# Campus & Data Centers – Why Ribbon Technology Works for You

Characteristics and Benefits of Ribbon Fiber & Ribbon Cables

By

Kurt Templeman, RCDD

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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

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Long History of Successful Deployment

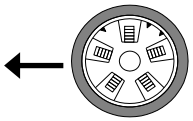
Over 35 years of successful deployment provides assurance that the technology is solid, reliable …

## History of 30 years

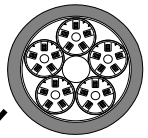
1980

**Ribbon Slotted Core Cable**

**Primarily 4, 8, 12 fiber ribbons**



Smaller diameter
High fiber count



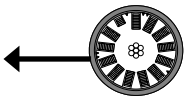
40mm

1990

**Mass Ribbon Fusion Splicer**

**1000-Fiber Ribbon "Multi" Slotted Core Cable**

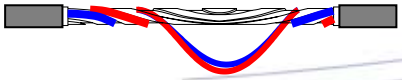
**1000-Fiber Ribbon "Single" Slotted Core Cable**



28mm

Mid-span access

**ROL stranded core**



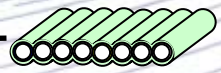
2000

**Small diameter and Light weight 1000-Fiber Ribbon Slotted Core Cable**

23mm

Single fiber operation

**Enhanced Peelable Ribbon**



**Easy Accessibility Cable**

Progress in Workability

2010

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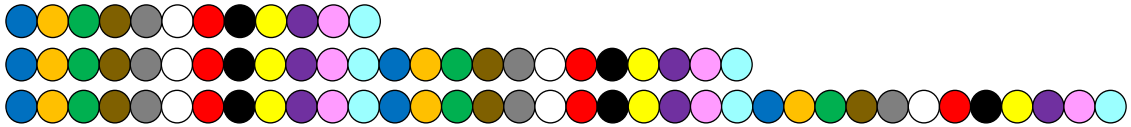
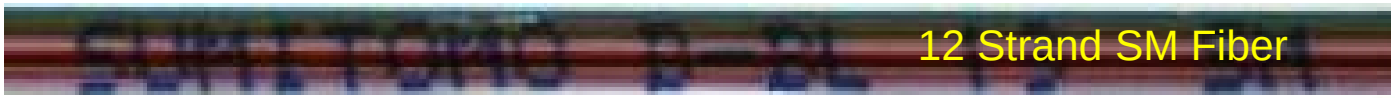
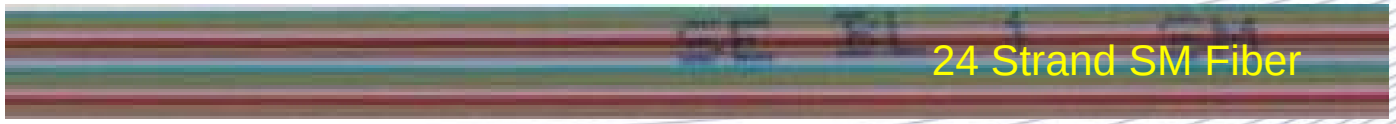
# Ribbon Fiber & Identification

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.







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# Optical Fiber Specifications & Guidelines

| FIBER TYPE | ITU | TIA DETAIL | ISO/IEC |
|---|---|---|---|
| 50um Multimode Fiber | G.651 | 492AAAB<br>492AAAC-A | 11801 |
| 62.5um Multimode Fiber | G.651 | 492AAAA | 11801 |
| Non-Dispersion Shifted Single Mode Fiber | G.652B | 492CAAA | 60793-2-50 B1.1 |
| Non-Dispersion Shifted Single Mode Fiber with "Zero Water Peak" | G.652D | 492CAAB | 60793-2-50 B1.3 |
| Dispersion Shifted Single Mode Fiber | G.653B | 492DAAA | 60793-2-50 B2 |
| Cut-Off Shifted Fiber | G.654C | see ITU | see ITU |
| Non-Zero Dispersion Shifted Single Mode Fiber (NZDSF) | G.655C | 492EAAA | 60793-2-50 B4 |
| | G.655D | 492EAAA | 60793-2-50 B4 |
| | G.655E | 492EAAA | 60793-2-50 B4 |
| Non-Zero Dispersion Shifted Wideband Transport Fiber (NZWTF) | G.656 | see ITU | 60793-2-50 B5 |
| Bend-Insensitive Single Mode Fiber | G.657A1 | see ITU | 60793-2-50 B6A |
| | G.657A2 | see ITU | 60793-2-50 B6A |
| | G.657B2 | see ITU | 60793-2-50 B6B |
| | G.657B3 | see ITU | 60793-2-50 B6B |

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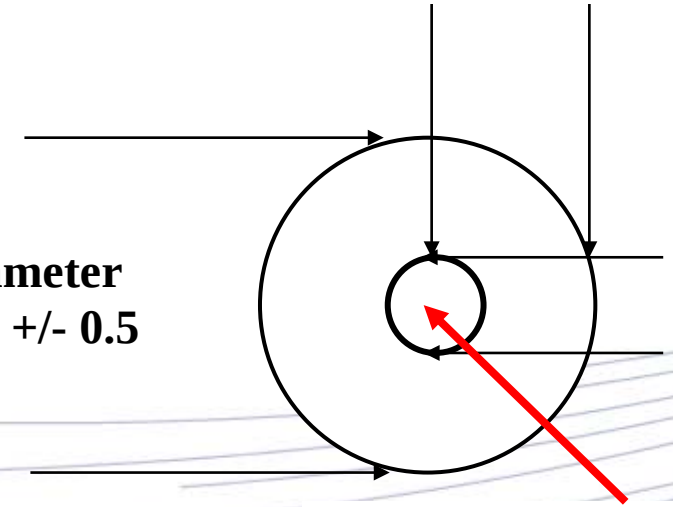
# ITU – T G.652D

**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

## STANDARD SINGLE MODE FIBER

**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.**

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# Optical Fiber Standards

| | ITU-T G.652.D<br>Max. / Typical | ITU-T G.657.A1<br>Max. / Typical | ITU-T G.657.A2<br>Max. / Typical |
|---|---|---|---|
| **General** | | | |
| Type | Single Mode | Single-Mode | Single-Mode |
| Refractive Index Profile | Matched Clad | Matched Clad | Matched Clad |
| Manufacturing Process | VAD | VAD | VAD |
| | | | |
| **Dimensional** | | | |
| Cladding Diameter | 125.0 ± 0.5 um | 125.0 ± 1.0 um | 125.0 ± 1.0 um |
| Cladding Non-circularity | < 0.5 % | < 1.0 % | < 1.0 % |
| Core to Cladding Concentricity | ≤ 0.4 um | ≤ 0.4 um | ≤ 0.4 um |
| Coating Diameter | 245 ± 5 um | 245 ± 10 um | 245 ± 10 um |
| **Transmission** | | | |
| Typical Uncabled Attenuation (1310/1550 nm) | ≤ 0.31 / 0.19 dB/km | 0.40dB/km @ 1310<br>0.22 dB/km @ 1550 nm<br>0.25 dB/km @ 1625 nm | 0.40 dB/km @ 1310nm<br>0.37 dB/km @ 1380 nm<br>0.22 dB/km @ 1550 nm<br>0.25 dB/km @ 1625 nm |
| Attenuation Point Discontinuities | ≤ 0.10 dB | ≤ 0.10 dB @ 1550 nm | ≤ 0.10 dB @ 1550 nm |
| Cabled Cutoff Wavelength | ≤ 1260 nm | ≤ 1450 nm | ≤ 1300 nm |
| Mode Field Diameter | 9.2 ± 0.4 um @ 1310nm<br>Typ. 10.4 ± 1.0 um @ 1550 nm | 9.2 ± 0.50 um | 8.3 ± 0.50 um |
| Zero Dispersion Wavelength | 1302 - 1322 nm | ≤ 1450 nm | ≤ 1450 nm |
| Zero Dispersion Slope | ≤ 0.090 ps/(nm$^2$ km) | < 0.060 ps/(nm$^2$ km) | < 0.05 ps/(nm$^2$ km) |
| Polarization Mode Dispersion | < 0.2 ps/ km$^{1/2}$ | < 0.2 ps/ km$^{1/2}$ | < 0.2 ps/ km$^{1/2}$ |
| **Mechanical** | | | |
| Proof Test | 120 kpsi | 100 kpsi | 125 kpsi |
| **Environmental (as fiber)** | | | |
| Temperature (-60 to 85°C) | ≤ 0.05 dB/km @ 1310/1550 nm | ≤ 0.05 dB/km @ 1550 nm | ≤ 0.05 dB/km @ 1550 nm |
| Temp-Humidity | ≤ 0.05 dB/km @ 1310/1550 nm<br>(-10 ~ 85°C / 30 ~ 98% RH) | ≤ 0.05 dB/km @ 1550 nm<br>(-40 ~ 85°C / 30 ~ 98% RH) | ≤ 0.05 dB/km @ 1550 nm<br>(-40 ~ 85°C / 30 ~ 98% RH) |

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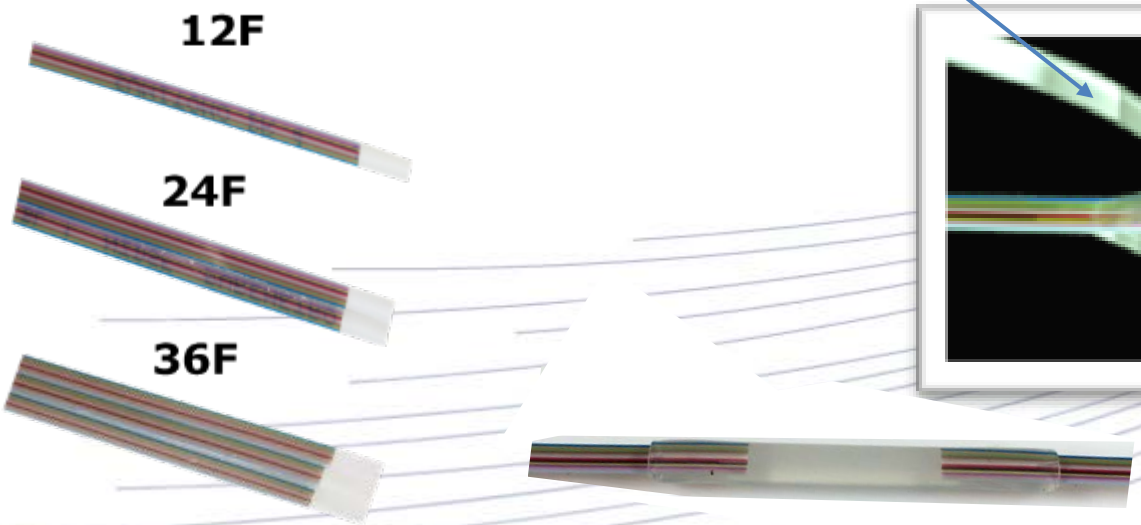
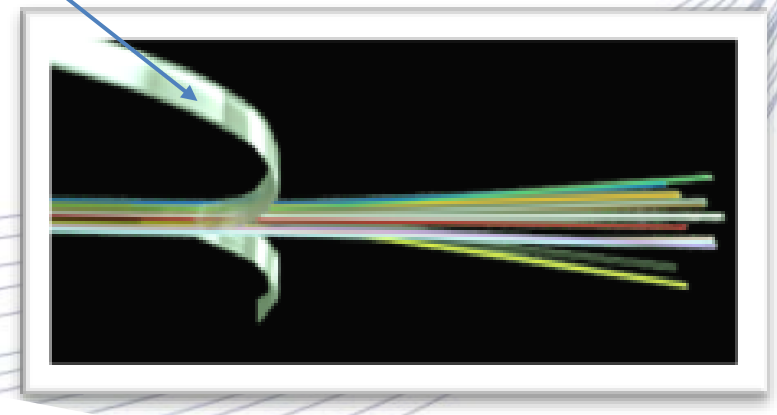
## Easy Peel Technology

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

- 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



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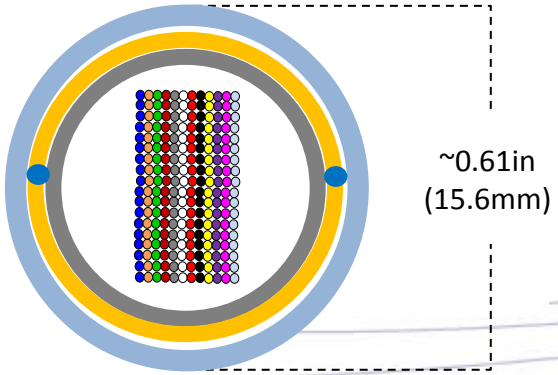
# Advantages of Fiber Optic Ribbon Cable

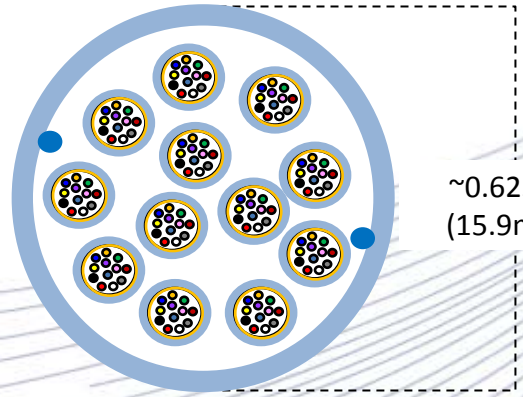
**Greater Fiber Packing Density**

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




144ct 250um Loose Tube Cable




At these counts and higher the smaller OD ribbon based cable allows for better utilization of cable trays and cable management

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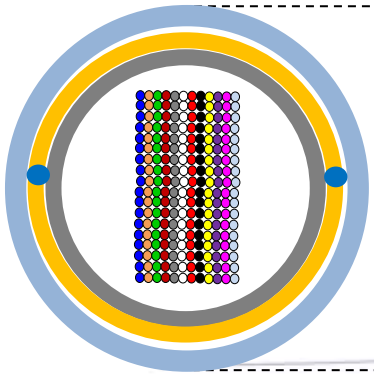
# Advantages of Fiber Optic Ribbon Cable

**Greater Fiber Packing Density Cable OD**

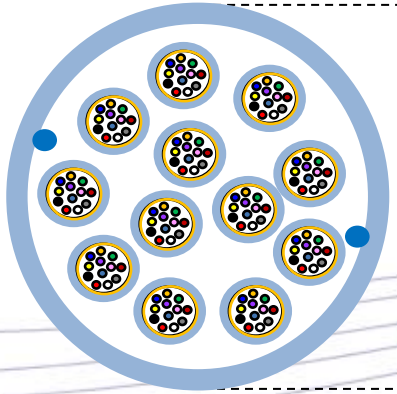
Comparing ribbon cables to loose tube or tight buffer cable constructions the fiber count per cable OD is significantly greater for the ribbon based central tube cable construction…

216ct Ribbon Central Tube Cable



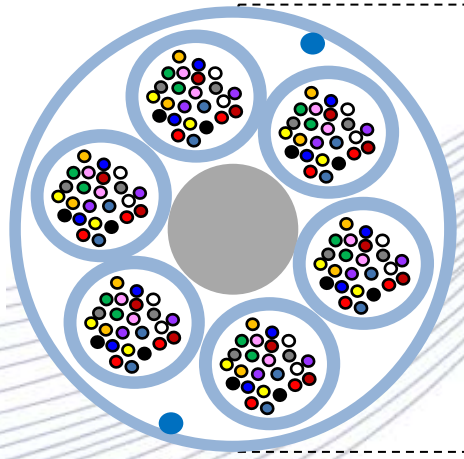
~0.61in. (15.6m)

144ct 250um Loose Tube Cable



~0.625 in. (15.9m)

144ct 900um Tight Buffer Cable



~0.93in. (23.6m)

At these counts and higher the smaller OD ribbon based cable allows for better utilization of cable trays and cable management

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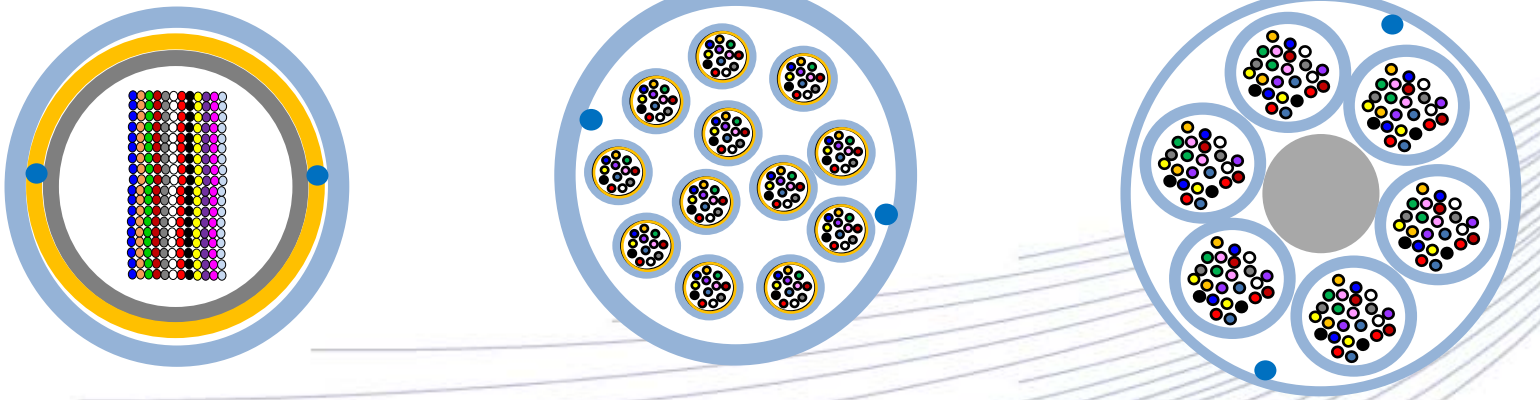
# Advantages of Fiber Optic Ribbon Cable

**Greater Fiber Packing Density Bend Radius**

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 | 144ct 250um Loose Tube Cable | 144ct 900um Tight Buffer Cable |
|---|---|---|
| MBR-I = 9.0in. (234mm)<br>MBR-O = 6.1in. (156mm) | MBR-I = 9.4in. (239mm)<br>MBR-O = 6.3in. (159mm) | MBR-I = 13.9in. (354mm)<br>MBR-O = 9.3in. (236mm) |



MBR-I = Minimum Bend Radius during Installation / MBR-O = Operational/After Installation

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

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| | Riser Ribbon | Plenum Ribbon | Interlock Armor Riser Ribbon | Interlock Armor Plenum Ribbon |
|---|---|---|---|---|
| **Fiber Count** | **48 - 864** | **48 - 432** | **48 - 432** | **48 - 432** |
| **SMF (652 / 657)** | ✓ | ✓ | ✓ | ✓ |
| **MM (OM2/3/4)** | ✓ | ✓ | ✓ | ✓ |
| **Tensile Load - I** | **600** | **600** | **600** | **600** |
| **Tensile Load - O** | **200** | **200** | **200** | **200** |
| **Operating Temperature Range** | **-40 to 70°C (-40 to 158°F)** | **-40 to 70°C (-40 to 158°F)** | **-40 to 70°C (-40 to 158°F)** | **-40 to 70°C (-40 to 158°F)** |
| **Outside Diameter** | 48 to 96-0.52"<br>108 to 216 -0.62"<br>288 to 432 -0.81"<br>576 to 864- 1.01" | 48 to 96-0.55"<br>108 to 216 -0.65"<br>288 to 432 -0.85" | 48 to 96 - 0.81"<br>108 to 216 - 0.91"<br>288 to 432 - 1.16" | 48 to 96 - 0.83"<br>108 to 216 - 0.87"<br>288 to 432 - 1.15" |

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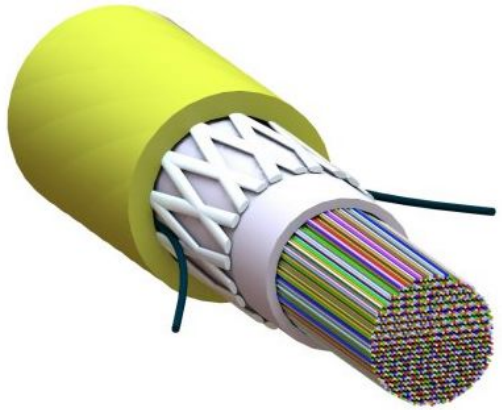
# New UHFC INDOOR CABLES

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. |

| | Indoor/Outdoor Ribbon | Indoor/Outdoor Ribbon | Indoor/Outdoor Interlock Armor Ribbon | Hostile Environment Cable |
|---|---|---|---|---|
| **Fiber Count** | **48 - 144** | **576 - 864** | **48 - 864** | **48 - 216** |
| **SMF (652 / 657)** | ✓ | ✓ | ✓ | ✓ |
| **MM (OM2/3/4)** | ✓ | | ✓ | |
| **Tensile Load - I** | **600** | **600** | **600** | **600** |
| **Tensile Load - O** | **200** | **200** | **200** | **200** |
| **Outside Diameter** | 48 - 0.61"<br>60 to 144 - 0.67" | 576 to 864 - 1.03" | 48 to 96 - 0.89"<br>108 to 144 - 1.02"<br>576 to 864 - 1.51" | 48 to 96 - 0.67"<br>108 to 216 - 0.77" |
| **Operating Temperature Range** | -40 to 70°C<br>(-40 to 158°F) | -40 to 70°C<br>(-40 to 158°F) | -40 to 70°C<br>(-40 to 158°F) | -40 to 130°C<br>(-40 to 266°F) |

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# Advantages of Splicing Ribbon

Equipment for Single versus Mass Splicing

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….

Single Fiber Core Alignment

Jacket Stripper

Multi-Fiber Mass Fusion

Can also splice single fibers

Thermal Jacket Remover

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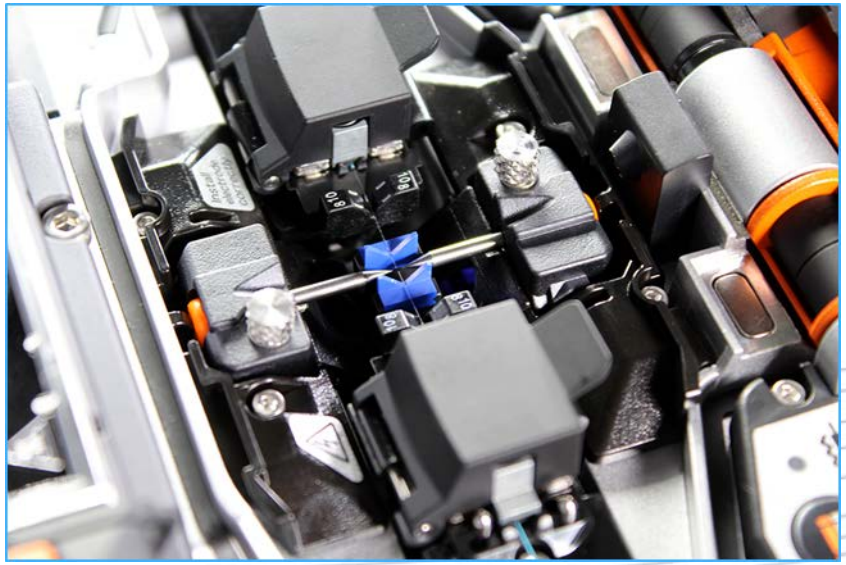
# Advantages of Splicing Ribbon

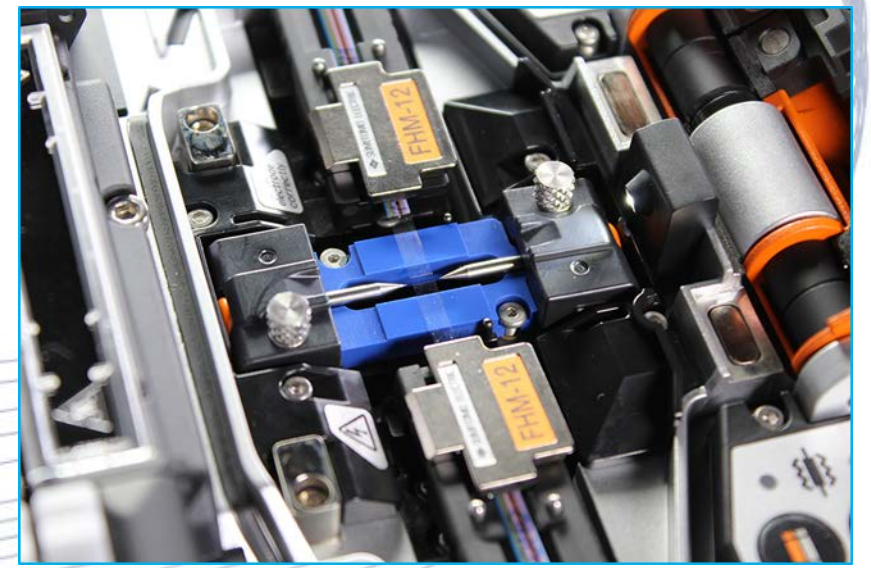
**Termination Advantages**

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

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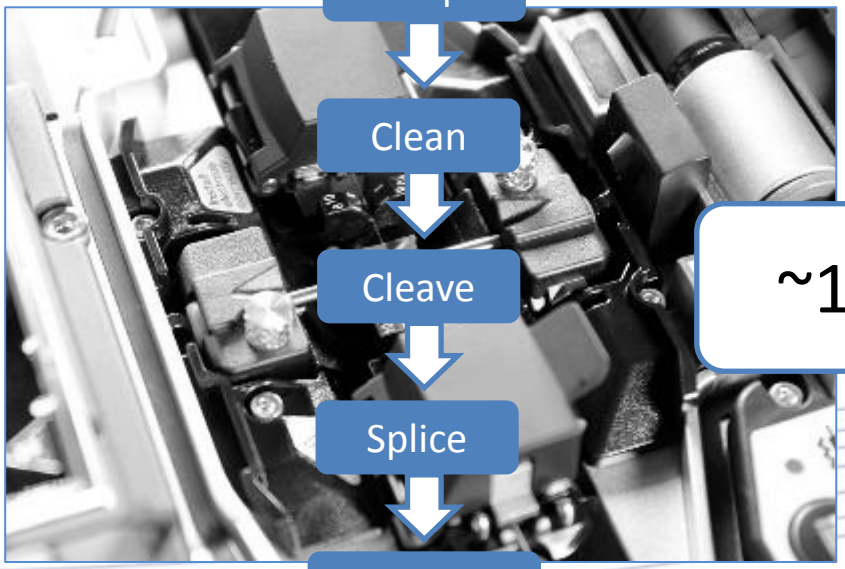
# Advantages of Splicing Ribbon

**Termination Advantages**

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

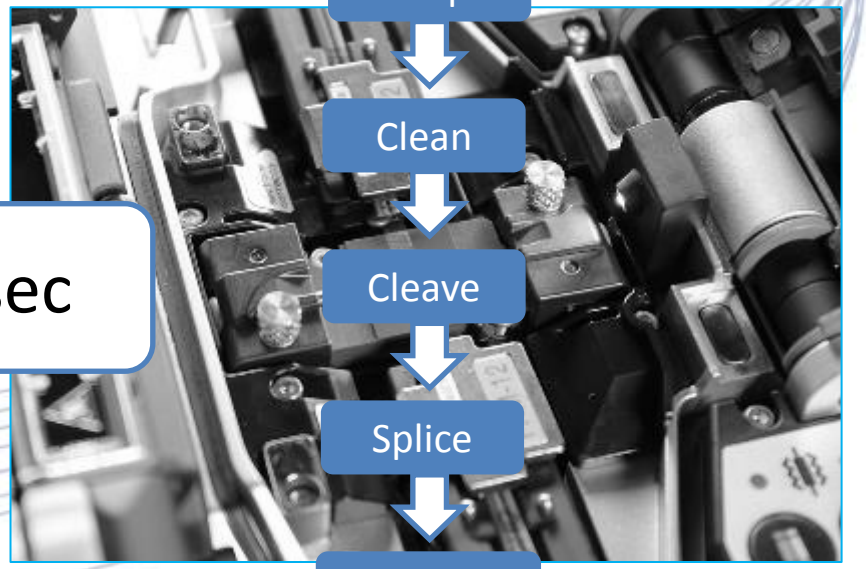
(This is an average time which may be less or more depending on technician experience and/or technicians per fusion splicing unit)

**Single Fiber Fusion Splicing Process**




~120sec

**12ct Ribbon Fusion Splicing Process**




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

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# 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

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# 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 | 12ct Ribbon Fusion Splice |
|---|---|
| 144 single splices<br>@ 120 sec per splice<br>=17,280 sec<br>Or<br>288 minutes<br>Or<br>4.8 hours | 144 fibers = 12 ribbons<br>@ 120 sec per splice<br>=1,440 sec<br>Or<br>24 minutes<br>Or<br>Half an Hour! |
|  |  |



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

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# 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

**Termination Advantages**

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

Single Fiber Fusion Splice Sleeve

Splice Tray

12ct Ribbon Fusion Splice Sleeve

Sing… …0/ea.
…0

Spl… …ea.
12 S… …Tray
144 Si… …Tray

Total… …Trays

90% Savings using Ribbon Based Cables!

*Not to even mention the space savings as well which correlates to a dollar savings too!!

*144ct fiber splicing scenario
Loose Tube or Tight Buffer

*144ct fiber splicing scenario
Ribbon Based Cable

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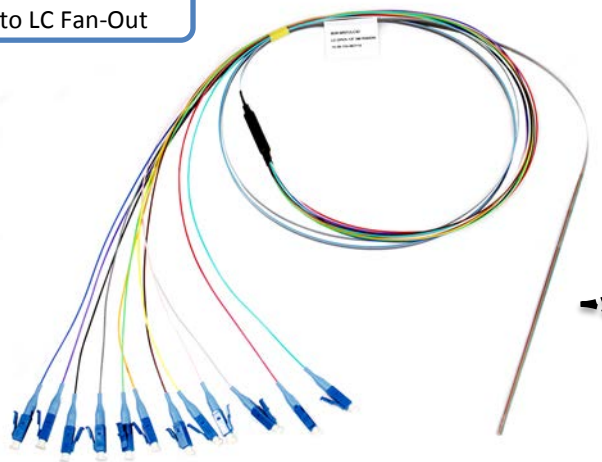
# Advantages of Standard Ribbon Cable

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



12ct Ribbon


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

RU with LC adapters

Terminating to connector for further distribution/patching

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# Yesterdays Connectivity Options

Connectivity of Yesterday

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??

## Mechanical Connectors

- Expensive
- Blind Results
- Index Matching Gel

## Pigtails (w/Splice trays)

- Expensive
- Additional space required
- Factory polished connector
- Requires Technician to pre-fit pigtail in splice tray

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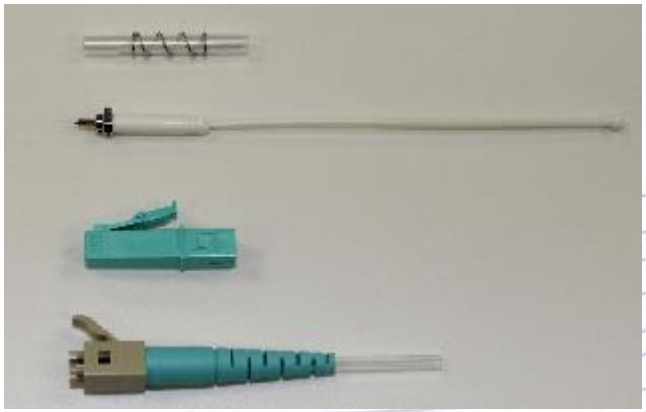
# Today's Connectivity Options for Fiber

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 todays/future networks

Splice-on Connectors solves the problems of yesterdays connectors…

- No Blind Splicing
- Factory Polished End Face
- No Index Matching Gel Issues
- Technician Independent

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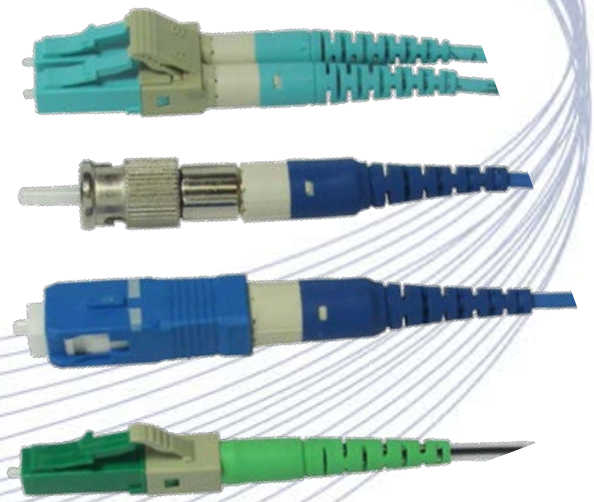
# Lynx2 CustomFit® SOC's

**Splice-On-Connectors**

Fast, reliable, no index matching gel, fusion splicer provides much higher yields… for all connector types

- 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



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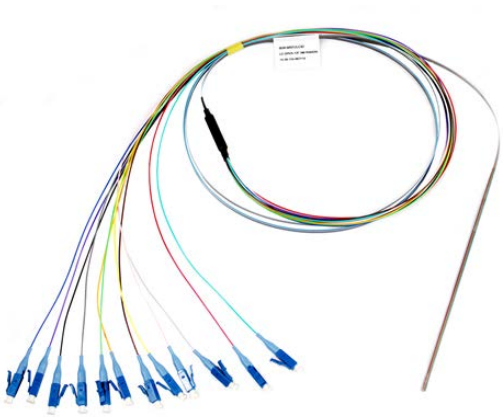
# Connectivity Options for Fiber Ribbon

Options for Ribbon Splicing

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?

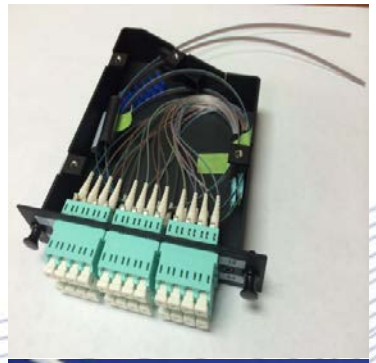
Lets explore the options further

## Ribbon Break Out Kits



## Splice On MPO

## Ribbon Fiber Cassette



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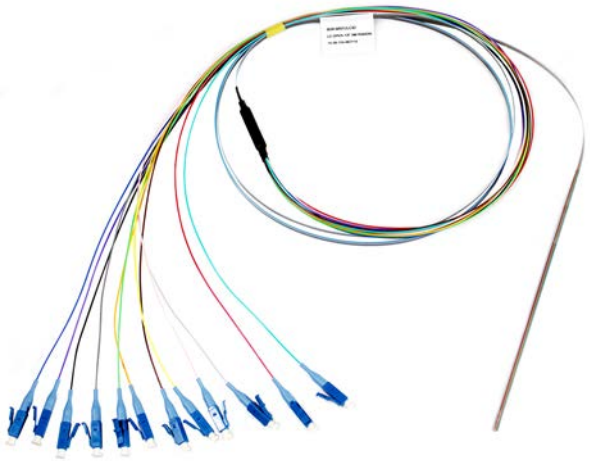
# Connectivity Options for Fiber Ribbon

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



Ribbon Interface

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

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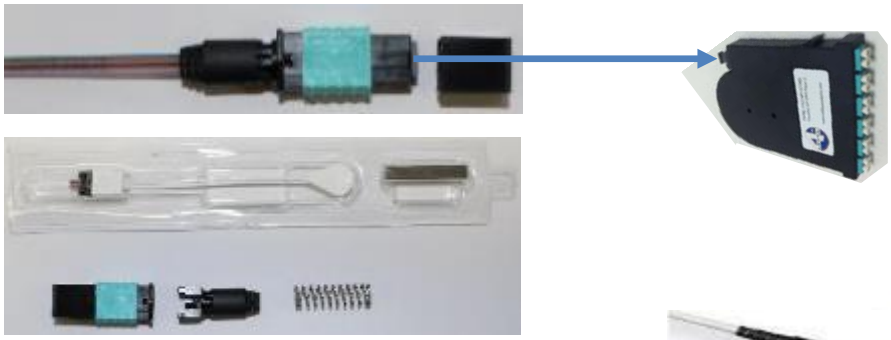
# MPO Cassette Interface Options

**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





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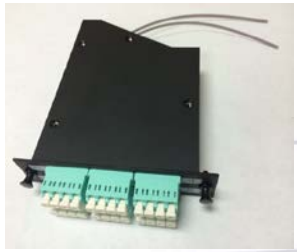
# Ribbon Fiber Cassette Interface Options

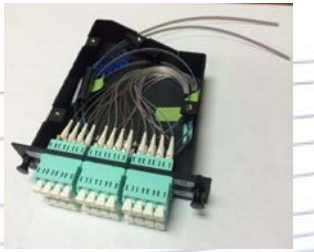
3rd Option Ribbon Fiber Cassettes

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

HD

SEL





LGX

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

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## 4th Option Pre-stubbed Ribbon Panels

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.

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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

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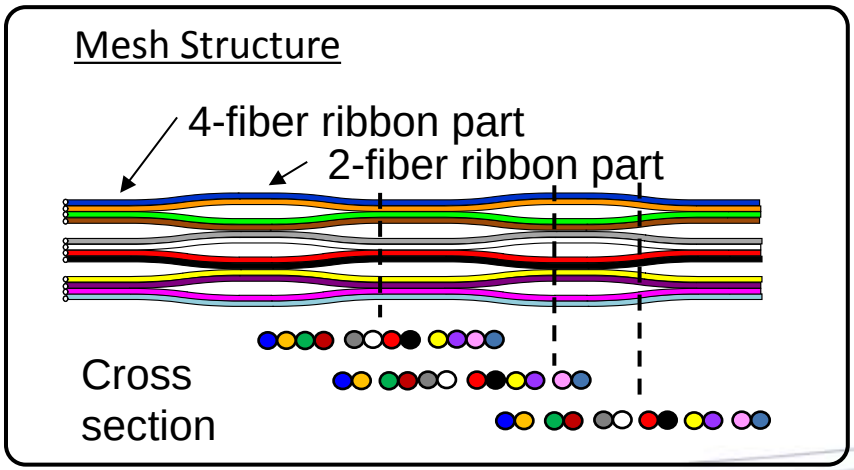
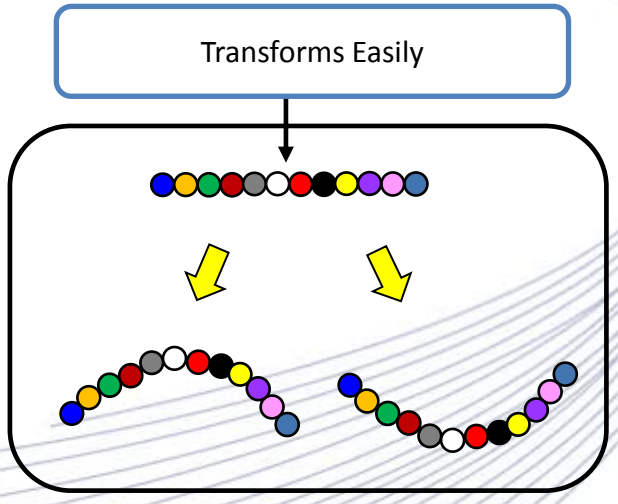
# Pliable Ribbon…Advantages & Benefits

**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

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# 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


Pliable Ribbon shown fanned out

Pliable Ribbon Spliced to Standard Ribbon

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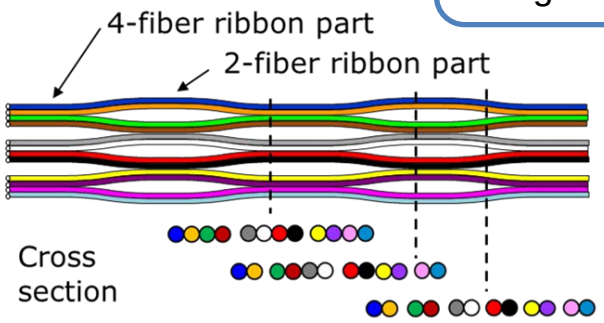
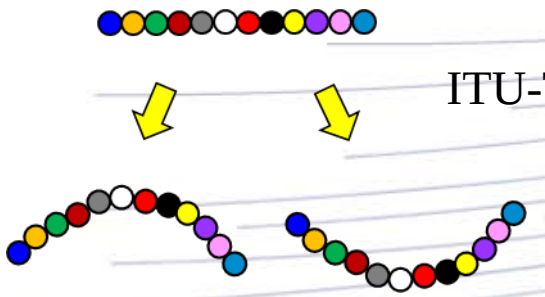
# Ultra High Fiber Count Cable Overview

**Ultra High Fiber Count Cable**

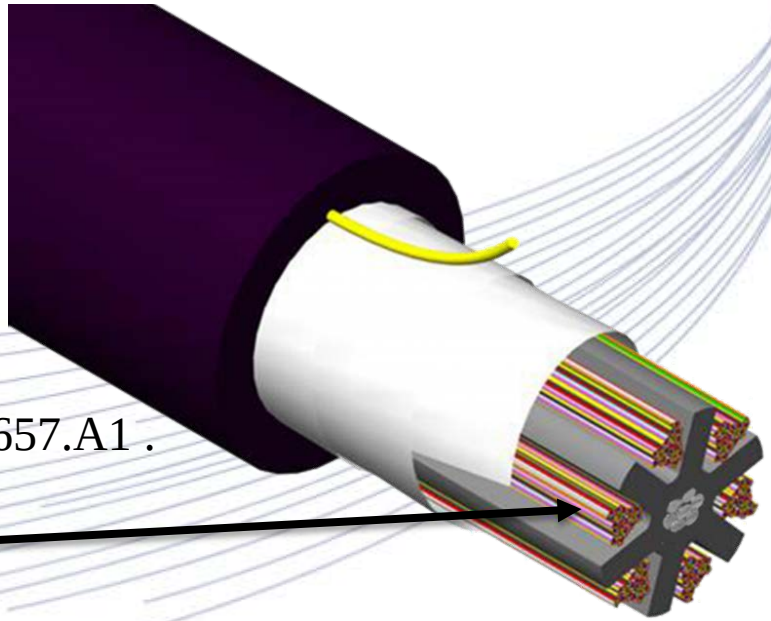
It's not just about making a cable with more fiber, it's about making a cable with a lot more fiber that can still work in existing conduit pathways

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



ITU-T G.652.D and G.657.A1 .



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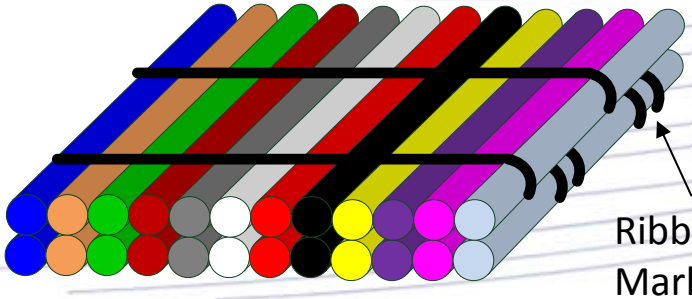
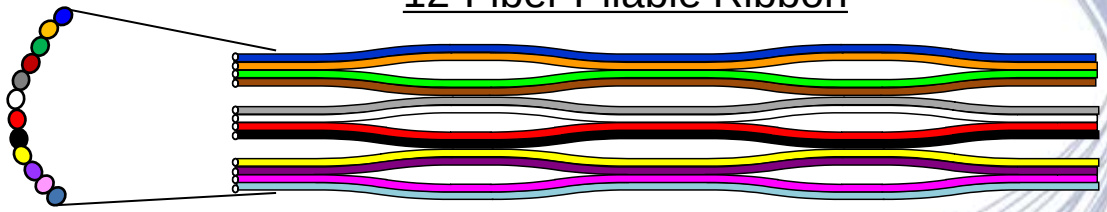
# Ultra High Fiber Count Cable with Pliable Ribbon

**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…




12-Fiber Pliable Ribbon



Ribbon Marking Code

| No. | Marking |
|---|---|
| 1 | ▮ |
| 2 | ▮▮ |
| … | … |
| 5 | ■ |
| 6 | ■▮ |
| … | … |
| 10 | ■■ |
| … | … |
| 36 | ■■■■■ |

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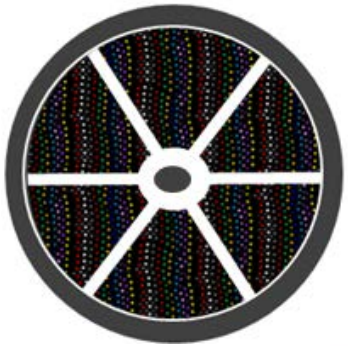
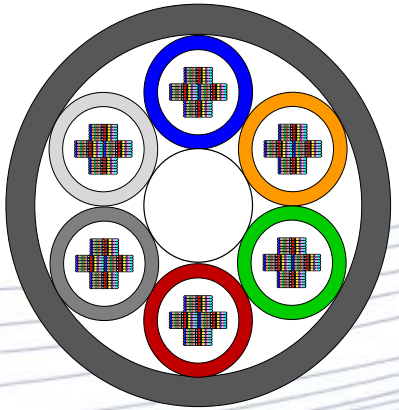
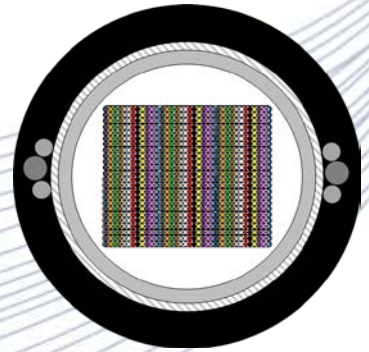
# Ultra High Fiber Count Cable Advantages

**Ultra High Fiber Count Cable**

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 | 1728ct LTR OSP Rated Cable | 864ct OSP Rated Cable |
|---|---|---|
|  |  |  |
| OD ~1.0in. (25.6mm) | OD ~1.34in. (34mm) | OD ~1.0in. (25.6mm) |
| Allowable Duct = 1.5” | Allowable Duct = 2.0” | Allowable Duct = 1.5” |

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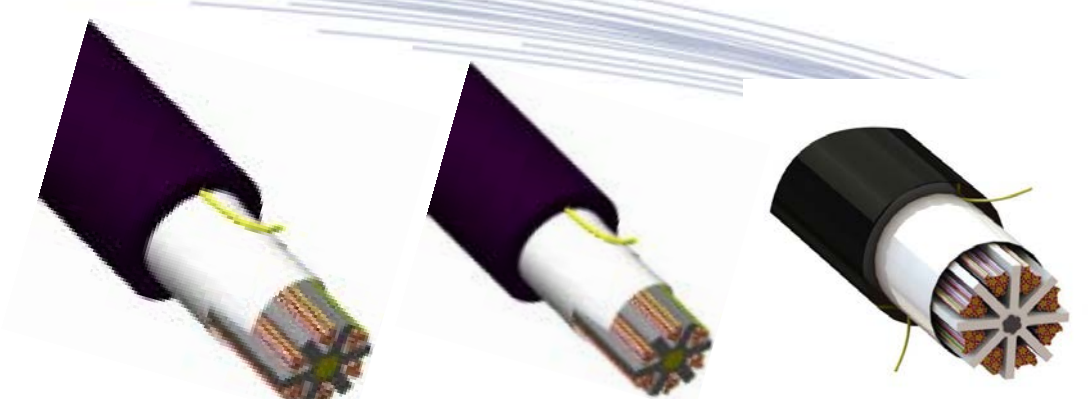
# Ultra High Fiber Count Cable Advantages



| Fiber Count | 1152 | 1728 | 3456 |
|---|---|---|---|
| SMF (652 / 657) | ✓ | ✓ | ✓ |
| Central Strength Member | ✓ | ✓ | ✓ |
| Tensile Load - I | 600 | 600 | 600 |
| Tensile Load - O | 200 | 200 | 200 |
| Operating Temperature Range | -40 to 70°C (-40 to 158°F) | -40 to 70°C (-40 to 158°F) | -40 to 70°C (-40 to 158°F) |
| OD | 25mm/0.98" | 26mm/1.02" | 34mm/1.34" |

## What's next?

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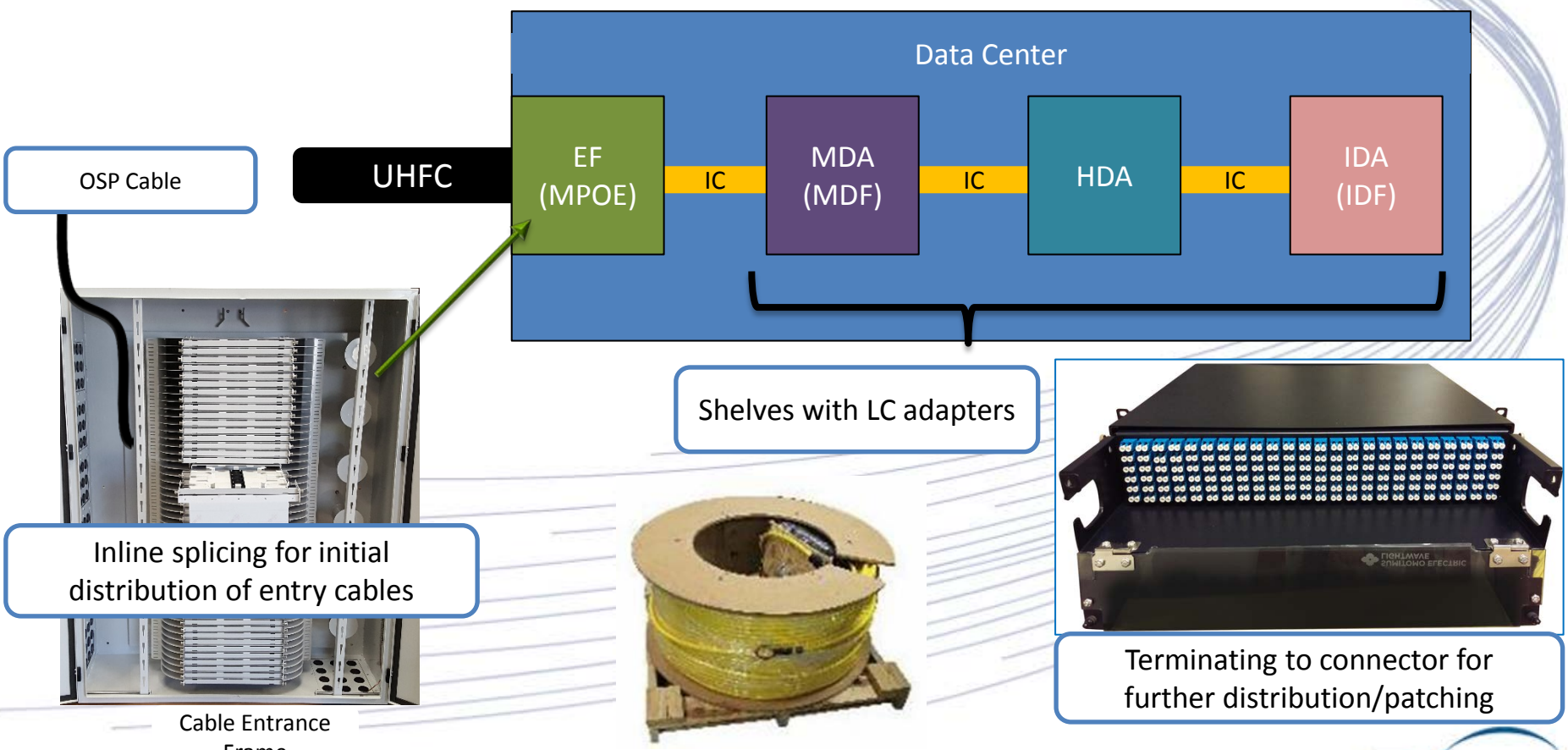
# Ultra High Fiber Count Cable Overview

Termination Advantages

What are your options for terminating UHFC?

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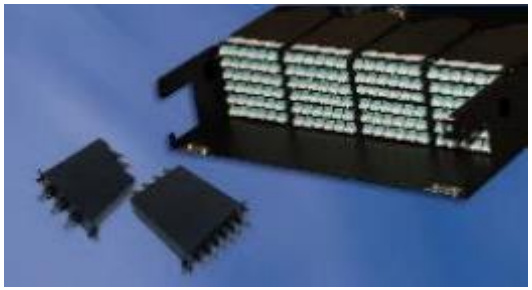
# Ultra High Fiber Count Cable Overview

**Termination Options**

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

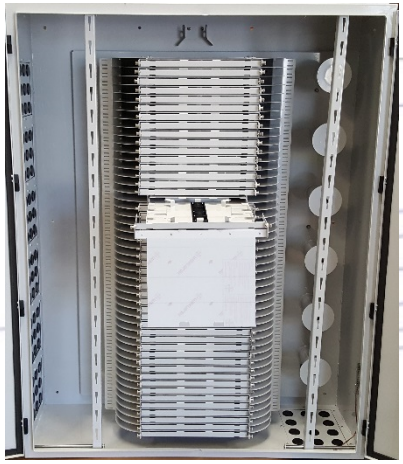
Pre-stubbed Shelves

Patch Panels



OSP HFC Closures

OSP Cable Entrance Facilities



Pre-terminated Shelves

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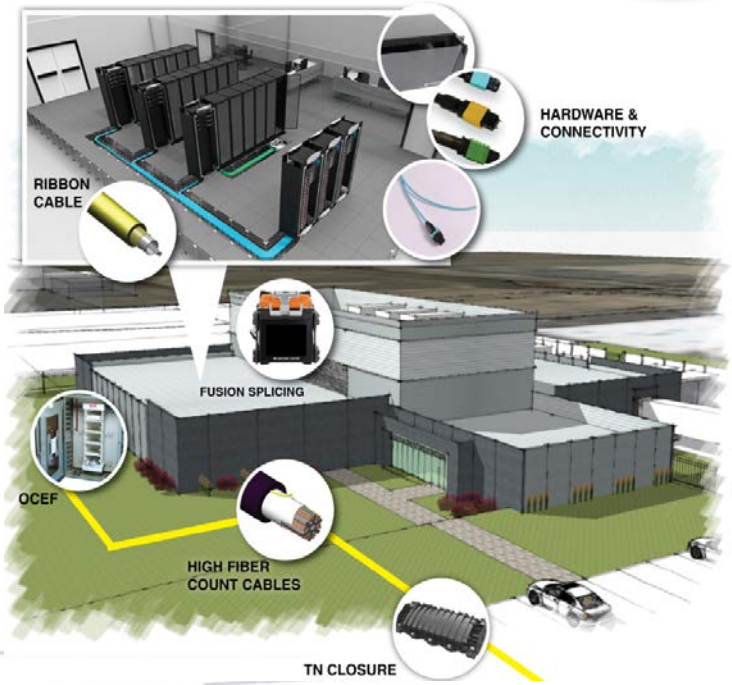
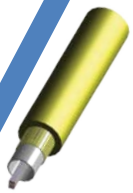
# End-To-End Solutions…



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*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

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# Questions?

Thank you!