

Section 1

Specification for 5kV

1. SCOPE

This specification covers manufacturing and testing of 5kV 3 x 185SQ.mm/50SQ.mm power and 2 x 24-core optical fiber composite double wire armoured submarine cable in accordance with IEC60228, IEC60502-2, ITU-T G.652 and/or Manufacturer's standard.

2. CONSTRUCTION AND MATERIALS

2.1 Conductor

Conductor shall be of compact round, stranded, annealed uncoated copper wires in accordance with IEC60228.

2.2 Conductor Water Barrier

A continuous watertight sealing material compatible with both the conductor and the conductor shielding shall be applied longitudinally in the interstices of the conductor strands.

2.3 Conductor Shielding

A layer of semi-conducting thermosetting compound compatible with the insulation shall be extruded over the conductor to form a stress control layer. The outer surface of the shield shall be cylindrical and shall be firmly bonded to the overlying insulation.

2.4 Insulation

The insulation shall consist of cross-linked polyethylene. For each piece of core, the smallest value measured shall not fall below 90 % of the nominal value by more than 0.1 mm, i.e.:

$$t_{\min} \geq 0.9 t_n - 0.1$$

and additionally:

$$(t_{\max} - t_{\min}) / t_{\max} \leq 0.15$$

Where

t_{\max} : Maximum thickness [mm]

t_{\min} : Minimum thickness [mm]

t_n : Nominal thickness [mm]

NOTE: t_{\max} and t_{\min} are measured at the same cross-section.

The three layers of the conductor shielding, insulation and insulation shielding shall be extruded simultaneously (Triple extrusion, single pass method shall be used for all three process).

The curing of the XLPE insulation shall be by dry (gas) curing process.

2.5 Insulation Shielding

The insulation shielding shall consist of extruded layer of semi-conducting thermosetting compound compatible with the insulation and bonded firmly and continuously to the insulation.

2.6 Power Insulation Identification

Each conductor shall be identified by a different colored plastic tape placed under the metallic shield. The color code shall be White, Red and Blue.

2.7 Metallic Shield

The insulation screen shall be covered with two layers of uncoated plain annealed copper tape applied with suitable overlap. A semi-conducting tape shall be applied between the insulation screen and the metallic screen. A suitable binder tape shall be applied over the metallic shield.

2.8 Individual Conductor Jacket

The sheath shall consist of extruded black polyethylene.

The minimum thickness at any point shall not be less than 80% of the nominal value.

2.9 Optical Fiber Cable (2-unit x 24-core)

The optical fiber cable shall be composed of 24 cores of single mode optical fibers and shall be housed into the stainless steel tube. 2 nos. of 24-core optical fiber unit shall be placed in the space between power cores.

2.9.1 Optical Fiber Core

The fibers fully comply with ITU-T G.652 (Single Mode).

a) Parameters

Mode field diameter	; 8.6 to $9.5 \pm 0.6 \mu\text{m}$ at 1310 nm
Cladding diameter	; $125 \pm 0.7 \mu\text{m}$
Mode field concentricity error	; Max. $0.6 \mu\text{m}$
Cladding noncircularity	; Max. 1.0%
UV Coating diameter	; Approx. 0.25mm

b) Optical Characteristics

Attenuation	; Max. 0.40 dB/km at 1310 nm ; Max. 0.30 dB/km at 1550 nm
Zero dispersion wavelength	; 1300 - 1324 nm
Zero dispersion slope	; Max. $0.092 \text{ ps/nm}^2\text{-km}$
Cable cut-off wave length	; Max. 1260 nm

2.9.2 Core Identification

All fibers have unique fiber color coding as shown in the table below for 48 fibers. The fiber color coding is in accordance with TIA/EIA-598-C. Fiber color black for fibers 8, 20, 32 and 44 is replaced with color natural due to black ring marking.

Element	Marking			
Ring Marking ¹⁾	0/0	1/150	0/0	1/150
Fiber Color				
Blue	1	13	25	37
Orange	2	14	26	38
Green	3	15	27	39
Brown	4	16	28	40
Grey	5	17	29	41
White	6	18	30	42
Red	7	19	31	43
Natural	8	20	32	44
Yellow	9	21	33	45
Violet	10	22	34	46
Pink	11	23	35	47
Aqua	12	24	36	48
Unit Number ²⁾	1		2	

1) Ring marking A/B is defined as follows:

A = number rings for each marking points

B = spacing between marking points (mm).

2) Unit Number shall be printed in white on the outer sheath of each F.O. unit.

2.9.3 Housing

Twenty four (24) nos. of fibers shall be supported strain free within jelly filled stainless steel tube.

2.9.4 Outer Sheath

The outer sheath shall consist of extruded black polyethylene. The minimum thickness at any point shall not fall below 80% of the nominal value shown in the attached table.

2.10 Cable Assembly

The three insulated power conductors and one optical fiber unit shall be cabled together with a left hand lay with a length of lay not exceeding 35 times the individual power core diameter.

The interstices of the cable shall be filled with polypropylene yarn fillers to form a firm cylindrical cross-section.

2.11 Cable Marking

The white narrow tape printed the following items in black shall be applied throughout the length of the cable over the laid-up core.

- a) Rated voltage (i.e. 5 kV)
- b) Insulation type / material and temperature rating (i.e. XLPE 90°C)
- c) Core manufacturer's name and year of manufacture (i.e. J-POWER SYSTEMS SAUDI 2019)
- d) Number and size of conductors (3x185MM²/3x50MM²)

i.e : 5kV XLPE 90°C J-POWER SYSTEMS SAUDI 2019 3x185MM²

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i.e : 5kV XLPE 90°C J-POWER SYSTEMS SAUDI 2019 3x50MM²

2.12 Cable Core Binder

A binder tape shall be applied half-lapped over the core.

2.13 Anti-Teredo Protection

Two layers of uncoated annealed copper tape shall be helically applied over the cable core binder.

The two tapes shall be laid on helically so that the outer tape is approximately central over the gap of the inner tape. The gap between two adjacent turns of each tape shall not exceed 50% of the width of the tape. Over the tape anti-teredo protection, anti-corrosion compound shall be applied.

A suitable bedding tape(s) may be applied under the anti-teredo copper tape at manufacturer's discretion.

2.14 Armour Bedding

Single layer of polypropylene yarn shall be applied over the anti-teredo protection to provide a bedding for the wire armour.

The bedding shall be completely flushed with an asphaltic compound.

2.15 Wire Armour

Double layers of close wound galvanized steel wire armour shall be spirally applied over the bedding and anti-corrosive compound shall be applied over the wire armour. The laying direction shall be same for two layers. Between two layers of the armour, single layer of polypropylene yarn shall be applied.

2.16 Servicing

Two layers of abrasion and UV resistant polypropylene yarn shall be applied over the armour. The outer layer shall be in a black and yellow stripe pattern.

Flushing material shall be asphaltic compound applied over the inner polypropylene yarn layer and shall be synthetic compound over the outer polypropylene yarn layer.

2.17 Cable Length Marking

The outside of the cable shall be marked by colored band PVC tape along its length at 500m intervals with the first and last 100m marked at 10m intervals. The band shall not be less than 100mm.

3. TESTING

3.1 Tests during Manufacture

Following tests shall be carried out prior to assembling of cores at manufacturer's works in accordance with IEC60502-2, ITU-T G.652D and/or manufacturer's standard.

3.1.1 Power Core

- a) Construction test (on a cable sample)
- b) High voltage test (on manufactured length) ; A.C. 12.5kV/5min. or D.C. 30kV/5min.
- c) Partial discharge test (on manufactured length) ; Max. 10pC at 6.5kV
- d) Insulation resistance test (on manufactured length) ; Min. 1,000 Mohm-km (for 185sq)
Min. 1,700 Mohm-km(for 50sq)
- e) D.C. conductor resistance test (on manufactured length);Max.0.0991ohm/km at 20°C(for185sq)
Max. 0.387 ohm/km at 20°C(for50sq)

3.1.2 Optical Fiber Unit

- a) Construction test (on a cable sample)
- b) Attenuation test (on completed cable) ; Max. 0.4 dB/km at 1310nm
; Max. 0.3 dB/km at 1550nm
- c) Chromatic dispersion test; Max. 3.5ps/nm.km at 1310nm, 18ps/nm.km at 1550nm

3.2 Completion Tests

Following tests shall be carried out prior to shipment at manufacturer's works in accordance with IEC60502-2, ITU-T G.652D and/or manufacturer's standard.

3.2.1 Power Core

- a) Construction test (on a cable sample)
- b) Water tightness test (on a cable sample)
In order to ensure the water tightness of the conductor, a 5m long sample of the insulated conductor taken from the completed cable shall be tested for 24 hours with water at a pressure of 5 kgf/cm² applied at one end of the sample. At the end of the 24 hours test period, there shall be no visible leakage of water at the other end of the sample.
- c) D.C. conductor resistance test (on completed cable) ; Max. 0.0991 ohm/km at 20°C(for185sq)
Max. 0.387 ohm/km at 20°C(for50sq)
- d) High voltage test (on completed cable) ; A.C. 12.5kV/5min. or D.C. 30kV/5min.
- e) Insulation resistance test (on completed cable) ; Min. 1,000 Mohm-km
Min. 1,700 Mohm-km(for 50sq)
- f) Continuity test of conductor, armour wire and metallic screen (on completed cable) ; For reference only
- g) Capacitance test (on completed cable) : 0.63µF/km (for 185sq)
0.397µF/km (for 50sq)

3.2.2 Optical Fiber Unit

- a) Construction test (on a cable sample)
- b) Attenuation test (on completed cable) ; Max. 0.4 dB/km at 1310nm
; Max. 0.3 dB/km at 1550nm
- c) Chromatic dispersion test; Max. 3.5ps/nm.km at 1310nm, 18ps/nm.km at 1550nm

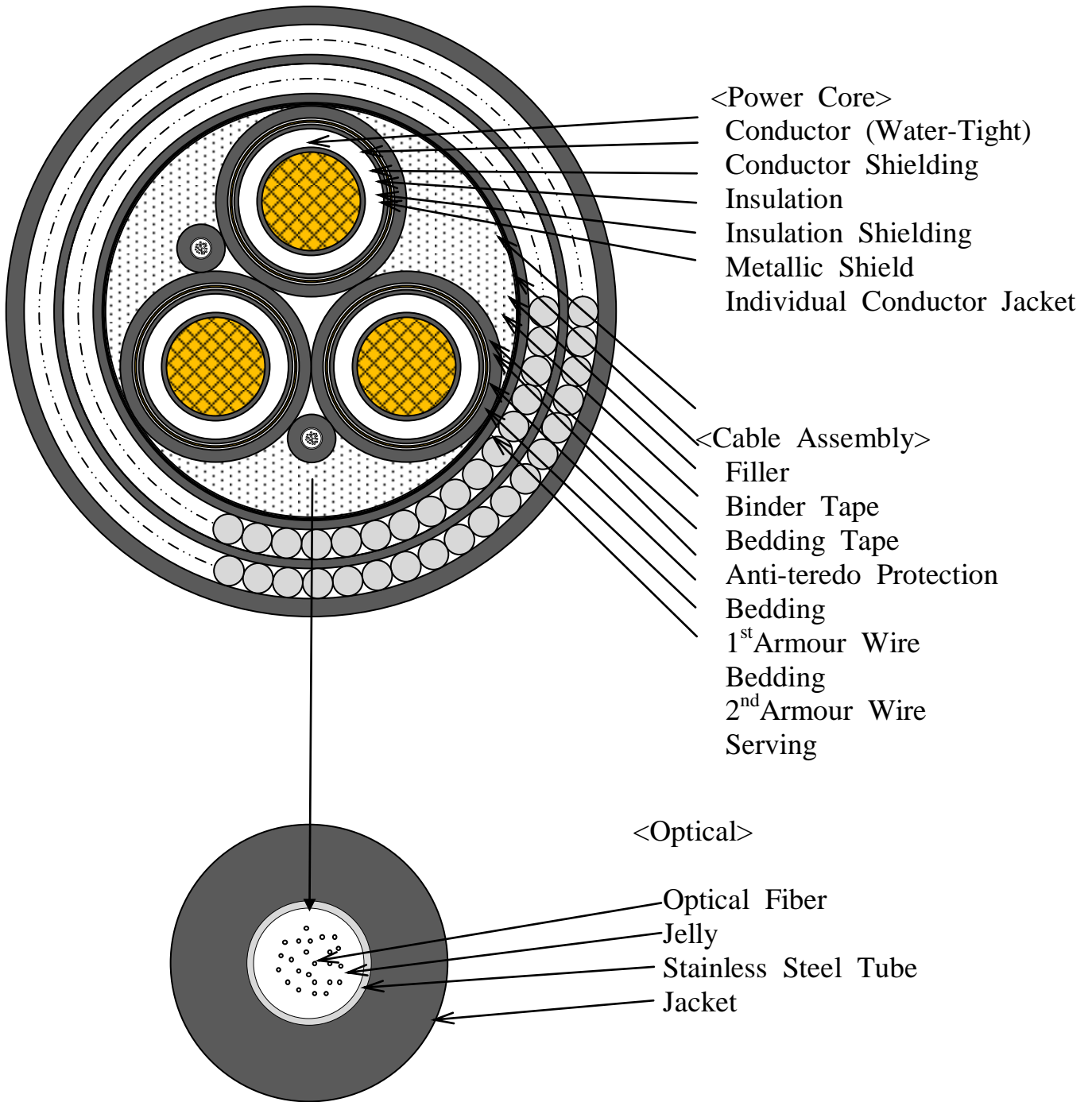
4. PACKING

Both ends of cable shall be capped in order to avoid ingress of water and provided with cable pulling grip for installation. The completed cable shall be wound on a non-returnable steel drum with suitable covers.

Table 1 : Dimension & Particular of Cable

Description	Unit	Static portion	
Rated Voltage	kV	5	
Power Conductor			
a. No. of core	-	3	3
b. Size	mm ²	185	50
c. Diameter	mm	Approx. 15.8	Approx. 8.1
Thickness of conductor shielding	mm	Approx. 0.8	Approx. 0.8
Thickness of insulation	mm	Nom. 2.5	Nom. 2.5
Thickness of insulation shielding	mm	Approx. 0.7	Approx. 0.7
Number & thickness of metallic shield	No. x mm	2 x Min. 0.127	2 x Min. 0.127
Thickness of individual conductor jacket	mm	Nom. 1.9	Nom. 1.7
Optical fiber unit (2-unit x 24-core)			
a. No. of optical fiber per unit		24	24
b. Type of optical fiber		ITU-T G.652	ITU-T G.652
c. Thickness of stainless steel tube	mm	Nom. 0.2	Nom. 0.2
d. Thickness of PE jacket	mm	Nom. 1.76 _{A2}	Nom. 1.76 _{A2}
e. Diameter of unit	mm	Approx. 8.0	Approx. 8.0
No. & thickness of binder tape	No. x mm	1 x Nom. 0.15	1 x Nom. 0.15
No. & thickness of bedding tape	No. x mm	1 x Nom. 0.09	1 x Nom. 0.09
No. & thickness of anti-teredo protection	mm	2 x Nom. 0.095	2 x Nom. 0.095
Thickness of polypropylene yarn bedding	mm	Nom. 1.5	Nom. 1.5
Diameter of galvanized steel wire (1 Layer) (Nom.)	mm	Nom. 5.0	Nom. 4.19
Thickness of polypropylene yarn bedding	mm	Nom. 1.5	Nom. 1.5
Diameter of galvanized steel wire(2 Layer) (Nom.)	mm	Nom. 5.0	Nom. 4.19
Thickness of polypropylene yarn serving (two layers)	mm	Nom. 3.0	Nom. 3.0
Diameter of completed cable	mm	Approx. 102	Approx.81
Weight of completed cable			
- In air	kg/m	Approx. 26	Approx. 15
- In water	kg/m	Approx. 17	Approx. 9
Max. D.C. conductor resistance at 20°C	Ohm/km	0.0991	0.387
Min. bending radius of completed cable			
- During installation	mm	2,100	1,700
- During storage with cable torsion (Coiling)	mm	2,300	1,850
- For final setting (without cable movement)	mm	1,050	850
Max. allowable pulling tension			
- Conductor	kN	12/core	3.4/core
- Pulling grip (Chinese finger)	kN	24.5	24.5
- Steel armour wire (for 2 layers)	kN	166	99
Max. allowable side wall pressure	kg/m	1,500	1,500

Cross Section of 5kV 3-Core XLPE Submarine Cable



(NOT TO SCALE)