How to recognize the key indicators of quality

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Quality is not everything, but everything without quality is NOTHING

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- Wrong installations (high filling of tubes)
- Fire/arking/grounding issues
- UV resistance of color cables

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Low quality in the PV industry - examples

Wrong installations – high filling in the tubes

Cables are heaters

Every cable has a loss because the resistance is always more than zero

$P = I^2 * R$

Example: 16 A and 4 mm2 (100m = 0.5 Ohm)
=> $16^2 * 0.5 = 128$ W

20 cables in this duct are loosing 2560 W (!)

2000 W is enough to heat up a room with 30m^2

What is wrong? => Too many cables in the duct. There is no space for circulation of cooling air.

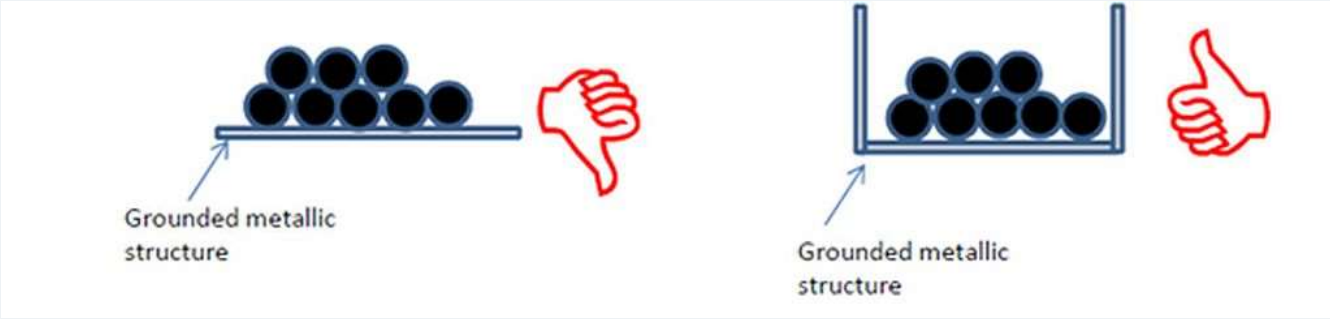
Result => FIRE

Low quality in the PV industry - examples

Fire/arking/grounding issues

Corona Effect

- Typically on large PV plants with central inverters (harmonics up to 10MHz are generating partial discharges)
- Affected in hot & humid areas
- Insufficient care of cable management (sharp edges, wrongly designed cable ducts, etc...



Low quality in the PV industry - examples

UV Resistance of color cables

UV is a killer of plastics

- Sunlight contains a significant amount of ultraviolet radiation. The ultraviolet radiation that is absorbed by a polymer material will result in it‘s degradation.
- Incorporating carbon black in polyolefines greatly increases their weather resistance. Carbon black acts as a UV absorbent and screens the polyolefine from damaging ultraviolet radiation.
- All known test results acc. Standards cannot be extrapolated based on a mathematical formula. Out of this tests we can only get comparable results, but no real statement about the real lifetime.
- **As has been demonstrated through over five decades of outdoor experience with polyethylene jacketed communication cables the addition of finely dispersed carbon black results in more than 25 years of protection against sunlight.**
- **It is possible to pass the weathering tests with red or blue cables but it is also a fact that this results cannot tell us the lifetime!**

Today´s main highlight:

DIRECT BURIAL CABLES

Direct burial of cables

Current standards vs. reality

Standards

- According to the IEC 62930 – Electric cables for PV Systems, Annex A „Guide to use“, it is **mandatory** to use the IEC 62440 (Guide to Use for low voltage cables)

„General guidance information given in IEC 62440 (Guide to use for low voltage cables) **must be used**“

- In the IEC 62440 „4. Safety“ it is clearly defined:

„Cables shall not be buried directly in the ground“

Reality

- PV cables have traditionally quite low thicknesses (costs **!!!**)
- These thicknesses make the cable relatively „fragile“ for directly buried installations

Direct burial of cables

Moist penetration of the polymer materials

- **Water, which is almost always present at 100% relative humidity at the typical 1 meter burial depth moves very quickly through any polymeric layer.**

- **It is important to recognize that because underground air does not freely circulate with athmospheric air below the to few centimeters of soil, the cables are permanently exposed to water.**

- **Generally all polymeric compounds are not humidity proof. It is only a question of time. This is the reason that all sea cables are having a metal barrier below the sheath. Only a closed metal barrier can guarantee a constant insulation resistance for decades of use. Wire or tape armoring is NOT a closed metal barrier.**

- Because standards are requiring halogen free materials which are also flame retardant, the used compounds are filled with anorganic mineral flame retardant additives. This kind of additives are stimulating the absorbtion of humidity in a long term use of this materials in humid areas.

Direct burial of cables

Underground fauna

- By locating the PV plants out of the urban areas brings an exposure of the systems with various animals.
- Rats, squirrels, or termites are able to cause severe damages on various parts of the installation.
- Cables are one of the most exposed and its design shall consider such exposure
- Chemical solutions are questionable/not sustainable and not always the friendliest for human/environmental issues

- **Mechanical barriers have been considered as the most effective ones**

Direct burial of cables

Chemical contamination of the ground

- There are many old landfills where the ground contamination is unknown.
- Many of them are used for PV Installations.
- Here is an extreme case to show what can happen:
- In this case there must be a high sulfuric acid content in the ground. Copper in contact to sulfuric acid generates copper sulphate which is toxic and corrosive.
- **Corrosion of contacts results in high resistance and can cause fire**

Solution?

New standard as a guideline for the PV market

Need for a new standard

Initiation & reasoning

- Because of the high cost pressure in the pv industry, all of main cables, typically 240 or 300 mm^2 are direct buried in the ground.
- We have seen in this presentation that cables needs a protection against humidity.
- The available PV cable standards are not optimal for this cable application.
- Cables in ground do not need fire resistance
- Cables in ground with 90°C rating is recommended

No more questionmarks.

The 2PfG2642 is here!

Standard 2PfG2642/11.17

Background

What is the meaning of a 2 PfG?

Example: 2 PfG 2642/11.17

2 : Identification number for TUV Rheinland (historic)

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

f : “**f**ür” (for)

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

2642 : Consecutive Number

11.17: Month/Year of listing (application date)

Standard 2PfG2642/11.17

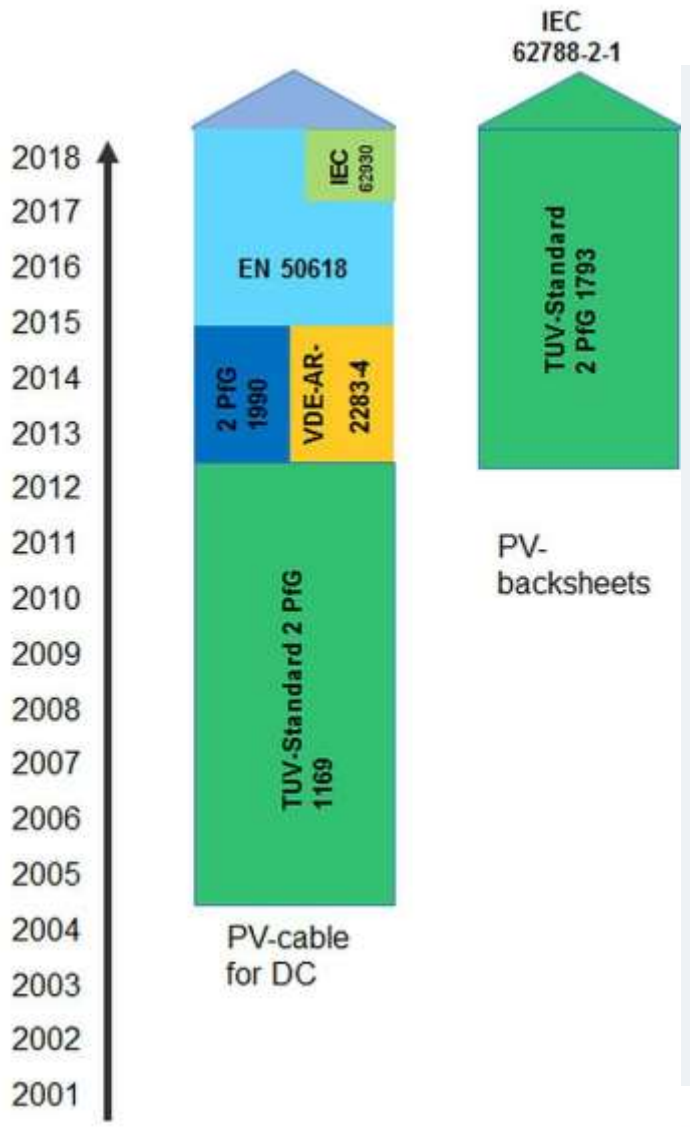
Background

How important are 2 PfG standards?

- International acceptance
- Basis for several IEC standards
- In some countries better known than IEC standards

When are 2 PfG standards applicable?

- If no or no national nor international standard is existing for a device or component
- If – for several reasons – the requirements of an existing standard are not sufficient.

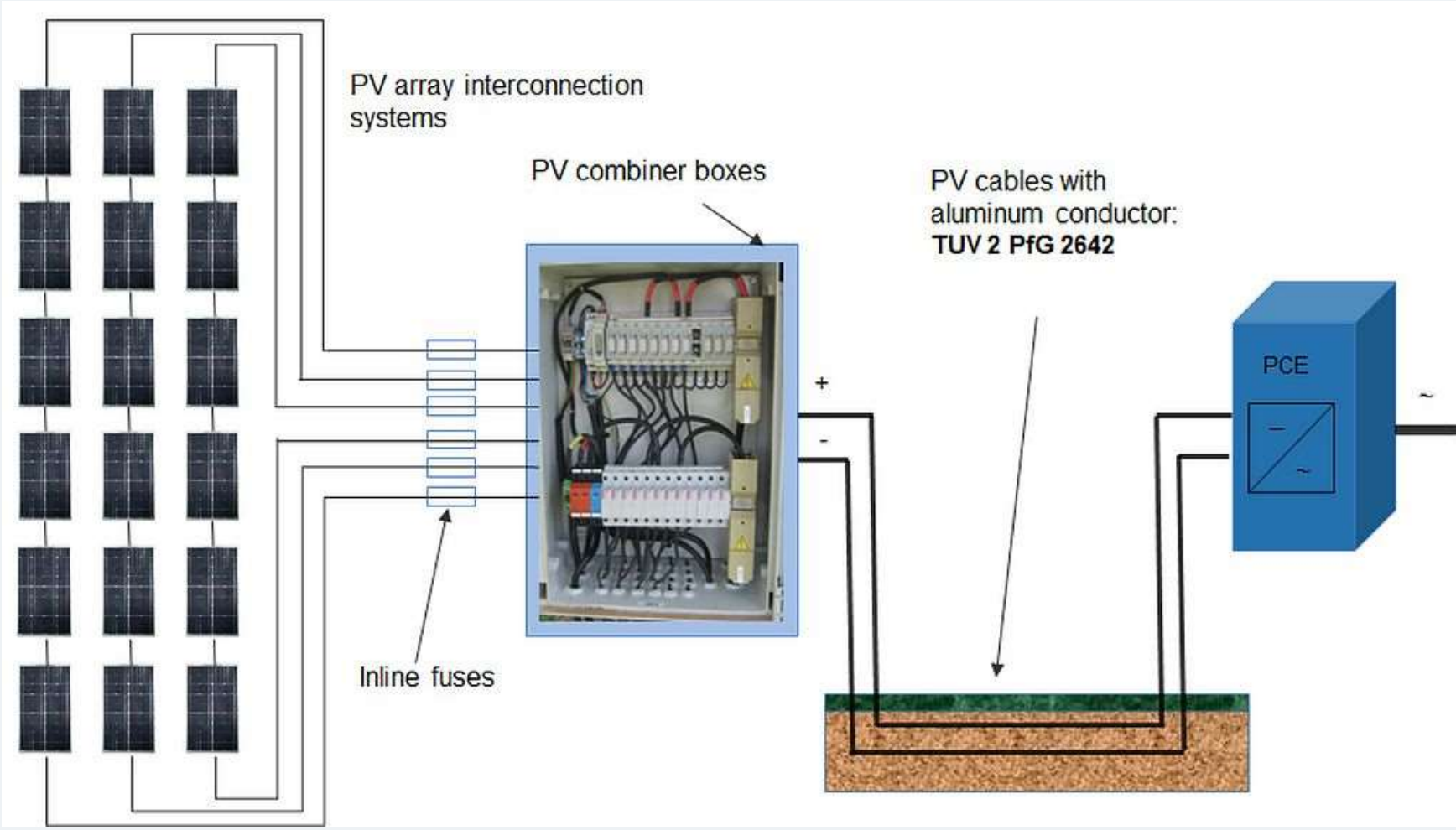


Standard 2PfG2642/11.17

Extract of the Standard

Scope

- 2 PfG 2642/11.17 applies to single-core cables (wires) having a solid or stranded aluminium conductor for fixed installations in PV-systems with a rated voltage up to and including U_0 DC 1,5 kV.
- This specification covers cables having aluminium conductors (of classes 1 or 2 acc. to IEC 60228) and for installation in ground.

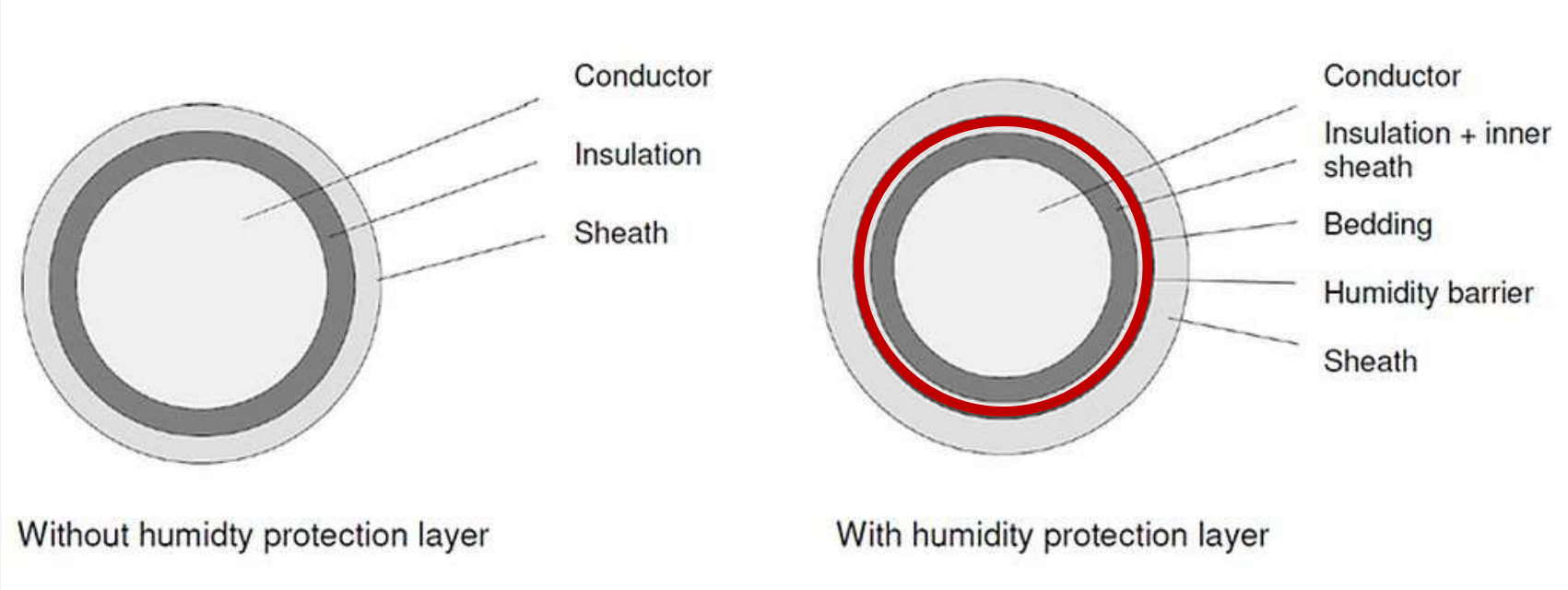


Standard 2PfG2642/11.17

Key criteria – testing objectives

Construction

- The cable shall exist of a conductor (class 1 or class 2), of an insulation layer, and of an outer sheath. In case of direct burial installation an inner sheath and protection layer against migration of humidity are required, the insulation and inner sheath can be combined as reinforced insulation.
- Cables for direct burying covered in this standard shall have a metallic layer for humidity protection and as screen.



Standard 2PfG2642/11.17

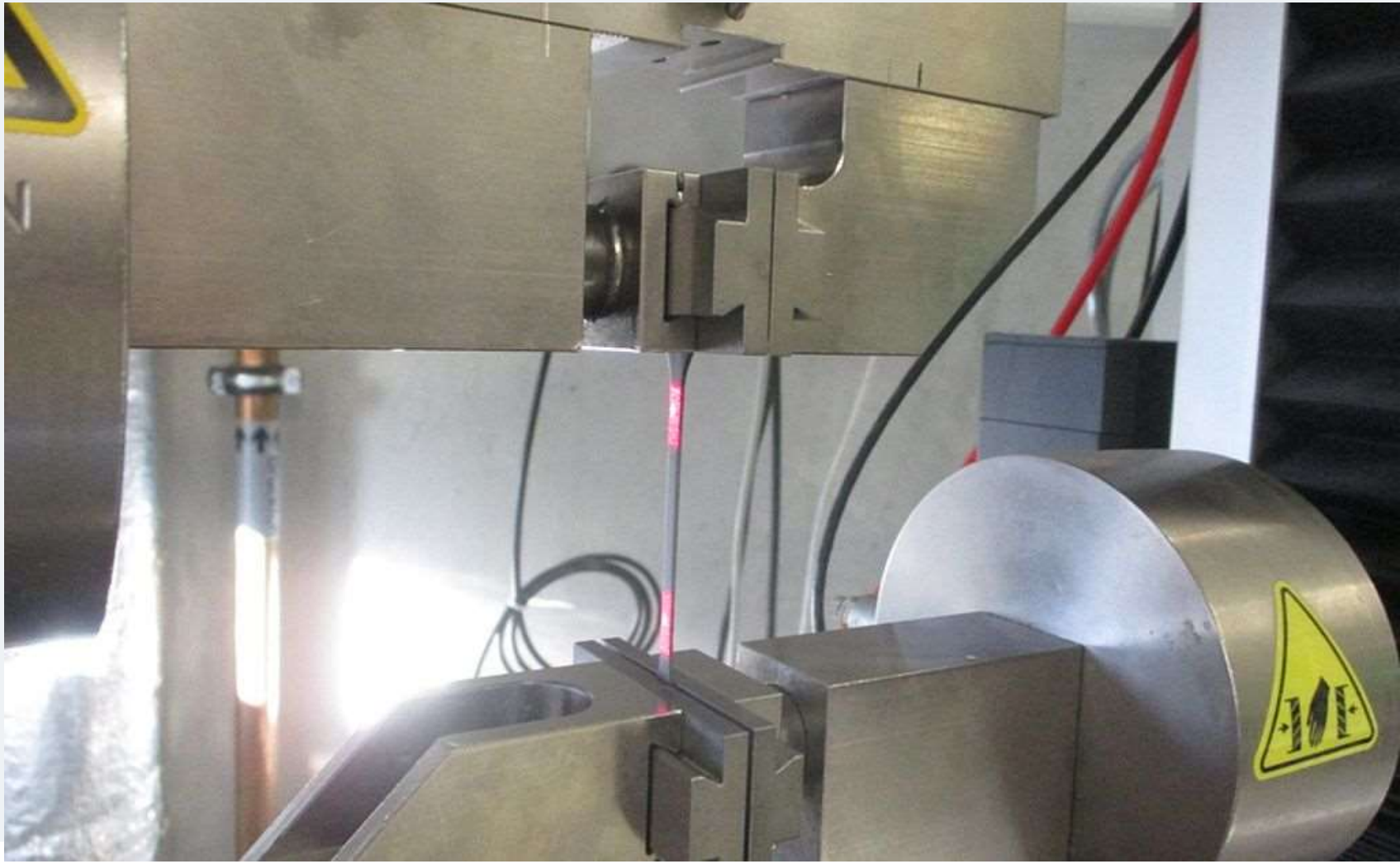
Relation to the EN50618

General

- This document based on EN 50618. Most of the requirements are equal or similar. So even weathering resistance is required since parts of the cable usually are not protected against direct sunlight. Nevertheless, there are some differences…

Differences between 2 PfG 2642/11.17 and EN 50618

- Construction (if intended for DB) Application
- Also non-halogen-free materials considered
- Maximum conductor temperature
- No fire performance needed



Introducing
SOLARpower
Alu-ATA XS

Solution – SOLARpower Alu-ATA XS

General Info

Features

- Direct burial water resistant cable
- Halogen – free
- XLPE insulation and termigon jacket
- Termite & rodent protected
- UV resistant
- Transversal watertight by metal barrier
- Simple feed, low friction on the jacket
- Aluminium shield, suitable as grounding and protective earth and for EMC shielding

Solution – SOLARpower Alu-ATA XS

Facts, figures & sizes

Construction

Conductor	Aluminium stranded wire, compacted. class 2
Insulation	XLPE, halogen free
Armouring	Aluminium tube / extra hard compound
Jacket	Copolymer, halogen free
	termite and rodent protection
Jacket colour	Black
Bending radius	Fixed installation > 12 × Ø

Electrical characteristics

Max. Voltage	Um = 1800 V DC
Rated voltage	U0/U = 1500 V / 1500 V DC
	U0/U = 1000 V / 1000 V AC, 50Hz
Test voltage	6500 V, 50 Hz, 5 min.
	(Conductor / Shielding)

Thermal characteristics

Operating temperature	–40 °C up to +90 °C
	–40 °F up to +194 °F
Ambient temperature	–40 °C up to +90 °C
Min. permissible installation temperature	-10 °C
Max. short circuit temp.	+250 °C, +482 °F / 5 s

Nominal cross section	Conductor-∅	Outer-∅	Resistance max.	Voltage drop	Weight	Order no.
n×mm²	mm	mm	mΩ/m	mV/Am	kg/km	
1×50/18	8.2	17.1	0.641	1.282	317	315684
1×70/20	9.9	18.8	0.443	0.886	398	315685
1×95/22	11.4	20.9	0.32	0.64	506	315686
1×120/24	12.9	22.4	0.253	0.506	603	315687
1×150/26	14.0	24.1	0.206	0.412	702	315688
1×185/30	16.4	27.7	0.164	0.328	896	315689
1×240/31	18.0	29.9	0.125	0.25	1091	315690
1×300/36	20.5	33.0	0.100	0.200	1331	315691
1×400/39	23.7	37.4	0.0778	0.1556	1704	315692
1×500/43	26.4	40.1	0.0605	0.121	2043	315693
1×630/48	30.1	44.8	0.0469	0.0938	2553	316121

Solution – SOLARpower Alu-ATA XS

Rodent & termite testing report

Thanks to a robust termigon jacket combined with the aluminimum layer, the cable offers a high rodent / termite protection as well as a transversal water tightness.

Independent laboratory results:

- According to the test method and the evaluation criteria DIN EN 117* all tested material variations were resistant against the attack by the most aggressive termite species – Australian Darwin termites* or Formosan Subterranean termites**. There was either no attack (rating 0) or only attempted attack (rating 1).
- The test samples showed **no toxic effect** against termites.

*** - The DIN EN117 testing is not part of the 2PfG2642 standard, and was done as an additional testing.**

* - Mastotermes Darwiniensis

** - Coptotermes Formosanus

Solution – SOLARpower Alu-ATA XS

Accessories

- Includes all materials for the installation
- Reliable and harmonized connection and grounding concept
- With accurate use, acc. to the instruction manual, no contact corrosion due to durable sealing
- Consistently safe contact with the aluminium conductor and the earthing screen
- Grounding wire in tinned copper braid with water blocking

Solution – SOLARpower Alu-ATA XS

References

Some of the projects finalized:

- Shotwick Solar Park (UK)
- Bradenstoke RAF Lyneham (UK)
- Wroughton Airfield Solar Park (UK)
- Owls Hatch Solar Park (UK)
- PLB Terang (MY)
- Bentley & Jaguar Works (UK)
- Southwick Solar Park (UK)
- Marriott & Sheraton Hotel (JOR)
- Fixborough Solar Park (UK)
- Bidor Solar Park, Perak (MY)
- MOD Lyneham (UK)
- Gading Kencana (MY)
- Proconics Mutoko, (ZW)
- Crowdown Lane (UK)
- Greenviro Solutions (MY)

CLOSING

Q&A

Closing

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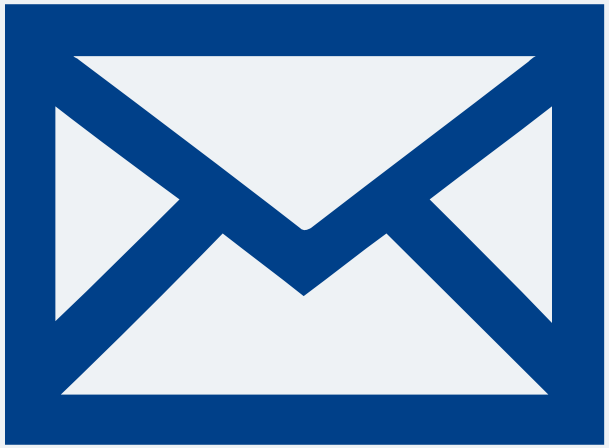


Thank you

Vielen Dank

Merci

Gracias

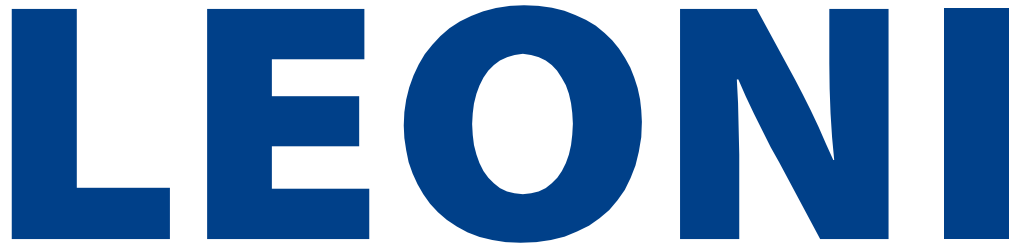
謝謝

Terima kasih

σας ευχαριστώ

धन्यवाद

Dank je



شكرا لكم

Teşekkür Ederim

תודה

Grazie

ありがとう

ขอบคุณ

cảm ơn bạn

고맙습니다

Obrigado