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# Waterproofed: new cable testing, standard for FPV



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# Cabling and electrical system components for FPV

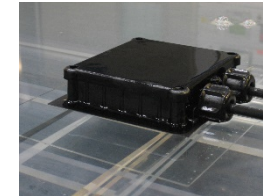


# Status of standards for Floating PV

- Modules for FLPV
  - Several Testing institutes started to write test programs
- Junction boxes for FLPV
  - Idea is to create an amendment for existing IEC 62790
- Connectors for FLPV
  - Project team for creation of a NWIP just founded. Goal is to create an amendment for IEC 62852 containing an annex with supplement requirements for connectors intended to be installed in a FLPV Power Plant.
- Wiring harness for FLPV
  - Project team for creation of a NWIP just founded. Here a complete new standard is under development, so requirements for FLPV will be included.



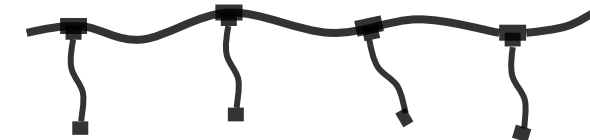
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# Status of standards for Floating PV – Cables for FLPV

## Cables for Floating PV

- No international standard available (yet)
- TÜV Rheinland's 2 PfG 2750/09.20:  
**“Requirements for cables with improved water resistance for installation in PV Systems”**
- Developed by TÜV Rheinland in cooperation with two cable manufacturers:
  - Studer (Switzerland)
  - KBE-Elektrotechnik (Germany)
- Based on IEC 62930:2017:  
**“*Electric cables for photovoltaic systems with a voltage rating of 1,5kV*”**

# Status of standards for Floating PV – Cables for FLPV

- **What is the meaning of a 2 PfG?**

Example: 2 PfG 2750/09.20

2 : Identification number for TÜV Rheinland (historic)

P : “**P**rüfgrundsatz” (Testing principle)

f : “**f**ür” (for)

G : “**G**erätesicherheit” (Product safety)

2750 : Consecutive Number

09.20: Month/Year of listing (application date)



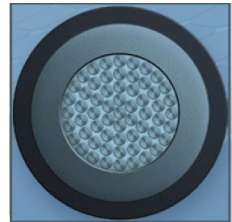
# Cables for FLPV

## 1 Scope

This test specification applies to **low smoke halogen free, flexible**, single-core cables (wires) with an **improved water resistance** having a copper conductor for installations in PV-systems, e.g. in Floating PV Plants, with a rated voltage up to and including  $U_0$  DC 1,5 kV.

...

The requirements for the conductor have to be those of **Class 5** according to IEC 60228(Fine stranded copper conductors for single and multi-core cables and wires(class 5))



Source: Studer

...

This specification does not cover requirements neither for direct burial cables **nor for cables for permanent submersion in water (AD8).**

# Test overview of 2 PfG 2750/09.20 “Requirements for cables with improved water resistance for installation in PV Systems”

Test overview of 2 PfG 2750/09.20 (Additional tests and tests with different requirements according to IEC 62930:2017 are highlighted)

## Table 2 – Tests for PV-cables with improved water resistance

- Resistance of conductors
- Voltage test on the complete cable with AC or DC
- Check for absence of faults on the insulation (or on complete cable)
- Measurement of insulation resistance
- **Long term resistance of insulation to d.c. on completed cables**
- **Change of capacitance**
- Surface resistance of sheath
- **Constructional and dimensional tests**
- Damp heat test
- Compatibility test
- Cold impact test

## Table 2 – Tests for PV-cables with improved water resistance (continued)

- **Ozone resistance on complete cable**
- Weathering/UV resistance on sheath
- Assessment of halogens
- Dynamic penetration test
- Shrinkage test on sheath
- Test for vertical flame propagation on complete cable
- Smoke emission of complete cable

## Table 3 – Requirements for insulation and sheath compounds

- Properties before ageing
- Properties after ageing in oven
- Hot set test
- Thermal endurance properties
- Bending at low temperature for insulated conductor/Cable overall diameter  $\leq 12,5\text{mm}$
- Elongation at low temperature for insulated conductor/Cable overall diameter  $>12,5\text{mm}$
- Sheath-resistance against acid and alkaline solution

# Differences/Additional Tests between IEC 62930:2017 and 2PfG 2750/09.2020

2PfG 2750/09.2020 only for cables for Class 5  
 Conductors  
 Additional Information: Table 2 of IEC 62930  
 is not applicable

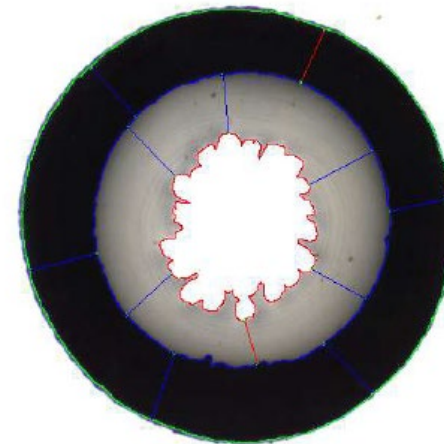
Increase of requirements for thickness of insulation  
 and sheath

Additional Remark

Table 1: Dimensional and insulation resistance values for class 5 conductor cables

1	2	3	4	5	6
Nominal cross-sectional area of conductors	Thickness of insulation specified value	Thickness of sheath specified value	vacant	Minimum insulation resistance at 20°C	Minimum insulation resistance at 90°C
mm <sup>2</sup>	mm	mm		MΩ x km	MΩ x km
1,5	0,7	0,8		1050	1,05
2,5	0,7	0,8		862	0,862
4	0,7	0,8		709	0,709
6	0,7	0,8		610	0,610
10	0,8	0,8		489	0,489
300	1,8	1,8		237	0,237
400	2,0	2,0		230	0,230

Remark: These values are theoretical minimum specified thicknesses, but the results of the long-term stability tests in water, see Table 2, are relevant for the final wall thickness





# Differences/Additional Tests between IEC 62930:2017 and 2PfG 2750/09.2020

Additional Test Change of Capacitance  
based on UL44, UL1581 and UL 2556  
Duration of 14 Days and 90°C Water  
Temperature

1	2	3	3	
Ref. No.	Test	Units	Requirements	Ca
1.6	<b>Change of Capacitance</b>			
1.6.1	Test conditions: - length of sample (complete cable) - duration of tests - temperature of the water	m d °C	3 14 90 ± 1	
1.6.2	Result to be obtained		Capacitance after 14 days ≤ 10 % of capacitance after 24h immersion.;  Capacitance after 14 days immersion ≤ 4% of capacitance after 7 days	

# Differences/Additional Tests between IEC 62930:2017 and 2PfG 2750/09.2020

Condition AD7 plus

1.4 Heavy	+
2 PRESENCE OF WATER	
2.1 Cables : Condition AD 7 <sup>b</sup>	+ improved water resistance acc. to this specification
3 CORROSIVE OR POLLUTING SUBSTANCES	
3.1 Condition AF 3 <sup>b</sup>	+
4 IMPACT	

Not suitable for  
Direct burial or AD8 conditions

Table 8.1 - Intended use of cables for PV systems (environmental conditions)	
Shape of cable	Round
Conductor construction	Class 5
1 DUTY <sup>a</sup>	
1.4 Heavy	+
2 PRESENCE OF WATER	
2.1 Cables : Condition AD 7 <sup>b</sup>	+ improved water resistance acc. to this specification
3 CORROSIVE OR POLLUTING SUBSTANCES	
3.1 Condition AF 3 <sup>b</sup>	+
4 IMPACT	
4.1 Condition AG 2 <sup>b</sup>	+
5 VIBRATIONS	
5.1 Condition AH 3 <sup>b</sup>	Class 5 +
6 FLORA	
6.1 Condition AK 2 <sup>b</sup>	+
7 FAUNA	
7.1 Condition AL 2 <sup>b</sup>	+ -
8 OUTDOOR USE	
8.1 Condition AN 3 <sup>b</sup>	+
8.2 Permanent <sup>c</sup>	+
9 FREQUENT FLEXING	-
10 FREQUENT TORSION	-
<sup>a</sup> + = acceptable - = not suitable <sup>a</sup> see Annex C of IEC 62440 for definitions. <sup>b</sup> see Annex A of IEC 62440 for definitions. <sup>c</sup> see Annex B of IEC 62440 for definitions.	

# Differences/Additional Tests between IEC 62930:2017 and 2PfG 2750/09.2020

Increase Requirements for Long term  
Resistance .....  
2016h (12weeks)

Water 90°C instead of 85°C

Applied DC Voltage 3,6kV instead of 1,8kV

1.5	Long term resistance of insulation to d.c. on completed cables		
1.5.1	Test conditions: length of sample (complete cable) Duration of tests temperature of the water DC-voltage applied  Voltage test acc. to Table 2 cl. 1.2 shall be performed	m h °C kV	5 2016 90 ± 5 3,6

# Thank you for your attention

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