

Type and Sample Test Report

# Waterproof insulation piercing connector SLIW52



**Test standard:**

EN 50483-4:2009 and EN 50483-1:2009

## ENSTO

Ensto Utility Networks Laboratory  
Ensto Finland Oy

Ensio Miettisen katu 2,  
P.O.Box 77  
06101 Porvoo, Finland

Tel. +358 204 76 21  
Fax +358 204 76 2770

Business ID: 0130215-8  
Reg. Office: Porvoo

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1

2

3

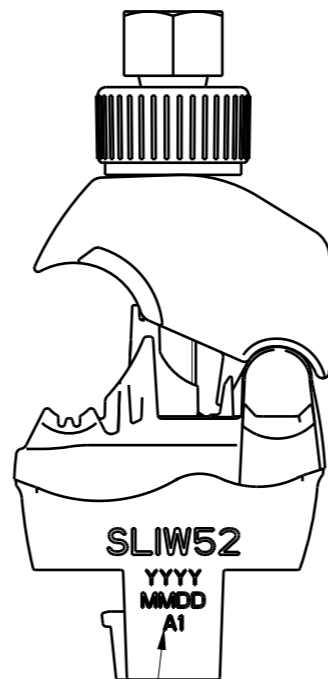
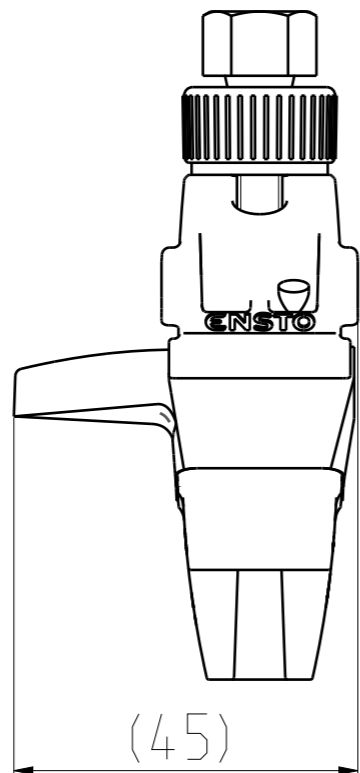
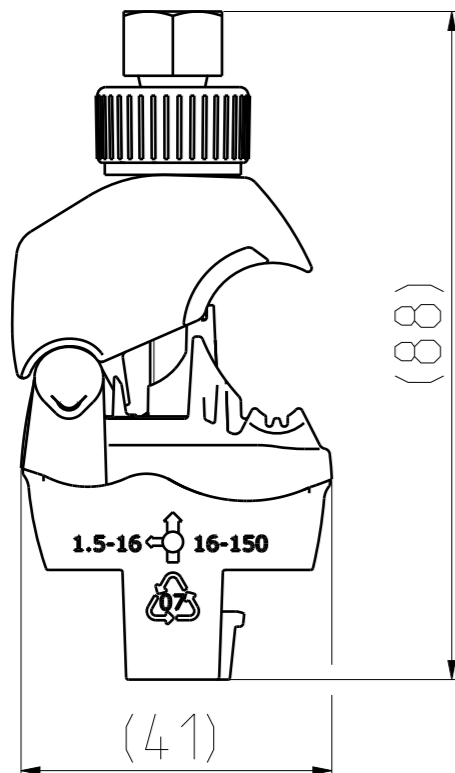
4

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8



Markings  
ENSTO logo, SLIW52,  
Production date,  
Cross-section range,  
Recycling mark,  
Connector class.

2:1

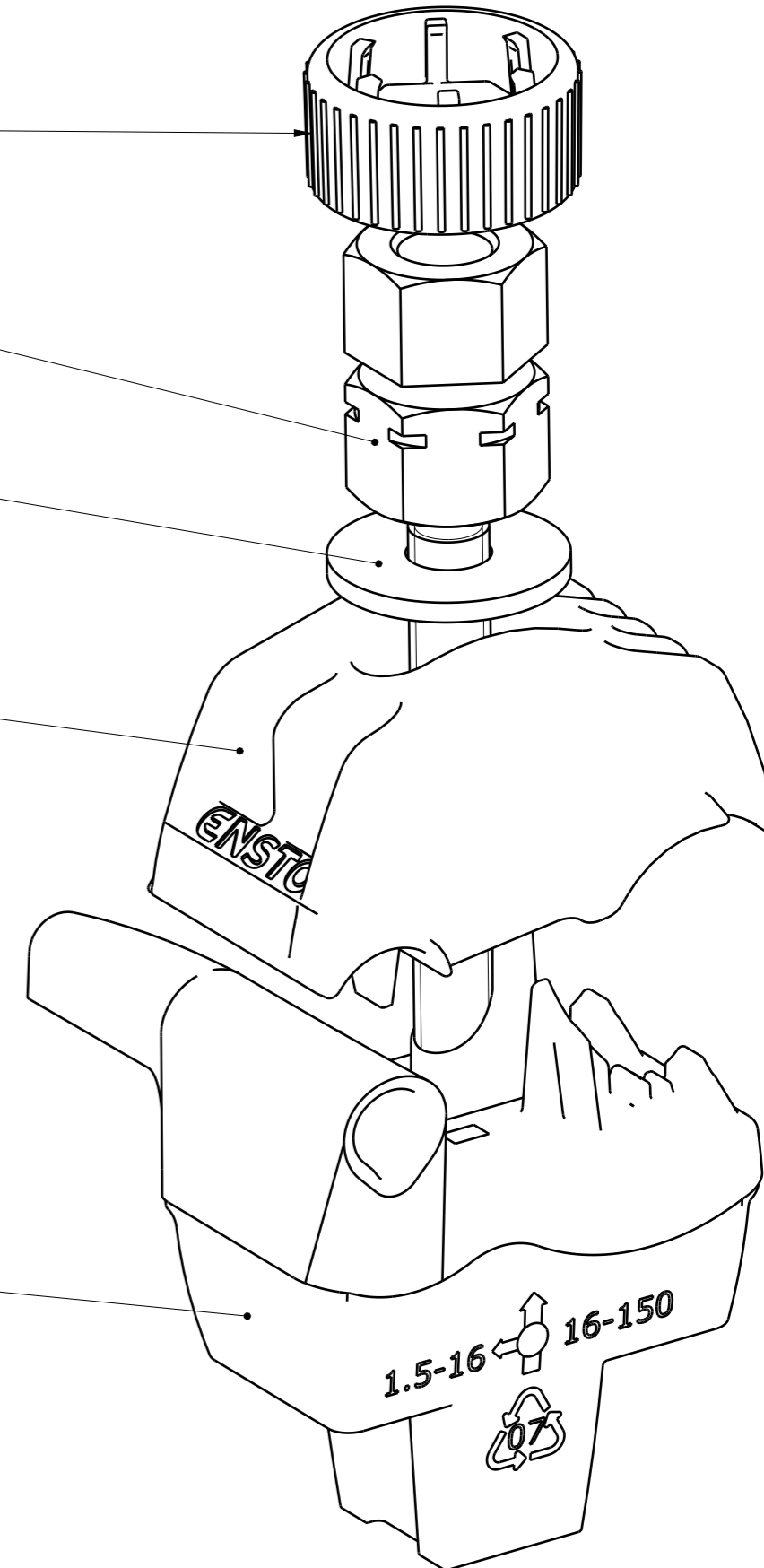
Polymeric protection  
ring

Aluminium alloy  
shear head nut

Stainless steel  
washer

Composite polymer  
clampig part

Body made of  
composite polymer  
and elastomer with  
tin plated aluminium  
alloy contact plates  
and coated stainless  
steel threaded rod



Product Specification	
Dimensions	
Weight	0,06 kg
Conductor size, main side	Cu/Al 16-150 mm <sup>2</sup>
Conductor size, branch side	Cu/Al 1,5-16 mm <sup>2</sup>
Conductor diameter, main side	7-18,6 mm
Conductor diameter, branch side	3-7 mm
Electrical values	
Test voltage in water:	6 kV / 50 Hz / 1 min
Highest system voltage:	1 kV
Mechanical	
Tightening torque	11±1 Nm
Standard EN 50483-4	

<b>ENSTO</b>		
Ensto Finland Oy Ensto Utility Networks		
Scale	Date	01.06.18
1:1	By	PDe
A3	Checked	
Sheet No: 2 (2)	Ctrl	

Product specification sheet Insulation piercing connector Low voltage Cu/Al 16-150 mm <sup>2</sup> / Cu/Al 1,5-16 mm <sup>2</sup>	Replaces:	
	Replaced:	
	Ref:	000088102 F
	Code:	SLIW52

# CERTIFICATE FI 30454

Our Ref. 293242-1

**Product** Connector for overhead line

**Type** SLIW52

**Trade mark** ENSTO

**Certificate Holder/  
Manufacturer** Ensto Finland Oy  
Ensio Miettisen katu 2  
FI-06150 PORVOO, FINLAND

**Technical information** Main conductor Al / Cu 16 – 150 mm<sup>2</sup>  
Branch conductor Al / Cu 1,5 – 16 mm<sup>2</sup>  
Connector class A1

**Other information** Waterproof insulation piercing connector, shear head screw

**The product is certified  
according to the  
following standard(s)** EN 50483-1:2009  
EN 50483-4:2009

**Validity** This certificate is valid until 30 May 2023 provided that the Conditions for FI certification are met. This certificate includes the right to use the FI mark under the condition that product changes (if any) will be approved at SGS Fimko before the product is brought onto market.

**Date of issue** 30 May 2018

**SGS Fimko Ltd**

**Signature**

Sixten Lökfors  
Project Manager

This certificate has 1 appendix



This certificate is issued by the company under its General Conditions for Certification Services accessible at <http://www.sgs.fi/en/Terms-and-Conditions.aspx>. Attention is drawn to the limitations of liability defined therein and in the Test Report here above mentioned which findings are reflected in this certificate. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

Appendix to Certificate: 30454

**Manufacturing site**

Ensto Ensek AS  
Paldiski mnt. 35 / 4A  
EE-76606 KEILA  
ESTONIA

**Additional information**



Tests are made and in manufacturer's premises.  
Manufacturer's test reports: 38338-1+2S, 38338-3S, 38338-4S,  
38338-14S, 38338-15S and 38338-16S

Low temperature assembly test clause 8.1.4, Shear head function test clause 8.1.2.4. and Low temperature impact test clause 8.1.2.5. were done in temperature  $-25 \pm 3^{\circ}\text{C}$ .

This certificate replaces Certificate FI 29649 A1 dated 16 May 2017, due to new testing.



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**Test object:**

Waterproof insulation piercing connector SLIW52.

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**Purpose of the test and relevant standards:**

Visual examination test and dimensional and material verification test, according to EN 50483-1:2009 Annex A, table A.1 and clause 6 Marking.

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**Conclusion:**

The connector passed the test.



Picture: SLIW52

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**Date of Report:** 7.5.2018

**Tested by:** Mika Karjalainen

**Approved by:** Janne Lappalainen

**ENSTO**  
UTILITY NETWORKS  
LABORATORY

**Ordered by:** T. Virtanen  
**Distribution:** OHL PD-team

**ENSTO**

# Laboratory Report

No.: 38338\_1+2S

Revision: A

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## 1. Test objects

Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Manufacturer:	Ensto Finland Oy
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
Shear head range:	11 ±1 Nm
Batch number:	0901182124
No of pcs:	1

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## 2. Testing procedure

The test was performed against the manufacturer specification sheet and standard requirement. The test included the visual examination part and the dimensional and material verification part.

### Requirements

The connector shall fulfill the manufacturer specification data and standard requirements.

## 3. Test results

### Visual examination:

Manufacturer's logo: ENSTO  
Product code: SLIW52  
Batch number (production date): in cardboard box 0901182124

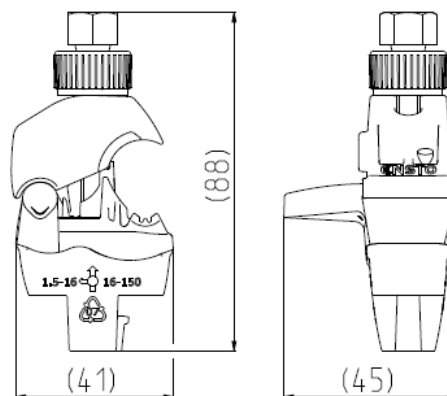
Minimum and maximum cross section,  
Main: 16-150 mm<sup>2</sup>  
Branch: 1,5-16 mm<sup>2</sup>

Recycling code: 07

### Dimensional and material verification:

Distance	Requirement [mm]	Measured [mm]	Result
Height	(88)	87,7	passed
Width	(41)	40,7	passed
Depth	(45)	44,1	passed

Table 1: Dimensions of the connector



Picture 1: Specification drawing



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Component	Material	Matching specification
Protection ring	Polymer	yes
Shear head nut	Aluminium alloy	yes
Washer	Stainless steel	yes
Clamping part	Composite polymer	yes
Body	Composite polymer and elastomer	yes
Contact plates	Tin plated aluminium	yes
Threaded rod	Coated stainless steel	yes

Table 2: Materials of the connector

## Summary

The connector fulfilled the test requirements.

## 4. Pictures



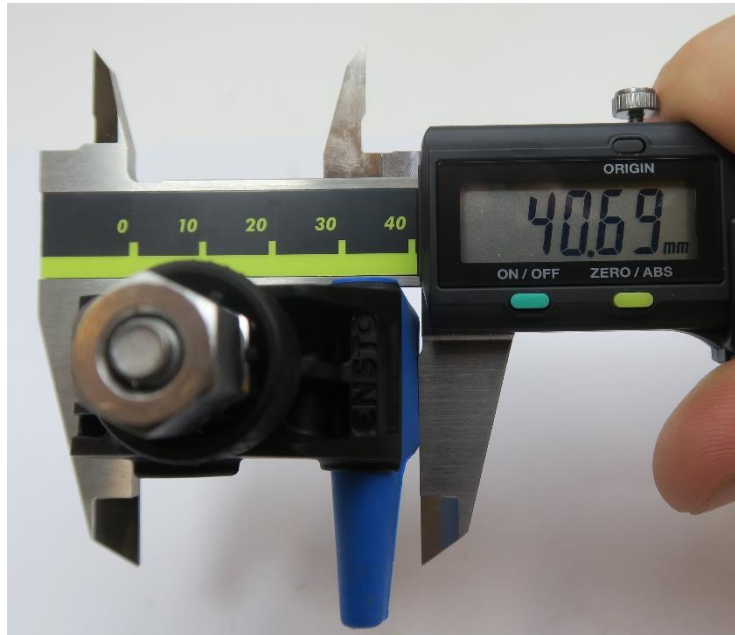
Picture 2: Markings of the connector

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Picture 3: Measuring the width connector

## 5. Test equipment

ID	Type	Model	Purpose	Latest calibration
A250	Caliper	Digital caliper CD-15APX	Measuring dimensions	30.08.2017

## 6. Test Id

38338\_1+2

## 7. Revision history

A



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**Test object:**

Waterproof insulation piercing connector SLIW52.

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**Purpose of the test and relevant standards:**

Test for permanent marking according to EN 50483-1:2009 clause 9.2.

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**Conclusion:**

The connector passed the test.



Picture 1: SLIW52

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**Date of Report:** 7.5.2018

  
**Tested by:** Mika Karjalainen

  
**Approved by:** Janne Lappalainen



**Ordered by:** T. Virtanen  
**Distribution:** OHL PD-team

## ENSTO

# Laboratory Report

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## Test objects

### Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Manufacturer:	Ensto Finland Oy
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
Shear head range:	11 ±1 Nm
Batch number:	0901182124
No of pcs:	2

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## 1. Testing procedure

The test procedure was according to standard. The marking of the connector was rubbed by hand for 15 s with a piece of cloth soaked with water and another 15 s with a piece of cloth soaked with petroleum spirit. The petroleum spirit used was Mineral turpentine from KIILTO / Finland.

### **Requirement:**

The marking shall remain clear and allow the accessory to be easily identified.

## 2. Test results

Sample	Markings clear after the test	Result
1	yes	passed
2	yes	passed

Table 1: Test results.

### **Summary**

The connector fulfilled the test requirements.

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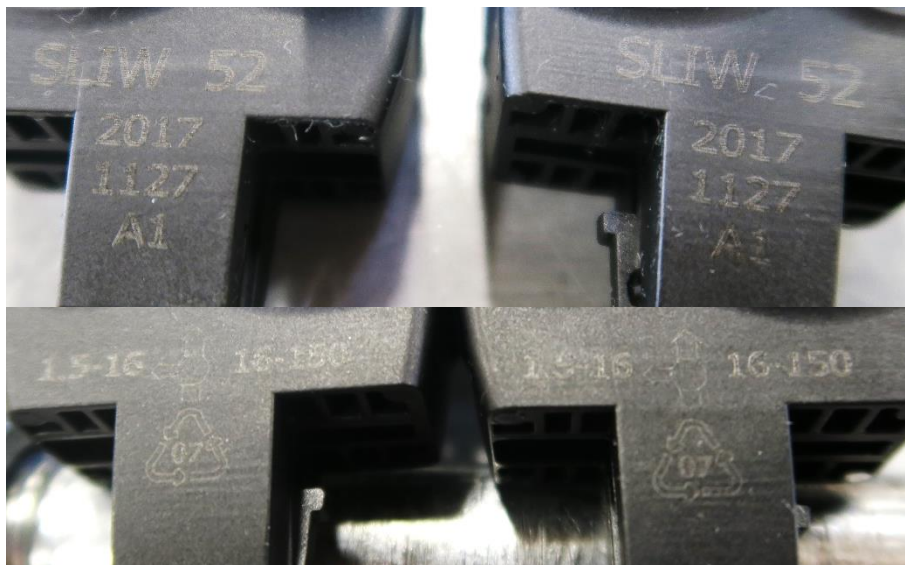
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## 3. Pictures



Picture 2: Test setup



Picture 3: Markings after the test.

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## 4. Test equipment

ID	Type	Model	Purpose	Latest calibration
L253	Stop watch	IHM	timekeeping	26.10.2015

## 5. Test Id

38338\_3

## 6. Revision history

A



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**Test object:**

Waterproof insulation piercing connector SLIW52.

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**Purpose of the test and relevant standards:**

Dielectrical voltage test in water according to EN 50483-4:2009 clause 8.1.3.1.3.1.

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**Conclusion:**

The connector passed the test.



Picture 1:SLIW52

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**Date of Report:** 4.5.2018

  
**Tested by:** Mika Karjalainen

  
**Approved by:** Janne Lappalainen

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LABORATORY

**Ordered by:** T. Virtanen  
**Distribution:** OHL PD-team

**ENSTO**



# Laboratory Report

No.: 38338\_4S

Revision: A

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## 1. Test objects

### Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Manufacturer:	Ensto Finland Oy
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
Shear head range:	11 ±1 Nm
Batch number:	0901182124
No of pcs:	4

### Conductors:

Type:	IMWS 3x150Al+1x70Alm
Used cross section:	150 mm <sup>2</sup>
Conductor material:	Al
Number of strands:	19
Conductor diameter:	14 mm
Conductor construction:	Compacted
Shape of conductor:	Round
Insulation material:	XLPE
Insulation thickness:	1,7 mm
Core diameter:	17,3 mm
Conductor MBL:	18 kN
Max operating temperature:	90 °C
Max short-circuit temperature:	250 °C
Manufacturer:	Silec Cable
Country:	France
Refer to standard:	NF C 33-209, HD626
Conductor ID:	408

Type:	AsXSn 4x16
Used cross section:	16 mm <sup>2</sup>
Conductor material:	Al
Number of strands:	7
Conductor diameter:	4,7 mm
Conductor construction:	Compacted
Shape of conductor:	Round
Insulation material:	XLPE
Insulation thickness:	1,1 mm
Core diameter:	7,2 mm
Conductor MBL:	*) 2,57 kN
Max operating temperature:	90 °C
Max short-circuit temperature:	250 °C
Manufacturer:	TF-Kable
Country:	Poland
Refer to standard:	ZN-TF-207:2007, PN-HD 626 S1:2002/A2:2003
Conductor ID:	477

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Type:	ML 1,5
Used cross section:	1,5 mm <sup>2</sup>
Conductor material:	Cu
Number of strands:	1
Conductor diameter:	1,4 mm
Shape of conductor:	Round
Insulation material:	PVC
Insulation thickness:	0,8 mm
Core diameter:	2,7 mm
Conductor MBL:	*) 0,228 kN
Max operating temperature:	70 °C
Max short-circuit temperature:	160 °C
Manufacturer:	Draka
Country:	Finland
Refer to standard:	EN 50525-2-31 IEC / EN 60332-1
Conductor ID:	474

\*) Conductor MBL does not fulfill manufacturer or standard requirement or it is not known.  
MBL determined by pulling three conductor samples from each conductor phases.

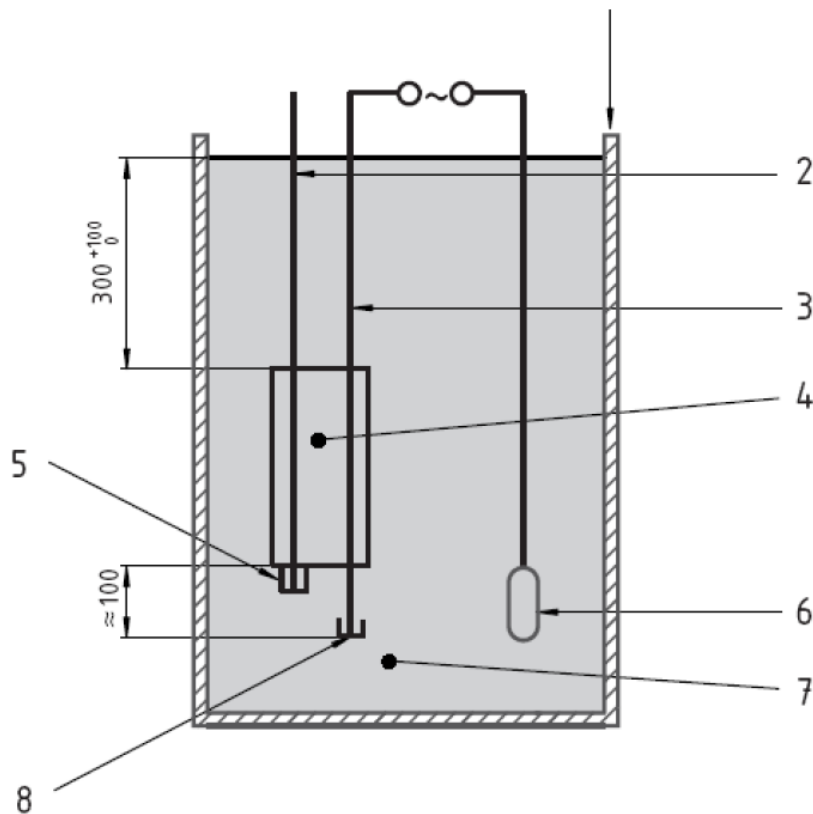
MBL = Minimum value of pulled conductors x 0,95

## 2. Testing procedure

The test was done with two different conductor setups (main-branch): min-min and max-min. Two connectors were tested with each of the conductor setups. The connectors were tightened to the minimum torque indicated by the manufacturer.

The assembly, of connector and cores, was placed at the bottom of a water tank. The connector was placed horizontally. The depth of water was measured from the upper part of the connector. The cores were such length to ensure that they were sufficiently above the water level to prevent flashover, see Picture 2. Normal tap water was used.

After 30 min under water, the voltage test was applied to the sample with a 6 kV a.c. for 60 s at a rate of approximately 1 kV/s.



### Key

1	tank	5	part of connectors for watertight of tap core
2	insulated tap conductor	6	metallic electrode
3	insulated main conductor	7	water
4	mounted connector	8	watertight insulating cap or core bent so that end is above the surface of water

Picture 2: Test arrangement

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## Requirements

No failure or flashover shall occur. The leakage current must stay below  $10 \pm 0,5$  mA during this period.

### 3. Test results

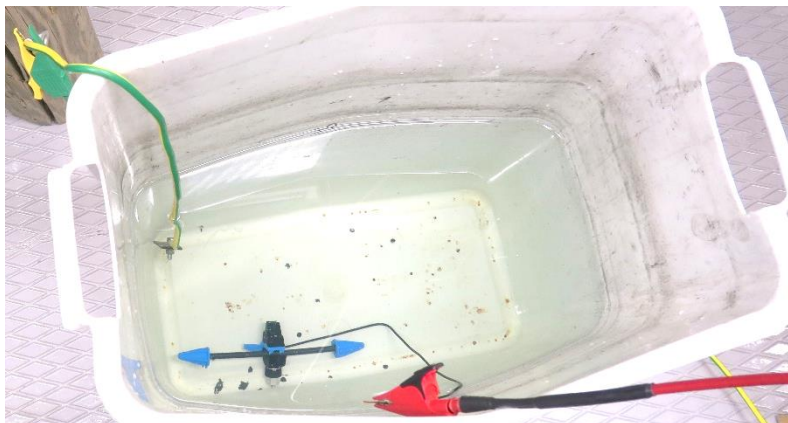
Sample	Conductor Main-Branch [mm <sup>2</sup> ]	Leakage current [mA]	Result
		6 kV / 1 min	
1	Max - Min 150 - 1,5	1,10	passed
2		1,11	passed
3	Min - Min 16 - 1,5	1,01	passed
4		1,02	passed

Table 1: Test results

## Summary

Connector fulfilled the test requirements.

### 4. Pictures



Picture 3: Test setup

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## 5. Test equipment

ID	Type	Model	Purpose	Latest calibration
L212	Torque wrench	ADS25	Torque measurement	06.06.2016
L211	High voltage test set	GLP2i	High voltage testing	05.10.2017
L317	Measuring tape	SL5M	Measuring length	08.09.2017

## 6. Test Id

38338\_4

## 7. Revision history

A



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**Test object:**

Waterproof insulation piercing connector SLIW52.

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**Purpose of the test and relevant standards:**

Test for mechanical damage to the main conductor according to EN 50483-4:2009 clause 8.1.2.1.

---

**Conclusion:**

The connector passed the test.



Picture 1: SLIW52

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**Date of Report:** 4.5.2018

  
**Tested by:** Mika Karjalainen

  
**Approved by:** Janne Lappalainen

**ENSTO**  
UTILITY NETWORKS  
LABORATORY

**Ordered by:** T. Virtanen  
**Distribution:** OHL PD-team

**ENSTO**

# Laboratory Report

No.: 38338\_14S

Revision: A

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## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Manufacturer: Ensto Finland Oy  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
Batch number: 0901182124  
No of pcs: 6

### Conductors:

Type: IMWS 3x150Al+1x70Alm  
Used cross section: 150 mm<sup>2</sup>  
Conductor material: Al  
Number of strands: 19  
Conductor diameter: 14 mm  
Conductor construction: Compacted  
Shape of conductor: Round  
Insulation material: XLPE  
Insulation thickness: 1,7 mm  
Core diameter: 17,3 mm  
Conductor MBL: 18 kN  
Max operating temperature: 90 °C  
Max short-circuit temperature: 250 °C  
Manufacturer: Silec Cable  
Country: France  
Refer to standard: NF C 33-209, HD626  
Conductor ID: 408

Type: AsXSn 4x16  
Used cross section: 16 mm<sup>2</sup>  
Conductor material: Al  
Number of strands: 7  
Conductor diameter: 4,7 mm  
Conductor construction: Compacted  
Shape of conductor: Round  
Insulation material: XLPE  
Insulation thickness: 1,1 mm  
Core diameter: 7,2 mm  
Conductor MBL: \*) 2,57 kN  
Max operating temperature: 90 °C  
Max short-circuit temperature: 250 °C  
Manufacturer: TF-Kable  
Country: Poland  
Refer to standard: ZN-TF-207:2007, PN-HD 626 S1:2002/A2:2003  
Conductor ID: 477

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Type:	ML 1,5
Used cross section:	1,5 mm <sup>2</sup>
Conductor material:	Cu
Number of strands:	1
Conductor diameter:	1,4 mm
Shape of conductor:	Round
Insulation material:	PVC
Insulation thickness:	0,8 mm
Core diameter:	2,7 mm
Conductor MBL:	*) 0,228 kN
Max operating temperature:	70 °C
Max short-circuit temperature:	160 °C
Manufacturer:	Draka
Country:	Finland
Refer to standard:	EN 50525-2-31 IEC / EN 60332-1
Conductor ID:	474

\*) Conductor MBL does not fulfill manufacturer or standard requirement or it is not known.  
MBL determined by pulling three conductor samples from each conductor phases.

MBL = Minimum value of pulled conductors x 0,95



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## 2. Testing procedure

The test was done with three different conductor setups, main-branch: max-max, min-min and min-max. Two connectors were tested with each conductor setup.

The core was mounted in a tensile test in a suitable manner. The core, on which the IPCs will be tested, was tensioned to 15 % of its MBL. The core length was between 0,5 m and 1,5 m.

Connectors were installed according to the manufacturer's instructions. Because connector was designed with a shear-head, it was tightened up to the manufacturer's specified maximum torque.

The connectors were not removed from the core before the mechanical tensile test.

A tensile load was applied to the main conductor until it reached the following value:

System type	Conductor	Tensile test load
Self supporting	Copper (4 mm <sup>2</sup> to 16 mm <sup>2</sup> )	20 % MBL of the cable
	Copper (> 16 mm <sup>2</sup> )	80 % of the cable
	Aluminium (16 mm <sup>2</sup> to 25 mm <sup>2</sup> )	1200 N or 40 % MBL of the cable, whichever is the greater
	Aluminium (> 25 mm <sup>2</sup> )	80 % MBL of the cable
Neutral messenger	Phase	60 % MBL of the cable
	neutral	90 % MBL of the cable

Table 1: Tensile loads for conductors

The load was maintained for 60 s.

### Requirements

The cores shall maintain the test load for 60 s without breaking or any damage that would prevent the correct function of the cable.

## 3. Test results

Sample	Conductor configuration Main-Branch [mm <sup>2</sup> ]	15 % of MBL [kN]	60 s test load [kN]	Damage of main core	Result
1	Max - Max 150 - 16	2,70	10,8	no	passed
2				no	passed
3	Min - Min 16 - 1,5	0,39	1,0	no	passed
4				no	passed
5	Min - Max 16 - 16	0,39	1,0	no	passed
6				no	passed

Table 2: Test results

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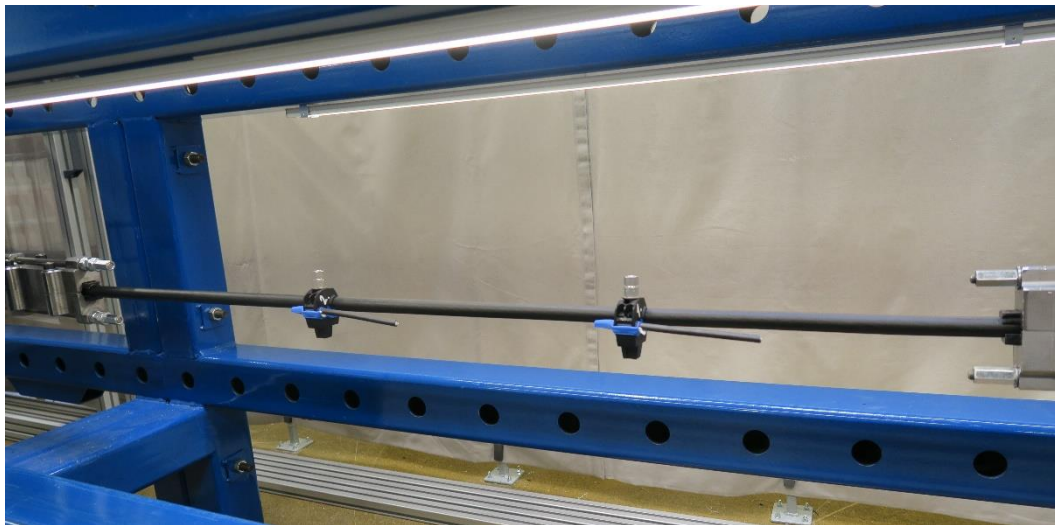
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## Summary

Connector fulfilled the test requirements.

## 4. Pictures



Picture 2: Test setup

## 5. Test equipment

ID	Type	Model	Purpose	Latest calibration
L212	Torque wrench	ADS25	Torque measurement	06.06.2016
L369	Force sensor	1210AF-25kN-B	Force measurement	26.09.2017
T3	Tensile test machine	ForceProof	Tensile test	No calibration

## 6. Test Id

38338\_14

## 7. Revision history

A



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**Test object:**

Waterproof insulation piercing connector SLIW52.

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**Purpose of the test and relevant standards:**

Branch cable pull-out test according to EN 50483-4:2009 clause 8.1.2.2.

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**Conclusion:**

The connector passed the test.



Picture 1: SLIW52

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**Date of Report:** 4.5.2018

  
**Tested by:** Mika Karjalainen

  
**Approved by:** Janne Lappalainen



**Ordered by:** T. Virtanen  
**Distribution:** OHL PD-team

## ENSTO

# Laboratory Report

No.: 38338\_15S

Revision: A

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## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Manufacturer: Ensto Finland Oy  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
Batch number: 0901182124  
No of pcs: 4

### Conductors:

Type: IMWS 3x150Al+1x70Alm  
Used cross section: 150 mm<sup>2</sup>  
Conductor material: Al  
Number of strands: 19  
Conductor diameter: 14 mm  
Conductor construction: Compacted  
Shape of conductor: Round  
Insulation material: XLPE  
Insulation thickness: 1,7 mm  
Core diameter: 17,3 mm  
Conductor MBL: 18 kN  
Max operating temperature: 90 °C  
Max short-circuit temperature: 250 °C  
Manufacturer: Silec Cable  
Country: France  
Refer to standard: NF C 33-209, HD626  
Conductor ID: 408

Type: AsXSn 4x16  
Used cross section: 16 mm<sup>2</sup>  
Conductor material: Al  
Number of strands: 7  
Conductor diameter: 4,7 mm  
Conductor construction: Compacted  
Shape of conductor: Round  
Insulation material: XLPE  
Insulation thickness: 1,1 mm  
Core diameter: 7,2 mm  
Conductor MBL: \*) 2,57 kN  
Max operating temperature: 90 °C  
Max short-circuit temperature: 250 °C  
Manufacturer: TF-Kable  
Country: Poland  
Refer to standard: ZN-TF-207:2007, PN-HD 626 S1:2002/A2:2003  
Conductor ID: 477

# Laboratory Report

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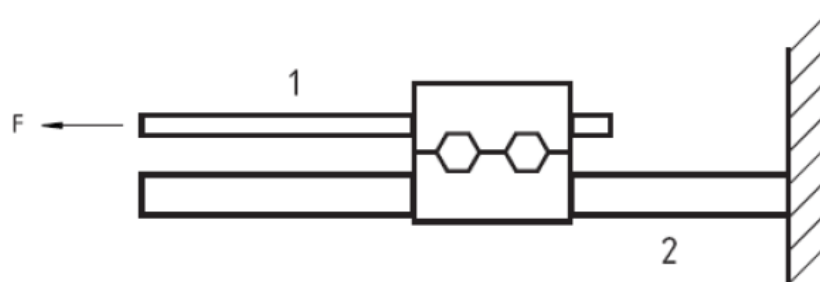
Type:	ML 1,5
Used cross section:	1,5 mm <sup>2</sup>
Conductor material:	Cu
Number of strands:	1
Conductor diameter:	1,4 mm
Shape of conductor:	Round
Insulation material:	PVC
Insulation thickness:	0,8 mm
Core diameter:	2,7 mm
Conductor MBL:	*) 0,228 kN
Max operating temperature:	70 °C
Max short-circuit temperature:	160 °C
Manufacturer:	Draka
Country:	Finland
Refer to standard:	EN 50525-2-31 IEC / EN 60332-1
Conductor ID:	474

\*) Conductor MBL does not fulfill manufacturer or standard requirement or it is not known. MBL determined by pulling three conductor samples from each conductor phases.

MBL = Minimum value of pulled conductors x 0,95

## 2. Testing procedure

The test was done with two different conductor setups, main-branch: min-min and max-min. Two connectors were tested with each conductor setup. The connectors were installed to the conductors according to manufacturer's installation instructions. The lengths of the conductors were between 0,2 and 0,5 m. The tightening torque was shear head maximum value. The core was marked at the connector so that any slippage during the test could be measured. The connector assembly was attached into a test assembly where a weight was used to set the correct load. A tensile load was axially applied to the branch conductor test arrangement is shown in a picture 2. The load was 10 % of the MBL of the branch conductor and it was maintained for 60 seconds. The cores were then checked for slippage and damage.



### Key

- 1 branch
- 2 main secured in mechanical device

Picture 2: Test arrangement

### Requirement:

Core slippage shall not exceed 3 mm. The cores shall maintain the test load for 60 s without breaking or any damage that would prevent the correct function of the cable.

## 3. Test results

Sample	Conductor configuration Main-Branch [mm <sup>2</sup> ]	60 s test load [kN]	Slippage [mm]	Result
1	Min - Min 16 - 1,5	0,023	0,0	passed
2			0,0	passed
3	Max - Min 150 - 1,5	0,023	0,0	passed
4			0,0	passed

Table 1: Test results.

### Summary

Connector fulfilled the test requirements.

# Laboratory Report

No.: 38338\_15S

Revision: A

Page: 5/5

## 4. Pictures



Picture 3: Test setup

## 5. Test equipment

ID	Type	Model	Purpose	Latest calibration
L212	Torque wrench	ADS25	Torque measurement	06.06.2016
L72	Force gauge	CFG	Force measurement	19.12.2017
L253	Stop watch	IHM	Timekeeping	26.10.2015
A250	Caliper	Digital caliper CD-15APX	Measuring dimensions	30.08.2017

## 6. Test Id

38338\_15

## 7. Revision history

A



---

**Test object:**

Waterproof insulation piercing connector SLIW52.

---

**Purpose of the test and relevant standards:**

Connector bolt tightening test according to EN 50483-4:2009 clause 8.1.2.3.

---

**Conclusion:**

The connector passed the test.



Picture 1: SLIW52

---

**Date of Report:** 4.5.2018

  
**Tested by:** Mika Karjalainen

  
**Approved by:** Janne Lappalainen



**Ordered by:** T. Virtanen  
**Distribution:** OHL PD-team

## ENSTO



# Laboratory Report

No.: 38338\_16S

Revision: A

Page: 2/5

## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Manufacturer: Ensto Finland Oy  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
Batch number: 0901182124  
No of pcs: 6

### Conductors:

Type: IMWS 3x150Al+1x70Alm  
Used cross section: 150 mm<sup>2</sup>  
Conductor material: Al  
Number of strands: 19  
Conductor diameter: 14 mm  
Conductor construction: Compacted  
Shape of conductor: Round  
Insulation material: XLPE  
Insulation thickness: 1,7 mm  
Core diameter: 17,3 mm  
Conductor MBL: 18 kN  
Max operating temperature: 90 °C  
Max short-circuit temperature: 250 °C  
Manufacturer: Silec Cable  
Country: France  
Refer to standard: NF C 33-209, HD626  
Conductor ID: 408

Type: AsXSn 4x16  
Used cross section: 16 mm<sup>2</sup>  
Conductor material: Al  
Number of strands: 7  
Conductor diameter: 4,7 mm  
Conductor construction: Compacted  
Shape of conductor: Round  
Insulation material: XLPE  
Insulation thickness: 1,1 mm  
Core diameter: 7,2 mm  
Conductor MBL: \*) 2,57 kN  
Max operating temperature: 90 °C  
Max short-circuit temperature: 250 °C  
Manufacturer: TF-Kable  
Country: Poland  
Refer to standard: ZN-TF-207:2007, PN-HD 626 S1:2002/A2:2003  
Conductor ID: 477

# Laboratory Report

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Revision: A

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Type:	ML 1,5
Used cross section:	1,5 mm <sup>2</sup>
Conductor material:	Cu
Number of strands:	1
Conductor diameter:	1,4 mm
Shape of conductor:	Round
Insulation material:	PVC
Insulation thickness:	0,8 mm
Core diameter:	2,7 mm
Conductor MBL:	*) 0,228 kN
Max operating temperature:	70 °C
Max short-circuit temperature:	160 °C
Manufacturer:	Draka
Country:	Finland
Refer to standard:	EN 50525-2-31 IEC / EN 60332-1
Conductor ID:	474

\*) Conductor MBL does not fulfill manufacturer or standard requirement or it is not known.  
MBL determined by pulling three conductor samples from each conductor phases.

MBL = Minimum value of pulled conductors x 0,95

# Laboratory Report

No.: 38338\_16S

Revision: A

Page: 4/5

## 2. Testing procedure

The test was done with three different conductor setups, main-branch: max-max, min-min and min-max. Two connectors were tested with each conductor setup. The connectors were installed to the conductors according to manufacturer's installation instructions. The main core, on which the IPC was installed on, was attached into a tensile test machine. The main core was tightened to 20 % of its MBL before the connector was installed. A short piece of conductor was used on branch side. The tightening torque was shear head maximum value +20 %. After the tightening the connectors were opened and checked for damage.

### Requirements

The connector shall be undamaged.

## 3. Test results

Sample	Conductor Main-Branch [mm <sup>2</sup> ]	Tension of main conductor, 20 % of MBL [kN]	Result
1	Max - Max 150 - 16	3,6	passed
2			passed
3	Min - Min 16 - 1,5	0,51	passed
4			passed
5	Min - Max 16 - 16	0,51	passed
6			passed

Table 1: Test results

### Summary

Connector fulfilled the test requirements.

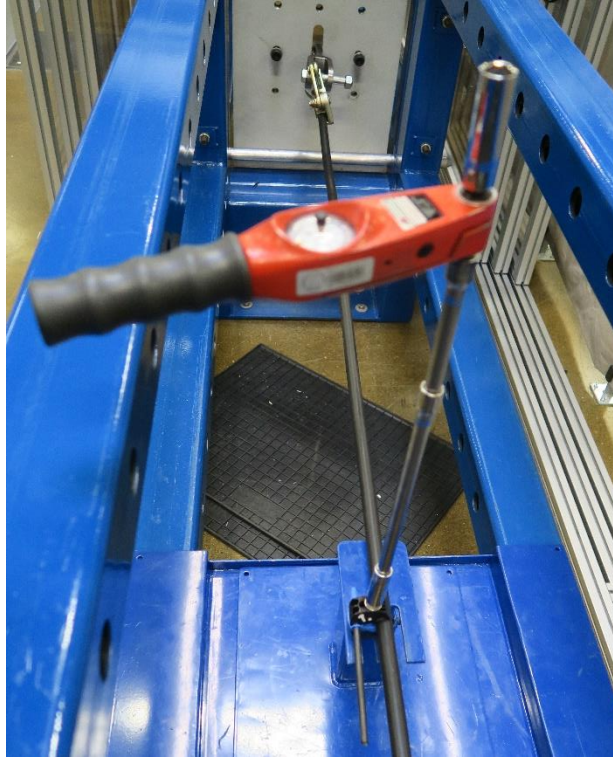
# Laboratory Report

No.: 38338\_16S

Revision: A

Page: 5/5

## 4. Pictures



Picture 2: Test setup

## 5. Test equipment

ID	Type	Model	Purpose	Latest calibration
L212	Torque wrench	ADS25	Torque measurement	06.06.2016
L369	Force sensor	1210AF-25kN-B	Force measurement	26.09.2017
T3	Tensile test machine	ForceProof	Tensile test	No calibration

## 6. Test Id

38338\_16

## 7. Revision history

A



*Saves Your Energy*

# WATERPROOF INSULATION PIERCING CONNECTOR SLIW52

## Type Test Report



**Test standard: EN50483, 2009**



**Contents**

**Document no**

1. Specification	SLIW52
2. Certificate	FI 28104
3. Test reports:	
3.1. Visual examination	2624S
3.2. Dimensional and material verification	2624S
3.3. Test for permanent marking	2625S
3.4. Dielectrical voltage test in water	2617S
3.5. Corrosion test	2640S
3.6. Climatic ageing test	2706S
3.7. Test for mechanical damage to main conductor	2612S
3.8. Branch cable pull-out test	2626S
3.9. Connector bolt tightening test	2616S
3.10. Low temperature assembly test	2614S
3.11. Shear head function test	2632S
3.12. Low temperature impact test	2613S
3.13. Electrical ageing test	2593S





# CERTIFICATE FI 28104

Our Ref. 272679-1

**Product** Connector for overhead line  
**Type** SLIW52  
**Trade mark** ENSTO  
**Certificate Holder/  
 Manufacturer** Ensto Finland Oy  
 Ensio Miettisen katu 2  
 FI-06150 PORVOO  
 FINLAND  
**Technical information** Main conductor Al / Cu 16 – 150 mm<sup>2</sup>  
 Branch conductor Al / Cu 1,5 – 16 mm<sup>2</sup>  
 Connector class A1  
**Other information** Waterproof insulation piercing connector, shear head screw.  
**The product is certified  
 according to the  
 following standard(s)** EN 50483-4:2009

**Validity** This certificate is valid until 18 June 2018 unless the standard in question has been amended or superseded with significant changes in requirements, in which case, SGS Fimko has the right to shorten the validity of the certificate based on the legislation of the European Union. This certificate includes the right to use the FI mark under the condition that changes (if any) will be checked at SGS Fimko before the product is brought onto market and that the conditions for FI certification are met.

**Date of issue** 18 June 2013

**Signature**  
**SGS Fimko Ltd**  
  
 Sixten Lökfors  
 Project Manager



This certificate has 1 appendix



This certificate is issued by the company under its General Conditions for Certification Services accessible at <http://www.sgs.fi/en/Terms-and-Conditions.aspx>. Attention is drawn to the limitations of liability defined therein and in the Test Report here above mentioned which findings are reflected in this certificate. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

SGS Fimko Ltd.

Särkiniementie 3 P.O.Box 30 FI-00211 Helsinki, Finland  
 t. +358 9 696 361 f. +358 9 692 5474 [www.sgs.fi](http://www.sgs.fi)

Business ID 0978538-5

Member of the SGS Group (SGS SA)

**Manufacturing site**

Ensto Ensek AS  
Paldiski mnt. 35 / 4A  
EE-76606 KEILA  
ESTONIA

**Additional information**

Tests made at manufacturer's premises.

Manufacturer's test reports: 2624S, 2625S, 2617S, 2640S, 2706S, 2612S, 2626S, 2616S, 2614S, 2632S, 2613S and 2593S





# SLIW52

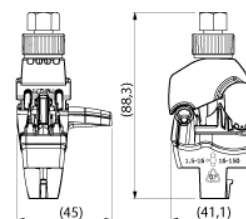
Name: **Insulation piercing connector**  
 16-150 mm<sup>2</sup> / 1.5-16 mm<sup>2</sup>, Waterproof

Type: SLIW52

EAN: 6438100312114

Description: SLIW52 is for use with insulated aluminium or copper conductors. Fully insulated bolt provides safe live line working. Both main and branch conductor insulations are pierced by single bolt action. Test voltage 6 kV/50 Hz/1 min in water. Connector's design enables live line installation without peeling insulation from conductor.

Package: 60  
 Unit: PCS



### Technical specification

Branch conductor mm<sup>2</sup>: 1,5 - 16  
 Main conductor mm<sup>2</sup>: 16 - 150  
 Weight (kg): 0.062  
 Conductor diameter mm: 7.0-18.6 / 3.0-7.8  
 Tightening torque Nm: 11 +/-1

Use: Connection when using insulated aluminum or copper conductors up to 1000V AC. Connector's design enables live line installation without peeling insulation from conductor.

Construction:	Component	Material
	Body and Seal	Heat and UV resistance two components insert molding of composite polymer and elastomer
	Contact plate	Tin plated corrosion resistant aluminum alloy
	Bolt	Coated stainless steel
	Nut with shear-head	Aluminum alloy
	Washer	Stainless steel
	End-cap	UV resistance elastomer

Installation: Unscrew the connector to have enough space for conductors. Place the conductors into the grooves and end-cap. Tighten the screw until shear-head breaks.

Tools required: 13mm hexagonal socket wrench, fork wrench ST34

Markings: ENSTO, SLIW52, 16-150, 1.5-16, production date,

Standard: EN 50483-4:2009, Connector class A1



Saves Your Energy

## LABORATORY REPORT

No.: 2624S

Revision: A

Page: 1/4

Date of Test: 11.12.2012

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### Test object:

Waterproof insulation piercing connector SLIW52.

---

### Purpose of the test and relevant standards:

Part of type test.

Visual examination test and Dimensional and material verification test, according to EN 50483-1:2009 Annex A, table A.1 and clause 6 Marking.

---

### Conclusion:

The connector passed the test.



Picture 1: Tested connector SLIW52



---

**Date of Report:** 12.12.2012

*Arne Liljeström*  
**Tested by:** Arne Liljeström

*Sami Hakonen*  
**Supervised by:** Sami Hakonen / SGS Fimko

*Janne Lappalainen*  
**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team



## 1. Test objects

Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Batch number:	20121107
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
No of pcs:	1

## 2. Testing procedure

The test was performed against the manufacturer specification sheet and standard requirement. The test included the visual examination part and the dimensional and material verification part.

### **Requirement:**

The connector shall fulfil the manufacturer specification data and standard requirement.



### 3. Test results

#### Visual examination:

The connector was visually looking the same as in the drawing.

All markings required by the standard were found.

Manufacturer's logo, ENSTO  
Product code, SLIW52  
Batch number (production date), 20121107  
Minimum and maximum cross section  
Main, 16-150  
Branch, 1,5-16  
Recycling code, 07

#### Dimensional and material verification:

Distance	Requirement [mm]	Measured [mm]
Height	(88)	88,4
Length	(41)	40,7
Width	(45)	44,0

Table 1: Dimensions of the connector

Component	Material	Matching specification
Body and seal	Heat and UV resistant composite polymer and elastomer	Yes
Contact plate	Tin plated corrosion resistant aluminium alloy	Yes
Bolt	Coated stainless steel	Yes
Nut with shear-head	Aluminium alloy	Yes
Washer	Stainless steel	Yes
End cap	UV resistant elastomer	Yes

Table 2: Materials of the connector

#### Summary:

The connector fulfilled all test requirements.

4. Pictures



Picture 2: Connector in the test

5. Test equipment

ID	Type	Model	Purpose	Latest calibration
A221	Slide gauge	Sylvac	Measuring dimensions	20.12.2011

6. Test Id

2031 and 2032

7. Revision history

A



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## LABORATORY REPORT

No.: 2625S

Revision: A

Page: 1/3

Date of Test: 11.12.2012

---

### Test object:

Waterproof insulation piercing connector SLIW52.

---

### Purpose of the test and relevant standards:

Part of type test.

Test for permanent marking acc. to EN 50483-1:2009 clause 9.2.

---

### Conclusion:

The connector passed the test.



Picture 1: Tested connector SLIW52



---

**Date of Report:** 12.12.2012

*Arne Liljeström*  
**Tested by:** Arne Liljeström

*Janne Lappalainen*  
**Reviewed by:** Janne Lappalainen

*Sami Hakonen*  
**Supervised by:** Sami Hakonen / SGS Fimko

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team



## 1. Test objects

Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Batch number:	20121107
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
No of pcs:	2

## 2. Testing procedure

The test procedure was acc. to standard.

The marking of the connector was rubbed by hand for 15 s with a piece of cloth soaked with water and another 15 s with a piece of cloth soaked with petroleum spirit.

The petroleum spirit used was Mineral turpentine from KIILTO / Finland

### **Requirement:**

The marking shall remain clear and allow the accessory to be easily identified.

## 3. Test results

The marking remained clear and was not at all affected of the rubbing.



**4. Pictures**



Picture 2: Connector after the test

**5. Test equipment**

ID	Type	Model	Purpose	Latest calibration
L253	Timer	IHM	timing of test	16.10.2012

**6. Test Id**

972

**7. Revision history**

A





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**Test object:**

Waterproof insulation piercing connector SLIW52.

---

**Purpose of the test and relevant standards:**

Part of type test.

Dielectric voltage test in water according to EN 50483-4:2009 clause 8.1.3.1.3.1.

---

**Conclusion:**

The connector passed the test.



Picture 1: Tested connector SLIW52



---

**Date of Report:** 7.12.2012

*Arne Liljeström*  
**Tested by:** Arne Liljeström

*Sami Hakonen*  
**Supervised by:** Sami Hakonen / SGS Fimko

*Janne Lappalainen*  
**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team



## 1. Test objects

### Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Batch number:	20121107
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
Shear head range:	11 ±1 Nm
No of pcs:	4

### Conductors:

Type:	IMWS RZ 0,6/1 kV NF C 33-209 3x150+70 mm <sup>2</sup>
Used cross section:	150 mm <sup>2</sup>
Manufacturer/country:	Silec Cable / France
Insulation thickness:	2,2 mm
Core diameter:	18,5 mm
Number of strands:	19
Insulation material:	XLPE
Conductor material:	Aluminum
Refer to standard:	6E HD626:S1
Conductor ID:	104

Type:	AsXSn 4x16 mm <sup>2</sup>
Used cross section:	16 mm <sup>2</sup>
Manufacturer/country:	TF-Kable / Poland
Insulation thickness:	1,1 mm
Core diameter:	6,8 mm
Number of strands:	7
Insulation material:	XLPE
Conductor material:	Aluminium
Refer to standard:	4J HD626:S1
Conductor ID:	127

Type:	ML 1,5 mm <sup>2</sup>
Used cross-sections:	1,5 mm <sup>2</sup>
Manufacturer/Country:	Kajote / Finland
Thickness of insulation:	0,7 mm
Core diameter:	2,8 mm
Number of strands:	1
Insulation material:	PVC
Conductor material:	Copper
Refer to standard:	HD 21.3 S3, H07V-U
Conductor ID:	139



## 2. Testing procedure

The test was done with 2 + 2 connectors on two different conductor setups, main-branch: max-min and min-min.

The connectors were installed to the conductors acc. to manufacturer's installation instructions. The tightening torque was shear head minimum value.

The two connectors for same conductor setup were installed on the same conductors. The connector assembly was put horizontally at the bottom of a water container with a water level of 30 cm above the upper part of the connector. The water was normal tap water and the conductors were bent so that one end was above the water level and the other end was sealed with an end cap.

The connectors were kept in water for 30 minutes before the voltage was applied to the conductor.

The voltage was raised with a rate of 1 kV per second up to 4 kV AC, where it was kept for 60 seconds. After that the voltage was raised to 6 kV and kept also there for 60 seconds.

### Requirement:

No breakthrough should occur between the conductive parts and the earthed water with the 4 kV voltage during 60 s. The leakage current must stay below  $10 \pm 0,5$  mA during this period..

## 3. Test results

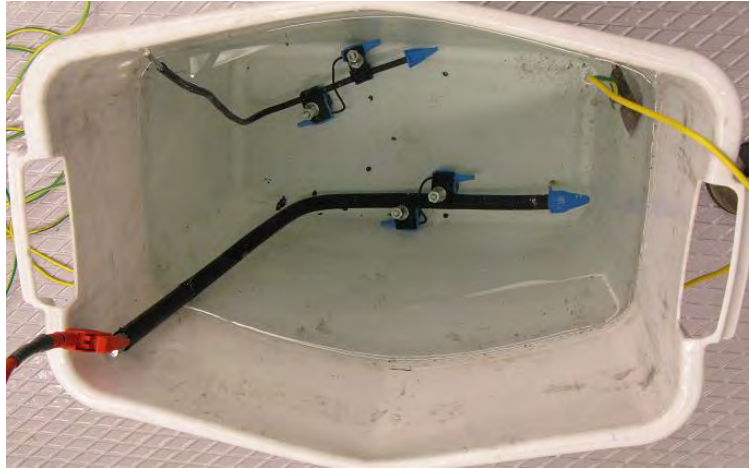
Sample	Conductor Main-Branch [mm <sup>2</sup> ]	Leakage current [mA]	
		4kV / 1min	6kV / 1min
1	Min - Min 16 – 1,5	0,5	0,7
2			
3	Max - Min 150 – 1,5	0,8	1,2
4			

Table 1: Test data

### Summary:

All samples fulfilled the standard requirement at 4 kV and also the higher test of 6 kV.

**4. Pictures**



Picture 2: Samples in test

**5. Test equipment**

ID	Type	Model	Purpose	Latest calibration
L190	Torque wrench	ADS25	Torque measurement	14.05.2012
L22	High voltage test set	PGK 150/5	High voltage testing	03.05.2012

**6. Test Id**

966

**7. Revision history**

A



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## LABORATORY REPORT

No.: 2640S

Revision: A

Page: 1/6

Date of Tests: 20.11.2012 – 4.1.2013

---

### Test object:

Waterproof insulation piercing connector SLIW52.

---

### Purpose of the test and relevant standards:

Part of type test.

Corrosion ageing test according to EN 50483-4 clause 8.1.5.1.3.2 and EN 50483-6 clause 8.4.2.2

Gas atmosphere (Method 2).

---

### Conclusion:

The connector passed the test.



Picture 1: Tested connector SLIW52



---

**Date of Report:** 7.1.2013

**Tested by:** Ola Forsström

**Supervised by:** Sami Hakonen / SGS Fimko

**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski

**Distribution:** ATo, PDe, MiH, KGa



## 1. Test objects

### Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Batch number:	20121107
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
Shear head range:	11 ± 1 Nm
No of pcs:	2

### Conductors:

Type:	AsXSn 4x16 mm <sup>2</sup>
Used cross-section:	16 mm <sup>2</sup>
Manufacturer/Country:	TF Kable / Poland
Insulation thickness:	1,1 mm
Core diameter:	6,8 mm
Number of strands:	7
Insulation material:	XLPE
Conductor material:	Aluminium
Refer to standard:	4J HD626:S1
Conductor ID:	127

Type:	ML 1,5 mm <sup>2</sup>
Used cross-section:	1,5 mm <sup>2</sup>
Manufacturer/Country:	Draka / Finland
Insulation thickness:	0,7 mm
Core diameter:	2,8 mm
Number of strands:	1
Insulation material:	PVC
Conductor material:	Copper
Refer to standard:	H07V-U





## 2. Testing procedure

Two samples were subjected to the corrosion ageing test.

The connectors were installed onto short pieces of insulated conductors in a min - min conductor combination on main - branch. The installation torque was shear head minimum.

The samples were photographed before the test, after every test week and after finishing the test. On completion of the test the samples were washed in running tap water for five minutes and after that five minutes in demineralized water. After washing, the samples were dried by shaking by hand.

The salt solution used consisted of demineralized water mixed with 0,05 % sodium chloride (NaCl) and 0,35 % ammonium sulphate (NH<sub>4</sub>)<sub>2</sub>(SO<sub>4</sub>) by mass. The amount of total impurities in the used salts was ≤ 0,01 % (standard says ≤ 0,3%). The pH of each batch of solution added to the test chamber's saline water tank was measured with a pH meter, and all readings were within the limits specified by the standard (pH 5,0 to 5,4). The test cycle consisted of a 1 hour drying period at 35 °C and a 1 hour fog period at ambient temperature 25 °C. This cycle was repeated 500 times for a total of 1000 hours.

Test settings:

pH of salt solution:	5,0 – 5,2
Compressed air supply pressure:	1,0 bar
Saline water through-flow:	200 cm <sup>3</sup> /h
Temperature of water used for washing:	30 °C

A calculation shows that a saline water through-flow of 200 cm<sup>3</sup>/h equals approximately 1,8 ml collected solution per hour for each 80 cm<sup>2</sup> of horizontal collecting area in the test chamber measuring 570 x 1560 mm. This was also confirmed in a separately performed test. The standard requirement is 1,0 to 2,0 ml collected solution.

### **Requirements:**

A visual inspection shall be carried out and there shall be no significant trace of red rust (more than 10% of the exposed surface area of the metallic parts). The sample's identification marking shall be legible when examined with normal or corrected vision, without magnification. No deterioration of the connectors shall occur which would impair their normal function. For a connector designed with a shear head it shall be able to be removed with a torque below or equal to the manufacturer's specified maximum torque.



### 3. Test results

In the visual inspection some rusting was visible on the bolt of one connector but the deterioration was not significant enough to impair the normal function. The identification marking was legible. The shear head opening torque after the corrosion test was much lower than required by the standard for both samples.

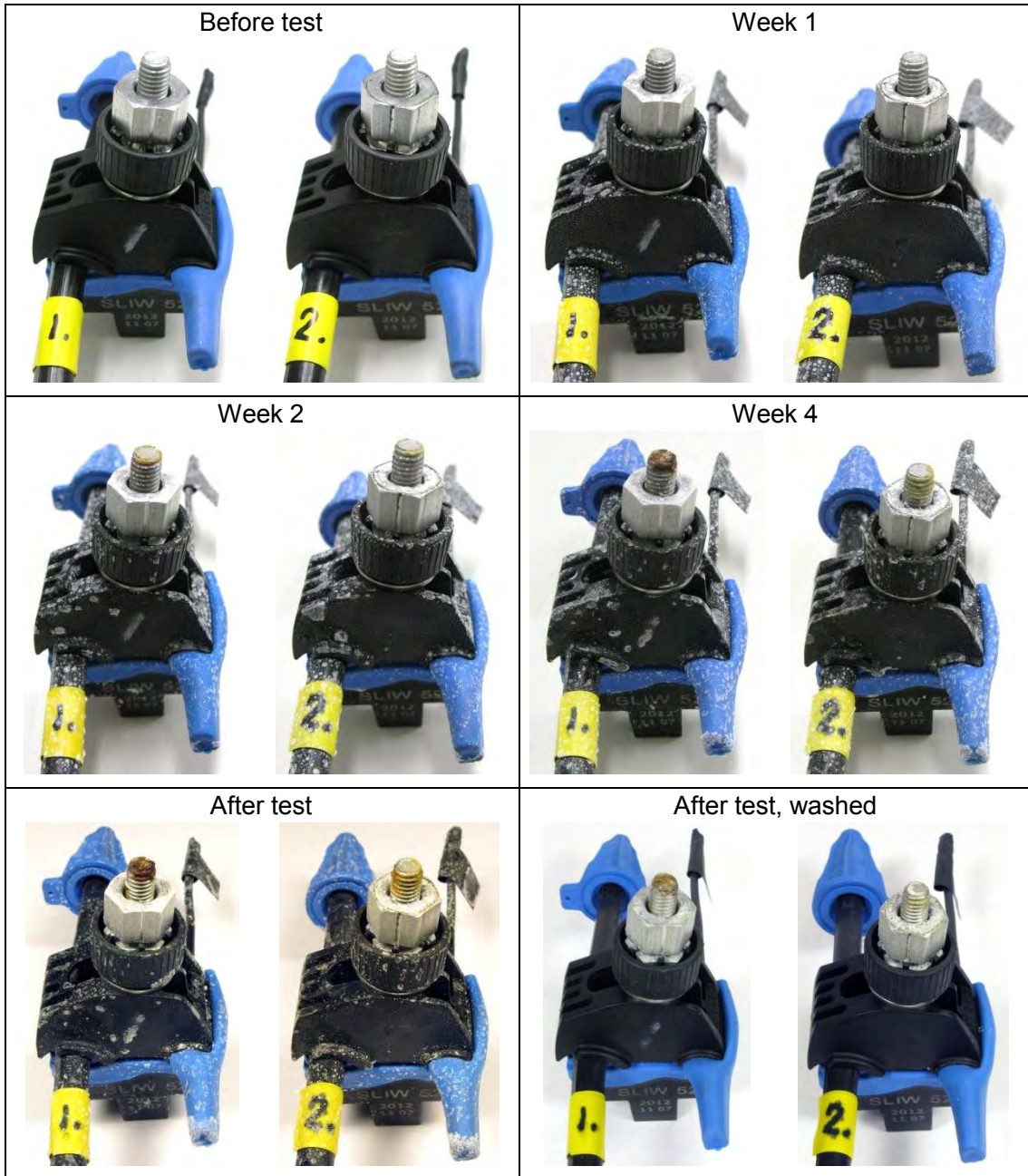
Sample	Conductor Main-Branch [mm <sup>2</sup> ]	Opening torque [Nm]	Result
1	Min - Min 16 - 1,5	3,2	Passed
2	Min - Min 16 - 1,5	3,4	Passed

**Summary:**

All samples fulfilled the test requirements.



4. Pictures



Picture 2: SLIW52, samples 1 and 2



Picture 3: Identification marking after test



5. Test equipment

ID	Type	Model	Purpose	Latest calibration
L245	Corrosion Chamber	SC / KWT 1000	Corrosion testing	15.05.2012
L257	pH/Temperature Tester	H198127	Measuring pH and temperature	Calibrated when used
L262	pH7.01	HI7007L/C	Reference material	26.01.2012
L261	pH4.01	HI7004L/C	Reference material	30.08.2012
L87	Multimeter	Fluke 87V	Temperature measurement	17.10.2012
L190	Torque wrench	ADS25	Torque measurement	14.05.2012

6. Test Id

965

7. Revision history

A



**LABORATORY REPORT**

No.: 2706S

Revision: A

Page: 1/7

Date of Tests: 14.2.2013 -

11.04.2013

---

**Test object:**

Waterproof insulation piercing connector SLIW52.

---

**Purpose of the test and relevant standards:**

Part of type test.

Climatic ageing test, method 2 (UV-test), according to EN50483-4:2009 clause 8.1.5.3.2, dielectrical voltage test in air, according to method 1, clause 8.1.3.1.3.2 and dielectrical voltage test in water according to clause 8.1.3.1.3.1.

---

**Conclusion:**

The connector passed the.





Picture 1: Tested connector SLIW52



---

**Date of Report:** 16.05.2013

  
**Tested by:** Arne Liljeström

  
**Supervised by:** Sami Hakonen / SGS Fimko

  
**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL-PD team



## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Batch number: 201301  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
No of pcs: 4

Type: Waterproof insulation piercing connector SLIW52, with RFL12 grease used in tube as replacement of normally used RFL8.  
Connector class: A1  
Batch number: 201301  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
No of pcs: 4

### Conductors:

Type: IMWS RZ 0,6/1 kV NF C 33-209 3x150+70 mm<sup>2</sup>  
Used cross section: 150 mm<sup>2</sup>  
Manufacturer/country: Silec Cable / France  
Insulation thickness: 2,2 mm  
Core diameter: 18,5 mm  
Number of strands: 19  
Insulation material: XLPE  
Conductor material: Aluminum  
Refer to standard: 6E HD626:S1  
Conductor ID: 104

Type: AsXSn 4x16 mm<sup>2</sup>  
Used cross section: 16 mm<sup>2</sup>  
Manufacturer/country: TF-Kable / Poland  
Insulation thickness: 1,1 mm  
Core diameter: 6,8 mm  
Number of strands: 7  
Insulation material: XLPE  
Conductor material: Aluminium  
Refer to standard: 4J HD626:S1  
Conductor ID: 127

Type: ML 1,5 mm<sup>2</sup>  
Used cross-sections: 1,5 mm<sup>2</sup>  
Manufacturer/Country: Kajote / Finland  
Thickness of insulation: 0,7 mm  
Core diameter: 2,8 mm  
Number of strands: 1  
Insulation material: PVC  
Conductor material: Copper  
Refer to standard: HD 21.3 S3, H07V-U  
Conductor ID: 155

2. **Testing procedure**

2.1 **Simulated solar radiation test (UV-test)**

The test was carried out in an enclosure, where an irradiance of 0,83 kW/m<sup>2</sup> with the spectral distribution given in Table 1 was provided over an irradiation measurement plane of 900 mm x 900 mm. This value includes any radiation reflected from the test enclosure. The radiation was produced with 20 pcs of 300 W Ultra-Vitalux lamps of Osram with burning age (50%) 1000 h. The distance to the measurement plane was 700 mm.

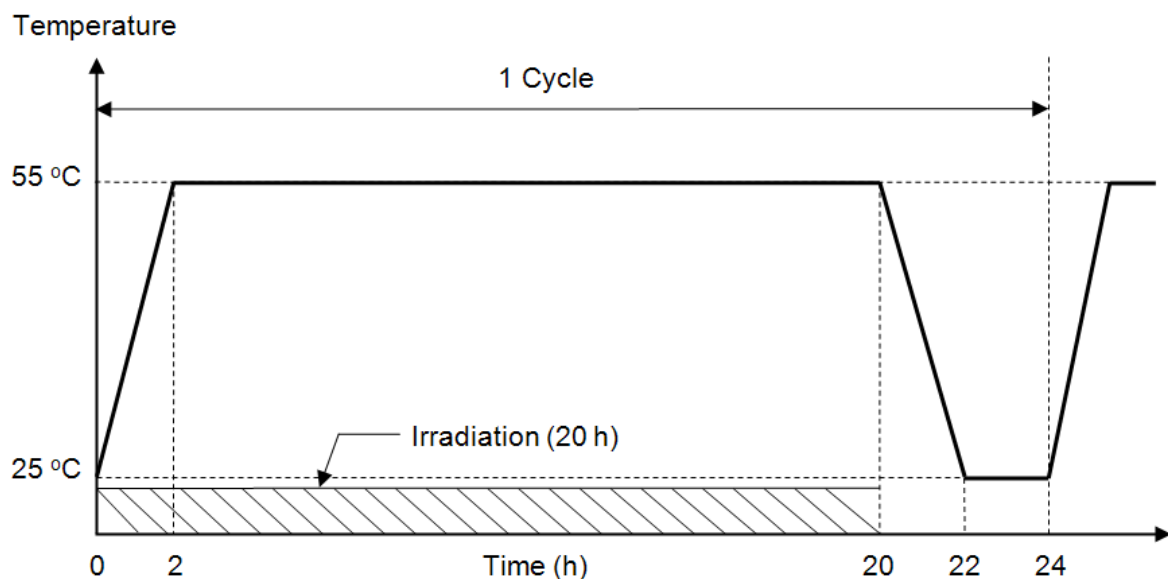
The test consists of 56 daily cycles (8 weeks). Each cycle consist of 20 h irradiation and 4 h darkness, Picture 2. The temperature was maintained at 55±2 °C during the irradiation period and at 25±2 °C during the darkness period. The temperature was measured with a thermocouple in a point 40 mm below the measurement plane at half the distance between the specimen and the wall.

**Deviation**

The irradiance of the visible light inside the test chamber does not fulfil the requirement of the standard. Visible light affects the visual colour and heating of the surface of the test item. This is non-critical for the test result, since the visual colour is not an issue if the markings can be seen. The temperature in the test chamber is continuous controlled by a cooling fan so the surface temperature of the test item is kept stable regarding of the generated heat.

Spectral region	Ultra-violet B	Ultra-violet A	Visible			Infra-red
Bandwidth	0,28 µm - 0,32 µm	0,32 µm - 0,40 µm	0,40 µm - 0,52 µm	0,52 µm - 0,64 µm	0,64 µm - 0,78 µm	0,78 µm - 3,00 µm
Irradiance measured	9,1 W/m <sup>2</sup>	47,3 W/m <sup>2</sup>	53,0 W/m <sup>2</sup>	105,1 W/m <sup>2</sup>	33,3 W/m <sup>2</sup>	578,6 W/m <sup>2</sup>
Std. requirements Irradiance Tolerance	5 W/m <sup>2</sup> ±35 %	63 W/m <sup>2</sup> ±25 %	200 W/m <sup>2</sup> ±10 %	186 W/m <sup>2</sup> ±10 %	174 W/m <sup>2</sup> ±10 %	492 W/m <sup>2</sup> ±20 %

Table 1: Spectral energy distribution and permitted tolerances



Picture 2: Temperature-radiation-time relationships





## 2.2 Dielectrical voltage test

For the both connector types the test was done with two different conductor setups, main-branch: max-min and min-min. Two connectors were tested with both setups. The connectors were installed to the conductors before the simulated solar radiation test. The conductors were bent appropriately for the dielectric voltage test in water. The connectors were installed according to manufacturer's installation instructions. The tightening torque was shear head minimum value. The two connectors for the same conductor setup were both installed on the same conductors.

First the voltage test in air was performed. The assembly was covered with metallic balls having a diameter of 1,6 mm. The balls were earthed and the voltage was applied to the conductor. The voltage was raised with a rate of 1 kV per second up to 4 kV AC, where it was kept for 60 seconds.

After the voltage test in air the connector assembly was taken out of the balls. The assembly was then put horizontally at the bottom of a water container with a water level of 30 cm above the upper part of the connector. The water was normal tap water. The connectors were kept in water for 30 minutes before the voltage was applied to the conductor. The voltage was raised with a rate of 1 kV per second up to 1 kV AC, where it was kept for 60 seconds.

### Requirements

#### Simulated solar radiation test (UV-test):

The sample may not have any degradation, which could affect the normal function and the identification marking shall be legible.

#### Dielectrical voltage test:

No breakthrough should occur between the conductive parts and the earthed balls with a 4 kV voltage or the conductive parts and the earthed water with a 1 kV voltage. The voltage is kept for 60 seconds in both cases and the leakage current must stay below  $10 \pm 0,5$  mA during this period.



3. Test results

Sample	Grease	Conductor Main- Branch [mm <sup>2</sup> ]	Leakage current [mA]	
			Test in AIR 4kV / 1min	Test in WATER 1kV / 1min
1	RFL8	Min - Min 16 - 1,5	0,42	0,20
2				
3		Max - Min 150 - 1,5	0,52	1,35
4				
5	RFL12	Min - Min 16 - 1,5	0,42	0,80
6				
7		Max - Min 150 - 1,5	0,55	1,54
8				

Table 2: Dielectric voltage test results

**Ambient conditions in dielectric test:**

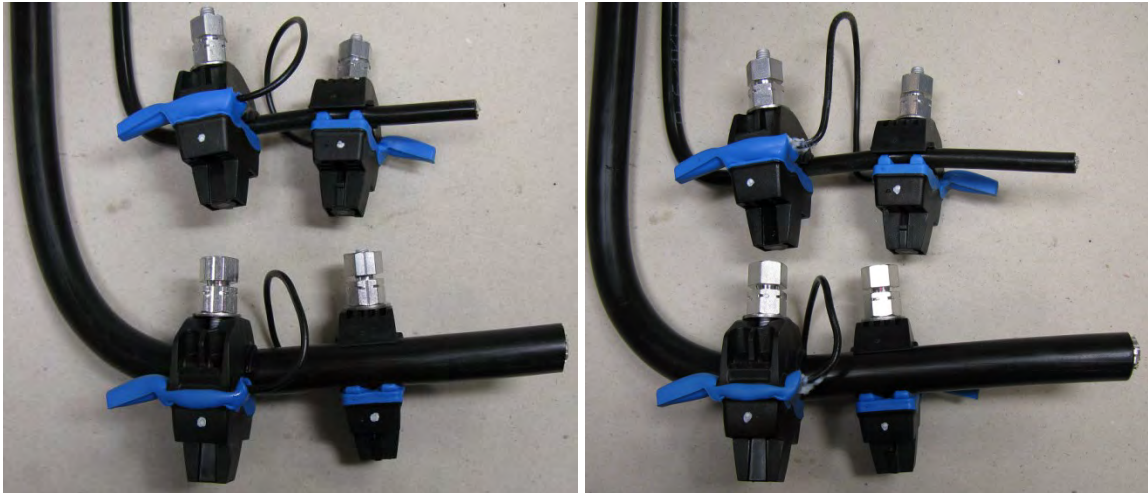
Temperature: 20,8 °C  
Relative humidity: 28,2 %

**Summary:**

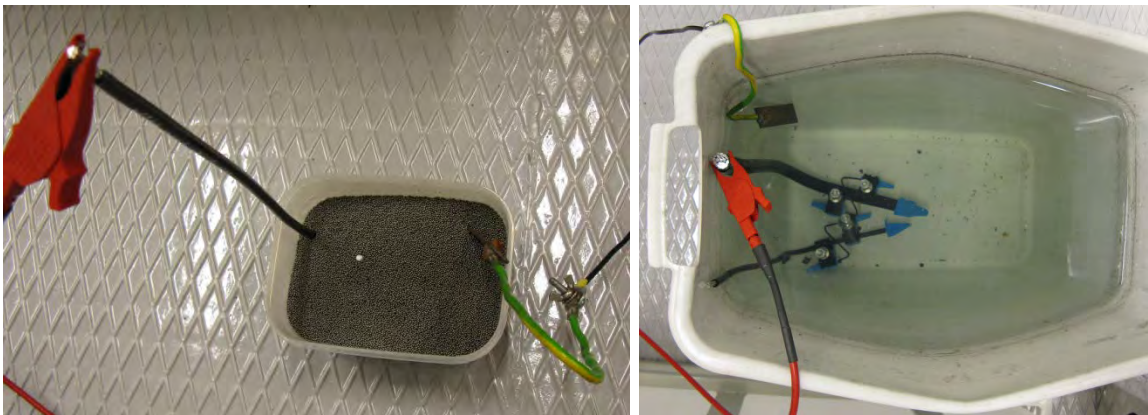
The connector passed the test with both type of grease RFL8 (transparent) and RFL12 (white). No visual degradation could be noticed and the markings were clearly legible after the climatic aging test.

All samples also fulfilled the standard requirement of the dielectrical voltage test at 4 kV in air and at 1 kV in water.

4. Pictures



Picture 3 (grease RFL8) and Picture 4 (grease RFL12): Samples after the solar radiation test



Picture 5 and Picture 6: Test setup for dielectric test in air and in water





5. Test equipment

ID	Type	Model	Purpose	Latest calibration
L212	Torque wrench	ADS25	Torque measurement	14.05.2012
UV1	UV-radiation chamber	Ensto	Climate testing	No calibration
L112	Thermometer	CENTER 309	Temperature measurements	10.02.2012
L211	High voltage test set	GLP2i Schleich GmbH	High voltage testing	03.05.2012
L223	Thermometer	Testo 623	Temperature and relative humidity	04.01.2012

6. Test Id

2124

7. Revision history

A



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**Test object:**

Waterproof insulation piercing connector SLIW52.

---

**Purpose of the test and relevant standards:**

Part of type test.

Mechanical damage to main conductor test according to EN 50483-4:2009 clause 8.1.2.1.

---

**Conclusion:**

The connector passed the test.



Picture 1: Tested connector SLIW52



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**Date of Report:** 7.12.2012

**Tested by:** Arne Liljeström

**Supervised by:** Sami Hakonen / SGS Fimko

**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team



## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Batch number: 20121107  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
No of pcs: 6

### Conductors:

Type: IMWS RZ 0,6/1 kV NF C 33-209 3x150+70 mm<sup>2</sup>  
Used cross section: 150 mm<sup>2</sup>  
Manufacturer/country: Silec Cable / France  
Insulation thickness: 2,2 mm  
Core diameter: 18,5 mm  
Number of strands: 19  
Insulation material: XLPE  
Conductor material: Aluminum  
Refer to standard: 6E HD626:S1  
Conductor ID: 104

Type: AsXSn 4x16 mm<sup>2</sup>  
Used cross section: 16 mm<sup>2</sup>  
Manufacturer/country: TF-Kable / Poland  
Insulation thickness: 1,1 mm  
Core diameter: 6,8 mm  
Number of strands: 7  
Insulation material: XLPE  
Conductor material: Aluminium  
Refer to standard: 4J HD626:S1  
Conductor ID: 127

Type: ML 1,5 mm<sup>2</sup>  
Used cross-sections: 1,5 mm<sup>2</sup>  
Manufacturer/Country: Kajote / Finland  
Thickness of insulation: 0,7 mm  
Core diameter: 2,8 mm  
Number of strands: 1  
Insulation material: PVC  
Conductor material: Copper  
Refer to standard: HD 21.3 S3, H07V-U  
Conductor ID: 139

## 2. Testing procedure

The test was done with three different conductor setups, main-branch: max-max, min-min and min-max. Two connectors were tested simultaneously with each conductor setup. The connectors were installed to the conductors according to manufacturer's installation instructions. The main core, on which the IPC was installed, was attached into a tensile test machine and tightened to 15 % of its MBL before installation of the connector. The length of the main core was between 0,5 and 1,5 m. The tightening torque was shear head maximum value. A tensile load was applied to the main core according to standard:

System type	Conductor	Tensile test load
Self supporting	Aluminium (16 to 25 mm <sup>2</sup> )	1200 N or 40 % MBL of the cable, whichever is less
Neutral messenger	Phase	60 % MBL of the cable

Table 1: Tensile loads for conductors

The load was maintained for 60 s.

### Requirement:

The cores shall maintain the test load for 60 s without breaking or any damage that would prevent the correct function of the cable.

## 3. Test results

Sample	Conductor configuration Main-Branch [mm <sup>2</sup> ]	MBL of main core [kN]	60 s test load [kN]	Damage of main core
1	Max - Max 150 - 16	18,0	10,8 (60 % MBL)	No
2				
3	Min - Min 16 - 1,5	2,8	1,2	No
4				
5	Min - Max 16 - 16	2,8	1,2	No
6				

Table 2: Test data

All connectors were tightened to 12 Nm, shear head maximum value.

### Summary:

All samples fulfilled the test requirements.

4. Pictures



Picture 2: Samples in test

5. Test equipment

ID	Type	Model	Purpose	Latest calibration
L190	Torque wrench	ADS25	Torque measurement	14.05.2012
T1	Tensile test machine	Matertest	Tensile test	No calibration
L110	Loadcell	1210AF-50kN-B	Force measurement	23.08.2012

6. Test Id

971

7. Revision history

A



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**Test object:**

Waterproof insulation piercing connector SLIW52.

---

**Purpose of the test and relevant standards:**

Part of type test.

Branch cable pull-out test according to EN 50483-4:2009 clause 8.1.2.2.

---

**Conclusion:**

The connector passed the test.




Picture 1: Tested connector SLIW52



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**Date of Report:** 12.12.2012

  
**Tested by:** Arne Liljeström

  
**Supervised by:** Sami Hakonen / SGS Fimko

  
**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team



## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Batch number: 20121107  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
No of pcs: 4

### Conductors

Type: IMWS RZ 0,6/1 kV NF C 33-209 3x150+70 mm<sup>2</sup>  
Used cross section: 150 mm<sup>2</sup>  
Manufacturer/country: Silec Cable / France  
Insulation thickness: 2,2 mm  
Core diameter: 18,5 mm  
Number of strands: 19  
Insulation material: XLPE  
Conductor material: Aluminum  
Refer to standard: 6E HD626:S1  
Conductor ID: 104

Type: AsXSn 4x16 mm<sup>2</sup>  
Used cross section: 16 mm<sup>2</sup>  
Manufacturer/country: TF-Kable / Poland  
Insulation thickness: 1,1 mm  
Core diameter: 6,8 mm  
Number of strands: 7  
Insulation material: XLPE  
Conductor material: Aluminium  
Refer to standard: 4J HD626:S1  
Conductor ID: 127

Type: ML 1,5 mm<sup>2</sup>  
Used cross-sections: 1,5 mm<sup>2</sup>  
Manufacturer/Country: Kajote / Finland  
Thickness of insulation: 0,7 mm  
Core diameter: 2,8 mm  
Number of strands: 1  
Insulation material: PVC  
Conductor material: Copper  
Refer to standard: HD 21.3 S3, H07V-U  
Conductor ID: 139





## 2. Testing procedure

The test was done with two different conductor setups, main-branch: min-min and max-min. Two connectors were tested with each conductor setup.

The connectors were installed to the conductors according to manufacturer's installation instructions. The lengths of the conductors were between 0,2 and 0,5 m. The tightening torque was shear head maximum value. The core was marked at the connector so that any slippage during the test could be measured. The connector assembly was attached into a test assembly where a weight was used to set the correct load. A tensile load was axially applied to the branch conductor. The load was 10 % of the MBL of the branch conductor and it was maintained for 60 seconds. The cores were then checked for slippage and damage.

### Requirement:

Core slippage shall not exceed 3 mm.

The cores shall maintain the test load for 60 s without breaking or any damage that would prevent the correct function of the cable.

## 3. Test results

The conductor MBL for ML 1,5 mm<sup>2</sup> had to be determined, because there was no factory value available. Three samples of conductor were pulled in the tensile test machine with a speed of 50 N/s until the conductor broke. MBL was determined as 90 % of the mean break value.

Test	Break	Mean	MBL [kN]
1	0,24	0,24	0,216
2	0,24		
3	0,24		

Table 1: MBL of conductor ML 1,5 mm<sup>2</sup>

Sample	Conductor Main-Branch [mm <sup>2</sup> ]	Test load, 60 s at 10 % of MBL [N]	Core slippage [mm]	Core damage
1	Min - Min 16 – 1,5	22	0	No damage
2			0	No damage
3	Min - Min 150 – 1,5	22	0	No damage
4			0	No damage

Table 2: Test data

### Summary:

All samples fulfilled the standard requirements.



**4. Pictures**



Picture 2: Sample in test

**5. Test equipment**

ID	Type	Model	Purpose	Latest calibration
L190	Torque wrench	ADS25	Torque measurement	14.05.2012
L72	Force gauge	CFG	Force measurement	11.10.2012

**6. Test Id**

962

**7. Revision history**

A



Saves Your Energy

## LABORATORY REPORT

No.: 2616S

Revision: A

Page: 1/4

Date of Test: 5.12.2012

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### Test object:

Waterproof insulation piercing connector SLIW52.

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### Purpose of the test and relevant standards:

Part of type test.

Connector bolt tightening test according to EN 50483-4:2009 clause 8.1.2.3.

---

### Conclusion:

The connector passed the test.




Picture 1: Tested connector SLIW52




---

**Date of Report:** 7.12.2012

**Tested by:**  Arne Liljeström

**Reviewed by:**  Janne Lappalainen

**Supervised by:**  Sami Hakonen / SGS Fimko

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team



## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Batch number: 20121107  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
No of pcs: 6

### Conductors:

Type: IMWS RZ 0,6/1 kV NF C 33-209 3x150+70 mm<sup>2</sup>  
Used cross section: 150 mm<sup>2</sup>  
Manufacturer/country: Silec Cable / France  
Insulation thickness: 2,2 mm  
Core diameter: 18,5 mm  
Number of strands: 19  
Insulation material: XLPE  
Conductor material: Aluminum  
Refer to standard: 6E HD626:S1  
Conductor ID: 104

Type: AsXSn 4x16 mm<sup>2</sup>  
Used cross section: 16 mm<sup>2</sup>  
Manufacturer/country: TF-Kable / Poland  
Insulation thickness: 1,1 mm  
Core diameter: 6,8 mm  
Number of strands: 7  
Insulation material: XLPE  
Conductor material: Aluminium  
Refer to standard: 4J HD626:S1  
Conductor ID: 127

Type: ML 1,5 mm<sup>2</sup>  
Used cross-sections: 1,5 mm<sup>2</sup>  
Manufacturer/Country: Kajote / Finland  
Thickness of insulation: 0,7 mm  
Core diameter: 2,8 mm  
Number of strands: 1  
Insulation material: PVC  
Conductor material: Copper  
Refer to standard: HD 21.3 S3, H07V-U  
Conductor ID: 139



## 2. Testing procedure

The test was done with 2 + 2 + 2 connectors at three different conductor setups, main-branch: max-max, min-min and min-max.

The connectors were installed to the conductors acc. to manufacturer's installation instructions. The main conductor was tensioned to 20 % of its MBL. A short piece of conductor was used on branch side. The tightening torque was shear head maximum value + 20 %.

After the tightening the connectors were opened and checked for damage.

### Requirement:

The connector shall be undamaged.

## 3. Test results

All connectors were tightened to 14,4 Nm, shear head max + 20 %.

Sample	Conductor Main-Branch [mm <sup>2</sup> ]	Tension of main conductor, 20 % of MBL [kN]	Result
1	Max - Max 150 - 16	3,6	No damage
2			No damage
3	Min - Min 16 - 1,5	0,6	No damage
4			No damage
5	Min - Max 16 - 16	0,6	No damage
6			No damage

Table 1: Test data

**Summary:** All samples fulfilled the test requirements.

**4. Pictures**



Picture 2: Sample in test

**5. Test equipment**

ID	Type	Model	Purpose	Latest calibration
L190	Torque wrench	ADS25	Torque measurement	14.05.2012
T1	Tensile test machine	Matertest	Tensile test	No calibration
L110	Loadcell	1210AF-50kN-B	Force measurement	23.08.2012

**6. Test Id**

964

**7. Revision history**

A



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**Test object:**

Waterproof insulation piercing connector SLIW52.

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**Purpose of the test and relevant standards:**

Part of type test.

Low temperature assembly test according to EN 50483-4:2009 clause 8.1.4.

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**Conclusion:**

The connector passed the test.

See **3. Test results** for detailed data.



Picture 1: Tested connector SLIW52



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**Date of Report:** 7.12.2012

**Tested by:** Arne Liljeström

**Supervised by:** Sami Hakonen / SGS Fimko

**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team





## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Batch number: 20121107  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
No of pcs: 6

### Conductors

Type: IMWS RZ 0,6/1 kV NF C 33-209 3x150+70 mm<sup>2</sup>  
Used cross section: 150 mm<sup>2</sup>  
Manufacturer/country: Silec Cable / France  
Insulation thickness: 2,2 mm  
Core diameter: 18,5 mm  
Number of strands: 19  
Insulation material: XLPE  
Conductor material: Aluminum  
Refer to standard: 6E HD626:S1  
Conductor ID: 104

Type: AsXSn 4x16 mm<sup>2</sup>  
Used cross section: 16 mm<sup>2</sup>  
Manufacturer/country: TF-Kable / Poland  
Insulation thickness: 1,1 mm  
Core diameter: 6,8 mm  
Number of strands: 7  
Insulation material: XLPE  
Conductor material: Aluminium  
Refer to standard: 4J HD626:S1  
Conductor ID: 127

Type: ML 1,5 mm<sup>2</sup>  
Used cross-sections: 1,5 mm<sup>2</sup>  
Manufacturer/Country: Kajote / Finland  
Thickness of insulation: 0,7 mm  
Core diameter: 2,8 mm  
Number of strands: 1  
Insulation material: PVC  
Conductor material: Copper  
Refer to standard: HD 21.3 S3, H07V-U  
Conductor ID: 139





## 2. Testing procedure

The test procedure was according to standard EN 50483-4:2009 clause 8.1.4. According to standard the temperature should be  $-10 \pm 3$  °C, but in this test  $-25 \pm 3$  °C was used. The connectors were assembled onto short pieces of insulated conductors.

The test was done with three different conductor setups, main-branch: max-max, min-max and max-min. Two connectors were tested with all conductor setups. The connector assemblies were put into a freezer and kept there until they reached the test temperature. The connector was then tightened according to the manufacturer's instructions until electric continuity was achieved and the torque value was recorded. Electric continuity was measured using a multimeter.

### **Requirement:**

Electrical continuity shall be achieved at a torque value less than, or equal to 70 % of the manufacturer's specified minimum installation torque.

## 3. Test results

Sample	Conductor Main-Branch [mm <sup>2</sup> ]	Connection torque [Nm]
1	Max - Max 150 -16	4,5
2		4,2
3	Min - Max 16 -16	6,0
4		5,0
5	Max - Min 150 – 1,5	5,9
6		6,0

Table 1: Test data

### **Summary:**

All samples fulfilled the requirement of the standard as none exceeded 7,0 Nm which is 70 % of the connectors shear head minimum torque 10 Nm.

**4. Pictures**



Picture 2: Test setup in freezer

**5. Test equipment**

ID	Type	Model	Purpose	Latest calibration
L33	Freezer	ALK 30	Climate testing	No calibration
L118	Thermometer	54 II	Temperature measurements	20.03.2012
L190	Torque wrench	ADS25	Torque measurement	14.05.2012
L87	Multimeter	Fluke 87V	Voltage drop measurements	17.10.2012

**6. Test Id**

2030

**7. Revision history**

A



Saves Your Energy

## LABORATORY REPORT

No.: 2632S

Revision: A

Page: 1/4

Date of Test: 20.12.2012

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### Test object:

Waterproof insulation piercing connector SLIW52.

---

### Purpose of the test and relevant standards:

Part of type test.

Shear head function test acc. to EN 50483-4:2009 clause 8.1.2.4.

---

### Conclusion:

The shear head fulfilled the requirement of the standard over the temperature range from -25 to +50 °C.

See **3. Test results** for detailed data.



Picture 1: Tested connector SLIW52



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**Date of Report:** 20.12.2012

  
**Tested by:** Arne Liljeström

  
**Supervised by:** Sami Hakonen / SGS Fimko

  
**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team



## 1. Test objects

### Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Batch number:	20121107
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
Shear head range:	11 ±1 Nm
No of pcs:	24

### Conductors:

Type:	IMWS RZ 0,6/1 kV NF C 33-209 3x150+70 mm <sup>2</sup>
Used cross section:	150 mm <sup>2</sup>
Manufacturer/country:	Silec Cable / France
Insulation thickness:	2,2 mm
Core diameter:	18,5 mm
Number of strands:	19
Insulation material:	XLPE
Conductor material:	Aluminum
Refer to standard:	6E HD626:S1
Conductor ID:	104

Type:	AsXSn 4x16 mm <sup>2</sup>
Used cross section:	16 mm <sup>2</sup>
Manufacturer/country:	TF-Kable / Poland
Insulation thickness:	1,1 mm
Core diameter:	6,8 mm
Number of strands:	7
Insulation material:	XLPE
Conductor material:	Aluminium
Refer to standard:	4J HD626:S1
Conductor ID:	127

Type:	ML 1,5 mm <sup>2</sup>
Used cross-sections:	1,5 mm <sup>2</sup>
Manufacturer/Country:	Kajote / Finland
Thickness of insulation:	0,7 mm
Core diameter:	2,8 mm
Number of strands:	1
Insulation material:	PVC
Conductor material:	Copper
Refer to standard:	HD 21.3 S3, H07V-U
Conductor ID:	139



## 2. Testing procedure

The test procedure was acc. to standard EN 50483-4:2009 clause 8.1.2.4.

Acc. to standard the lower temperature is  $-10 \pm 3 \text{ }^\circ\text{C}$ , but in this test  $-25 \pm 3 \text{ }^\circ\text{C}$  was used.

The connectors were assembled onto short pieces of insulated conductor. There was 12 samples with conductor configuration min – min ( $16 - 1,5 \text{ mm}^2$ ) and 12 samples with conductor configuration max – max ( $150 - 16 \text{ mm}^2$ ) on main – branch. Two test chambers were used, one with a temperature of  $-25 \pm 3 \text{ }^\circ\text{C}$  and the other with a temperature of  $+50 \pm 3 \text{ }^\circ\text{C}$ .

The connector assembly were put into the test chambers, six samples of each cross section combinations were put into each chamber.

The assemblies were in the chamber until they reached the test temperature and it was maintained for at least 15 min.

The connector was then tightened acc. to the manufacturer’s instruction until the shear head broke. The breaking torque was recorded.

### Requirement:

The torque at which the shear head break shall be within the tolerances of the manufacturer’s specified torque.

## 3. Test results

Sample	Conductor setup Main - Branch	Breaking torque [Nm]	
		Test in $+50 \pm 3 \text{ }^\circ\text{C}$	Test in $-25 \pm 3 \text{ }^\circ\text{C}$
1	Min - Min $16 - 1,5 \text{ mm}^2$	10,5	11,2
2		10,9	11,3
3		10,6	11,1
4		10,7	11,5
5		10,9	11,4
6		11,0	11,1
7	Max - Max $150 - 16 \text{ mm}^2$	10,5	11,1
8		11,1	11,2
9		11,2	11,2
10		10,9	11,3
11		10,7	11,1
12		10,6	11,1

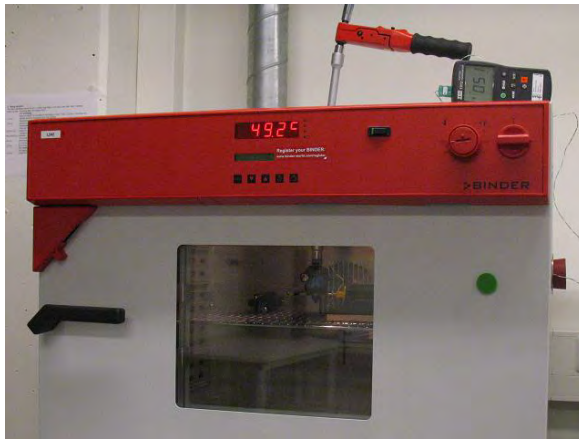
Table 1: Test data

**Summary:** The shear head of the connector fulfilled the requirement of the standard as all results are within the manufacturer’s tolerance of  $11 \pm 1 \text{ Nm}$ .

4. Pictures



Picture 2: Samples after the test with conductor configuration min-min and max-max



Pictures 3 and 4: Test in 50 °C oven and in -25 °C freezer

5. Test equipment

ID	Type	Model	Purpose	Latest calibration
L190	Torque wrench	ADS25	Torque measurement	14.05.2012
L33	Freezer	ALK 30	Climate testing	No calibration
L242	Oven	FP 115	Heating oven	No calibration
L70	Thermometer	TES 1312	Temperature measurements	20.03.2012

6. Test Id

970

7. Revision history

A





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**Test object:**

Waterproof insulation piercing connector SLIW52.

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**Purpose of the test and relevant standards:**

Part of type test.

Low temperature impact test according to EN 50483-4:2009 clause 8.1.2.5.

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**Conclusion:**

The connector passed the test at  $-25 \pm 3$  °C.



Picture 1: Tested connector SLIW52



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**Date of Report:** 7.12.2012

**Tested by:** Arne Liljeström

**Supervised by:** Sami Hakonen / SGS Fimko

**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team





## 1. Test objects

### Connectors:

Type: Waterproof insulation piercing connector SLIW52  
Connector class: A1  
Batch number: 20121107  
Main conductor range: 16 – 150 mm<sup>2</sup>  
Branch conductor range: 1,5 – 16 mm<sup>2</sup>  
Shear head range: 11 ±1 Nm  
No of pcs: 4

### Conductors:

Type: IMWS RZ 0,6/1 kV NF C 33-209 3x150+70 mm<sup>2</sup>  
Used cross section: 150 mm<sup>2</sup>  
Manufacturer/country: Silec Cable / France  
Insulation thickness: 2,2 mm  
Core diameter: 18,5 mm  
Number of strands: 19  
Insulation material: XLPE  
Conductor material: Aluminum  
Refer to standard: 6E HD626:S1  
Conductor ID: 104

Type: AsXSn 4x16 mm<sup>2</sup>  
Used cross section: 16 mm<sup>2</sup>  
Manufacturer/country: TF-Kable / Poland  
Insulation thickness: 1,1 mm  
Core diameter: 6,8 mm  
Number of strands: 7  
Insulation material: XLPE  
Conductor material: Aluminium  
Refer to standard: 4J HD626:S1  
Conductor ID: 127

Type: ML 1,5 mm<sup>2</sup>  
Used cross-sections: 1,5 mm<sup>2</sup>  
Manufacturer/Country: Kajote / Finland  
Thickness of insulation: 0,7 mm  
Core diameter: 2,8 mm  
Number of strands: 1  
Insulation material: PVC  
Conductor material: Copper  
Refer to standard: HD 21.3 S3, H07V-U  
Conductor ID: 139



## 2. Testing procedure

The test procedure was according to standard EN 50483-4:2009 clause 8.1.2.5. According to standard the temperature should be  $-10 \pm 3 \text{ }^\circ\text{C}$ , but in this test  $-25 \pm 3 \text{ }^\circ\text{C}$  was used.

The test was done with two different conductor setups, main-branch: max-min and max-max. Two connectors were tested with both conductor setups. The connectors were assembled to the conductors according to manufacturer's installation instructions and the assemblies were kept in a  $-25 \pm 3 \text{ }^\circ\text{C}$  freezer until they reached the test temperature. The impact was done immediately to the sample when it was taken out of the freezer.

Two impacts were done on each sample, one acting on the top and one acting on the side. The impact was caused by a 900 g hammer falling freely through 200 mm on a cylindrical anvil with a mass of approximately 100 g and a diameter of 20 mm positioned on the test sample. The contact radius of the anvil was approximately 300 mm.

### Requirement:

No damage shall occur which would affect the correct function of the connector.

## 3. Test results

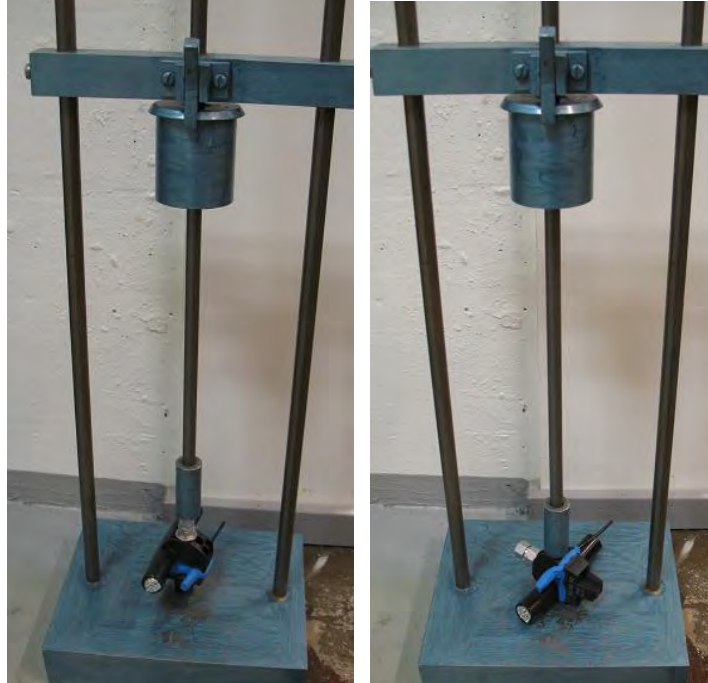
Sample	Conductor Main-Branch [mm <sup>2</sup> ]	Result
1	Max - Min 150 - 1,5	No damage
2		No damage
3	Max - Max 150 - 16	No damage
4		No damage

Table 1: Test data

### Summary:

All samples passed the impact test at  $-25 \pm 3 \text{ }^\circ\text{C}$ .

**4. Pictures**



Picture 2 and Picture 3: Samples in test

**5. Test equipment**

ID	Type	Model	Purpose	Latest calibration
L33	Freezer	ALK 30	Climate testing	No calibration
L118	Thermometer	54 II	Temperature measurements	20.03.2012
L190	Torque wrench	ADS25	Torque measurement	14.05.2012
S1	Striker	NA	Mechanical strength	No calibration

**6. Test Id**

969

**7. Revision history**

A



Saves Your Energy

## LABORATORY REPORT

No.: 2593S

Revision: A

Page: 1/8

Date of Tests: 28.08.2011 –  
25.10.2011

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### Test object:

Waterproof insulation piercing connector SLIW52.

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### Purpose of the test and relevant standards:

Part of type test.

Electrical ageing test according to EN 50483-5:2009.

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### Conclusion:

The connector passed the test.

See **3. Test results** and **Summary** for detailed data.



Picture 1: Tested connector SLIW52



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**Date of Report:** 21.11.2012

  
**Tested by:** Arne Liljeström

  
**Witnessed by:** Sami Hakonen / SGS Fimko

  
**Reviewed by:** Janne Lappalainen

**Ordered by:** K. Gajewski  
**Distribution:** OHL PD-team



## 1. Test objects

### Connectors:

Type:	Waterproof insulation piercing connector SLIW52
Connector class:	A1
Batch number:	16.6.2012
Main conductor range:	16 – 150 mm <sup>2</sup>
Branch conductor range:	1,5 – 16 mm <sup>2</sup>
Shear head range:	11 ± 1 Nm
No of pcs:	6

### Conductors:

Type:	AsXSn 4x16 mm <sup>2</sup>
Used cross section:	16 mm <sup>2</sup>
Manufacturer/country:	Bitner / Poland
Insulation thickness:	1,1 mm
Core diameter:	6,8 mm
Number of strands:	7
Insulation material:	XLPE
Conductor material:	Aluminium
Refer to standard:	4J HD626:S1

Type:	IMWS 3x150mm <sup>2</sup> +70mm <sup>2</sup> ABC N-46
Used cross-section:	150 mm <sup>2</sup>
Manufacturer/country:	ACL Cables / Sri Lanka
Insulation thickness:	1,7 mm
Core diameter:	17,8 mm
Number of strands:	19
Insulation material:	XLPE
Conductor material:	Aluminium
Refer to standard:	6E HD626:S1



## 2. Testing procedure

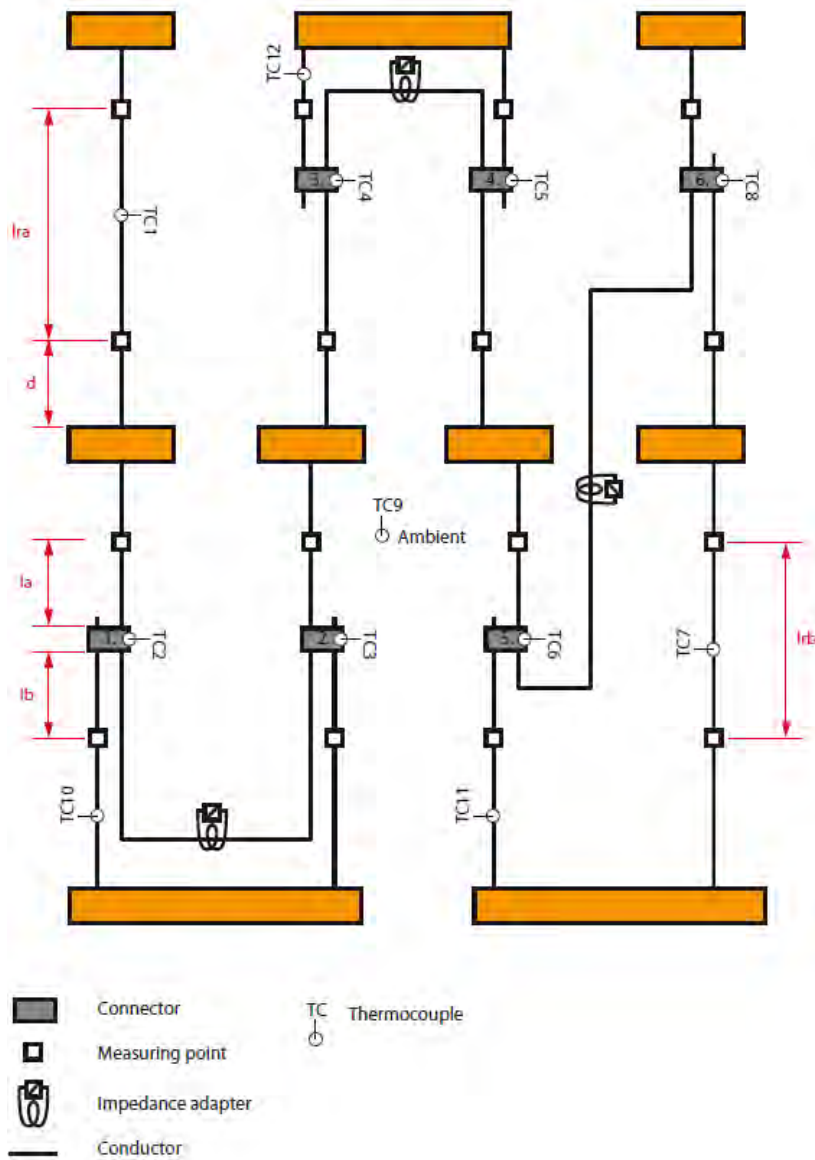
Six connectors were subjected to the ageing test according to standard EN50483-5:2009. Connectors were installed to preconditioned (120°C / 1 hour) conductors according to installation instructions and the applied torque was shear head minimum. The equalizing points were welded. Thermocouples for temperature measurements were installed into a hole that was drilled in the middle of the teeth plate in the lower body. In the reference conductors the thermocouples were installed under the strands. Adapting impedances were used on the main conductors that were parallel with the branch conductor to set the correct current for the branch conductor.

A PC-controlled LabView system controlled the ageing test. During the heating period the main reference conductor was heated up to maximum operating temperature +5 to +15 °C and the branch reference conductor to maximum operating temperature +5 to +10 °C. The heating period was followed by a cooling period where the connectors and conductors were cooled to a temperature below 35 °C.

In short circuit test the loop was subjected to six short circuit pulses. Standard says that used current shall be chosen so that it is able to raise the temperature of the branch reference conductor from ambient temperature to maximum short circuit temperature in  $1 \pm 0,15$  seconds. The time used was between 1,40 and 1,50 seconds because a higher current was not available. After each short circuit pulse the test loop was cooled down to a temperature below 35 °C. All six connectors were tested simultaneously.

### Test settings:

Tightening torque:	10 Nm
Total number of cycles:	1000 cycles
Cycles before short-circuit:	200 cycles
Number of SC pulses:	6 pulses
Heating period duration:	50 min
Heating period current, AC:	498 A on main and 113 A on branch
Cooling period duration:	18 min
Cooling period type:	accelerated, using fans
Resistance meas. current, DC:	50 A



Picture 2: Test loop

The required connector lengths were measured. Reference conductor lengths are  $I_{ra}$  (main) and  $I_{rb}$  (branch). Distance between connector and measuring point is marked with  $I_a$  (main) and  $I_b$  (branch). The connector resistance can be calculated by using these lengths and the measured resistances between the measuring points.

	Conn 1	Conn 2	Conn 3	Conn 4	Conn 5	Conn 6	Ref. Main $I_{ra}$	Ref. Branch $I_{rb}$
$I_a$ [mm]	252	254	252	254	253	253	501	-
$I_b$ [mm]	173	177	174	174	177	172	-	499

Table 1: Measured lengths



Requirements:

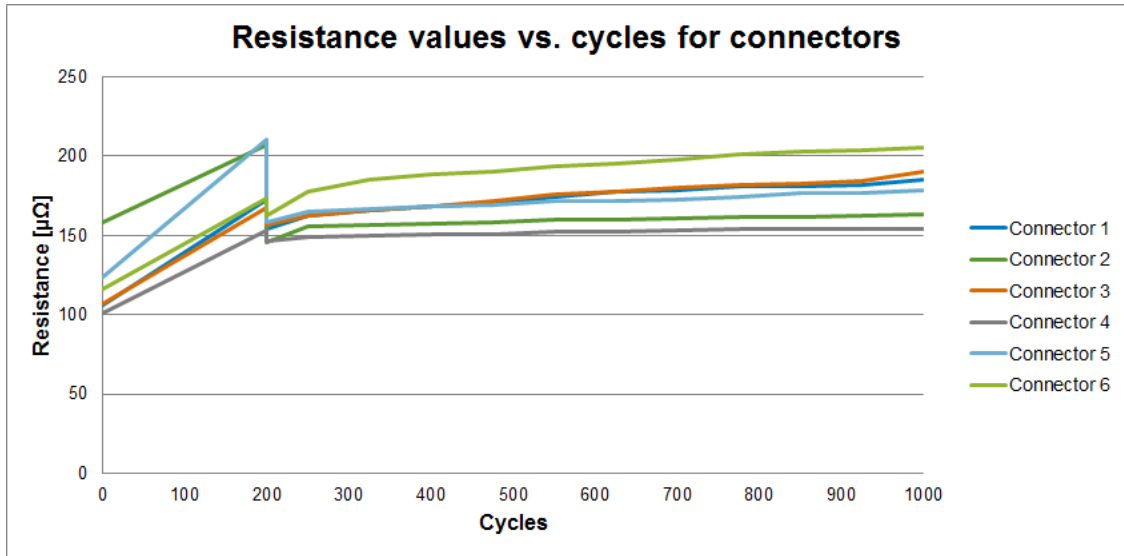
Parameter	Maximum value
Initial scatter $\delta$	0,3
Mean scatter $\beta$	0,3
Assesment of resistance stability	15 %
Resistance factor ratio $\lambda$	2
Temperature stability $\Delta\Theta_j$	$\overline{\Delta\theta_j} - 10 \leq \Delta\theta_j \leq \overline{\Delta\theta_j} + 10$
Maximum temperature $\Theta_j$ of each connector	$\Theta_R$

Table 2: Test requirements according to standard

3. Test results

Cycles	Connector 1		Connector 2		Connector 3		Connector 4		Connector 5		Connector 6	
	Res. [ $\mu\Omega$ ]	Res. factor ratio	Res. [ $\mu\Omega$ ]	Res. factor ratio	Res. [ $\mu\Omega$ ]	Res. factor ratio	Res. [ $\mu\Omega$ ]	Res. factor ratio	Res. [ $\mu\Omega$ ]	Res. factor ratio	Res. [ $\mu\Omega$ ]	Res. factor ratio
0	106	1,0	158	1,0	107	1,0	101	1,0	123	1,0	116	1,0
200	172	1,6	207	1,3	168	1,6	153	1,5	210	1,7	174	1,5
200	154	1,5	146	0,9	156	1,5	146	1,4	158	1,3	163	1,4
250	162	1,5	155	1,0	162	1,5	149	1,5	164	1,3	177	1,5
325	165	1,6	157	1,0	166	1,5	150	1,5	167	1,4	185	1,6
400	168	1,6	157	1,0	168	1,6	150	1,5	168	1,4	188	1,6
475	170	1,6	158	1,0	171	1,6	151	1,5	169	1,4	190	1,6
550	174	1,6	160	1,0	176	1,6	152	1,5	171	1,4	194	1,7
625	177	1,7	160	1,0	177	1,7	152	1,5	172	1,4	195	1,7
700	178	1,7	161	1,0	180	1,7	153	1,5	173	1,4	198	1,7
775	181	1,7	162	1,0	181	1,7	154	1,5	174	1,4	201	1,7
850	181	1,7	162	1,0	183	1,7	154	1,5	176	1,4	202	1,7
925	182	1,7	162	1,0	185	1,7	154	1,5	177	1,4	204	1,8
1000	185	1,7	163	1,0	190	1,8	154	1,5	178	1,4	205	1,8
Mean value	175		160		176		152		172		194	
Resistance stability	13 %		5 %		16 %		4 %		8 %		14 %	

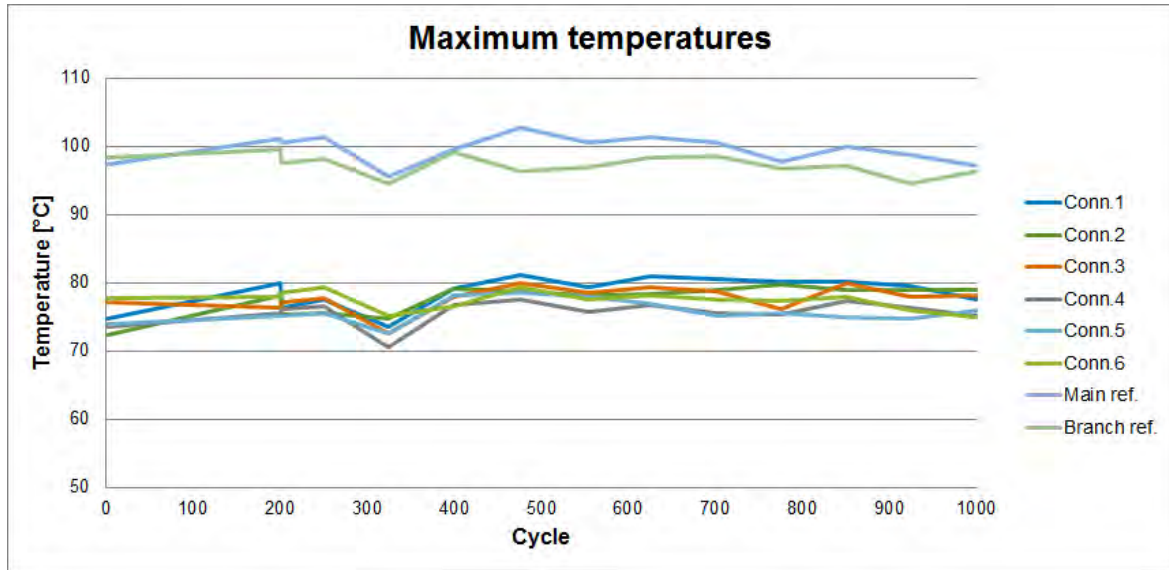
Table 3: Resistance data referred to 20 °C



Graph 1: Connector resistances

Cycle	Temperatures [°C]								
	Main ref.	Branch ref.	Conn. 1	Conn. 2	Conn. 3	Conn. 4	Conn. 5	Conn. 6	Ambient
1	97	98	75	72	77	74	74	78	23
200	101	100	80	78	76	76	75	78	23
201	101	98	76	75	77	76	75	79	23
250	101	98	78	76	78	77	76	79	23
324	96	95	74	75	73	71	73	75	23
399	100	99	79	79	78	77	78	77	24
475	103	96	81	79	80	78	79	79	24
553	101	97	79	78	79	76	78	78	24
624	101	98	81	78	79	77	77	78	24
701	101	99	81	79	79	76	75	78	24
775	98	97	80	80	76	75	76	77	23
850	100	97	80	79	80	77	75	78	24
923	99	95	80	79	78	76	75	76	23
1000	97	96	78	79	78	75	76	75	23
Max value	103	100	81	80	80	78	79	79	

Table 4: Heat cycle end temperatures



Graph 2: Heat cycle end temperatures

Sample	Pulse	Time [s]	Current [kA]	Branch ref. temp [°C]
All connectors	1	1,40	1,92	250
	2	1,40	1,76	241
	3	1,46	1,76	245
	4	1,50	1,76	262
	5	1,50	1,60	252
	6	1,50	1,76	262

Table 5: SC-test data

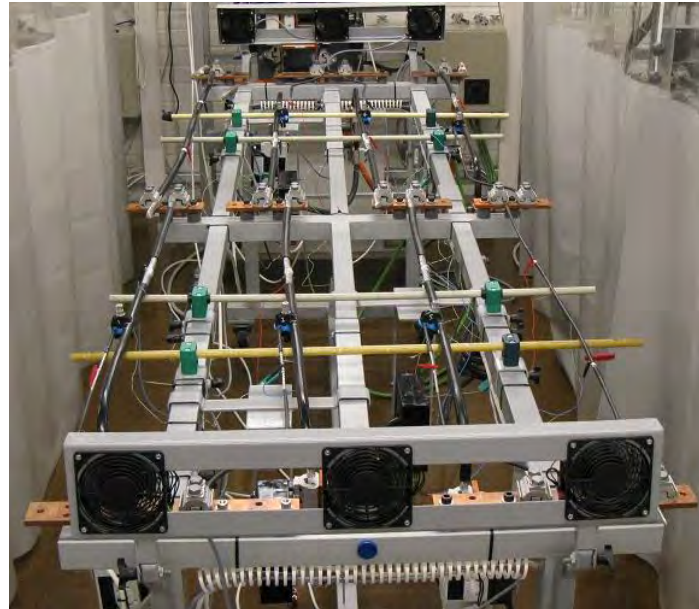
Parameter	Designation	Result	Requirement
Initial Scatter	$\delta$	0,3	$\leq 0,3$
Mean Scatter	$\beta$	0,1	$\leq 0,3$
Assessment of resistance stability	D	16 %	$\leq 15 \%$
Resistance ratio factor	$\lambda$	1,8	$\leq 2,0$
Maximum temperature	$\theta_{max}$	81	$\leq 103$
Temperature stability	$\Delta\theta_j$	-4 / 3	$\overline{\Delta\theta_j} - 10 \leq \Delta\theta_j \leq \overline{\Delta\theta_j} + 10$

Table 6: Test results

**Summary:**

Even though the assessment of resistance stability for connector 3 was just above the standard requirement, the connector was considered to pass the test, because the temperature values were still stable and well below the reference temperature.

4. Pictures



Picture 3: Test setup

5. Test equipment

ID	Type	Model	Purpose	Latest calibration
TB3	AC Transformer	100 - 800 A	AC-supply for heating	No calibration
L160	Analog input/output module	cFP-AIO-610	Current measurements	12.12.2011
L156	Thermocouple module	cFP-TC-125	Temperature measurements	29.05.2012
L157	Thermocouple module	cFP-TC-125	Temperature measurements	29.05.2012
L158	Thermocouple module	cFP-TC-125	Voltage measurements	12.12.2011
L178	Clamp on multimeter	353	AC current meas	10.10.2011
L190	Torque wrench	ADS25	Torque measurement	14.05.2012
SM2	Short-circuit transformer	230 kVA	Supply for s-c test	No calibration
L182	Shunt	12 kA	S-c current meas	04.12.2009
L68	Scopemeter	105B	Short-circuit current	11.10.2011
L176	Thermocouple module	cFP-TC-125	Temperature measurements	28.08.2012
L177	Thermocouple module	cFP-TC-125	Temperature measurements	28.08.2012

6. Test Id

1690

7. Revision history

A