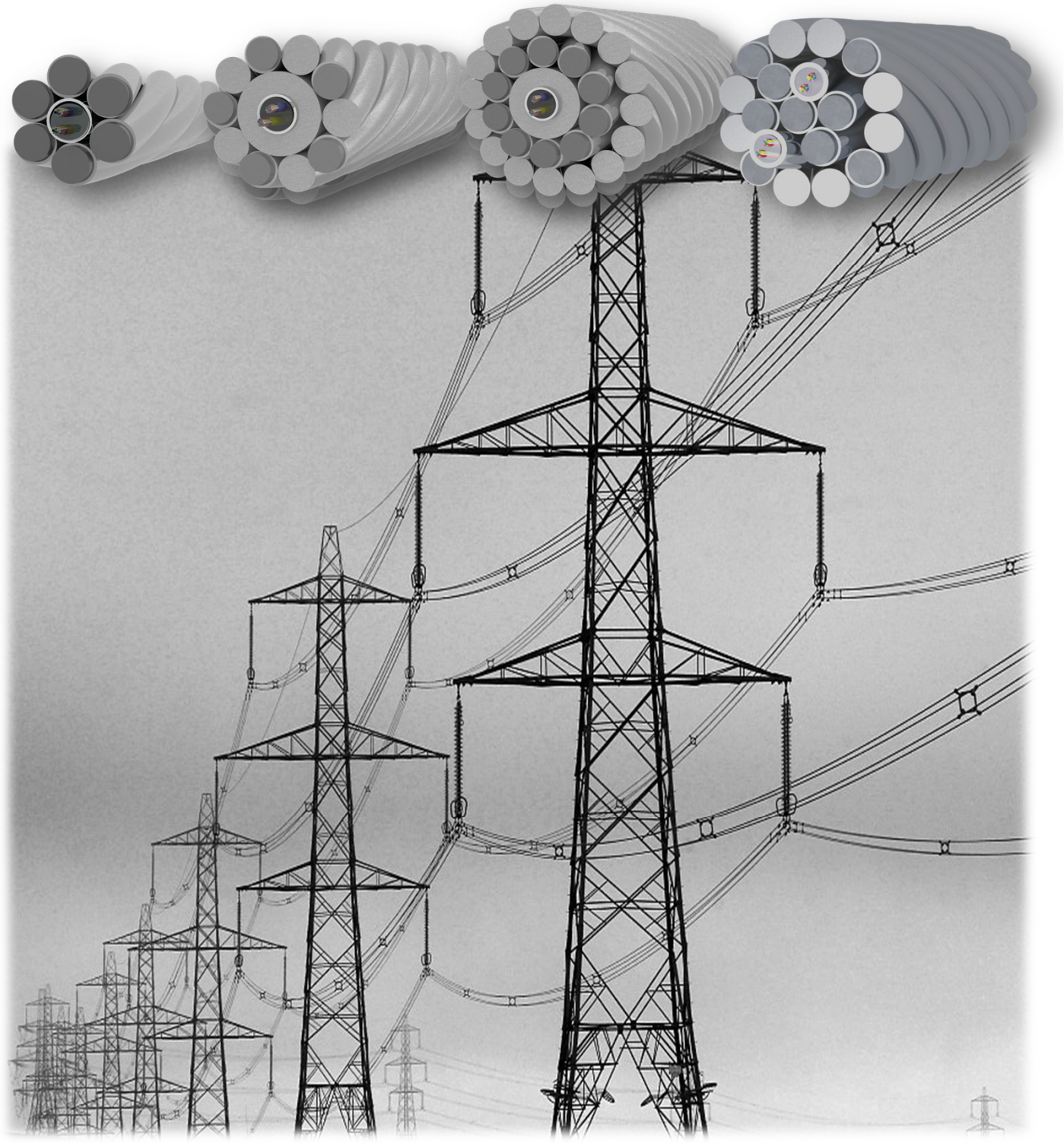
M-TEC

OPGW

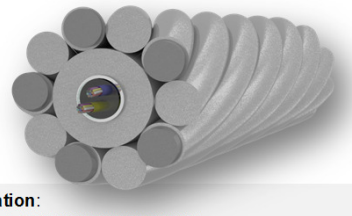
Optic fiber Protection Overhead Ground Wire



Other Aluminium products:

- AAC (All aluminium conductor)
- AAAC (All aluminium alloy conductor)
- AACSR (All aluminium alloy conductor steel reinforced)
- ACSR (All aluminium alloy conductor steel reinforced)
- Solid sector shaped aluminium conductor
- Aluminium strip
- Aluminium wire
- Aluminium alloy wire

OPGW
Centre SUS tube single layer



Application:
OPGW conductor is strung on poles or structures in air, supporting its own weight.
Grounding via Aluminium cladded steel and Aluminium alloy conductor,
communication is done via optic fibres in stainless steel SUS tube.

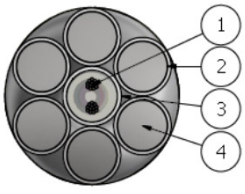
Construction:
Centre wire: SUS tube or Al cladded SUS
1st layer: Aluminium cladded steel wires; Aluminium alloy wires; or combination of ACS & AA Wires

Illustration sketches is for reference only and may not always represent the exact conductor construction.

Specification:
NRS 061-1, IEC793, 794, ITU-T G 650,
IEEE P1138, IEC 61089

OPGW Size: short circuit rating	kA, 1sec	3.2	5	5	7	12.00	12.50	12.22
Tensile rating, RTS	**kN**	**65**	**36**	**60**	**60**	**60**	**62**	**107**
Construction								
Fibres per SUS tube	number	12, 24 or 48 fibres per SUS tube.						
Number of SUS tubes	number	1	1	1	1	1	1	1
Fibre SUS tube outer diameter	mm	3.1	3.4	4.00	6.3	7.4	9.1	7.9
Aluminium in Al cladded SUS tube (where applicable).	mm²	0.0	0.0	0.0	18.0	29.8	51.8	35.8
Aluminium Clad Steel								
Number of wires	#	6	6	6	9	5	5	8
Wire diameter		3.1	3.5	4.0	3.15	3.3	3.4	3.5
Wire area	mm²	7.5	9.6	12.6	7.8	8.6	9.1	9.6
Total wire area nominal	mm²	45.3	57.7	75.4	70.1	42.8	45.4	77.0
Aluminium in ACS	mm²	19.5	32.4	32.4	30.2	18.4	13.2	33.1
Conductivity of wire @ 20℃	%	30	40	30	30	30	20.3	30
Aluminium Alloy								
Number of wires	#	-	-	-	-	5	6	2
Wire diameter	mm	-	-	-	-	3.3	3.4	3.5
Aluminium alloy area nom.	mm²	-	-	-	-	43	54	19
Conductor physical properties								
Diameter 1st layer	mm	9.3	10.4	12.0	12.6	14.0	15.9	14.9
Diameter 2nd layer	mm	-	-	-	-	-	-	-
Total weight nominal	kg/km	322	461	461	523	517	630	697
Total OPGW area (conductive components)	mm²	45	58	75	88	73	97	113
Final layer stranding direction	S/Z	S	Z	Z	Z	Z	Z	Z
* RTS (rated tensile strength)	kN	54	60	60	60	71.2	72.2	72.2
** Modulus of elasticity Initial	kgf/mm²	16,519	14,378	13,500	13,500	10,095	12,339	12,339
	Mpa	162,000	141,000	132,390	132,390	99,000	121,000	121,000
** Modulus of elasticity Final	kgf/mm²	15,693	13,659	12,825	12,825	9,590	11,722	11,722
	Mpa	153,900	133,950	125,770	125,770	94,050	114,950	114,950
** Coefficient of linear expansion nom.	10-6/℃	13.0	14.5	13.8	14.7	17.2	17.4	15.2
Maximum allowable temperature	℃	200						
Conductor electrical properties								
* DC Resistance @ 20℃	Ω/km	1.90	0.75	0.74	0.55	0.35	0.27	0.38
* Short Circuit 1.0 second	kA	3.2	5	5	7	12	12.5	12.22
* Short circuit current capacity - Initial temperature 20℃ - Final temperature maximum 200℃	kA².s	10	25	25	31	144	156	149
Continues current rating	A							
Lightning Class: 0, 1, 2 or 3 Ransfer rate (0:50C, 1:100C, 2:150C, 3:200C)	Class	3	3	3	3	3	3	3
Lightning maximum durtation	0.5 seconds							
Fibre identification: In all groups	1. Blue 2. Orange 3. Green 4. Brown 5. Slate/Grey 6. White 7. Red 8. Black 9. Yellow 10. Violet 11. Pink 12. Aqua							
Fiber group identification: Binder colour:								
1 x 12 fiber SUS tube: 12 fiber cable	12 fiber: group: no binder							
1 x 24 fiber SUS tube: 24 fiber cable	12 fiber: groups: 1st group (Blue), 2nd group (Yellow)							
1 x 48 fiber SUS tube: 12 fiber cable	1st tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Red),							
Shipping length	m	4000	4000	4000	4000	4000	4000	4000
Grease filling if applicable (IEC61089)		Case 4	Case 4	Case 4	Case 4	Case 4	Case 4	Case 4
* Grease weight calculated: Nominal	kg/km	4.4	5.6	7.4	4.6	5.0	5.3	5.6

Note: * calculated value, **data for information only
In addition to the sizes above, any other construction can be designed and manufactured on customer request.



Item	Description
1	Optical Fibers
2	Thixotropic Gel
3	Stainless Steel Tube
4	Aluminium Cladded Steel Wire

Revision: R03 14/06/2017

OPGW
Multi layer, inner layer SUS tube

Application:
OPGW conductor is strung on poles or structures in air, supporting its own weight. Grounding via Aluminium cladded steel and Aluminium alloy conductor, communication is done via optic fibres in stainless steel SUS tube.

Construction:
1st layer: Aluminium cladded steel wires with integrated SUS tube filled with thixotropic gel protecting the optical fibres.
2nd Layer: Aluminium alloy wires.

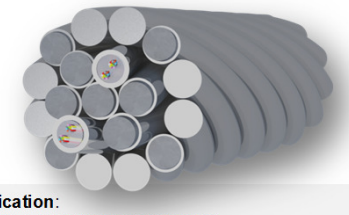
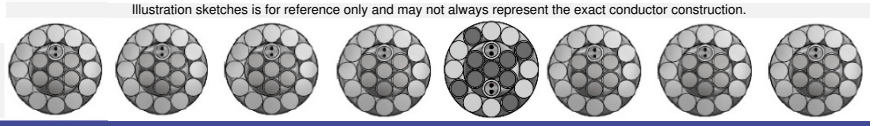


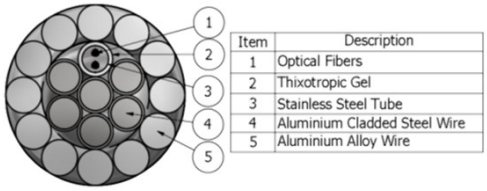
Illustration sketches is for reference only and may not always represent the exact conductor construction.



Specification:
NRS 061-1, IEC793, 794, ITU-T G 650, IEEE P1138, IEC 61089

OPGW Size: short circuit rating	kA, 1sec	10	11	12	13	13	16	18	21
Tensile rating, RTS	**kN**	**58**	**58**	**60**	**72**	**75**	**60**	**70**	**95**
Fibres per SUS tube	number	12 or 24 per SUS tube under 4.00mm diameter or 48 fibres per SUS tube per SUS tube over 4.00mm diameter							
Number of SUS tubes	number	1 / 2	1 / 2	1 / 2	1 / 2	1 / 2	1 / 2	1 / 2	1 / 2
Fibre SUS tube outer diameter	mm	2.70	3.00	3.10	3.10	3.10	3.40	3.75	4.00
Aluminium Clad Steel									
Number of wires	#	5	6 / 5	6 / 5	6 / 5	10 / 9	5 / 4	5 / 4	5 / 4
Wire diameter									
Centre	mm	2.8	3.0	3.2	3.2	3.2	3.5	3.80	4.1
1st layer	mm	2.8	3.0	3.2	3.2	3.0	3.5	3.80	4.1
2nd layer	mm	2.8	3.0	3.2	3.2	3.4	3.5	3.80	4.1
Wire area	mm²	6.2	7.1	8.0	8.0	3.2mm: 8.05 3.0mm: 7.07 3.4mm: 9.08	9.6	11.3	13.2
Total wire area nominal	mm²	30.8	42.4 / 35.3	48.2 / 40.2	48.2 / 40.2	79.7 / 72.6	81.2 / 76.3	92 / 84.9	101.3 / 94.2
Aluminium in ACS	mm²	13.2	12.7 / 10.6	20.8 / 17.3	14 / 11.7	34.3 / 31.2	34.9 / 32.8	39.6 / 36.5	39.2 / 36.4
Conductivity of wire @ 20℃	%	30	30	30	20.3	30	30	30	27
Aluminium Alloy									
Number of wires	#	12	15	12	12	7	12	12	12
Wire diameter	mm	2.8	2.36	3.2	3.2	3.4	3.5	3.80	4.1
Aluminium alloy area nom.	mm²	74	66	97	97	64	115	136	158
Conductor physical properties									
Diameter 1st layer	mm	8.4	9.0	9.6	9.6	9.2	10.5	11.4	12.3
Diameter 2nd layer	mm	14.0	13.7	16.4	16.0	16.0	17.5	19.0	20.5
Total weight nominal	kg/km	424	457	551	560	646	656	771	914
Total OPGW area (conductive components)	mm²	105	149 / 142	145 / 137	188 / 180	145 / 137	412188	485878	565623
Final layer stranding direction	S/Z	Z	Z	Z	Z	Z	Z	Z	Z
* RTS (rated tensile strength)	kN	58	58	60	72	75	70	70	95
** Modulus of elasticity Initial	kgf/mm²	8,900	9,900	8,800	9,280	10,500	8,800	8,800	9,000
	Mpa	87,279	97,086	86,299	91,000	102,970	86,299	86,299	88,260
** Modulus of elasticity Final	kgf/mm²	8,455	9,405	8,360	8,816	9,975	8,360	8,360	8,550
	Mpa	82,915	92,232	81,984	86,455	97,821	81,984	81,984	83,847
** Coefficient of linear expansion nom.	10.6	18.3	17.0	18.3	17.8	16.3	18.3	18.4	18.1
Maximum allowable temperature	℃	200							
Conductor electrical properties									
* DC Resistance @ 20℃	Ω/km	0.40	0.37	0.27	0.29	0.35	0.23	0.19	0.17
* Short Circuit 1.0 second	kA	10	11	12	13	13	16	18	20
* Short circuit current capacity - Initial temperature 20℃ - Final temperature maximum 200℃	kA².s	100	121	144	174	169	256	324	441
Continues current rating	A								
Lightning Class: 0, 1, 2 or 3 Ransfer rate (0:50C, 1:100C, 2:150C, 3:200C)	Class	1	1	1	1	1	1	1	1
Lightning maximum durtation	0.5 seconds								
Fibre identification: In all groups	1. Blue 2. Orange 3. Green 4. Brown 5. Slate/Grey 6. White 7. Red 8. Black 9. Yellow 10. Violet 11. Pink 12. Aqua								
Fiber group identification: Binder colour:									
1 x 12 fiber SUS tube: 12 fiber cable	12 fiber: group: no binder								
1 x 24 fiber SUS tube: 24 fiber cable	12 fiber: groups: 1st group (Blue), 2nd group (Yellow)								
2 x 24 fiber SUS tubes: 48 fiber cable	1st tube12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 2nd tube12 fiber: groups: 1st group (Green), 2nd group (Red)								
2 x 48 fiber SUS tubes: 96 fiber cable	1st tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Red), 2nd tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Brown),								
3 x 48 fiber SUS tubes: 144 fiber cable	1st tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Red), 2nd tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Brown), 3rd tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Grey),								
Shipping length	m	4000	4000	4000	4000	4000	4000	4000	4000
Grease filling if applicable (IEC61089)		Case 2	Case 2	Case 2	Case 2	Case 2	Case 2	Case 2	Case 2
* Grease weight calculated: Nominal	kg/km	13	13	16	16	18	19	23	26

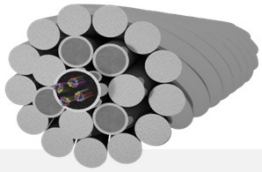
Note: * calculated value, **data for information only
In addition to the sizes above, any other construction can be designed and manufactured on customer request.



Item	Description
1	Optical Fibers
2	Thixotropic Gel
3	Stainless Steel Tube
4	Aluminium Cladded Steel Wire
5	Aluminium Alloy Wire

Revision: R03 14/06/2017

OPGW
Multi layer, Centre SUS tube



Specification:
NRS 061-1, IEC793, 794, ITU-T G 650,
IEEE P1138, IEC 61089

Application:
OPGW conductor is strung on poles or structures in air, supporting its own weight.
Grounding via Aluminium cladded steel and Aluminium alloy conductor,
communication is done via optic fibres in stainless steel SUS tube.

Construction:
Centre wire: SUS tube filled with thixotropic gel
1st layer: Aluminium cladded steel wires; Aluminium alloy wires; or combination of ACS & AA Wires
2nd Layer: Aluminium alloy wires.

Construction			
OPGW Size: short circuit rating	**kA, 1sec**	**10**	**12**
Tensile rating, RTS	**kN**	**65**	**62**
Fibres per SUS tube	number	48 per SUS tube	
Number of SUS tubes	number	1	1
Fibre SUS tube outer diameter	mm	3.60	3.80
Aluminium Clad Steel			
Number of wires	#	7	4
Wire diameter Centre 1st layer 2nd layer	mm	2.70	2.85
Wire area	mm²	5.7	7.1
Total wire area nominal	mm²	40.1	25.5
Aluminium in ACS	mm²	8.1	3.6
Conductivity of wire @ 20℃	%	20.3	14
Aluminium Alloy			
Number of wires	#	14	16
Wire diameter	mm	2.5	2.85
Aluminium alloy area nom.	mm²	69	102
Conductor physical properties			
Diameter 1st layer	mm	9.0	9.5
Diameter 2nd layer	mm	14.0	15.2
Total weight nominal	kg/km	476	473
Total OPGW area (conductive components)	mm²	109	128
Final layer stranding direction	S/Z	Z	Z
* RTS (rated tensile strength)	kN	65	62
** Modulus of elasticity Initial	kgf/mm²	9,891	8,667
	Mpa	97,000	85,000
** Modulus of elasticity Final	kgf/mm²	9,396	8,234
	Mpa	92,148	80,745
** Coefficient of linear expansion nom.	10-6/℃	16.9	18.6
Maximum allowable temperature	℃	200	
Conductor electrical properties			
* DC Resistance @ 20℃	Ω/km	0.39	0.30
* Short Circuit 1.0 second	kA	10	12
* Short circuit current capacity - Initial temperature 20℃ - Final temperature maximum 200℃	kA².s	100	144
Continues current rating	A		
Lightning Class: 0, 1, 2 or 3 Ransfer rate (0:50C, 1:100C, 2:150C, 3:200C)	Class	1	1
Lightning maximum durtation	0.5 seconds		

Fibre identification: In all groups	1. Blue 2. Orange 3. Green 4. Brown 5. Slate/Grey 6. White 7. Red 8. Black 9. Yellow 10. Violet 11. Pink 12. Aqua
Fiber group identification: Binder colour:	
1 x 12 fiber SUS tube: 12 fiber cable	12 fiber: group: no binder
1 x 24 fiber SUS tube: 24 fiber cable	12 fiber: groups: 1st group (Blue), 2nd group (Yellow)
2 x 24 fiber SUS tubes: 48 fiber cable	1st tube12 fiber: groups: 1st group (Blue), 2nd group (Yellow),
	2nd tube12 fiber: groups: 1st group (Green), 2nd group (Red)
2 x 48 fiber SUS tubes: 96 fiber cable	1st tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Red),
	2nd tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Brown),
3 x 48 fiber SUS tubes: 144 fiber cable	1st tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Red),
	2nd tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Brown),
	3rd tube 12 fiber: groups: 1st group (Blue), 2nd group (Yellow), 3rdgroup (Green), 4th group (Grey),

Shipping length	m	4000	4000
Grease filling if applicable (IEC61089)		Case 2	Case 2
* Grease weight calculated: Nominal	kg/km	10	13

Note: * calculated value, **data for information only
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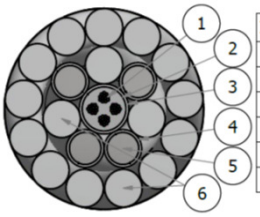
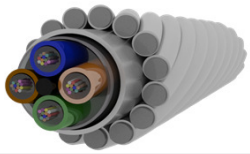


Item	Description
1	Fiber optic
2	Thixotropic gel
3	Stainless steel tube
4	Aluminium cladding ACS wire
5	Steel centre ACS wire
6	Aluminium alloy wire

Revision: R03 14/06/2017

OPGW LT
ACS / Central AA Loose tube



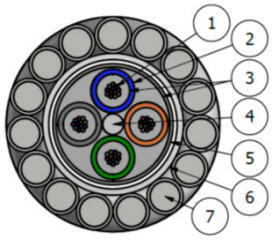
Specification:
NRS 061-1, IEC793, 794, ITU-T G 650,
IEEE P1138, IEC 61089

Application:
OPGW conductor is strung on poles or structures in air, supporting its own weight.
Grounding via Aluminium cladded steel conductor, communication is done via optic fibres in PBT Loos tubes encased in an Aluminium extruded tube.

Construction:
1st layer: Aluminium cladded steel wires with integrated SUS tube filled with thixotropic gel protecting the optical fibres.

Construction		
OPGW Size: short circuit rating	**kA, 1sec**	**10**
Tensile rating, RTS	**kN**	**58**
Fibres per PBT / AA loose tube	number	48
Fibre AA loose tube outer diameter	mm	2.70
Aluminium Clad Steel		
Number of wires	#	5
Wire diameter Centre 1st layer	mm	2.8
Wire area	mm²	6.2
Total wire area nominal	mm²	30.8
Aluminium in ACS	mm²	13.2
Conductivity of wire @ 20℃	%	30
Conductor physical properties		
Diameter 1st layer	mm	8.4
Diameter 2nd layer	mm	15.2
Total weight nominal	kg/km	424
Total OPGW area (conductive components)	mm²	31
Final layer stranding direction	S/Z	Z
* RTS (rated tensile strength)	kN	58
** Modulus of elasticity	kgf/mm²	8,900
	Mpa	87,279
** Coefficient of linear expansion nom.	10-6/℃	18.3
Maximum allowable temperature	℃	200
Conductor electrical properties		
* DC Resistance @ 20℃	Ω/km	0.40
* Short Circuit 1.0 second	kA	10
* Short circuit current capacity - Initial temperature 20℃ - Final temperature maximum 200℃	kA².s	100
Continues current rating	A	
Lightning Class: 0, 1, 2 or 3 Ransfer rate (0:50C, 1:100C, 2:150C, 3:200C)	Class	1
Lightning maximum durtation	0.5 seconds	
Fibre identification: In all tubes.	1. Blue 2. Orange 3. Green 4. Brown 5. Slate/Grey 6. White 7. Red 8. Black 9. Yellow 10. Violet 11. Pink 12. Aqua	
Loose Tube identification:	1. Blue 2. Orange 3. Green 4. Brown	
Shipping length	m	4000
Grease filling if applicable (IEC61089)		Case 2
* Grease weight calculated: Nominal	kg/km	13

Note: * calculated value, **data for information only
In addition to the sizes above, any other construction can be designed and manufactured on customer request.



Item	Description
1	Fibre Optic
2	PBT loose tube
3	Thixotropic Gel
4	FGRP
5	Wrapping tape
6	Aluminium Tube
7	Aluminium clad steel wire

Revision: R03 14/06/2017

1. GENERAL

This specification covers the design requirements and performance standard for OPGW in overhead transmission line.

1.1 Conductor Description

Loose tube conductor is a design that has high tensile strength and flexibility in a compact cable size.
The stainless steel loose tube cable provides excellent optical transmission and physical performance.

1.2 Quality

Level of quality in our cable products is ensured through several quality control program including ISO 9001.

1.3 Reliability

Product reliability is ensured through rigorous qualification testing of each product family.
Both initial and periodic qualification testing are performed to assure the cable's performance and durability in the field environments.

2. OPTICAL FIBER

2.1 Single Mode Fiber, G652D

Single mode fiber manufactured by the vapour axial deposition (VAD) process to produce the highest quality glass with excellent geometry, high strength characteristics, and attenuation that approaches theoretical minimum. The single mode fiber is fully compatible with other commercially available single mode fibres and has the zero dispersion wavelength around 1310nm. The main operating wavelength region of the fiber is around 1310 nm and 1550 nm.

2.2 General Design

Its optical properties are achieved through a germanium doped silica based core with a pure silica cladding.
An acrylate protective coating is applied over glass cladding to provide the necessary maximum fiber lifetime.

2.3 Construction

Mode field diameter at 1310nm	9.2μm ± 0.4μm
Mode field diameter at 1550nm	10.4μm ± 0.5μm
Mode field concentricity error	< 0.5μm
Cladding diameter	125 ± 0.7μm
Cladding non-circularity	≤ 0.7%
Primary coating material	UV curable acrylate
Fibre diameter	250 ± 10μm

2.4 Optical characteristics

Attenuation at 1310 nm	≤ 0.36 dB/km
Attenuation at 1550 nm	≤ 0.25 dB/km
Dispersion at 1285 ~ 1330nm	≤ 3.5ps/(nm.km)
Dispersion at 1550nm	≤ 18ps/(nm.km)
Zero dispersion wavelength	1300 ~ 1322nm
Zero dispersion slope	< 0.093 ps/(nm².km)
Cable cut off wavelength (λccf)	< 1260nm

2.5 Mechanical characteristics

Fiber proof test level	≥ 1% x 1sec
Bending test (75 mm diameter mandrel 100 turns)	≤ 0.05 dB at 1550nm

2.6 Removal of primary coating

For jointing, removal of primary coating is achieved without the use of any chemicals. A simple mechanical operation is sufficient to prepare the fiber for jointing.

3. Test and Inspection

All tests and inspection shall be made in accordance with above mentioned standard specification.

4. Packing and Marking

4.1 Finished cable shall be delivered on wooden drum or metal drum.
4.2 Each dead-end of cable shall have effectively sealed with heat shrinkable cap.
4.3 On side of the cable drum, required marking shall be printed.
4.4 The barrel diameter shall not be less than 40 times of the diameter of the cable.

Dimension of Wooden Drum

[Unit: mm]

Drum details (Nominal)						
Reel number	Flange diameter	Flange diameter	Barrel diameter	Spindle hole diameter	Inner width	Outer width
AS	1900	1900	960	90	1088	1240
TB	2000	2000	1200	90	908	1060
SB	1700	1700	830	90	908	1060
SC	1600	1600	830	90	900	1052
CB	1300	1300	700	90	900	1052
DB	1000	1000	500	90	800	952

- We apply ISO, BS and DEF standard for drum construction, bolt size and etc.
- The dimension of drum is nominal value and so, if necessary, it will be possible to change applicable dimensions if needed.

Wooden Drum Construction