Campus & Data Centers - Why Ribbon Technology Works for You

Characteristics and Benefits of Ribbon Fiber & Ribbon Cables

By

Kurt Templeman, RCDD
1. Fiber Optic Specifications

2. Advantages of Standard Fiber Optic Ribbon Based Cables

3. Advantages of Splicing Fiber Optic Ribbon

4. Connectivity Options for Splicing Fiber Optic Ribbon

5. 2nd Generation Fiber Optic Ribbon

6. Ultra High Fiber Count Cable Overview & Advantages

7. Conclusion – Review of Benefits
History of Fiber Cable

Long History of Successful Deployment

Over 35 years of successful deployment provides assurance that the technology is solid, reliable …

History of 30 years

1980

Ribbon Slotted Core Cable
Mass Ribbon Fusion Splicer

1990

1000-Fiber Ribbon “Multi” Slotted Core Cable
1000-Fiber Ribbon “Single” Slotted Core Cable

2000

Small diameter and Light weight
1000-Fiber Ribbon Slotted Core Cable
Enhanced Peelable Ribbon
Easy Accessibility Cable

2010

Primarily 4, 8, 12 fiber ribbons

Small diameter
High fiber count

Mid-span access

Single fiber operation

Progress in Workability

40mm
28mm
23mm
Ribbon Fiber & Identification

Easy Identification

Standard color codes and print string on ribbon make identification easy. Many more fibers installed in less time, terminated faster and proven reliability show why ribbon growth has been explosive.
## Optical Fiber Specifications & Guidelines

<table>
<thead>
<tr>
<th>FIBER TYPE</th>
<th>ITU</th>
<th>TIA DETAIL</th>
<th>ISO/IEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>50um Multimode Fiber</td>
<td>G.651</td>
<td>492AAAB</td>
<td>11801</td>
</tr>
<tr>
<td>62.5um Multimode Fiber</td>
<td>G.651</td>
<td>492AAAC-A</td>
<td>11801</td>
</tr>
<tr>
<td>Non-Dispersion Shifted Single Mode Fiber</td>
<td>G.652B</td>
<td>492CAAA</td>
<td>60793-2-50 B1.1</td>
</tr>
<tr>
<td>Non-Dispersion Shifted Single Mode Fiber</td>
<td>G.652D</td>
<td>492CAAB</td>
<td>60793-2-50 B1.3</td>
</tr>
<tr>
<td>Cut-Off Shifted Fiber</td>
<td>G.654C</td>
<td>see ITU</td>
<td>see ITU</td>
</tr>
<tr>
<td>Non-Zero Dispersion Shifted Single Mode Fiber (NZDSF)</td>
<td>G.655C</td>
<td>492EAAA</td>
<td>60793-2-50 B4</td>
</tr>
<tr>
<td>Non-Zero Dispersion Shifted Single Mode Fiber (NZDSF)</td>
<td>G.655D</td>
<td>492EAAA</td>
<td>60793-2-50 B4</td>
</tr>
<tr>
<td>Non-Zero Dispersion Shifted Single Mode Fiber (NZDSF)</td>
<td>G.655E</td>
<td>492EAAA</td>
<td>60793-2-50 B4</td>
</tr>
<tr>
<td>Non-Zero Dispersion Shifted Wideband Transport Fiber (NZWTF)</td>
<td>G.656</td>
<td>see ITU</td>
<td>60793-2-50 B5</td>
</tr>
<tr>
<td>Bend-Insensitive Single Mode Fiber</td>
<td>G.657A1</td>
<td>see ITU</td>
<td>60793-2-50 B6A</td>
</tr>
<tr>
<td></td>
<td>G.657A2</td>
<td>see ITU</td>
<td>60793-2-50 B6A</td>
</tr>
<tr>
<td></td>
<td>G.657B2</td>
<td>see ITU</td>
<td>60793-2-50 B6B</td>
</tr>
<tr>
<td></td>
<td>G.657B3</td>
<td>see ITU</td>
<td>60793-2-50 B6B</td>
</tr>
</tbody>
</table>
Core concentricity offset:
0.8 microns (SEL = 0.4)

Cladding diameter:
125 microns, +/- 0.5

Mode field diameter:
8.6-9.2 microns, +/- 0.6 microns

Bend Insensitive Fibers are typically at the low end of the mode field measurement, 8.6 microns, or better.

Uniformity of Fiber in Ribbon
Ribbons manufactured with fiber which adhere to the standards provide compatibility...
The core concentricity offset allows ribbon to be spliced uniformly.
## Optical Fiber Standards

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Single Mode</td>
<td>Single-Mode</td>
<td>Single-Mode</td>
</tr>
<tr>
<td>Refractive Index Profile</td>
<td>Matched Clad</td>
<td>Matched Clad</td>
<td>Matched Clad</td>
</tr>
<tr>
<td>Manufacturing Process</td>
<td>VAD</td>
<td>VAD</td>
<td>VAD</td>
</tr>
<tr>
<td><strong>Dimensional</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cladding Diameter</td>
<td>125.0 ± 0.5 um</td>
<td>125.0 ± 1.0 um</td>
<td>125.0 ± 1.0 um</td>
</tr>
<tr>
<td>Cladding Non-circularity</td>
<td>&lt; 0.5 %</td>
<td>&lt; 1.0 %</td>
<td>&lt; 1.0 %</td>
</tr>
<tr>
<td>Core to Cladding Concentricity</td>
<td>≤ 0.4 um</td>
<td>≤ 0.4 um</td>
<td>≤ 0.4 um</td>
</tr>
<tr>
<td>Coating Diameter</td>
<td>245 ± 5 um</td>
<td>245 ± 10 um</td>
<td>245 ± 10 um</td>
</tr>
<tr>
<td><strong>Transmission</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical Uncabled Attenuation (1310/1550 nm)</td>
<td>≤ 0.31 / 0.19 dB/km</td>
<td>0.40 dB/km @ 1310</td>
<td>0.40 dB/km @ 1310nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.22 dB/km @ 1550 nm</td>
<td>0.37 dB/km @ 1380 nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.25 dB/km @ 1625 nm</td>
<td>0.22 dB/km @ 1550 nm</td>
</tr>
<tr>
<td>Attenuation Point Discontinuities</td>
<td>≤ 0.10 dB</td>
<td>≤ 0.10 dB @ 1550 nm</td>
<td>≤ 0.10 dB @ 1550 nm</td>
</tr>
<tr>
<td>Cabled Cutoff Wavelength</td>
<td>≤ 1260 nm</td>
<td>≤ 1450 nm</td>
<td>≤ 1300 nm</td>
</tr>
<tr>
<td>Mode Field Diameter</td>
<td>9.2 ± 0.4 um @ 1310nm Typ. 10.4 ± 1.0 um @ 1550 nm</td>
<td>9.2 ± 0.50 um</td>
<td>8.3 ± 0.50 um</td>
</tr>
<tr>
<td>Zero Dispersion Wavelength</td>
<td>1302 - 1322 nm</td>
<td>≤ 1450 nm</td>
<td>≤ 1450 nm</td>
</tr>
<tr>
<td>Zero Dispersion Slope</td>
<td>≤ 0.090 ps/(nm² km)</td>
<td>&lt; 0.060 ps/(nm² km)</td>
<td>&lt; 0.05 ps/(nm² km)</td>
</tr>
<tr>
<td>Polarization Mode Dispersion</td>
<td>&lt; 0.2 ps/ km¹/²</td>
<td>&lt; 0.2 ps/ km¹/²</td>
<td>&lt; 0.2 ps/ km¹/²</td>
</tr>
<tr>
<td><strong>Mechanical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proof Test</td>
<td>120 kpsi</td>
<td>100 kpsi</td>
<td>125 kpsi</td>
</tr>
<tr>
<td><strong>Environmental (as fiber)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (-60 to 85°C)</td>
<td>≤ 0.05 dB/km @ 1310/1550 nm</td>
<td>≤ 0.05 dB/km @ 1550 nm</td>
<td>≤ 0.05 dB/km @ 1550 nm</td>
</tr>
<tr>
<td>Temp-Humidity</td>
<td>≤ 0.05 dB/km @ 1310/1550 nm (-10 ~ 85°C / 30 ~ 98% RH)</td>
<td>≤ 0.05 dB/km @ 1550 nm (-40 ~ 85°C / 30 ~ 98% RH)</td>
<td>≤ 0.05 dB/km @ 1550 nm (-40 ~ 85°C / 30 ~ 98% RH)</td>
</tr>
</tbody>
</table>
- Fibers separate easily, cleanly - improves productivity, no additional cleaning of fibers necessary
- Provides for access to individual fibers easily
- Various fiber counts available – Flexibility
- Supports 1G/10G/100G/400G with 12F based ribbons, 40G with 8F based ribbons

The most user friendly ribbon is craft friendly…. Strips faster and easier for speed of termination
1. Fiber Optic Specifications

2. Advantages of Standard Fiber Optic Ribbon Based Cables

3. Advantages of Splicing Fiber Optic Ribbon

4. Connectivity Options for Splicing Fiber Optic Ribbon

5. 2nd Generation Fiber Optic Ribbon

6. Ultra High Fiber Count Cable Overview & Advantages

7. Conclusion – Review of Benefits
Advantages of Fiber Optic Ribbon Cable

Greater Fiber Packing Density

For indoor rated cables with fiber counts of 144 or greater the fiber packing density with fiber optic ribbon based central tube cables exceeds that of typical loose tube construction...

216ct Ribbon Central Tube Cable
250um Loose Tube Cable

~0.61in (15.6mm)
~0.625in. (15.9mm)

At these counts and higher the smaller OD ribbon based cable allows for better utilization of cable trays and cable management.
At these counts and higher the smaller OD ribbon based cable allows for better utilization of cable trays and cable management.
Advantages of Fiber Optic Ribbon Cable

In this example, due to the greater fiber packing density the 216ct ribbon central tube cable has the smallest bend radius compared to the 144ct loose tube and tight buffer constructions.

216ct Ribbon Central Tube Cable
- MBR-I = 9.0in. (234mm)
- MBR-O = 6.1in. (156mm)

144ct 250um Loose Tube Cable
- MBR-I = 9.4in. (239mm)
- MBR-O = 6.3in. (159mm)

144ct 900um Tight Buffer Cable
- MBR-I = 13.9in. (354mm)
- MBR-O = 9.3in. (236mm)

At these and higher fiber counts, the ribbon central tube construction installation and operation in terms of handling and routing is the same or better than that of the loose tube and tight buffer constructions.
<table>
<thead>
<tr>
<th></th>
<th>Riser Ribbon</th>
<th>Plenum Ribbon</th>
<th>Interlock Armor Riser Ribbon</th>
<th>Interlock Armor Plenum Ribbon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fiber Count</strong></td>
<td>48 - 864</td>
<td>48 - 432</td>
<td>48 - 432</td>
<td>48 - 432</td>
</tr>
<tr>
<td><strong>SMF (652 / 657)</strong></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>MM (OM2/3/4)</strong></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>Tensile Load - I</strong></td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td><strong>Tensile Load - O</strong></td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td><strong>Operating Temperature Range</strong></td>
<td>-40 to 70°C (-40 to 158°F)</td>
<td>-40 to 70°C (-40 to 158°F)</td>
<td>-40 to 70°C (-40 to 158°F)</td>
<td>-40 to 70°C (-40 to 158°F)</td>
</tr>
<tr>
<td><strong>Outside Diameter</strong></td>
<td>48 to 96-0.52&quot; 108 to 216 -0.62&quot; 288 to 432 -0.81&quot; 576 to 864-1.01&quot;</td>
<td>48 to 96-0.55&quot; 108 to 216 -0.65&quot; 288 to 432 -0.85&quot;</td>
<td>48 to 96 - 0.81&quot; 108 to 216 - 0.91&quot; 288 to 432 - 1.16&quot;</td>
<td>48 to 96 - 0.83&quot; 108 to 216 - 0.87&quot; 288 to 432 - 1.15&quot;</td>
</tr>
</tbody>
</table>
New UHFC INDOOR CABLES

Greater Fiber Packing Density

With the Market demanding more fiber in smaller packages…

New Cables include:
LSHF – Low Smoke Halogen Free
UHFC - 1728

PLIABLE RIBBON / INDOOR RISER CABLE
1728 FIBER COUNT
25.6mm / 1.01” O.D.
# Fiber Optic Cable – Outside Plant

## Indoor/Outdoor Ribbon

<table>
<thead>
<tr>
<th>Fiber Count</th>
<th>48 - 144</th>
<th>576 - 864</th>
<th>48 - 864</th>
<th>48 - 216</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMF (652 / 657)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>MM (OM2/3/4)</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Tensile Load - I</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Tensile Load - O</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Outside Diameter</td>
<td>48 - 0.61”</td>
<td>576 to 864 - 1.03”</td>
<td>48 to 96 - 0.89”</td>
<td>48 to 96 - 0.67”</td>
</tr>
<tr>
<td></td>
<td>60 to 144 - 0.67”</td>
<td></td>
<td>108 to 144 - 1.02”</td>
<td>108 to 216 - 0.77”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>576 to 864 - 1.51”</td>
<td>576 to 864 - 1.51”</td>
<td></td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-40 to 70°C</td>
<td>-40 to 70°C</td>
<td>-40 to 70°C</td>
<td>-40 to 130°C</td>
</tr>
<tr>
<td></td>
<td>(-40 to 158°F)</td>
<td>(-40 to 158°F)</td>
<td>(-40 to 158°F)</td>
<td>(-40 to 266°F)</td>
</tr>
</tbody>
</table>
1. Fiber Optic Specifications
2. Advantages of Standard Fiber Optic Ribbon Based Cables
3. Advantages of Splicing Fiber Optic Ribbon
4. Connectivity Options for Splicing Fiber Optic Ribbon
5. New Pliable Fiber Optic Ribbon...Advantages & Benefits
6. Ultra High Fiber Count Cable Overview & Advantages
7. Conclusion – Review of Benefits
Advantages of Splicing Ribbon

The difference in splicing ribbon fiber versus single fiber is the thermal jacket remover versus using the jacket stripping tool… AND you are doing 12 fibers at a time….

Equipment for Single versus Mass Splicing

Single Fiber Core Alignment
- Jacket Stripper

Multi-Fiber Mass Fusion
- Thermal Jacket Remover
  Can also splice single fibers
Ribbon based cable constructions offer multiple advantages over loose tube and tight buffer cable constructions in the area of terminations. Advantages exist in both time and costs…

- Single Fiber Fusion Splice
- 12ct Ribbon Fusion Splice
Advantages of Splicing Ribbon

Termination Advantages

Typical splicing time for inline fusion splicing either two single 250um coated fibers or two 12ct ribbons is about the same, ~120sec

(This is an average time which may be less or more depending on technician experience and/or technicians per fusion splicing unit)

Single Fiber Fusion Splicing Process

1. Strip
2. Clean
3. Cleave
4. Splice
5. *Protect

12ct Ribbon Fusion Splicing Process

1. Strip
2. Clean
3. Cleave
4. Splice
5. *Protect

~120sec

*Advancements in heater technology & dual heater splicers equalize protection time for single and ribbon splicing
Advantages of Splicing Ribbon

Termination

Advantages

How about quality of splice between core alignment and ribbon splicing?

Core Alignment Fiber Fusion Splicer

Typical Splice Loss, Identical Fibers for *CA fusion splicer
SMF: 0.02dB
MMF: 0.01dB

12ct Ribbon Fusion Splicer (and/or V-Groove alignment fusion splicers)

Typical Splice Loss, Identical Fibers for *Ribbon fusion splicer
SMF: 0.05dB
MMF: 0.02dB

While the core alignment fusion splicer yields lower loss splices, the ribbon based splicer yields splice losses well inside the typical allowable loss per splice point.

*Splice loss performance dependent on specific splicer manufacturers and models
Advantages of Splicing Ribbon

Termination Advantages

…so, at ~120sec per splice for either a single fiber or 12ct ribbon splice the following comparison is true for in-line splicing a 144ct loose tube and 144ct ribbon based cable…

Single Fiber Fusion Splice

144 single splices
@ 120 sec per splice
=17,280 sec
Or
288 minutes
Or
4.8 hours

12ct Ribbon Fusion Splice

144 fibers = 12 ribbons
@ 120 sec per splice
=1,440 sec
Or
24 minutes
Or
Half an Hour!

Splicing 12ct ribbon in this scenario is 92% more efficient than splicing single fiber
Advantages of Splicing Ribbon

Termination Advantages

Not only is splicing 12ct ribbon significantly more efficient in regards to time, but the time savings is a DIRECT correlation to cost savings…

Single Fiber Fusion Splice

12ct Ribbon Fusion Splice

- Advantage of Ribbon Cable
  - More advantageous for network owner to deploy ribbon based cable and specify ribbon splicing, as ribbon splicing requires fewer splices

- Labor Saving Advantage of Ribbon
  - More advantageous for contractor to have ribbon based cable installed and utilize ribbon splicing to reduce the amount of time/labor to complete the splicing
Advantages of Splicing Ribbon Cable

A few additional termination advantages when deploying ribbon based cable compared to loose tube or tight buffer cable constructions…

Single Fiber Fusion Splice Sleeve

12ct Ribbon Fusion Splice Sleeve

Splice Tray

90% Savings using Ribbon Based Cables!

*Not to even mention the space savings as well which correlates to a dollar savings too!!
Advantages of Standard Ribbon Cable

Termination Advantages

What if the application requires termination to single fiber based connectors, such as LC connectors? Isn’t it better then to have loose tube or tight buffer cable construction?

12ct Ribbon to LC Fan-Out

Fusion splice ribbon based cable to 12ct ribbon to LC fan-out

RU with LC adapters

Terminating to connector for further distribution/patching
1. Fiber Optic Specifications
2. Advantages of Standard Fiber Optic Ribbon Based Cables
3. Advantages of Splicing Fiber Optic Ribbon
4. Connectivity Options for Splicing Fiber Optic Ribbon
5. 2nd Generation Fiber Optic Ribbon
6. Ultra High Fiber Count Cable Overview & Advantages
7. Conclusion – Review of Benefits
Yesterdays Connectivity Options

First there was the labor intensive Puck & Polish, then Pigtails which required splice trays and then Mechanical Connectors which had index matching gel issues...

- **Puck & Polish Connector**
  - Labor Intensive
  - Blind Results
  - Totally Technician Dependent
  - Yield??

- **Pigtails (w/Splice trays)**
  - Expensive
  - Additional space required
  - Factory polished connector
  - Requires Technician to pre-fit pigtail in splice tray

- **Mechanical Connectors**
  - Expensive
  - Blind Results
  - Index Matching Gel
Today’s Connectivity Options for Fiber

Connectivity of Today

Fusion splicing of individual fibers is faster, easier, not dependent on technician, known results… Splice-on Connectors provide the greatest in speed and accuracy, reliability for today's/future networks.

Splice-on Connectors solves the problems of yesterday's connectors...
- No Blind Splicing
- Factory Polished End Face
- No Index Matching Gel Issues
- Technician Independent
Lynx2 CustomFit® SOC’s

Splice-On-Connectors

- Kevlar strength members attached to the housing provide excellent pull out strength without pulling back on ferrule
- Fast and exact lengths achieved on-site without the problems of slack
- Instant splice loss feedback
- Factory ferrule and fiber bond
- Removes the technician judgment call inherent in mechanical splice technology

Fast, reliable, no index matching gel, fusion splicer provides much higher yields... for all connector types
Connectivity Options for Fiber Ribbon

So we have seen the differences in single fiber splicing versus splicing ribbon and the old style connectors. How can these advantages be exploited for connectivity options?

Options for Ribbon Splicing

- Ribbon Break Out Kits
- Ribbon Fiber Cassette
- Splice On MPO

Let's explore the options further.
Connectivity Options for Fiber Ribbon

1st Option Breakout Kits

What if the application requires termination from ribbon to single fiber based connectors, such as LC connectors?

12 Fiber Ribbon Break Out Kit

1. Most cost effective per connector
2. Available in all currently available connector types, fiber types, and lengths
3. Ribbon break-outs allow the fast, easy change of connector types with a single ribbon splice

Ribbon Interface
MPO Cassette Interface Options

2nd Option Splice-On MPO
MPO connectors plug into the cassette to allow quick, easy and technician independent change.

Splice-On MPO connector allows you to work with any ribbon cable and have the exact length you need without any pre-engineering design work.

Lynx2 MPO

MPO Interface
- HD
- SEL
- LGX
- LGX-Conversion
What if the application requires termination from ribbon to single fiber based connectors, such as LC connectors?

1. Cassettes with ribbon pigtails can provide any standard type connector.
2. Cassettes with ribbon pigtails are terminated with a single mass splice.
3. Cassettes with ribbon pigtails allow the fast, easy change of connector types with a single splice.
4. Cost Effective because no pre-engineered cable length is required.
What if the application requires termination from ribbon to single fiber based connectors, such as LC connectors?

- Cable comes pre-terminated with choice of connector/shelf
- The fastest installation method for high fiber count applications
- Exact length cable available to make installation even faster
- The lowest loss installation method- NO IN-PANEL SPLICES
SOC’s – Cover your every connector need

Comparing ribbon cables to loose tube or tight buffer cable constructions the fiber count per cable OD is significantly greater for the ribbon based central tube cable construction…

Panel with ribbon termination options.
1. Fiber Optic Specifications

2. Advantages of Standard Fiber Optic Ribbon Based Cables

3. Advantages of Splicing Fiber Optic Ribbon

4. Connectivity Options for Splicing Fiber Optic Ribbon

5. 2nd Generation Fiber Optic Ribbon

6. Ultra High Fiber Count Cable Overview & Advantages

7. Conclusion – Review of Benefits
Pliable Ribbon...Advantages & Benefits

- Greater Fiber Packing Density

Comparing ribbon cables to loose tube or tight buffer cable constructions the fiber count per cable OD is significantly greater for the ribbon based central tube cable construction...

- Pliable ribbon is splice compatible with Conventional ribbon
- Pliable ribbon promotes smaller cable diameter
- Pliable ribbon is used for higher count slotted and central core cables
Pliable Ribbon...Advantages & Benefits

Pliable Ribbon Structure

- Pliable ribbon structure is similar to standard ribbon structure but with spaced separations of fiber groupings.

- Pliable ribbon creates a paradigm shift for cable design and construction
- Increases ribbon packing density
- Retains the termination advantages of standard ribbon
1. Fiber Optic Specifications
2. Advantages of Standard Fiber Optic Ribbon Based Cables
3. Advantages of Splicing Fiber Optic Ribbon
4. Connectivity Options for Splicing Fiber Optic Ribbon
5. 2nd Generation Fiber Optic Ribbon
6. Ultra High Fiber Count Cable Overview & Advantages
7. Conclusion – Review of Benefits
Ultra High Fiber Count Cable Overview

Ultra High Fiber Count Cable

It’s not just about making a cable with more fiber, it’s about making a cable with a lot more fiber that can still work in existing conduit pathways.

By utilizing the combined technology of pliable ribbon and bend insensitive fiber (such as G657A1) high fiber count cables can be designed to improve utilization of existing cable pathways.

Ultra High Fiber Count Cable with Pliable Ribbon

Comparing ribbon cables to loose tube or tight buffer cable constructions the fiber count per cable OD is significantly greater for the ribbon based central tube cable construction...

12-Fiber Pliable Ribbon

Ribbon Marking Code

<table>
<thead>
<tr>
<th>No.</th>
<th>Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>[ ]</td>
</tr>
<tr>
<td>2</td>
<td>[ ]</td>
</tr>
<tr>
<td>5</td>
<td>[ ]</td>
</tr>
<tr>
<td>6</td>
<td>[ ]</td>
</tr>
<tr>
<td>10</td>
<td>[ ]</td>
</tr>
<tr>
<td>36</td>
<td>[ ]</td>
</tr>
</tbody>
</table>
Ultra High Fiber Count Cable Advantages

UHFC design utilizing the combination of pliable ribbon and bend insensitive fiber gives higher packing density to achieve cable with 2X+ fiber capacity within same duct space.

Additionally, the UHFC/pliable ribbon based design allows for identical termination advantages as presented earlier with standard ribbon based cable constructions.

1728ct UHFC OSP Rated Cable
- OD ~1.0in. (25.6mm)
- Allowable Duct = 1.5"

1728ct LTR OSP Rated Cable
- OD ~1.34in. (34mm)
- Allowable Duct = 2.0"

864ct OSP Rated Cable
- OD ~1.0in. (25.6mm)
- Allowable Duct = 1.5"
Ultra High Fiber Count Cable Advantages

<table>
<thead>
<tr>
<th>Fiber Count</th>
<th>1152</th>
<th>1728</th>
<th>3456</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMF (652 / 657)</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Central Strength Member</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Tensile Load - I</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Tensile Load - O</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-40 to 70°C (-40 to 158°F)</td>
<td>-40 to 70°C (-40 to 158°F)</td>
<td>-40 to 70°C (-40 to 158°F)</td>
</tr>
<tr>
<td>OD</td>
<td>25mm/ 0.98&quot;</td>
<td>26mm/ 1.02&quot;</td>
<td>34mm/ 1.34&quot;</td>
</tr>
</tbody>
</table>

What’s next?

[Logo] Bicsi
Ultra High Fiber Count Cable Overview

Termination
Advantages

What are your options for terminating UHFC?

- OSP Cable
- UHFC
- Inline splicing for initial distribution of entry cables
- Cable Entrance Frame
- EF (MPOE)
- MDA (MDF)
- HDA
- IDA (IDF)
- Shelves with LC adapters
- Terminating to connector for further distribution/patching

Data Center

SUMITOMO ELECTRIC LIGHTWAVE

BICSI
Ultra High Fiber Count Cable Overview

Termination Options

- Comparing the density of the various options and ease of installation versus……

- Pre-stubbed Shelves

- Patch Panels

- OSP HFC Closures

- OSP Cable Entrance Facilities

- Pre-terminated Shelves
End-To-End Solutions...
1. Fiber Optic Specifications
2. Advantages of Standard Fiber Optic Ribbon Based Cables
3. Advantages of Splicing Fiber Optic Ribbon
4. Connectivity Options for Splicing Fiber Optic Ribbon
5. 2nd Generation Fiber Optic Ribbon
6. Ultra High Fiber Count Cable Overview & Advantages
7. Conclusion – Review of Benefits
* Easily identifiable
* Available in SMF & MMF
* Easy Peel Ribbon Technology
* Smaller Cable OD’s per fiber
* Save’s space in cable trays
* Fastest splicing per fiber
* Multiple termination options
* New Higher fiber count cables

Cost savings unmatched
Questions?

Thank you!