T-25e, T-39 & T-66

G657 fibres and how to splice them

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What is G657 fibre?

G657 is a new class of single mode fibre which can be bent more severely then normal G652 single mode without losing the signal it's carrying. It's designed for use in Fibre to the Home applications.

The ITU defines 4 classes of G657 fibre as below.

- G657A1 10mm minimum bend radius, other specs as G652
- G657A2 7.5mm minimum bend radius, other specs as G652
- G657B2 7.5mm minimum bend radius, other specs may deviate from G652
- G657B3 5mm minimum bend radius, other specs may deviate from G652

In summary a G657A fibre is like a G652D fibre but with improved bending characteristics. G657B fibres have improved bending characteristics and are allowed to deviate from some G652D specifications, such as PMD and Chromatic Dispersion.

Sometimes these fibres are all called "BIF" or Bend Insensitive Fibre

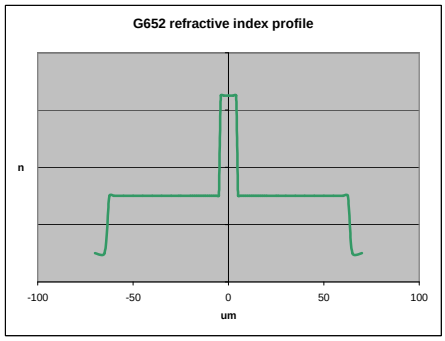
How does G657 fibre work?

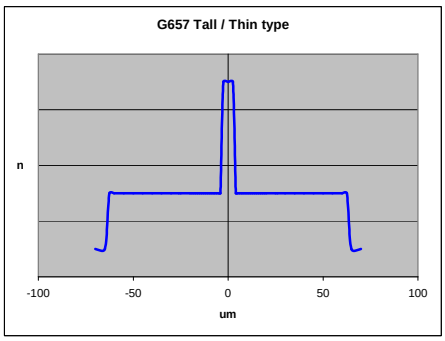
To meet the G657A1 specification requires minimal changes to a G652 design, so G657A1 fibres can be very similar in structure to G652 fibres and can usually be spliced using a standard G652 SMF program.

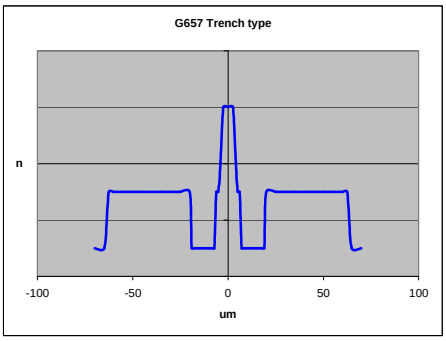
To meet the other G657 specs, the fibre either needs a different shape core to G652, or some additional structure around the core to keep the light in the core when the fibre is bent. To date there have been 4 commercially available designs of G657 fibre...

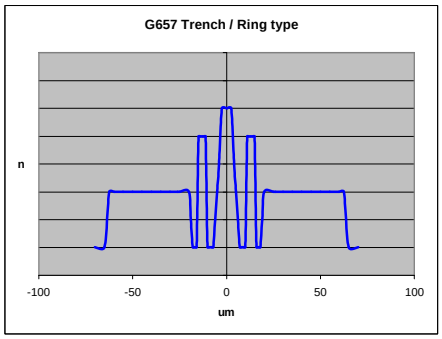
- Tall / thin core
- Trench around the core - also called Trench Assisted Fibre
- Trench and ring around the core - also called Ring Assisted Fibre
- Voids around the core – also called Void Assisted Fibre

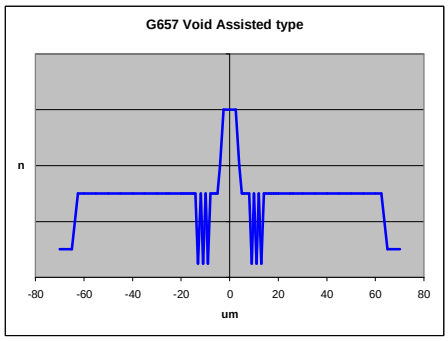
If you could see the refractive index profiles of these fibres they'd look something like the diagrams below...











Who makes these G657 fibres?

Sumitomo pioneered the design of Bend Insensitive fibres using a profile with a tall and very thin core. Our design, called Pure Access Ultra, was launched in Japan in 2004. It's no longer produced and you're unlikely to find any in Europe. It has a much smaller MFD than a typical G652 fibre. The MFD mismatch when it's joined to G652 gives quite high insertion loss so it's no longer considered practical to use.

Design	Producer	G657A1	G657A2	G657B2	G657B3
Tall / thin core	Sumitomo	Pure Access			
	Corning	ClearCurve XB			
	OFS	AllWave FLEX			
	Prysmian	CasaLite			
Trench only	Sumitomo				PureAccess-R5
	Draka	Bendbright	Bendbright-XS		Bendbright-Elite
	Corning		ClearCurve LBL		
	Corning				ClearCurve ZBL
Trench & ring	OFS				EZ-Bend
Voids	Prysmian			CasaLite-Plus	CasaLite-Xtreme

What are the special problems splicing these fibres?

- General issues
  - The G657B fibres are not perfectly MFD matched with G652 SMF. Typically their MFD at 1310nm is a little smaller than the MFD of a G652 fibre. So when a G657B is spliced to a G652 there is always some extra insertion loss due to the MFD mismatch.
  - In a G652 fibre the distribution of power in the fibre (the mode profile) closely follows a Gaussian distribution. In the G657 fibres the light transmission path is different and the mode profile may be non-Gaussian. This means there can be some mode profile mis-match when G657 fibres are spliced to G652 fibres. This can create extra insertion loss, in addition to extra insertion loss created by MFD mis-match.

- The refractive index of the pure silica glass used to make a fibres' cladding is increased or decreased by adding dopant materials. Generally Germanium (Ge) is used to raise the index (to make the core) and Fluorine (Fl) is used to reduce the index (to make a trench). Addition of dopants to the pure Silica can change the melting point of the glass so these fibres may have a different melting point to G652 fibres. Making an Arc Test will compensate for this.
- These are new fibre designs which are still evolving. It's possible they may change in the future. See the section on splicing these fibres with a T-39 below.

- Splicing G657 fibres on a fixed v-groove splicer
  - These splicers cannot "see" the core. They "don't care" that the core is different to a G652 fibre. Choose the SMF Standard program, make an Arc Test and start working.

- Splicing G657 fibres on a core aligning splicer
  - The splicer needs to be able to "see" the core to do a core alignment. Splicers view fibres by looking through the "side" of the fibre. If the fibre has extra structure around the core it can shield or distort the core image, or make it difficult for the splicer to find the correct core focus position. See the pictures below for examples of how these fibres look on a T-39.

Draka BendBright XS (Trench assisted type G657A2) spliced to G652

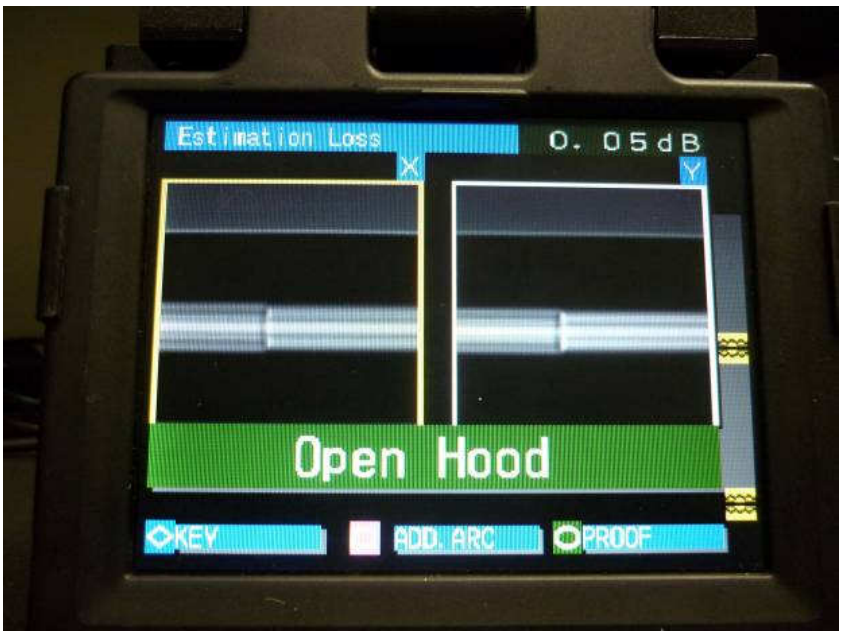
Left fibre: Draka BendBright XS

Right fibre: G652 SMF

Draka BendBright Elite (Trench assisted type G657B3) spliced to G652

Left fibre: BendBright Elite

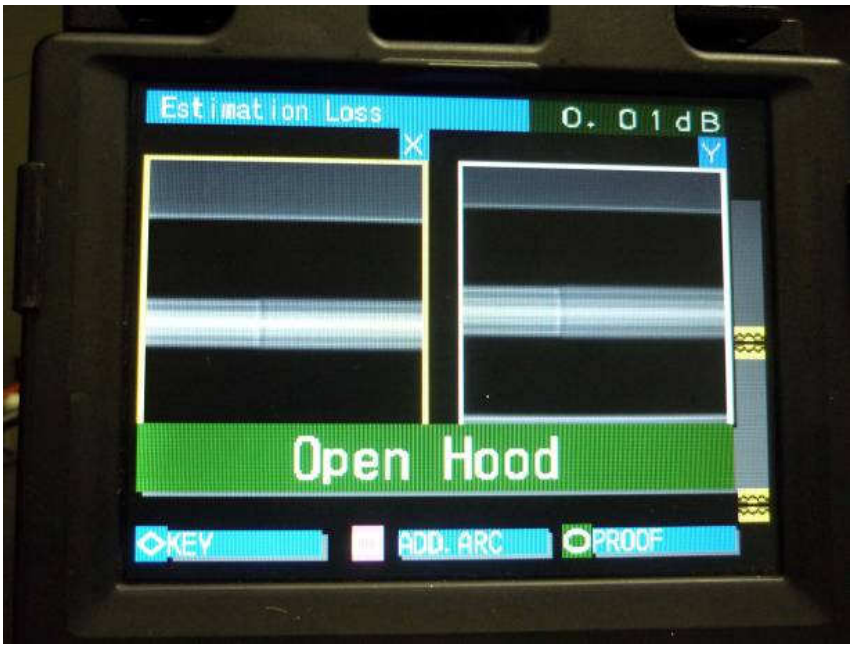
Right fibre: G562 SMF



Draka BendBright XS spliced to BendBright Elite (Trench Assisted G657A2 to G657B3)

Left fibre: BendBright XS

Right fibre: BendBright Elite



OFS EZ-Bend (Trench/Ring Assisted type G657B3) spliced to SMF

Left fibre: EZ-Bend

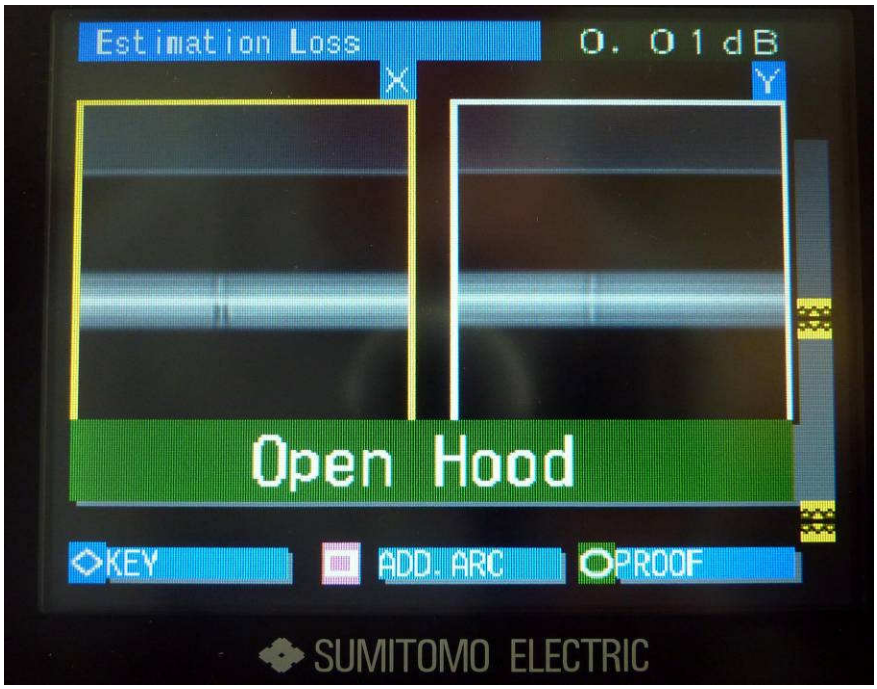
Right fibre G652

The ring in the EZ-Bend fibre completely shields the core. So for Core alignment the splicer is actually aligning on the centre of the ring. OFS have confirmed that the ring and the core are close to perfectly concentric, hence aligning on the ring centre can be considered the same as aligning on the core centre.

Corning ClearCurve ZBL (Trench type G657B3) spliced to itself

Left fibre: Corning ClearCurve ZBL

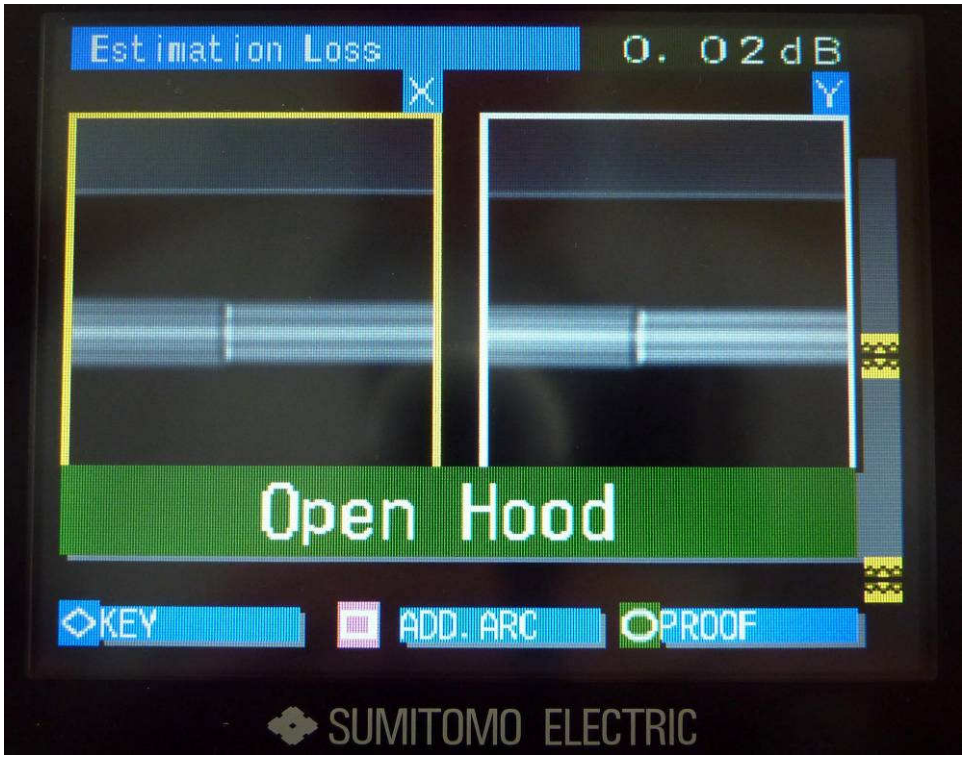
Right fibre: Corning Clear Curve ZBL



Corning ClearCurve ZBL (Trench type G657B3) spliced to SMF

Left fibre: Corning ClearCurve ZBL

Right fibre: G652 SMF



Sumitomo PureAccess-R5 (Trench type G657B3) spliced to itself

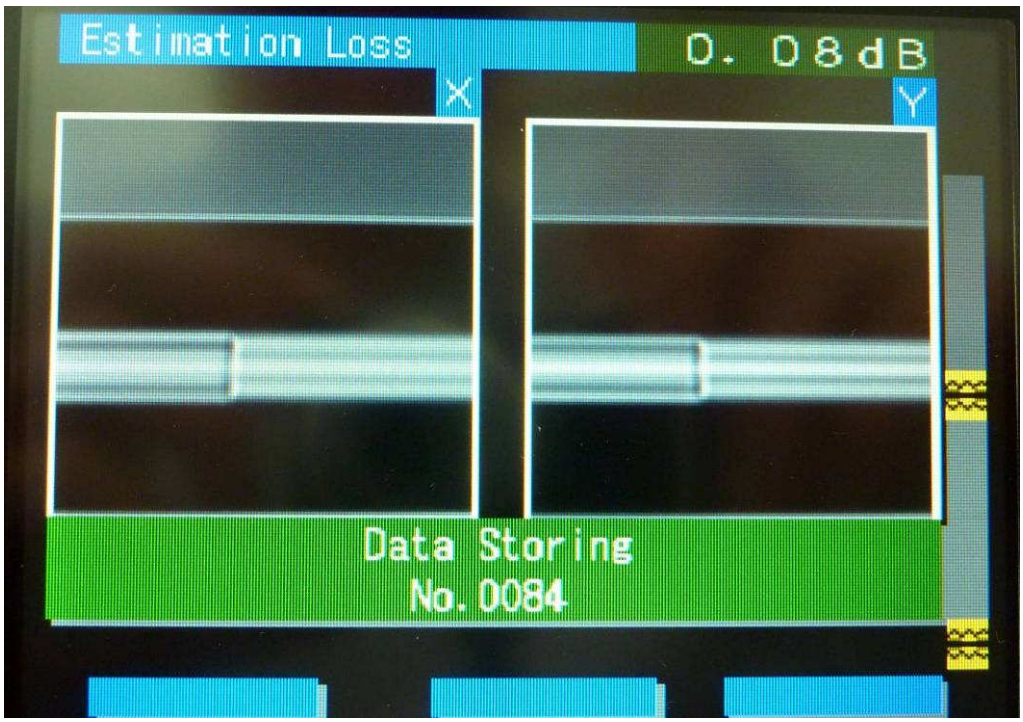
Left fibre: PureAccess-R5

Right fibre: PureAccess-R5

Sumitomo PureAccess-R5 (Trench type G657B3) spliced to SMF

Left fibre: PureAccess-R5

Right fibre: G652 SMF



Does the splicer need special software to splice G657 fibres?

- Fixed v-groove splicers: T-25e, T-66
    - No special software is needed. These splicers cannot “see” the core so they “don’t care” if the core looks different to a G652 fibre core. Just use the SMF Standard program and make an Arc Test before starting to splice.

- Core aligning splicers: T-39
    - Software before 1.26 and 1.46

      These software versions cannot make Core aligning splices on BendBright XS or Corning ClearCurve.

      As a stop-gap, you can create a SMF program that uses Diameter alignment. Splicing BendBright XS to BendBright XS using Diameter alignment on a T-39 gives a typical break and remake insertion loss of about 0.04 to 0.05dB. This is only about a 0.02dB increase over the value achieved using later software versions which can splice with Core alignment.

      Due to EZ-Bend’s simple image structure it’s quite likely you can splice it using the SMF Standard program. Although this should make good splices, the loss estimate may be too low, as the SMF Standard program assumes a 9um MFD.

    - Software versions 1.26 and 1.46

      This can make core alignment splices of BendBright XS produced up to mid-2009, but not on more

recently produced BendBright XS. It has special programs for splicing the pre-mid-2009 design of BendBright XS to itself and to G652 fibre.

- Software versions 1.28 and 1.48

  This software has two major enhancements over earlier versions

  - A more resilient image processing algorithm for Core alignment
  - A new “Adaptive” alignment mode, which can be manually selected if the improved Core alignment mode still fail to align the fibres.

  This software has special programs for Core alignment splicing of BendBright XS, EZ-Bend and the void assisted version of Corning ClearCurve, both themselves and to G652 fibre. The BendBright XS program will also splice BendBright Elite.

- Software versions 1.32, 1.52 and 1.72

  This software has 3 new splice programs

  - A program for core alignment splicing of Sumitomo PureAccess-R5
  - A program for core alignment splicing of Prysmian CasaLight+ to itself
  - A program for core alignment splicing of Prysmian CasaLight+ to G652 fibre

  Although Corning's void assisted ClearCurve fibre has now been withdrawn from the market, the T-39 retains the dedicated "BIF ClearCurve" program for splicing this fibre.

  If you're splicing Corning ClearCurve LBL or ClearCurve ZBL it's not necessary to use the "BIF ClearCurve" program. Just choose the "BIF Adaptive" program and the T-39 should make a core aligning splice on these fibres.

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