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### LV UNDERGROUND PIERCING CONNECTORS

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## 1 SCOPE

The scope of this document is to provide the technical requirements for the supply of LV underground piercing connectors of the Enel Group Distribution companies listed below:

- Enel Distribución Chile (Chile)
- Codensa (Colombia)
- Enel Distribución Perú (Perù)
- Edesur (Argentine)
- e-distribuzione (Italy)
- Endesa Distribución Eléctrica (Spain)
- Enel Distribuição Ceará (Brazil)
- Enel Distribuição Rio (Brazil)
- Enel Distribuție Banat (Romania)
- Enel Distribuție Dobrogea (Romania)
- Enel Distribuție Muntenia (Romania)

Note: the indication "LATAM" refers to the Enel Group Distribution companies in South America.

Some requirements are applicable only to one or more companies. Therefore, depending on the destination, the supplied equipment shall comply with these specific requirements.

## 2 APPLICATION FIELD

This standard defines the quality requirements and the tests to be passed for insulated connections for underground electrical distribution networks in low voltage. This standard applies to isolated derivation connectors for unipolar cables with aluminum or copper conductors, according to standard HD 603. This standard does not extend to the joint or connecting elements supplied independently.

Note: the figures in this standard does not presuppose design since only provided as a guide.

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### 3 LIST OF COMPONENTS

The following components are covered by this Global Standard:


Type code	Designation (Product reference)	Admissible range of cable cross section (mm <sup>2</sup> )	
		Main cable	Branch cable
GSCC007/1	CDA 50/240-6/95	50÷240 <sup>(a)</sup>	6÷95 <sup>(a)</sup>
GSCC007/2	CDA 240/400-240/400	240÷400	240÷400
GSCC007/3	CDA 240/400-120/240	240÷400	120÷240
GSCC007/4	CDA 240/400-50/95	240÷400	50÷95
GSCC007/5	CDA 240/400-10/35	240÷400	10÷35
GSCC007/6	CDA 120/240-120/240	120÷240	120÷240
GSCC007/7	CDA 120/240-50/95	120÷240	50÷95
GSCC007/8	CDA 120/240-10/35	120÷240	10÷35
GSCC007/9	CDA 95/150-95/150	95÷150	95÷150
GSCC007/10	CDA 50/95-50/95	50÷95	50÷95
GSCC007/11	CDA 50/95-25/50	50÷95	25÷50
GSCC007/12	CDA 50/95-10/35	50÷95	10÷35
GSCC007/13	CDA 10/35-10/35	10÷35	10÷35
GSCC007/14	CDA 10/35-2.5/6	10÷35	2.5÷6

(a) The following combinations shall be used:

- 240 mm<sup>2</sup> main cable with 95 mm<sup>2</sup> branch cable.
- 150 mm<sup>2</sup> main cable with 35÷95 mm<sup>2</sup> branch cable.
- 95 mm<sup>2</sup> main cable with 50÷95 mm<sup>2</sup> branch cable.
- 70 mm<sup>2</sup> main cable with 25÷70 mm<sup>2</sup> branch cable.
- 50 mm<sup>2</sup> main cable with 6÷50 mm<sup>2</sup> branch cable.

**Table 1 - List of components**

For local components codification see Annex A.

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## 4 REFERENCE LAWS AND STANDARDS

### 4.1 Laws

#### 4.1.1 Italy

D.Lgs n. 81 of the 9<sup>th</sup> of April 2008 and subsequent modifications.

#### 4.1.2 Spain

- R.D. 614/2001, de 8 de junio, sobre disposiciones mínimas para la protección de la salud y seguridad de los trabajadores frente al riesgo eléctrico.
- Real Decreto 842/2002, de 2 de agosto, por el que se aprueba el Reglamento Electrotécnico para Baja Tensión y sus instrucciones técnicas complementarias (ITC) BT 01 a BT 51.

#### 4.1.3 Latam

##### 4.1.3.1 Brazil

NR-10 – segurança em instalações e serviços em eletricidade.

##### 4.1.3.2 Colombia

RETIE – Reglamento Técnico de Instalaciones Eléctricas.

##### 4.1.3.3 Peru

Código Nacional de Electricidad ( Suministro 2011)

### 4.2 Standards

The below listed reference documents shall be intended in the in-force edition at the contract date (amendments included). Unless otherwise specified, these documents are valid until the new editions replace them.

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#### 4.2.1 Common and international standards

Where two standards are indicated, for Latam the reference standard is the IEC/ISO, whilst for Europe the reference standard is the correspondent European one (EN).

Standard code	Edition	Standard name
GSC002	Rev. 02	TECHNICAL SPECIFICATION OF LOW VOLTAGE CABLES WITH RATED VOLTAGE U <sub>0</sub> / U (UM) 0,6/1,0 (1,2) KV
HD 603S1	1994/A3:2007	DISTRIBUTION CABLES OF RATED VOLTAGE 0,6/1 KV.
EN 61238-1	2003	COMPRESSION AND MECHANICAL CONNECTORS FOR POWER CABLES FOR RATED VOLTAGES UP TO 36 KV (UM = 42 KV) -- PART 1: TEST METHODS AND REQUIREMENTS. (IEC 61238-1:2003, MODIFIED)
EN 50483-1	2009	TEST REQUIREMENTS FOR LOW VOLTAGE AERIAL BUNDLED CABLE ACCESSORIES -- PART 1: GENERALITIES
EN 50483-4	2009	TEST REQUIREMENTS FOR LOW VOLTAGE AERIAL BUNDLED CABLE ACCESSORIES -- PART 4: CONNECTORS
ISO 2859-1	1999/ Cor.1:2001/ Amd 1:2011	SAMPLING PROCEDURES FOR INSPECTION BY ATTRIBUTES -- PART 1: SAMPLING SCHEMES INDEXED BY ACCEPTANCE QUALITY LIMIT (AQL) FOR LOT-BY-LOT INSPECTION
EN 50393	2015	TEST METHODS AND REQUIREMENTS FOR ACCESSORIES FOR USE ON DISTRIBUTION CABLES OF RATED VOLTAGE 0,6/1,0 (1,2) KV
IEC 60529 (EN 60529)	1989/A2:2013 (1991/A2:2013)	DEGREES OF PROTECTION PROVIDED BY ENCLOSURES (IP CODE) (IEC 529.1989).
IEC 60695-11-10 V0 (EN 60695-11-10 V0)	2013/COR1:2014 (2013/AC:2014)	FIRE HAZARD TESTING - PART 11-10: TEST FLAMES - 50 W HORIZONTAL AND VERTICAL FLAME TEST METHODS
IEC 60068-2-11 (EN 60068-2-11)	1981 (1999)	ENVIRONMENTAL TESTING. PART 2: TESTS. TEST KA: SALT MIST
ISO 286-1 (EN ISO 286-1)	2010 (2010)	GEOMETRICAL PRODUCT SPECIFICATIONS (GPS) - ISO CODE SYSTEM FOR TOLERANCES ON LINEAR SIZES - PART 1: BASIS OF TOLERANCES, DEVIATIONS AND FITS
ISO 6506 (EN ISO 6506)	2014 (2014)	METALLIC MATERIALS - BRINELL HARDNESS TEST

**Table 2 - Common Standards**

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#### 4.2.2 Specific ENDESA standards

Standard code	Edition	Standard name
UNE-HD 603-5X	2007	CABLES DE DISTRIBUCIÓN DE TENSIÓN ASIGNADA 0,6 / 1KV. PARTE 5: CABLES CON AISLAMIENTO DE XLPE, SIN ARMADURA. SECCIÓN X: CABLES SIN CONDUCTOR CONCÉNTRICO Y CON CUBIERTA DE POLIOLEFINA (TIPO 5X-1)
UNE 211022	2016	ACCESORIOS DE CONEXIÓN. CONEXIONES AISLADAS PARA REDES SUBTERRÁNEAS DE DISTRIBUCIÓN CON CABLES DE TENSIÓN ASIGNADA 0,6/1 KV.

Table 3 - Specifics ENDESA Standards

#### 4.2.3 Specifics Latam Standards

##### 4.2.3.1 Colombia

Standard code	Edition	Standard name
ET106	2013	Cable aislado de PVC 75°C 600V AI 1350

## 5 COMMON RATED CHARACTERISTICS

### 5.1 Rated voltage


The rated voltage of the accessories shall be:

$$U_0/U (U_m) = 0,6/1,0 (1,2) \text{ kV}$$

Where:

- $U_0$ : phase-to-ground/screen rated voltage
- $U$ : phase-to-phase rated voltage.
- $U_m$ : maximum voltage, corresponding to the highest phase-to-phase voltage during normal operation.



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## 5.2 Maximum current

The highest value of current is determined by the ampacity of the installed cable in the accessory.

The accessories shall operate without anomalies during normal operation, with a continuous operating temperature of 90 °C, corresponding to the COT of the cable.

## 5.3 Manufacturing features

The accessories shall guarantee all the necessary features in order to ensure simultaneous electrical connection and continuity of insulation as well as the outer sheath of the cable.

The connectors must be suitable for both direct buried installation and installation in buried chambers.

Shear-head bolt (breaks at tightening torque) shall be used, in order to ensure precise tightening control for all piercing contacts. In addition, a double piercing systems shall be used.

The installation of the connector shall be made using a single work tool. When several bolts should be tightened, the bolts heads shall have the same dimensions.

During the installation process there will be no possibility of electrical contact, not even with the cables energized.


As soon as the bolt head brakes, the body of the accessory shall ensure complete insulation without using additional measures.

The piercing connectors shall comply with the requirements specified for “type 1” in standard EN 50393 clause 3.1.1 as well as for “Class A” in chapter 1 of the standard EN 61238-1.

The piercing connector shall be clearly identifiable for underground installation, using a light brown color in order to avoid confusion with the black color.

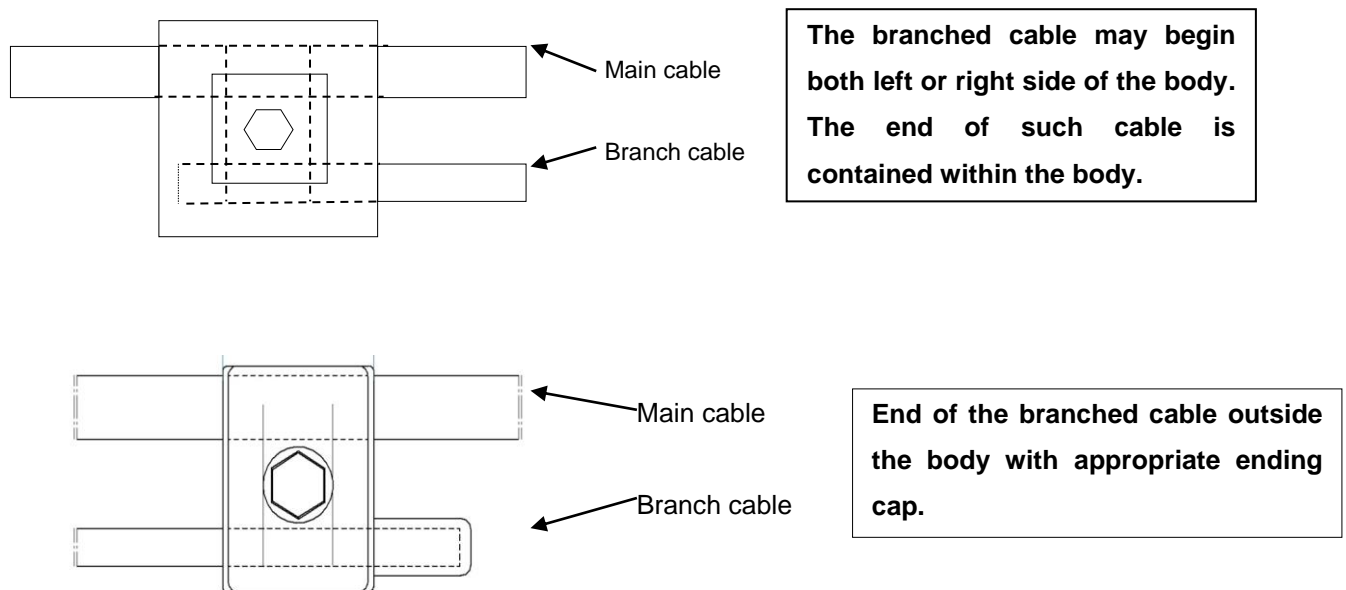
The piercing connectors shall be manufactured as indicated in the following:

- a) Enclosure made of rigid self-extinguish insulating material.
- b) Sealing gasket made of flexible insulating material.
- c) Shear-head bolt (breaks at tightening torque).
- d) Contacts made of tinned aluminum alloy, tinned copper or tinned copper alloy with Brinell hardness >100 (with minimum tinning same as 5 µm).

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- e) The connectors contact resistance (between the contact teeth and the cable conductor) shall be projected to be same as  $20 \div 30 \mu\Omega$ . In addition, after performing the thermal tests, such value cannot be greatest than  $40 \mu\Omega$ .
- f) If a gel material is used within the body (in order to ensure the water impenetrability), it shall preserve all its features over time. In addition, such gel shall guarantee a non-toxic level according to the law. It is forbidden the use any kind of resin.
- g) When the bolt head breaks, it shall be impossible to apply additional tightening torque, but still, disassemble operation of the connector shall be possible, obtaining access to both main and branch cables.
- h) The active part of the branch cable, shall be protected from accidental contact.
- i) The overall maximum dimension of the piercing connector (length  $\times$  width  $\times$  height) shall be same as indicated in table 4.
- j) After the tightening of the connector, all the external parts shall be de-energized during operation.
- k) All the metallic elements not considered above shall be made of stainless steel.
- l) Once installed, the connector must guarantee the insulation of the dead end of the branched cable.

Two possible configurations are shown in the following figure (Not binding).



**Figure 1 - Possible configurations of piercing connectors.**

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The minimum number of Shear-head bolts is the indicated in the following table:

Type code	Overall maximum dimension	N° Bolts
	length x width x height (mm)	minimum
GSCC007/1	150 x 120 x 150	1
GSCC007/2	200 x 120 x 150	2
GSCC007/3	200 x 120 x 150	2
GSCC007/4	150 x 120 x 150	1
GSCC007/5	150 x 120 x 150	1
GSCC007/6	200 x 120 x 150	2
GSCC007/7	150 x 120 x 150	1
GSCC007/8	150 x 120 x 150	1
GSCC007/9	200 x 120 x 150	2
GSCC007/10	150 x 120 x 150	1
GSCC007/11	150 x 120 x 150	1
GSCC007/12	150 x 120 x 150	1
GSCC007/13	80 x 70 x 80	1
GSCC007/14	80 x 70 x 80	1

**Table 4 - Overall maximum dimension and minimum number of Shear-head Marking**

The accessories shall be marked: in relief, by graving or by painting. In addition, marking must be indelible and easily legible, and shall contain the following information:

- Name of the manufacturer.
- Product reference + range of suitable cable cross-section (range of main cable – range of branch cable).
- The year and the month of the manufacturing, including the batch number.

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The marking of the product reference shall be done according to the following:

“Manufacturer’s name” + “CDA” + “Range of use for the main cable” + “Range of use for the branch cable” + “date of manufacture” + “batch number”

Example: *XXXXXX CDA 150/240-50/95 1601 YYY*

Piercing connector manufactured by *XXXXXX*, suitable for cross-sections same as *150/240 mm<sup>2</sup>* in the main cable and *50/95* in the branch cable, manufactured on *January 2016* and with batch number *YYY*.

#### **5.4 Conditions of supply**

Each unit shall be provided on single package. Such package shall include the installation and assembly manuals, written in local language.

The accessories rated voltage (0.6/1 kV) shall be indicated on the packing and in the installation manual.

In order to tight the bolt a wrench socket shall be used. This information shall be contained in the installation or assembly manuals, as well as the number of the socket.

#### **5.5 Installation conditions**

The connection elements shall be installed according to the manufacturer indications. If electrical tools are used, they shall be appropriated for this purpose, being allowed only a screwdriver model.

Furthermore, the installation shall be possible with energized main cables, without the possibility of contact during the entire process.

## **6 TESTING**


Tests are classified into type tests and acceptance tests.

### **6.1 TYPE TEST**

The piercing connector shall comply the following tests:

#### **6.1.1 Manufacturing features verification**

The manufacturing features (material characteristics, dimensional features, marking, etc) shall be verified according to standard EN 50483-4.

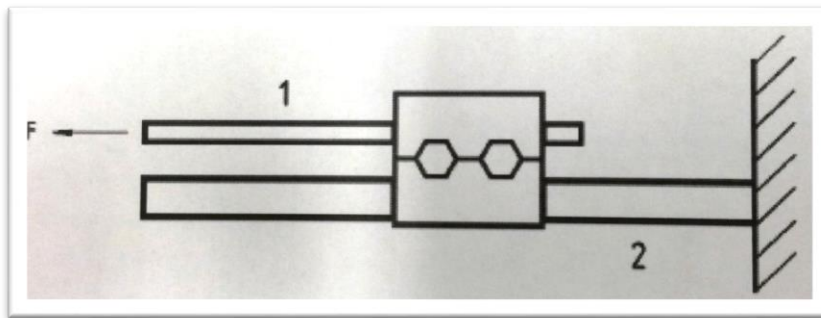
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Marking inscription shall remain legible after scrubbing the enclosure with a water soaked towel for 15 s, subsequently the same process shall be done using isopropyl alcohol.

### 6.1.2 Electrical and mechanical tests.

Class A tests of standard EN 61238-1 as well as Type 1 of standard EN 50393 shall be performed, including the following particularities:

- Standard EN 50393: Insulation test > 1000 M $\Omega$ , following the procedure depicted in clause 8.4.
- The traction test shall be performed using the configuration contained in the standard EN 50483-4 (Figure 2), maintaining the main cable anchored and applying traction over the branch cable, using the values contained in the standard EN 61238-1.



**Figure 2 - Traction test for branch tables diagram.**

- Local requirement for Enel Distribuição Rio and Enel Distribuição Ceará (Brazil): For tests to be performed with the connectors submerged in water, according to the standard EN 50393, a depth of 10m is required (or equivalent in a pressure vessel).

### 6.1.3 Self-extinguishing verification

Such test shall be performed in accordance with the standard IEC 60695-11-10 Class V0.

### 6.1.4 Tolerance margins

The tolerance margins regarding all dimensional values, are indicated in the standard EN ISO 286-1.

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### **6.1.5 Corrosion test**

The corrosion test shall be performed using the method specified in standard EN 60068-2-11, with a duration same as 336 h (2 weeks).

Once the test has been performed, the accessories shall be subjected to an external and internal visual examination. The test will be considered finished, if and only if, the accessories do not present corrosion zones that affect the optimal functioning.

### **6.1.6 Minimum tinning and brinell hardness of contacts.**

Such test shall be performed in accordance with the standard EN ISO 6506, and the results must be compliant with the requirements indicated in paragraph 5.3.

### **6.1.7 Bolt tightening test**

Such test shall be performed in accordance with the standard EN 50483-4 paragraph 8.1.2.4

## **6.2 Acceptance test**

Acceptance test shall be performed in accordance with the standard CEI EN 50483-1 ( Annex A-Table A1-Sample test). In addition, double sampling process shall be performed in accordance with the standard ISO 2859-1 as indicated in the table below. The samples for the acceptance tests shall be selected from among the entire batch that was prepared for testing even if made up of different material codes.

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Acceptance test			Batch (units)		
			≤ 50 units	> 50 and ≤ 1200	> 1200 units
Visual examination (According to section 6.1.1)			2	5	10
Dimensional and material verification (According to section 6.1.1)			2	5	10
Test for permanent marking (According to section 6.1.1)			2	5	10
Bolt tightening test (According to section 6.1.7)	Main cable: max. section	Temp = -10±3°C	1	2	5
	Branch cable: max. section	Temp = 50±3°C	1	2	5
	Main cable: min. section	Temp = -10±3°C	1	2	5
	Branch cable: min. section	Temp = 50±3°C	1	2	5
Branch cable pull-out test (According to section 6.1.2)			2	5	10
Dielectrical voltage test (According to standard EN 50393 section 8.3)		In air	2	4	10
		Immersed	2	4	10

**Table 5 - Samples for each material code prepared for testing**

In all cases, the acceptance number must be 0 and the rejection number must be 1.

On the scheduled acceptance testing date the supplier shall prepare the connectors. This will facilitate and reduce the testing time, which benefits both parties.

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## ANNEX A

Type code	Edesur	Enel Distribuição Rio Enel Distribuição Ceará	Enel Distribución Chile	Codensa	Enel Distribución Perú	e-distribuzione	Enel Distributie	Endesa D.E.
<b>GSCC007/1</b>		-				852020	852020	
<b>GSCC007/2</b>	xxx	4692360			6815781			
<b>GSCC007/3</b>	xxx	4692361			6815782			
<b>GSCC007/4</b>	xxx	4692362			6815783			
<b>GSCC007/5</b>	xxx	4692363			6815784			
<b>GSCC007/6</b>		4692364			6815785			6711174
<b>GSCC007/7</b>		4692365			6815786			6711173
<b>GSCC007/8</b>		4692366			6815787			
<b>GSCC007/9</b>		4692367			-			6711172
<b>GSCC007/10</b>		4692368			6815788			
<b>GSCC007/11</b>		-			6815789			6711171
<b>GSCC007/12</b>		4692369			6815790			
<b>GSCC007/13</b>		4692370			6815791			
<b>GSCC007/14</b>		4692371						

**List of components**