG+3SVL	Enel Chile		
GSCH014/06	LB-U-CC-CB	Enel Chile		
GSCH014/01	LB-O-SC-DG	Enel Perú		
GSCH014/02	LB-O-SC-3SVL	Enel Perú		
GSCH014/03	LB-U-CC-DG	Enel Perú		
GSCH014/04	LB-U-CC-6SVL	Enel Perú		
GSCH014/05	LB-U-CC-DG+3SVL	Enel Perú		
GSCH014/06	LB-U-CC-CB	Enel Perú		
GSCH014/01	LB-O-SC-DG	Enel Colombia		
GSCH014/02	LB-O-SC-3SVL	Enel Colombia		
GSCH014/03	LB-U-CC-DG	Enel Colombia		
GSCH014/04	LB-U-CC-6SVL	Enel Colombia		
GSCH014/05	LB-U-CC-DG+3SVL	Enel Colombia		
GSCH014/06	LB-U-CC-CB	Enel Colombia		