Specification No: RE650/660-- FTTH CABLE DEC 2001

SINGLE MODE OPTICAL FIBER FTTH CABLE

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1.0 INTRODUCTION TO RENKA SINGLE MODE OPTICAL FIBER FTTH CABLE

This document describes the Renka Specifications for Single Mode Optical Fiber FTTH (Fiber To The Home) Dielectric Cables. The cable designs described herein are capable of transmitting telephone, data and video signals utilizing single mode optical fibers.

Renka Single Mode Optical Fiber FTTH Cables are constructed with Dispersion Unshifted Single Mode Optical Fibers, with a matched cladding. This special design of cable allows universal deployment of these cables for duct, direct burial or aerial installations and the slim and strong construction allows for easy handling as well as time and labor saving during cable installation.

Each fiber is proof-tested to 100kpsi, which ensures it will survive installation loads and associated long term residual stresses, even under extreme environmental conditions. The optical, dimensional, and mechanical properties are measured for compliance to Industry Specifications (Bellcore, EIA/TIA, IEC, etc.). In addition, all Single Mode Fibers are manufactured to meet low Polarization Mode Dispersion (PMD) specifications.

2.0 CONSTRUCTION SPECIFICATIONS

2.1 Optical Fiber

The dispersion unshifted single mode fiber utilized in the cable
is made to the following specifications:

2.1.1 Typical Core Diameter: 8.3µm

2.1.2 Cladding Diameter: 125.0 ± 1µm

2.1.3 Core-to-Cladding Offset: ≤ 0.8µm

2.1.4 Cladding Non-Circularity: ≤ 1% *[1–(min cladding dia / max cladding dia)]*100*

2.1.5 Coating Diameter: 245 ± 10µm

2.1.6 Colored Fiber Diameter: Nominal 250µm

2.1.7 Cutoff Wavelength: The cabled fiber cutoff wavelength is less than 1260nm.

2.1.8 Mode-Field Diameter: 9.30 ± 0.50µm at 1310nm 10.50 ± 1.00µm at 1550nm

2.1.9 Cabled Fiber Attenuation:

Wavelength	Maximum attenuation (dB/km)	Average attenuation (dB/km)
1310nm	0.38	0.35
1550nm	0.25	0.20

2.1.10 Attenuation Uniformity: No point discontinuity greater than 0.1dB at either 1310nm or 1550nm.

2.1.11 Attenuation at Water Peak: Attenuation at 1383 ± 3nm < 1.5dB/km

2.1.12 Maximum total dispersion: 1285-1330nm: $\leq$ 3.2ps / (nm^2 km) 1550nm: $\leq$ 18.0ps / (nm^2 km)

2.1.13 Zero Dispersion Wavelength: 1301.5nm $\leq$ ZDW $\leq$1321.5nm

2.1.14 Zero Dispersion Slope: $\leq$ 0.092ps / (nm^2 km)

2.1.15 Fiber Polarization Mode Dispersion (PMD): < 0.5ps / √km

2.1.16 Fiber Curl: ≥4.0m radius of curvature

2.1.17 All fibers in the cable are usable fibers and meet required specifications.

2.1.18 Each optical fiber consists of a doped silica core surrounded by a concentric silica cladding. The fiber is a matched clad design.

2.2 Optical Fiber FTTH Cable:

2.21 Specified number of colored optical fibers are placed inside a loose buffer tube, filled with non-hygroscopic, non-nutritive to fungus, electrically non conductive, homogenous gel. Optical Fibers are color coded in accordance with TIA/EIA –598A

2.22 Individual fiber colors used in buffer tube are given in the following table:

Fiber No	Color
1	Blue (BL)
2	Orange (OR)
3	Green (GR)
4	Brown (BR)
5	Slate (SL)
6	White (WH)
7	Red (RD)
8	Black (BK)
9	Yellow (YL)
10	Violet (VI)
11	Rose (RS)
12	Aqua (AQ)

The fibers are colored with ultraviolet curable ink.

2.22 A smooth layer of Fiber reinforced Plastic is protruded over the buffer tube to give the cable tensile strength and compression / Impact resistance.

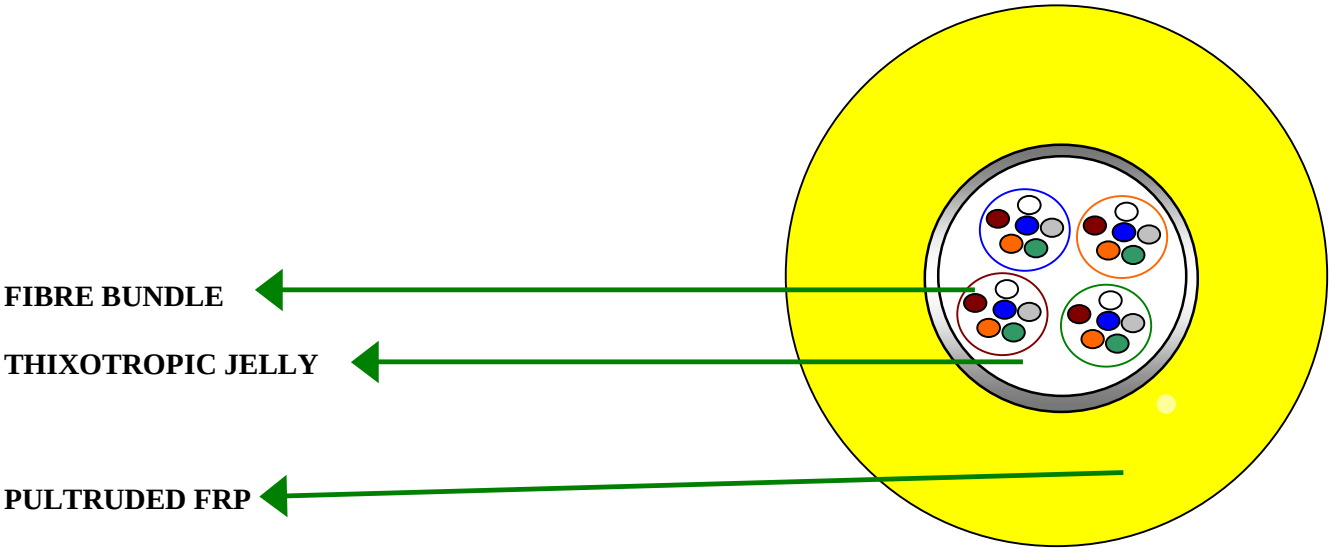
2.23 An outer jacket of black HDPE is extruded over the cable core to protect the cable from environmental stresses experienced during operation. Also the polyethylene used contains carbon black to provide protection from Ultraviolet light.

2.24 The Typical construction of cable is as follows:

a. The typical construction of FTTH Cables (Pultruded FRP) is as follows:

Type of Cable	No. of Loose Tubes	Cable Diameter (mm)	Cable Weight Kg/Km (Nominal)
2F	1	2.5±0.1	8±1
4F	1	2.5±0.1	8±1
6F	1	2.5±0.1	8±1
8F	1	3.5±0.1	12±1
12F	1	3.5±0.1	12±1
24F	1	6.0±0.1	30±2

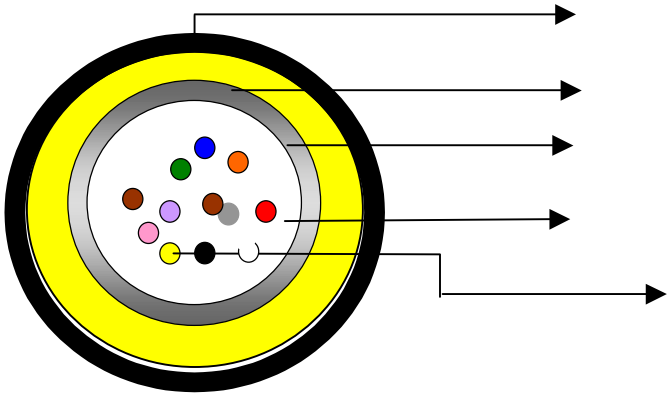
CROSS SECTIONAL VIEW OF 24 F FTTH PULTRUDED FRP CABLE



b. The typical construction of FTTH Cables (Polyethylene) is as follows:

Type of Cable	No. of Loose Tubes	Cable Diameter (mm)	Cable Weight Kg/Km (Nominal)
2F	1	3.5±0.1	12.5±1
4F	1	3.5±0.1	12.5±1
6F	1	3.5±0.1	12.5±1
8F	1	4.5±0.1	18±1
12F	1	4.5±0.2	18±1
24F	1	7.0±0.2	39±2

CROSS SECTIONAL VIEW OF 12F FTTH POLYETHYLENE CABLE



2.2.1 The fibers will be color coded for easy identification, in accordance with EIA/TIA- 598. The color-coding of the optical fibers is as follows:

Blue, Orange, Green, Brown, Slate, White, Red, Black, Yellow, Rose, Aqua.

3.0 Water-Blocking Compounds

Water-blocking materials are used to prevent water penetration. These materials are filled inside the Buffer Tubes.

3.1 Sheath Design

The cable is available in two types of single jacket design.

a. Pultruded FRP

A smooth layer of Fiber Reinforced Plastic (FRP) is provided over the Loose Buffer tube to provide Tensile strength, Impact resistance to the cable.

b. Polyethylene Sheath

In this case, a smooth coating of HDPE/MDPE is applied over the FRP layer of the cable.

3.2 Jacket Compound

The jacket compound is HDPE/MDPE. It meets the requirements of ASTM D1248. It is non-nutrient to fungus and it is electrically non-conductive. To minimize the effects of ultraviolet radiation, it contains 2.6 $\pm$ 0.25% of carbon black.

3.3 Cable Sheath Marking

All cables have sequential length markings along the cable sheath. The cable is marked in Black color in case of FRP cable and in white print in case of Polyethylene sheathed cable every three feet, and is

marked in foot measurement. At the customer's request, the cable can be marked in meters. The height of the marking is approximately 1.5mm.

As required by Section 350 G of the NESC, ANSI C2-1993, all cables have a visual identifier resembling a telephone hand-set to identify them as telecommunications / data-communications cables. The marking on the sheath contains the following information:

SmartLITE FTTH
SM XXF where XX is the number of fibers
Renka Corp
Telephone Symbol
Sequential foot marking

On any length of cable, the length markers shall not run through "00000".

The markings are dimensioned and spaced to produce good legibility.

The accuracy of the sequential marking is within -0% and +1% of the actual measured length of the cable.

4.0 PERFORMANCE SPECIFICATIONS FOR SM OFC

4.1 When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and other Passive Fiber Optic Components", the change in attenuation within operational temperature range (-40ºC to +70ºC) is 0.05 dB/km at 1550nm or 1310nm.

4.2 When tested in accordance with FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable", a one-meter length of unaged cable can withstand a one-meter static head or equivalent continuous pressure of water for twenty-four hours without leakage through the open cable end.

4.3 When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable", the cable exhibits no flow (drip or leak) of filling and/or flooding material at 65ºC

4.4 When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables", a minimum compressive load is applied uniformly over the length of the cable at the rate of 3mm to 20mm per minute and maintained for ten minutes. Dielectric cables withstand a load of 220N/cm (125lbf/in). The change in attenuation does not exceed 0.4dB during loading and 0.2dB after loading at 1550nm.

4.5 When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test", the cable can withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation does not exceed 0.1dB at 1550nm.

4.6 When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies", the cable can withstand 25 impact cycles. The change in attenuation does not exceed 0.2dB at 1550nm.

4.7 When tested in accordance with FOTP-33, "Fiber Optic Tensile Loading and Bending Test", using a maximum mandrel and sheave diameter of 560mm, the cable can withstand a tensile load of 1000N (225lbf). The change in attenuation does not exceed 0.2dB during loading and 0.1dB after

loading at 1550nm. The load does not produce a strain exceeding 0.25% in fiber and does not cause any permanent physical or optical damage to any component of cable.

4.8 When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test", a length of cable no greater than 4 meters can withstand 10 cycles of mechanical twisting. The change in attenuation does not exceed 0.1dB at 1550nm.

4.9 When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable", after conditioning for four hours at test temperatures of -30ºC and +60ºC: dielectric cables can withstand four full turns around a mandrel ≤10 times the cable diameter. Neither the inner nor the outer surfaces of the jacket exhibit visible cracks, splits, tears, or other openings. Optical continuity is maintained throughout the test.

4.10 When tested in accordance with FOTP-181, ``Lightning Damage Susceptibility Test for Optic Cables with Metallic Components'', Armored cables can withstand a simulated lightning strike with a peak value of the current pulse equal to 105kA without loss of fiber continuity. A dampened oscillatory test current is used with a maximum time-to-peak value of 15µs, which corresponds to a minimum frequency of 16.7kHz and a maximum frequency of 30kHz. The time to half- value of the waveform envelope is between 40 and 70ºs.

5.0 SHIPPING SPECIFICATIONS FOR SM OFC

5.1 Reels

Each fiber optic cable is shipped on a separate, strongly constructed new wooden reel. The reels are designed to prevent damage to the cable during shipment and installation.

5.2 Cable End Fastening:

To provide access for testing, the inner end of the cable protrudes through the inside of the drum. The end is wound between wooden rings located on the side of the flange to protect it during transport and storage. The length of the inner end is 3.0m. The cable ends are securely fastened so as not to protrude beyond any portion of the reel in an unprotected manner and to prevent the cable from becoming loose during transportation. Both ends of the cable are available for testing.

5.3 Information Accompanying the Reel:

The following information is securely attached to each reel:

A durable weatherproof label shows the actual length of cable on the reel
Renka Corporation
Renka Part Number
Customer Part Number
Cable Description
Index of Refraction
Weight of Cable and Reel
Reel ID
Shipped Length
Beginning and Ending Length Markings
Certified Test Data Sheet (Attenuation Measurements)

5.4 Pre-Shipment End Sealing and Termination

The ends of all cables are sealed to prevent the escape of filling compound and to prevent the entry of moisture during shipping, handling, storage, and installation. As a standard offering, both cable ends are terminated with plastic end caps. If requested, kellem grips can be factory installed on one or both ends of the cable.

5.5 Thermal Wrap for Cable on Reel

A thermal protective wrap is securely applied over the outer turns of the cable on each reel. The wrap is weather resistant and limits solar heating of the cable such that cable surface temperatures do not exceed 9ºC (15ºF) above ambient temperature under solar radiation loading of 1000 watts per square meter in still air. The wrap is labeled "Do Not Remove Wrap Until Cable is placed".

5.6 Reel Lagging

A composite board wrap lagging is used for domestic shipments with flange diameters less than or equal to 68 inches. This composite lagging completely covers the cable from inside flange to inside flange. The composite board is high strength and exhibits very good puncture resistance. Three steel bands are strapped about the lagging to help secure the lagging boards to the reel.

6.0 QUALITY ASSURANCE AND TESTING FOR SM OFC

6.1 Routine Testing: Critical dimensions are monitored during the production of the cable and the Renka Final Inspection Laboratory performs the routine tests found in section 4.1.2 of IEEE P1222 on 100% of the cables, including the following specific quality assurance checks:

6.2 Jacket Thickness: Section 4.1.2.1.1 in the IEEE P1222 draft document mandates that the thickness of the outer jacket at any cross-section may not be less than 70% of the nominal thickness.

6.3 Cable Outer Diameter: The IEEE P1222 draft document also states that the cable outer diameter must be ± 5% of the nominal outer diameter.

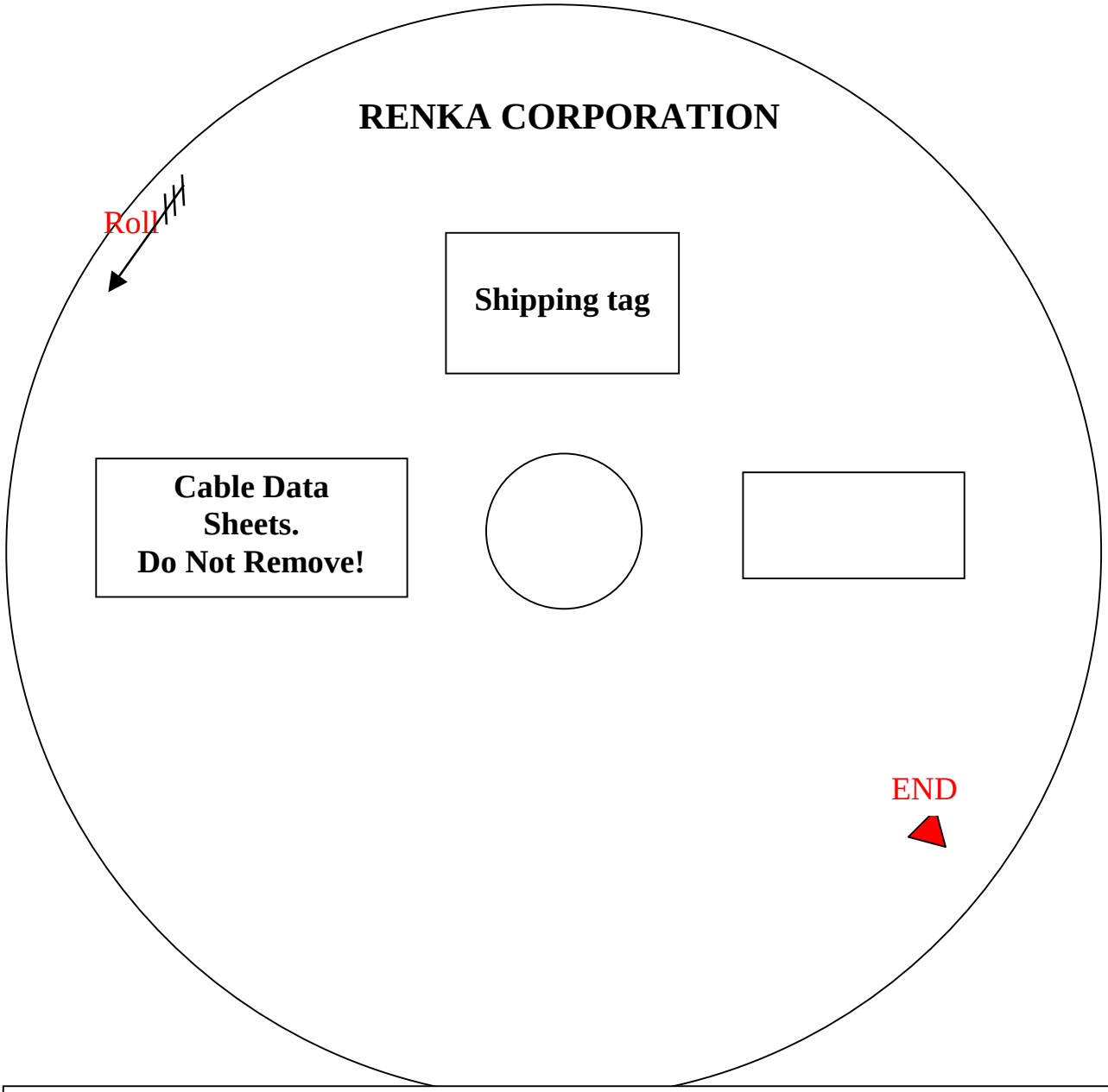
6.4 Optical Acceptance Test: Section 4.1.2.2 of IEEE P1222 requires that optical tests be performed on each reel. This section states that single-mode fiber attenuation measurements are in accordance with EIA/TIA-455- 78, "Spectral Attenuation Cutback Measurement for Single-Mode Fibers" or with EIA/TIA-455-61, "Measurement of Fiber or Cable Attenuation using an OTDR". These attenuation measurements are made from both ends of the cable, and then averaged. The maximum allowed step in attenuation at Renka Final Inspection is ± 0.1dB.

6.5 All cabled optical fibers greater than 1000m in length are 100% attenuation tested. The attenuation of each fiber is provided with each cable reel.

6.6 All optical fibers are proof tested to a minimum load of 0.7 GN/m² (100kpsi).

Renka reserves the right to improve, enhance, or modify the cable features or specifications. Renka Optical Fiber Cable products are designed for optimum performance and ease of installation, and support applicable industry technical specifications, standards and references including Telcordia (Bellcore) GR-20, ICEA-640, RUS PR-90, GTE Int'l, ITU-T recommendations G650 series, IEC 793 and EN 18800 requirements, and ISO 9001 & TIA/EIA quality standards.

Annex. 1 Drum marking



※ 'Shipping Tag' includes the below information.

- **Purchase Order No, Drum No, Cable description, Cable length, Gross weight etc.**