BS EN 50411-2-5:2009

BSI British Standards

Fibre organisers and closures to be used in optical fibre communication systems — Product specifications —

Part 2-5: Sealed closures for air blown fibre microduct, type 1, for category S & A

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British Standards

National foreword

This British Standard is the UK implementation of EN 50411-2-5:2009.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/2, Fibre optic interconnecting devices and passive components.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Fibre organisers and closures to be used in optical fibre communication systems - Product specifications - Part 2-5: Sealed closures for air blown fibre microduct, type 1, for category S & A

Organiseurs et boîtiers de fibres à utiliser dans les systèmes de communication par fibres optiques - Spécifications de produits - Partie 2-5: Boîtiers scellés pour microconduits de fibres soufflées à l'air comprimé, pour les catégories S & A

LWL-Spleißkassetten und -Muffen für die Anwendung in LWL-Kommunikationssystemen - Produktnormen - Teil 2-5: Abgedichtete LWL-Muffen für ABF-Mikrorohre, Bauart 1, für die Kategorien S und A

This European Standard was approved by CENELEC on 2008-12-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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CENELEC

European Committee for Electrotechnical Standardization

Comité Européen de Normalisation Electrotechnique

Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 86BXA, Fibre optic interconnect, passive and connectorised components.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50411-2-5 on 2008-12-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2009-12-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2011-12-01

Fibre organisers and closures to be used in optical fibre communication systems – Product specifications

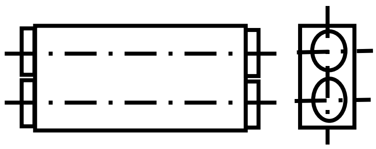
Sealed closures for air blown fibre microduct, type 1, for category S & A

Description		Performance	
Construction:	Multiple ported closure	**Applications:**	
Cable management:	Microduct , protected microduct, ducts and/or sub-ducts.	Blown optical fibre cable networks:	
Cable seals:	Heat activated and or cold applied	for underground: for aerial:	EN 61753-1 Category S EN 61753-1 Category A

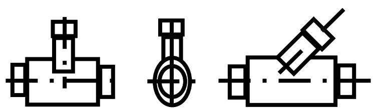
Related documents:

EN 60793-2-50	Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres (IEC 60793-2-50)
EN 60794-5	Optical fibre cables – Part 5: Sectional specification – Microduct cabling for installation by blowing (IEC 60794-5)
EN 61300 series	Fibre optic interconnecting devices and passive components – Basic test and measurement procedures (IEC 61300 series)
EN 61753-1	Fibre optic interconnecting devices and passive components performance standard – Part 1: General and guidance for performance standards (IEC 61753-1)
EN 61756-1	Fibre optic interconnecting devices and passive components – Interface standard for fibre management systems – Part 1: General and guidance (IEC 61756-1)
EN 61758-1	Fibre optic interconnecting devices and passive components – Interface standard for closures – Part 1: General and guidance (IEC 61758-1)
ETSI EN 300 019 series	Environmental Engineering (EE) – Environmental conditions and environmental tests for telecommunications equipment

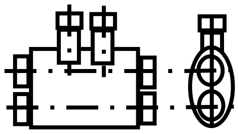
Construction:

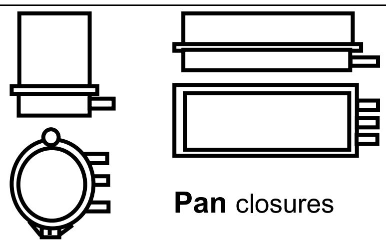


Inline closures

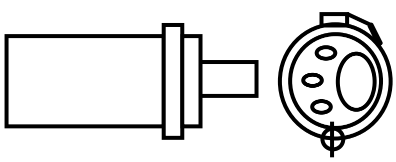


Tee closures





Pan closures



Dome closures

Duct and cable port entries and dimensions (Direct burial or jointing pit mounted)

Closure		Max sizes of protected microduct cables mm	Closure designs (Type and/or sub-group)	Maximum physical dimensions in mm Length L Width W Depth D
Central split access	**Inline (multiple ports)**	112	Type 1a	975 x 394 x 330
		35	Type 2a	648 x 274 x 152
		26	Type 2b	828 x 274 x 401
	Tee (single and double port)	32	Single port ends	300 x 200 x 100
		50	Double port ends	720 x 435 x 210
Single end entry	**Pan (circular or rectangular)**	30	Rectangular	710 x 515 x 148
		40	Circular	450 x 350 x 700
		40	Elliptical	520 x 450 x 300
	Dome (single end entry)	19	Type 1a	600 x 185 x 265
		26	Type 1b	750 x 270 x 310
		35	Type 1c	1 050 x 275 x 310

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1 Scope

1.1 Product definition

This specification contains the initial, start of life dimensional, optical, mechanical and environmental performance requirements which a fully installed blown fibre protected microduct closure must meet in order for it to be categorised as an EN standard product.

These products are suitable for installation of and use with microduct fibre units, microduct optical fibre cables, microduct and protected microduct as defined within EN 60794-5.

1.2 Operating environment

The tests selected combined with the severities and duration are representative of an outside plant for subterranean and/or aerial environment defined by:

- ETSI EN 300 019 series: Class 8.1: underground locations (without earthquake requirement);
- EN 61753-1: Category S: subterranean environment;
  Category A: aerial environment.

1.3 Reliability

Whilst the anticipated service life expectancy of the product in this environment is a minimum of 20 years, compliance with this specification does not guarantee the reliability of the product. This should be predicted using a recognised reliability assessment programme.

1.4 Quality assurance

Compliance with this specification does not guarantee the manufacturing consistency of the product. This should be maintained using a recognised quality assurance programme.

1.5 Allowed fibre and cable types

This closure standard covers all IEC standard optical fibre microducts, and protected microducts with their various fibre capacities, types and designs. This includes, but is not limited to, optical fibre cable standard EN 60794-5.

This product specification has only considered protected microduct cables containing microducts of same outside diameters. There are other hybrid protected microduct cables with microducts of differing OD’s, with too many variants to be included in this PS.

1.6 Allowed microduct connector types

This closure standard covers all EN standard microduct connectors, including: straight, reducer/enlarger stem, reducer/enlarger, close down, liquid block, liquid block with barb end, and end stop connectors. This includes, but is not limited to, EN 50411-2-8.

1.7 Microduct storage constraints

Microduct excess storage is not required in all air blown fibre closures. Some closure types do not have sufficient internal space to provide storage. The need for microduct storage is provided inside the closure when opened, typically to ensure that there is enough microduct to fulfil the following functions:

- remove the coiled microduct attached to the ‘closedown’ connectors, to a remote location, close to blowing equipment, in the process uncoiling the microducts to aid blowing;
- provide additional microduct if repeated cut backs for connectors are planned or likely to be fitted throughout the closure life.

The minimum microduct storage bend radius is based on the outside diameter and material selection, typically based on 12 times the outside diameter (below 8 mm) and 20 times above. During fibre blowing the bend radius is typically 20 times the microduct diameter.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50411-2-8	Fibre organisers and closures to be used in optical fibre communication systems – Product specifications – Part 2-8: Microduct connectors, for air blown optical fibres, Type 1
EN 60068-2-10	Environmental testing – Part 2-10: Tests – Test J and guidance: Mould growth (IEC 60068-2-10)
EN 60794-1-2:2003	Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures (IEC 60794-1-2:2003)
EN 60794-5	Optical fibre cables – Part 5: Sectional specification – Microduct cabling for installation by blowing (IEC 60794-5)
EN 61300 series	Fibre optic interconnecting devices and passive components – Basic test and measurement procedures (IEC 61300 series)
EN 61300-2-1	Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal) (IEC 61300-2-1)
EN 61300-2-4	Part 2-4: Tests – Fibre/cable retention (IEC 61300-2-4)
EN 61300-2-5	Part 2-5: Tests – Torsion/twist (IEC 61300-2-5)
EN 61300-2-10	Part 2-10: Tests – Crush resistance (IEC 61300-2-10)
EN 61300-2-12:2005	Part 2-12: Tests – Impact (IEC 61300-2-12:2005)
EN 61300-2-22	Part 2-22: Tests – Change of temperature (IEC 61300-2-22)
EN 61300-2-23:1997	Part 2-23: Tests – Sealing for non-pressurized closures of fibre optic devices (IEC 61300-2-23:1995)
EN 61300-2-26	Part 2-26: Tests – Salt mist (IEC 61300-2-26)
EN 61300-2-33	Part 2-33: Tests – Assembly and disassembly of closures (IEC 61300-2-33)
EN 61300-2-34	Part 2-34: Tests – Resistance to solvents and contaminating fluids (IEC 61300-2-34)
EN 61300-2-37	Part 2-37: Tests – Cable bending for fibre optic closures (IEC 61300-2-37)
EN 61300-2-38:2006	Part 2-38: Tests – Sealing for pressurized fibre optic closures (IEC 61300-2-38:2006)
EN 61300-3-1	Part 3-1: Examinations and measurements – Visual examination (IEC 61300-3-1)
EN 61300-3-3:2003	Part 3-3: Examinations and measurements – Active monitoring of changes in attenuation and return loss (IEC 61300-3-3:2003)
EN 61300-3-28	Part 3-28: Examinations and measurements – Transient loss (IEC 61300-3-28)
EN 61753-1	Fibre optic interconnecting devices and passive components performance standard – Part 1: General and guidance for performance standards (IEC 61753-1)
ETSI EN 300 019 series	Environmental Engineering (EE) – Environmental conditions and environmental tests for telecommunications equipment
ISO 1998-1	Petroleum industry – Terminology – Part 1: Raw materials and products
EN 590	Automotive fuels – Diesel – Requirements and test methods

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
ducts
semi-rigid underground pipe, typically manufactured from a polymeric material, and typically greater than 65 mm outside diameter

3.1.2
sub-ducts
underground semi-flexible pipes, which may fit inside a duct, typically manufactured from a polymeric material, and typically less than 50 mm outside diameter

3.1.3
microducts (MD)
small, flexible, lightweight tube with an outer diameter typically less than or equal to 16 mm

3.1.4
protected microducts
one or more microducts surrounded by a protective sheath and/or protected by a duct/sub-duct

3.1.5
microduct optical fibre cables
optical fibre cables suitable for installation by blowing into a microduct

3.1.6
microduct fibre units
fibre unit that is suitable for installation by blowing into a microduct. It differs from microduct optical fibre cables in that it provides less protection to the fibres that it contains

3.1.7
air blown fibre (ABF) microduct closure
ABF microduct closures provide a physical housing for microduct management; connection, fixing, sealing, anchoring, liquid and/or gas blocking, storage and routing up to the input and output protected microduct of the air blown fibre cable closure system

3.1.8
blowing point closure
closure used as a position for blowing fibre at multiple points in series (cascade blowing). Typically the closure contains 'close down' microduct connectors, for fibre access to the blowing head equipment

3.1.9
straight microduct connectors
microduct connectors are used to connect two microducts together. This connector has a means of microduct attachment and sealing on both sides and is typically unsupported (floating inside the closure)

3.1.10
straight bulkhead microduct connectors
microduct connectors are used to connect two microducts together. This connector has a means of microduct attachment and sealing on both sides and is typically supported on a bulkhead attached by a suitable fixing system (i.e. nut or clip)

3.1.11
different ID reducers/enlarger stem microduct connectors
stem connector which connects two microducts with the same OD but different ID, with a smooth internal transition to prevent fibre hang ups. Typically they have microduct attachment and sealing at one end of the connector, and a stem on the other end to facilitate attachment to a straight connector

3.1.12
different ID reducers/enlarger microduct connectors
connectors which connects two microducts with the same OD but different ID, including a smooth internal transition to prevent fibre hang ups. Typically they are used to connect a heavy walled to a thinner wall MD

3.1.13
different OD reducers/enlarger stem microduct connectors
stem which connects two microducts with the same ID but different OD. Typically they have microduct attachment and sealing at one end of the connector, and a stem on the other end to facilitate attachment to a straight connector

3.1.14
different OD reducers/enlarger microduct connectors
connector which connects two microducts with the same ID, but different OD

3.1.15
different ID and OD reducers/enlarger stem microduct connectors
stem which connects two microducts with a different OD and different ID; including a smooth internal transition to prevent fibre hang ups. Typically they have microduct attachment and sealing at one end of the connector, and a stem on the other end to facilitate attachment to a straight connector

3.1.16
different ID and OD reducers/enlarger microduct connectors
connector which connects two microducts with different OD's and different ID's, including a smooth internal transition to prevent fibre hang ups

3.1.17
close down microduct connectors
microduct connectors that are used for fibre access for blowing head equipment for cascade blowing, allowing a microduct to be opened and resealed after blowing, without detriment to the fibre in situ

3.1.18
liquid block microduct connectors
microduct connectors that are used at a transition point to stop liquids from flowing between the connected microducts to avoid liquid and contaminant ingress and liquid damage to other equipment

3.1.19
liquid block with a barb end
similar to a liquid block connector, at the barb end. The barb end is designed to interface with the non-microduct (transport tubing), which protects the fibre at a "fibre management system" closure

3.1.20
end stop microduct connectors
microduct connectors that are used for sealing open ended microduct, avoiding air leakage, water or foreign material ingress

3.1.21
connector insertion force
force required to insert the microduct into the connector without damage

3.1.22
fibre management system (FMS)
system to control fibre routing from the incoming to the outgoing fibres, containing one or more splice cassettes and additional functional elements

3.1.23
microduct management system
system to control microduct routing inside a closure or housing, from the incoming to the outgoing microduct, all jointed together with microduct connectors of various functional types

3.1.24
burst pressure
point at which the closure fails to contain pressure

3.1.25
cut backs
process to remove a short length of microduct in order to prepare the ends, prior to fitting a new connector, ensuring better sealing and attachment faces

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

PS Product Specification

MD Microduct

ABF Air Blown Fibre

ID Inside Diameter (microducts)

OD Outside Diameter (microducts)

AC Across Corners

MMS Microduct Management System

4 Description

4.1 Microduct closure

An ABF microduct closure comprises a closure housing that is attached to the ends of

- an underground installed duct or sub duct or
- an air blown fibre protected microduct.

Microduct closures comprises an access housing that allows the interconnection and storage of microducts or protected microducts. Figure 1, shows the minimum space profile required to house microduct connectors.

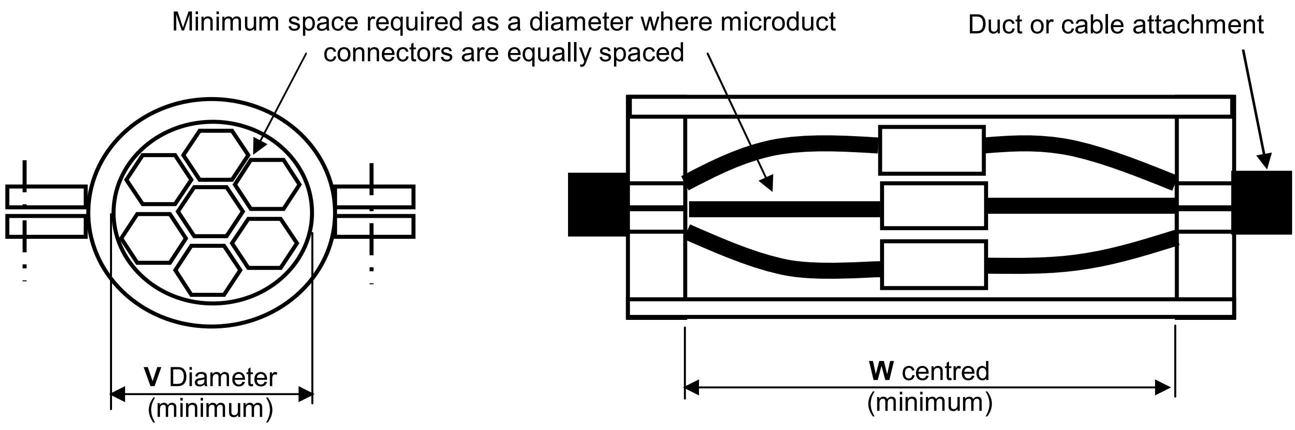


Figure 1 – Schematic – Minimum microduct and connector space profile (see Annex C)

4.2 Closure housing functions

Microduct closures for protected microducts have three basic functions they are to provide:

- a branch off for secondary microduct installation to a customer;
- an intercept to an existing pre-installed protected microduct;
- an access point for blowing fibre onward using conventional blowing equipment.

4.3 Burst pressure

The microduct system may fail therefore the closure must be able to be fitted with an over pressure safety system. This system should be able to exhaust air fast enough to ensure that a safe working pressure of equal to, or less than 0,4 bars is maintained when the correct installation pressure is applied.

4.4 Closure housing configurations

4.4.1 Inline closure housing configurations (I)

Inline closures have cable entry ports in two positions at opposite ends. Each end typically has one or two ports. Figure 2 shows a typical option for the 'I' closure type, any entry port can also be an exit port.

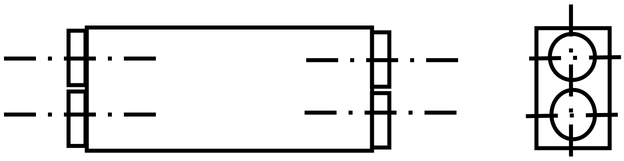


Figure 2 – Inline – Double port ended (I)

4.4.2 Tee closure housing configurations (T)

Tee closures have cable entry ports in three positions, one at each end and one at an acute angle, typically at 90°. Each position typically has one or two ports. Figures 3 and 4 show typical options for the 'T' closure type. This group also covers 'Y' closures at various angles.

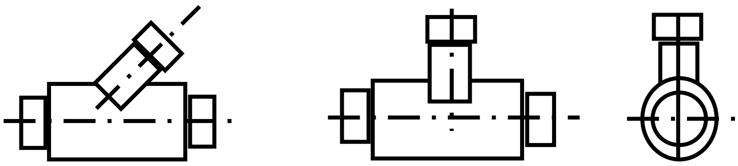


Figure 3 – 'Tee' – Single entry port ends with a single port at an acute angle

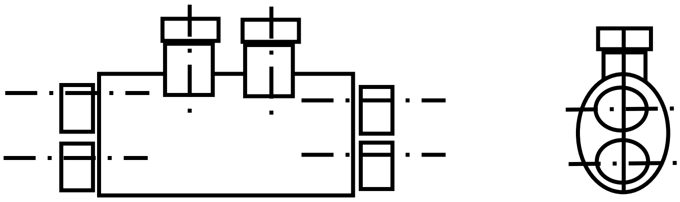


Figure 4 – 'Tee' – Double entry port ends with single or double ports at an acute angle

4.4.3 Pan closure housing configuration (P)

Pan closures have cable entry ports in one position at 90° to the cover removal axis. They have typical three or more ports. Figures 5 and 6 show typical options for the 'P' closure body types, typically circular, elliptic or rectangular.

Figure 5 – Pan – Entry ports in one position at 90° to the circular cover removal axis

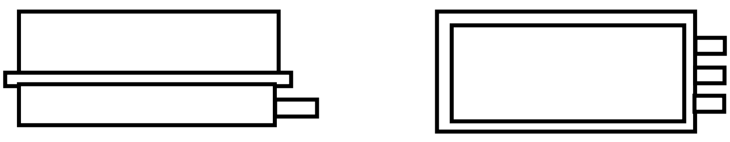


Figure 6 – Pan – Entry ports in one position at 90° to the rectangular cover removal axis

4.4.4 Dome closure housing configuration (D)

Dome closures have cable entry ports entering and exiting the same side, with high numbers of small cable ports and low numbers of larger ports. Microduct storage is required over 180°. Figure 7 shows a typical option for the 'D' closure type.

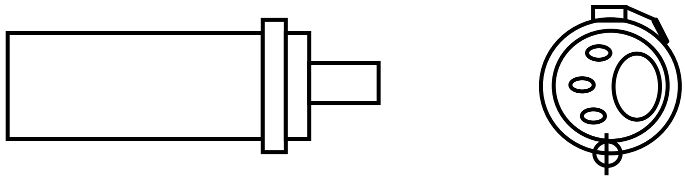


Figure 7 – Dome – Single end entry ported closure

4.5 Entry seals

Entry seal systems can be either:

- **(H) Dedicated heat activated heat source for example, electrical, infrared, hot air or flame**
  - thermo-shrinkable materials,
  - hot melt adhesives,
  - polyethylene injection welding.
- **(C) Dedicated cold applied**
  - mastic, tapes, pastes, potting compounds, gels and cold adhesives,
  - o-rings, grommets, rubber shapes, are cold processes.
- **(U) Combined heat activated and cold applied**

All seals should be installed according to manufacturer's guidelines.

4.6 Common base configurations

The design of the closure housing shall allow the jointing of two or more microducts, or protected microducts in the following configuration or applications:

Track joint: configuration used to connect two sub-ducts or protected microducts, with a minimum of 2 entry ports

Spur joint: configuration used on local feeder cable with minimum of 3 cable entry ports

Distribution joint: configuration used on customer feed cable with minimum of 8 cable entry ports

NOTE Entry ports can accommodate more than one sub-duct or protected microduct.

The design of the distribution and spur closure housing shall allow the joining together of at least one pair of cables which are not at the end of a cable section. This application is generally known as distribution, external node or a mid-span closure.

It is desirable that the closure can be re-opened when necessary without interruption or disturbance of the traffic of the live circuits within the microducts.

4.7 Microduct management system

The microduct management system consists of stored or routed microducts to EN 60794-5 and microduct connectors to EN 50411-2-8. The system provides a means for routing, storing (if appropriate) and protecting of microduct connectors or other passive optical devices (e.g. a blowing head) in a predetermined order.

A closure used as a blowing location requires storage of fibre microducts of a length suitable for remote deployment to a blowing head.

4.8 Materials

All materials that are likely to come in contact with personnel shall meet appropriate health and safety regulations. Materials must conform to ROHS requirements.

Closure and sealing materials shall be compatible with each other and with the materials of the cables.

All components of the closure shall be resistant to solvents and degreasing agents typically used.

The effects of fungus shall be determined by measuring a suitable property both before and after exposure and tested according to EN 60068-2-10 (micro-organisms), using the 28-day test.

The effects of UV light shall not affect product performance for aerial closures. The use of UV stabilised materials for the outer housing is required.

Metallic parts shall be resistant to the corrosive influences they may encounter during the lifetime of the product.

4.9 Colour and marking

Marking/identification of the variant number (see Clause 5) should be on the product or packaging label along with the following:

a) identification of manufacturer;

b) manufacturing date code: year / month.

4.10 Microduct connectors applications and capacity

The different types of microduct connectors can be found in EN 50411-2-8, ABF Microduct connectors for non-sealed closures, this covers all applications and include the following connector types:

- straight connector (see note);
- straight bulkhead connector;
- ID reduce/enlarger stem connector;
- ID reduce/enlarger connector;
- OD reduce/enlarger stem connector;
- OD reduce/enlarger connector;
- ID and OD reduce/enlarger stem connector;
- ID and OD reduce/enlarger connector;
- close down connector;
- liquid block connector;
- liquid block with a barb end connector;
- end stop connector.

NOTE In order to reduce the number of variables, all connector volumes for any given closure size is based on the microduct outside diameter with a standard size straight connector. The straight connector has been selected as it is the most widely used type.

5 Variants

Table 1 – Variants for sealed closures for ABF protected microduct, for category S & A

EN 50411-2-5 – X_1 – X_2 – X_3 – X_4 – XXX_5 – XX_6 – XX_7 – XX_8

Variant No. X_1	Environmental performance
S	Subterranean environment (underground)
A	Aerial environment (above ground level)
B	Both subterranean and aerial

Variant No. X_2	Operating environment
T	Track closure (2 cable entries minimum)
S	Spur closure (3 cable entries minimum)
D	Distribution closure (8 cable entries minimum)

Variant No. X_3	Protected microduct sealing technology
R	Cold applied
H	Heat activated (heat source required)
U	Universal, both methods in a single cable entry base

Variant No. X_4	Closure type, shape and port configuration
I	Inline – multiple port ends
T	Tee
P	Pan
C	Dome (all at the same end)

Variant No. XXX_5	Microduct storage and fibre blow through
BNS	Fibre blow through with no storage
BWS	Fibre blow through and storage
BFS	Blow from (not through) but has storage

Variant No. XX_6	Microduct outside diameter – Stored (straight connector only)
	Outside diameter
03	3 mm
04	4 mm
05	5 mm
06	6 mm
07	7 mm
08	8 mm
10	10 mm
12	12 mm
14	14 mm

Depending on the primary protected microduct cable selection in Variant **XX_6** and **XX_7** (number of microducts 1, 2, 4, 7, 8, 9, 12, 19, 24 and 30) refer to one of the following Tables 2, 3, 4 and 5 to find **X_8**.

Tables 2, 3, 4 and 5 are based on buried protected microduct cables.

Table 2 – Line closure capacity – Protected microduct cable selection – Maximum

XX_6 → **Microduct O/D**	03	04	05	06	07	08	10	12	14
	Number of microducts in the protected microduct cable **XX_7** (number in box)								
XX_8 Closure									
NA	19	7	7	4	2	1			
NB	24	24	24	24	24	19	12	7	1
NC	24	24	24	24	24	24	19	19	1
ND	24	24	24	24	24	24	19	19	1
NE	24	24	24	24	24	24	19	19	1
NF	24	24	24	19	7	7	4	2	1
NG	24	19	7	4	4	4	2	1	1
NH	19	7	7	4	2	1			
NJ	19	7	7	4	2	1			
NK	19	7	7	4	2	1			
NL	19	7	7	4	2	1			

Table 3 – Tee closure capacity – Protected microduct cable selection – Maximum

XX_6 → **Microduct O/D**	03	04	05	06	07	08	10	14
	Number of microducts in the protected microduct cable **XX_7** (number in box)							
XX_8 Closure								
TA	24	12	7	4	4	2	1	
TB	24	24	12	12	12	7	4	1
TC	24	24	24	12	12	12	7	1
TD	24	24	24	12	12	12	7	1
TE	24	24	24	12	12	19	7	1
TF	24	24	24	12	12	19	7	1

Table 4 – Pan closure capacity – Protected microduct cable selection – Maximum

XX_6 → **Microduct O/D**	03	04	05	06	07	08	10	14
	Number of microducts in the protected microduct cable **XX_7** (number in box)							
X_8 Closure								
PA	12	7	2	2	1			
PB	24	12	7	4	4	2	1	1
PC	24	19	12	7	7	4	2	1
PD	24	19	12	12	12	4	2	1
PE	24	19	12	12	12	4	2	1
PF	24	19	12	12	12	4	2	1
PG	24	19	12	12	12	4	2	1
PH	24	19	12	12	12	4	2	1

Table 5 – Closure capacity – Protected microduct cable selection – Maximum

XX_6 → **Microduct O/D**	03	04	05	06	07	08	10	14
	Number of microducts in the protected microduct cable **XX_7** (number in box)							
X_8 Closure								
DA	12	7	2	2	2	1		
DB	12	7	2	2	2	1		
DC	24	12	7	4	4	2	1	1
DD	24	12	7	4	4	2	1	1
DE	24	24	19	7	7	7	4	1
DF	24	24	19	7	7	7	4	1
DG	24	24	19	7	7	7	4	1
DH	24	24	19	7	7	7	4	1

6 Dimensional requirements

6.1 Dimensions of inline closures

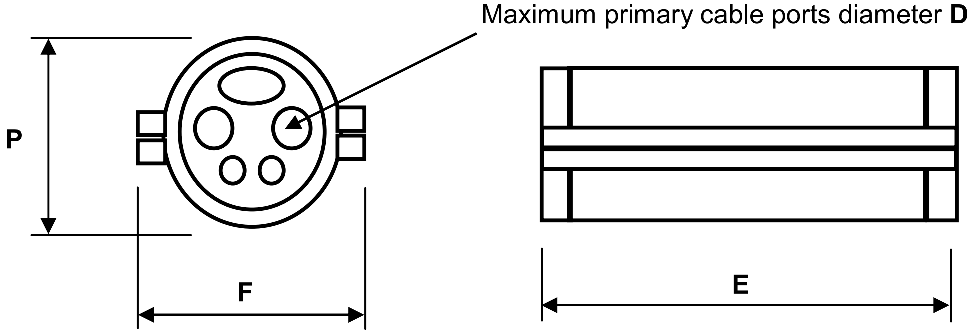


Figure 8 – Diagram showing inline – Closures dimensions – Type 1 configuration

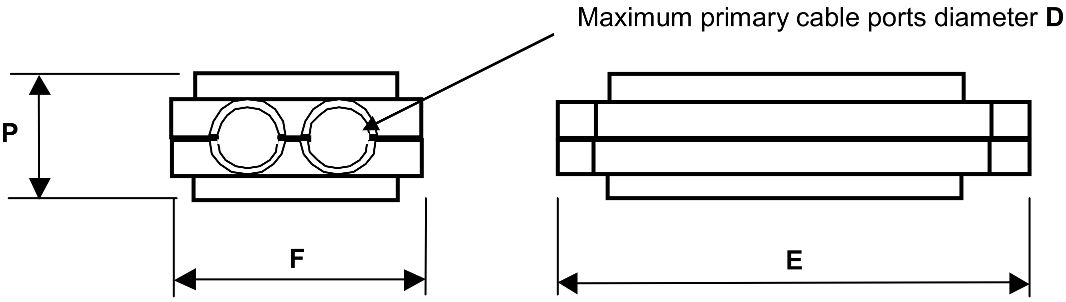


Figure 9 – Diagram showing inline – Closures dimensions – Type 2a and 2b configurations

Table 6 – Dimensions of inline closures – Type 1, 2a and 2b configurations

Inline closure design type	**Inline closure size**	**Maximum overall length** mm	**Maximum overall width** mm	**Maximum overall height** mm	**Maximum cable diameter** mm
		E	F	P	D
Type 1	NA	655	219	184	26
	NB	914	273	235	56
	NC		318	254	86
	ND	975	394	330	
	NE	914	318	305	112
Type 2a	NF	828	274	152	35
	NG	648	160	150	28
Type 2b	NH	557	216	119	26
	NJ			287	
	NK			401	
	NL	828	274	254	

6.2 Dimensions of tee closures

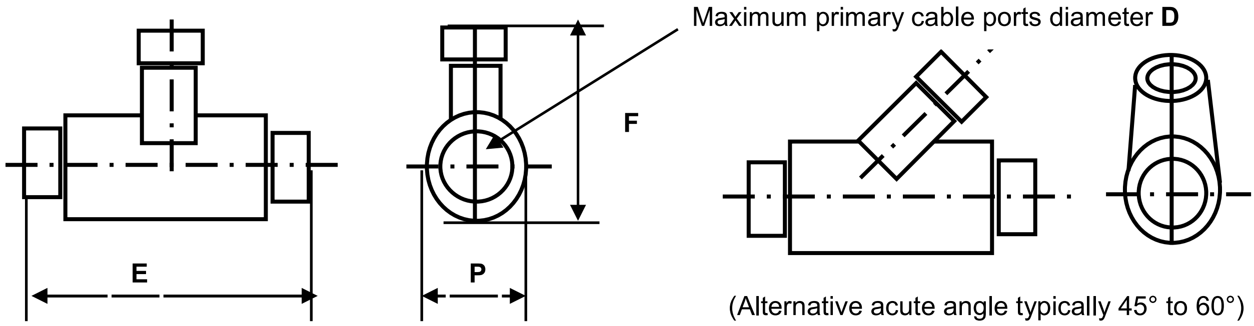


Figure 10 – Diagram showing tee – Closures dimensions showing single ports

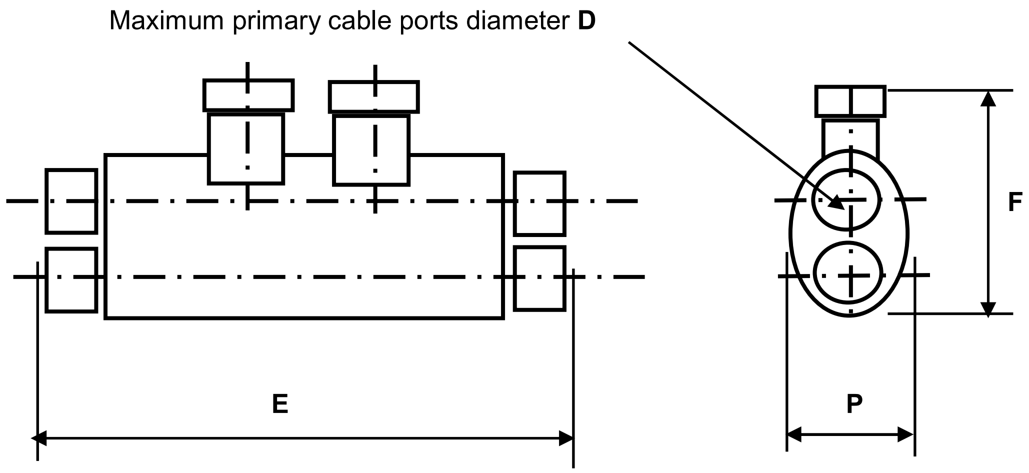


Figure 11 – Diagram showing tee – Closures dimensions showing double ports

Table 7 – Dimensions of tee closures

Tee closure design type / Sub-group	Tee closure size	Overall length mm	Maximum overall width mm	Maximum overall height mm	Maximum cable diameter mm
		E	F	P	D
Single port ends	TA	260	200	100	25
	TB	300	160	70	32
Double port ends	TC	650	100	100	40
	TD	720	435	210	
	TE	316	220	70	50
	TF	560	210	180	

6.3 Dimensions of pan closures

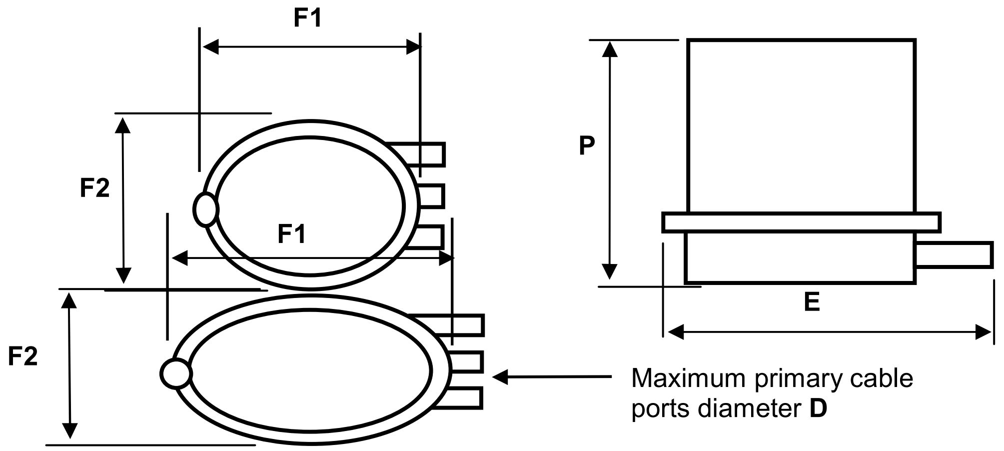


Figure 12 – Diagram showing pan – Circular or elliptical closures dimensions

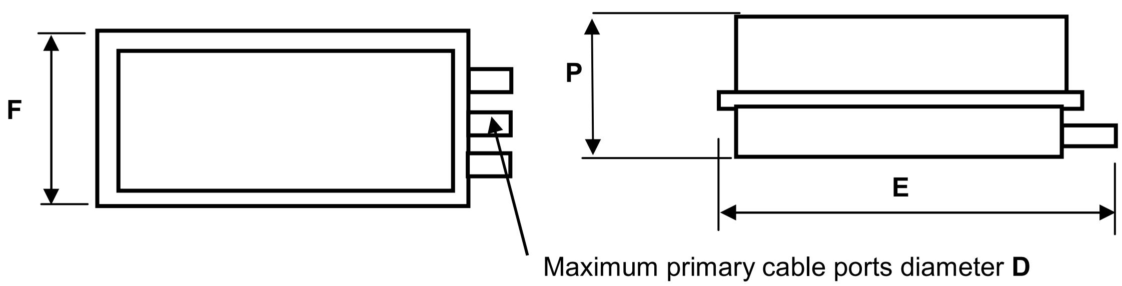


Figure 13 – Diagram showing pan – Rectangular closures dimensions

Table 8 – Dimensions of pan closures

Pan closure size	Shape sub-group	Maximum overall length mm	Maximum overall diameter mm	Maximum overall diameter mm	Maximum overall height mm	Maximum cable diameter mm
		E	F1	F2	P	D
PA		373	247	N/A	100	19
PB	Rectangular	523	515	N/A	140	25
PC		710	315	N/A	148	30
PD					250	
PE					300	
PF	Circular	450	350	395	400	40
PG					550	
PH					700	
PJ	Elliptical	520	450	600	200	40
PK					300	

6.4 Dimensions of dome closures

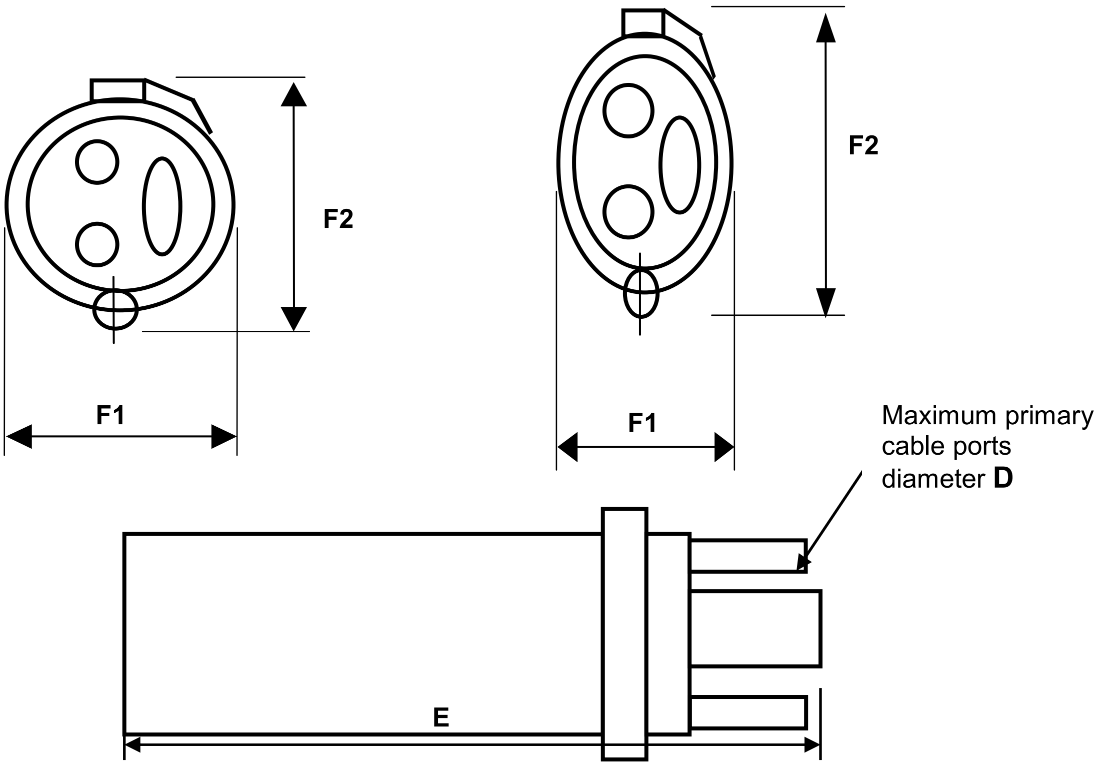


Figure 14 – Diagram showing dome – Circular and elliptical closures dimensions

Table 9 – Dimensions of dome closures

Dome closure design type	Dome closure size	Maximum overall length mm	Maximum overall diameter mm	Maximum overall diameter mm	Maximum cable port diameter mm
		E	F1	F2	D
Type 1a	DA	505	185	265	19
	DB	600			
Type 1b	DC		270	312	26
	DD	750			
Type 1c	DE	540	275	310	35
	DF	620			
	DG	800			
	DH	1 050			

7 Tests

7.1 Sample size

Separate test samples for sealing performance and optical evaluation may be used. For the purposes of this standard, a sealing performance test sample is defined as a closure installed with several cable ends.

Optical test samples shall be constructed as described in 7.2. Due to their complexity, consecutive testing on the same optical sample is allowed. The minimum recommended sample sizes are given in Annex B.

7.2 Test sample preparation

7.2.1 Sealing performance test samples

Sealing performance test samples shall be provided with an air pressure test access valve. The length of the protected microduct cables extending the closure shall be at least 1 m. The open ends of the microduct cables shall be sealed. Each applicable cable type with minimum and maximum cable dimensions shall be represented in the test program.

7.2.2 Optical test samples

Optical test samples shall be constructed in such a way that they will cover all allowed functions of a track joint and/or distribution joint. The fibres for the optical test samples are covered in Annex A.

7.2.3 Optical test sample construction

Protected microduct cables should be sealed to the closure and the internal microducts separated and routed inside the closure. Microducts are to be connected inside the closure using microduct connectors.

For the track joint closure (see Figure 15), the length of the test looped microduct cable is chosen in such a way that it is longer than the dead zone of an OTDR. The required length depends on the selected pulse width and dynamic range of the OTDR. Typically a cable loop length of 25 m to 50 m is chosen for this purpose. Part of the test involves blowing the fibre bundle around the entire test circuit, from the test equipment input to output position.

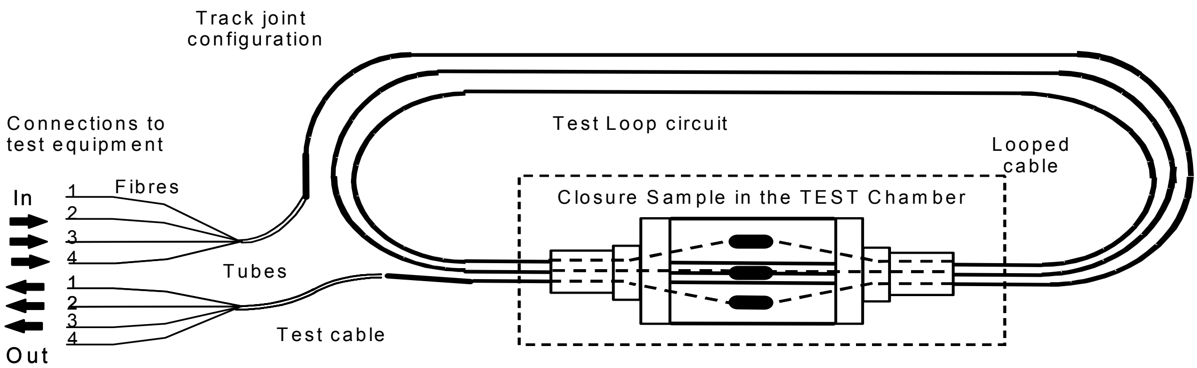


Figure 15 – Track joint configuration sample

In the track joint closure the fibres from one microduct cable end are connected to the fibres of the other microduct cable end in such a way that light will sequentially flow through 4 selected fibres in the fibre bundle. The first and the last fibre of this circuit will be spliced to the fibres of a drop cable for making external connections to a light source and power meter.

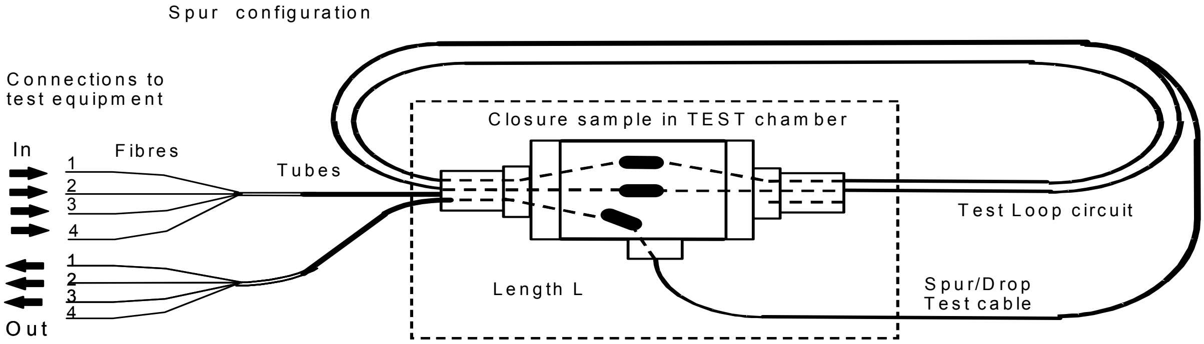


Figure 16 – Spur joint configuration sample

Protected microduct cables should be sealed to the closure as stated in the track closure test sample. For the track joint closure (see Figure 16), an active protected microduct drop cable will be installed in the spur joint closure extending from at least one port.

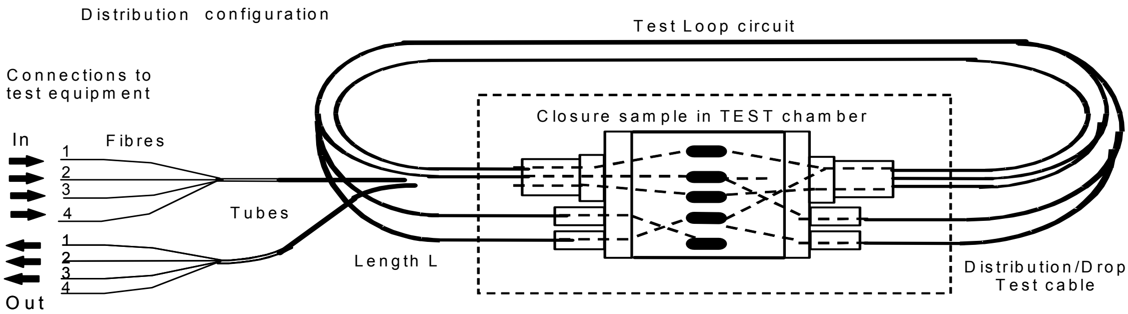


Figure 17 – Distribution joint configuration sample

Protected microduct cables should be sealed to the closure as stated in the track and spur closure test samples for the distribution joint closure (see Figure 17).

Active microduct drop cables will be installed in the distribution joint closure extending from at least four ports.

7.3 Test and measurement methods

All tests and measurements have been selected from EN 61300 series.

Unless otherwise stated in the individual test details, all attenuation measurements shall be performed at (1 310 ± 25) nm, (1 550 ± 25) nm and (1 625 ± 25) nm for the environmental optical tests, and at (1 550 ± 25) nm and (1 625 ± 25) nm for the mechanical optical tests.

All optical losses indicated are referenced to the initial attenuation at the start of the test. No deviation from the specified test method is allowed.

7.4 Test sequence

There is no defined sequence in which tests 6 – 23 must be run.

7.5 Pass/fail criteria

A product will have met the requirements of this specification provided no failures occur in any test.

In the event of a failure occurring on a sealing performance test sample, the test shall be re run using a sample size double that of the original.

Due to the complexity of the optical test samples, consecutive testing on the same optical sample is allowed. In case of a failure during testing, a new sample shall be prepared and the failed test shall be redone.

8 Test report

A fully documented test report and supporting data shall be prepared and must be available for inspection as evidence that the tests described in Clause 9 have been carried out in accordance with this specification.

Test the closure with fibre extremes: optical element based on the following options:

- 12 fibre unit (5 mm/3,5 mm to 8 mm/6,0 mm MD, minimum ID);
- 4 fibre unit (3 mm/2,1 mm and 4 mm/2,5 mm MD, minimum ID);
- microduct cable – filling 66 % of the bore (4 mm to 16 mm MD).

At least one of these options should be selected for any size of closure.

Blow a ball bearing through the test loop (see Figures 15, 16 or 17). The diameter of ball bearing should be between 10 % to 20 % below the MD nominal bore.

Optical testing should be performed during the temperature cycling and vibration test.

9 Performance requirements

9.1 Dimensional and marking requirements

Dimensions and marking of the product shall be in accordance with the requirements of Clause 6, and shall be measured using the appropriate EN test method.

9.2 Sealing, optical and appearance performance criteria

Table 10 – Tightness, optical and appearance performance criteria

No.	Test	Category	Requirement	Details	
1	Sealing performance after test	**S & A**	No emission of air bubbles indicating a leak	Method:	EN 61300-2-38:2006, Method A
				Test temperature:	(23 ± 3) °C
				Test pressure:	Internal overpressure (40 ± 2) kPa
				Immersion depth:	Just below surface of water
				Duration:	15 min
				Pre-conditioning procedure:	Sample should be conditioned to room temperature for at least 2 h.
2	Pressure loss during test	**S**	Difference in pressure before and after test shall be less than 2 kPa. Measurements taken at same atmospheric conditions	Method:	EN 61300-2-38:2006, Method B
				Test temperature:	As specified by individual test
				Test pressure:	Internal overpressure (40 ± 2) kPa at test temperature
				Pressure detector:	Minimum resolution 0,1 kPa
				Pre-conditioning procedure:	Sample should be conditioned to specified temperature at test pressure for at least 4 h.
3	Visual appearance	**S & A**	No defects which would affect functionality of the closure	Method:	EN 61300-3-1
				Examination:	Product shall be checked with naked eye.
4	Change in attenuation (NOTE 1, NOTE 2)	**S & A**	Excursion losses:	Method:	EN 61300-3-3:2003, Method 1
			δIL ≤ 0,2 dB at 1 310 nm and 1 550 nm per incoming fibre during test	Wavelengths:	(1 310 ± 25) nm (1 550 ± 25) nm (1 625 ± 25) nm
			δIL ≤ 0,5 dB at 1 625 nm per incoming fibre during test	Source stability:	Within ± 0,05 dB over the measuring period
			Residual losses:	Detector linearity:	Within ± 0,05 dB over the dynamic range to be measured
			δIL ≤ 0,1 dB at 1 310 nm, 1 550 nm and 1 625 nm per incoming fibre after test	Measurements required:	Before, during and after the test
				Sampling rate:	Every 10 min

Table 10 – Tightness, optical and appearance performance criteria *(continued)*

No.	Test	Category	Requirement	Details	
5	Transient loss (NOTE 1)	**S & A**	Transient losses: δIL ≤ 0,5 dB at 1 550 nm per active circuit during test δIL ≤ 1 dB at 1 625 nm per active circuit during test Residual losses: δIL ≤ 0,1 dB at 1 550 nm and 1 625 nm per active circuit after test	Method: Wavelengths: Source stability: Detector linearity: Measurements required: Active circuit:	EN 61300-3-28 (1 550 ± 25) nm (1 625 ± 25) nm Within ± 0,05 dB over the measuring period Within ± 0,05 dB over the dynamic range to be measured Before, during and after the test 10 incoming fibres in series
NOTE 1 All optical losses indicated are referenced to the initial attenuation at the start of the test. NOTE 2 An 'incoming fibre' is defined as a part of an optical circuit containing the fibre entering the product, and leaving the product. One optical circuit can contain many 'incoming f bres'. Light will sequentially flow through all 'incoming fibres'.					

9.3 Mechanical sealing performance requirements

Table 11 – Mechanical performance requirements

No.	Test	Category	Requirement	Details	
6	Vibration (sinusoidal)	**S**	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-1
				Frequency:	10 Hz
				Amplitude	3 mm
				Duration:	10 days
				Test temperature:	(23 ± 3) °C
				Test pressure:	Internal overpressure (40 ± 2) kPa
				Pre-conditioning procedure:	Sample should be conditioned to room temperature for at least 2 h.
		A	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-1
				Frequency range:	5 Hz – 500 Hz at 1 octave/min
				Amplitude / acceleration force:	3 mm or 1 g_n max.
				Cross-over frequency:	9 Hz
				Number of sweeps	10 sweeps (5 - 500 - 5)
				Number of axes:	3 mutually perpendicular
				Test temperature:	(23 ± 3) °C
				Test pressure:	Internal overpressure (0 ± 2) kPa
				Pre-conditioning procedure:	Sample should be conditioned to room temperature for at least 2 h.

Table 11 – Mechanical performance requirements *(continued)*

No.	Test	Category	Requirement	Details	
7	Cable retention	**S**	Sealing performance (test 1) Pressure loss (test 2) Visual appearance (test 3)	Method: Test temperatures: Load: Duration: Test pressure: Pre-conditioning procedure:	EN 61300-2-4 (-15 ± 2) °C and (+45 ± 2) °C ∅ Cable (mm)/45*1 000 N or 1 000 N max. 1 h per cable Internal overpressure (40 ± 2) kPa Sample should be conditioned to specified temperature for at least 4 h.
		A	Sealing performance (test 1) Visual appearance (test 3)	Method: Test temperatures: Load: Duration: Test pressure: Pre-conditioning procedure:	EN 61300-2-4 (-15 ± 2) °C and (+45 ± 2) °C ∅ Cable (mm)/45*1 000 N or 1 000 N max. 1 h per cable Internal overpressure (0 ± 2) kPa Sample should be conditioned to specified temperature for at least 4 h.
8	Cable bending	**S**	Tightness Sealing performance (test 1) Pressure loss (test 2) Visual appearance (test 3)	Method: Test temperatures: Force: Force application: Number of cycles: Test pressure: Pre-conditioning procedure:	EN 61300-2-37 (-15 ± 2) °C and (+45 ± 2) °C 30° or max. 500 N 400 mm from end of seal 5 cycles per cable Internal overpressure (40 ± 2) kPa Sample should be conditioned to specified temperature for at least 4 h.
		A	Tightness Sealing performance (test 1) Visual appearance (test 3)	Method: Test temperatures: Force: Force application: Number of cycles: Test pressure: Pre-conditioning procedure:	EN 61300-2-37 (-15 ± 2) °C and (+45 ± 2) °C 30° or max. 500 N 400 mm from end of seal 5 cycles per cable Internal overpressure (0 ± 2) kPa Sample should be conditioned to specified temperature for at least 4 h.

Table 11 – Mechanical performance requirements *(continued)*

No.	Test	Category	Requirement	Details	
9	Torsion/ Twist	**S**	Sealing performance (test 1) Pressure loss (test 2) Visual appearance (test 3)	Method:	EN 61300-2-5
				Test temperatures:	(-15 ± 2) °C and (+45 ± 2) °C
				Torque:	90° or max. 50 Nm
				Force application:	400 mm from end of seal
				Number of cycles:	5 cycles per cable
				Test pressure:	Internal overpressure (40 ± 2) kPa
				Pre-conditioning procedure:	Sample should be conditioned to specified temperature for at least 4 h.
		A	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-5
				Test temperatures:	(-15 ± 2) °C and (+45 ± 2) °C
				Torque:	90° or max. 50 Nm
				Force application:	400 mm from end of seal
				Number of cycles:	5 cycles per cable
				Test pressure:	Internal overpressure (0 ± 2) kPa
				Pre-conditioning procedure:	Sample should be conditioned to specified temperature for at least 4 h.
10	Impact (free fall)	**S & A**	Sealing performance (test 1)	Method:	EN 61300-2-12:2005, Method A
				Test temperatures:	(-15 ± 2) °C and (+45 ± 2) °C
				Severity:	Drop height 75 cm
				Number of drops:	1
				Test pressure:	Internal overpressure 0 kPa
				Pre-conditioning procedure:	Sample should be conditioned to specified temperature for at least 4 h.

Table 11 – Mechanical performance requirements *(continued)*

No.	Test	Category	Requirement	Details	
11	Impact	**S**	Sealing performance (test 1) Pressure loss (test 2) Visual appearance (test 3)	Method:	EN 61300-2-12:2005, Method B
				Test temperatures:	(-15 ± 2) °C and (+45 ± 2) °C
				Impact tool:	Steel ball of 1 kg
				Drop height:	2 m
				Impact locations:	0°, 90°, 180° and 270°
				Number of impacts:	1 per location
				Test pressure:	Internal overpressure (40 ± 2) kPa
				Pre-conditioning procedure:	Sample should be conditioned to specified temperature for at least 4 h.
		A	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-12:2005, Method B
				Test temperatures:	(-15 ± 2) °C and (+45 ± 2) °C
				Impact tool:	Steel ball of 1 kg
				Drop height:	1 m
				Impact locations:	0°, 90°, 180° and 270°
				Number of impacts:	1 per location
				Test pressure:	Internal overpressure (0 ± 2) kPa
				Pre-conditioning procedure:	Sample should be conditioned to specified temperature for at least 4 h.
12	Crush resistance	**S**	Sealing performance (test 1) Pressure loss (test 2) Visual appearance (test 3)	Method:	EN 61300-2-10
				Test temperatures:	(-15 ± 2) °C and (+45 ± 2) °C
				Load:	1 000 N
				Application area:	25 cm^2
				Locations:	Centre of closure at 0° and 90° around longitudinal axis of closure
				Duration:	10 min
				Test pressure:	Internal overpressure (40 ± 2) kPa
				Pre-conditioning procedure:	Sample should be conditioned to specified temperature for at least 4 h.
13	Re-entries	**S & A**	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-33
				Test temperature:	(+23 ± 3) °C
				Conditioning between each re-entry:	Ageing of minimum 1 temperature cycle as specified in test 14
				Number of re-entries:	10

9.4 Environmental sealing performance requirements

Table 12 – Environmental sealing performance requirements

No.	Test	Category	Requirement	Details	
14	Change of temperature	**S**	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-22
				Extreme temperatures:	(-30 ± 2) °C and (+60 ± 2) °C
				Dwell time:	4 h
				Rate of change	1 °C/min
				Number of cycles:	20
				Test pressure:	Internal overpressure regulated at (40 ± 2) kPa during test
		A	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-22
				Extreme temperatures:	(-40 ± 2) °C and (+65 ± 2) °C
				Dwell time:	4 h
				Rate of change	1 °C/min
				Number of cycles:	20
				Test pressure:	Internal overpressure (0 ± 2) kPa sealed at room temperature
15	Water immersion	**S**	No water ingress Visual appearance (test 3)	Method:	EN 61300-2-23:1997, Method 2
				Test temperatures:	(+23 ± 3) °C
				Water column height:	5 m or an equivalent external water pressure of 50 kPa
				Wetting agent:	None
				Duration:	7 days
				Test pressure:	0 kPa overpressure
16	Salt mist	**S & A**	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-26
				Test temperatures:	(+35 ± 2) °C
				Salt solution:	5 % NaCl (pH 6,5 – 7,2)
				Duration:	5 days
				Test pressure:	0 kPa overpressure
17	Resistance to solvents and contaminating fluids	**S**	Sealing performance (test 1) Visual appearance (test 3)	Method:	EN 61300-2-34
				Test temperatures:	(+23 ± 3) °C
				Submersion in:	HCl at pH 2 NaOH at pH 12 Kerosene (lamp oil) ISO 1998/I 1,005 Petroleum jelly Diesel fuel for cars EN 590
				Drying time at 70 °C:	None
				Duration:	5 days
				Test pressure:	Internal overpressure (40 ± 2) kPa

Table 12 – Environmental sealing performance requirements *(continued)*

No.	Test	Category	Requirement	Details	
18	Resistance to stress cracking solvents	**S**	Sealing performance (test 1) Visual appearance (test 3) No visible cracking allowed	Method:	EN 61300-2-34
				Test temperatures:	(+50 ± 2) °C
				Submersion in:	10 % detergent solution (Igepal)
				Drying time at 70 °C:	None
				Duration:	5 days
				Test pressure:	Internal overpressure (40 ± 2) kPa
18a	Resistance to shot gun blast	**A**	Sealing performance (test 1) Visual appearance (test 3) No damage to fibre management system	Method:	EN 60794-1-2:2003, Method E13
				Test sample:	It is allowed to use an external protection (example: cover) for this test.
				Test temperature:	(+23 ± 3) °C
				Distance:	20 m
				Calibre:	12/70
				Lead pellets:	Size number 5 (3 mm)
				Test pressure:	Internal overpressure 0 kPa

9.5 Mechanical optical performance requirements

Table 13 – Mechanical optical performance requirements

No.	Test	Category	Requirement	Details	
19	Vibration (sinusoidal)	**S & A**	Transient loss (test 5) Visual appearance (test 3)	Method: Test temperature: Frequency range: Amplitude / acceleration force: Cross-over frequency: Number of sweeps Number of axes: Optical circuit:	EN 61300-2-1 (+23 ± 3) °C (5 – 500) Hz at 1 octave/min 3 mm or 1 g_n max. 9 Hz 10 sweeps (5 - 500 - 5) 3 mutually perpendicular 10 live fibres placed in series
20	Cable bending	**S & A**	Transient loss (test 5) Visual appearance (test 3)	Method: Test temperatures: Force: Force application: Number of cycles: Optical circuit:	EN 61300-2-37 (+23 ± 3) °C 30° or max. 500 N 400 mm from end of seal 5 cycles per cable 10 live fibres in series
21	Torsion/ Twist	**S & A**	Transient loss (test 5) Visual appearance (test 3)	Method: Test temperature: Torque: Force application: Number of cycles: Optical circuit:	EN 61300-2-5 (+23 ± 3) °C 90° or max. 50 Nm 400 mm from end of seal 5 cycles per cable 10 live fibres in series
22	Intervention and reconfiguration	**S & A**	Transient loss (test 5) Visual appearance (test 3) See test sample preparation 7.2	Method: Test temperature: Operations: Optical circuit:	EN 61300-2-33 (+23 ± 3) °C All manipulations that will normally occur during an intervention after initial installation. These are typically: 1. moving closure to working location. Handling of cables attached to node; 2. open/close closure; 3. adding/installing drop cables. 10 live fibres placed in series

9.6 Environmental optical performance requirements

Table 14 – Environmental optical performance requirements

No.	Test	Category	Requirement	Details	
23	Change of temperature	**S**	Change in attenuation (test 4) Visual appearance (test 3)	Method:	EN 61300-2-22
				Low temperature:	(-30 ± 2) °C
				High temperature:	(+60 ± 2) °C
				Duration at temperature extreme:	4 h
				Rate of change of temperature:	1 °C/min
				Number of cycles:	20
				Measurements required:	Before, during (max. interval 10 min) and after the test
				Recovery procedure:	4 h at normal ambient conditions
				Test protected microduct length	At least 3 m per cable should be inside the test chamber (measured from the closure ports)
		A	Change in attenuation (test 4) Visual appearance (test 3)	Method:	EN 61300-2-22
				Low temperature:	(-40 ± 2) °C
				High temperature:	(+65 ± 2) °C
				Duration at temperature extreme:	4 h
				Rate of change of temperature:	1 °C/min
				Number of cycles:	20
				Measurements required:	Before, during (max. interval 10 min) and after the test
				Recovery procedure:	4 h at normal ambient conditions
				Test protected microduct length	At least 3 m per cable should be inside the test chamber (measured from the closure ports)

Annex A
(informative)

Fibre for test sample details

Table A.1 – Fibre references

Fibre type	**EN 60793-2-50 Type B1.1** **Dispersion unshifted single mode fibre**
Proof stress strain:	≥ 1 %
Mode field diameter at 1 310 nm:	(9,3 ± 0,7) µm
Mode field diameter at 1 550 nm:	(10,5 ± 1,0) µm
Cabled fibre cut off wavelength:	≤ 1 260 nm
1 550 nm loss performance:	< 0,5 dB for 100 turns on 60 mm mandrel diameter
Cladding diameter:	(125 ± 1) µm
Non coloured primary coating diameter:	(245 ± 10) µm
Coloured primary coating diameter:	(250 ± 15) µm

Annex B
(informative)

Sample size and product sourcing requirements

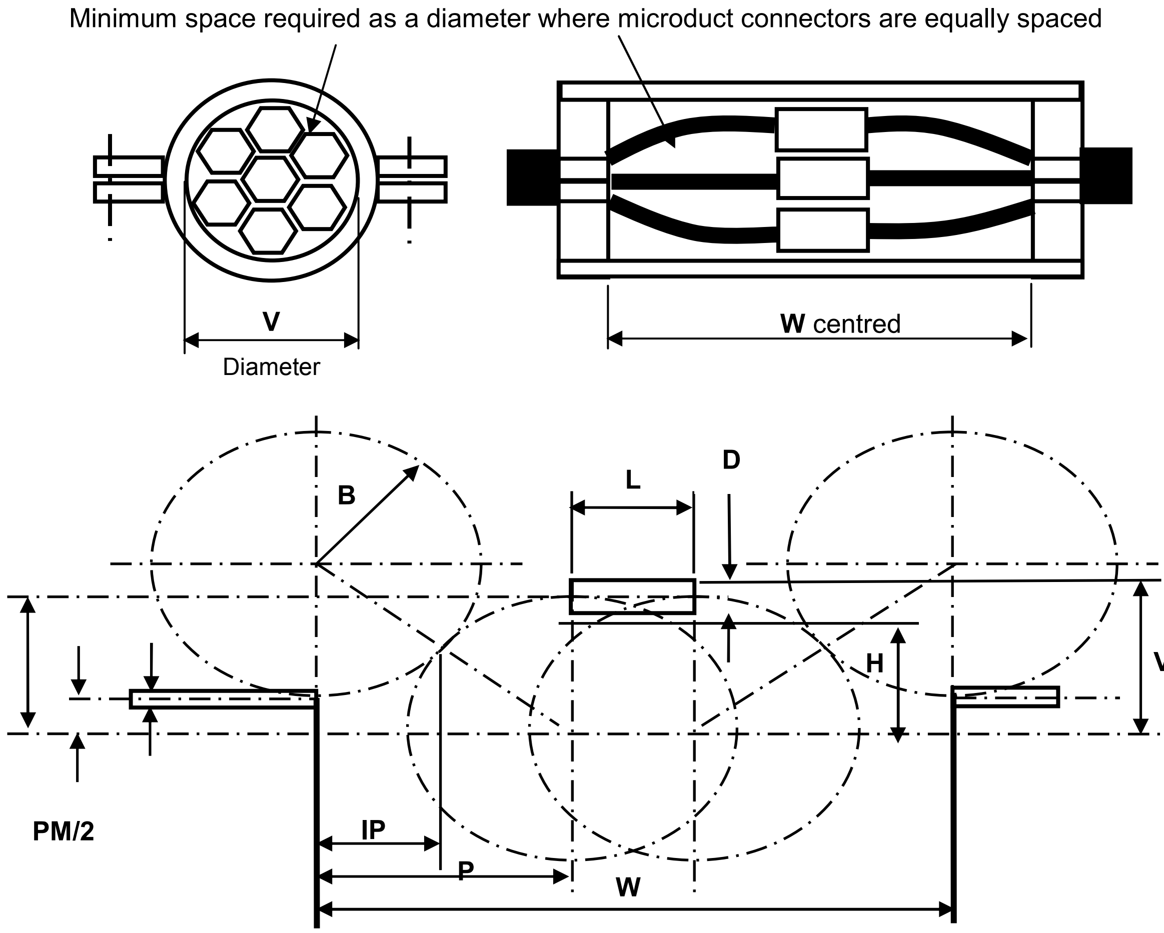
Table B.1 – Minimum sample size requirements

No.	Test	Sample size	
		Sealing performance	Optical
NA	Dimensional	3	NA
1	Sealing performance	Criterion	NA
2	Pressure loss during test	Criterion	NA
3	Visual appearance	Criterion	Criterion
4	Change in attenuation	NA	Criterion
5	Transient loss	NA	Criterion
6	Vibration (sinusoidal)	3	NA
7	Cable retention	3	NA
8	Cable bending	3	NA
9	Torsion/Twist	3	NA
10	Impact (free fall)	3	NA
11	Impact	3	NA
12	Crush resistance	3	NA
13	Re-entries	3	NA
14	Change of temperature	3	NA
15	Water immersion	3	NA
16	Salt mist	3	NA
17	Resistance to solvents and fluids	3	NA
18	Resistance to stress cracking solvents	3	NA
19	Vibration (sinusoidal) (optical)	NA	1
20	Cable bending (optical)	NA	1
21	Torsion/Twist (optical)	NA	1
22	Intervention and reconfiguration (optical)	NA	1
23	Change of temperature (optical)	NA	1
Key NA = Not Applicable.			

Tests 1 to 5 are performance criteria tests that need to be performed during other mechanical or environmental tests (6 to 23).

Annex C
(informative)

Closure minimum internal diameters, containing microduct connectors



Key

W =	Space required inside the ABF closure – Minimum	P =	Microduct path minimum length to the connector
D =	Connector outside envelope/diameter	B =	Bend radii – Minimum
L =	Connector length	IP =	Intersection point between minimum bend radii
M =	Microduct diameter	PM =	Protected microduct outside
V or Y =	Connector bundle diameter (whichever is the larger)	H =	Bend height – Centres lines of the offset microducts

Dimensions D, L, M and L found in Tables 2 to 7

Dimensions B found in 9.1 (storage 12 x M)

Dimensions V found in Tables C.2 to C.8 (suppliers information)

Formula to calculate W Dimension:

$$W = 2P + L$$

$$P = IP \times 2$$

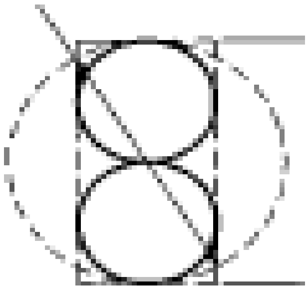
$$IP = \sqrt{B^2 - [B - (H/2)]^2}$$

$$H = \frac{(V - D) - (PM - M)}{2}$$

Figure C.1 – Schematic – Minimum microduct and connector space profile

Table C.1 – Typical ABF closure minimum internal diameters, containing 2 blown fibre microduct connectors

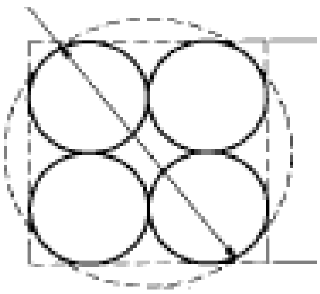
V diameter



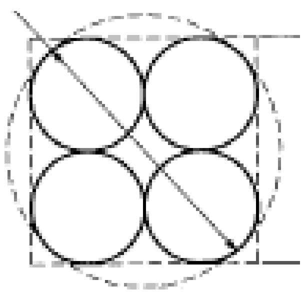
Microduct outside diameter M mm	**The maximum theoretical space required** mm (with 2 microduct connector bundle)
	Diameter V mm
3	18
4	28
5	31
7	35
8	40
10	48
12	50
14	55
15	66
16	64

Table C.2 – Typical ABF closure minimum internal diameters, containing 4 blown fibre microduct connectors

V diameter



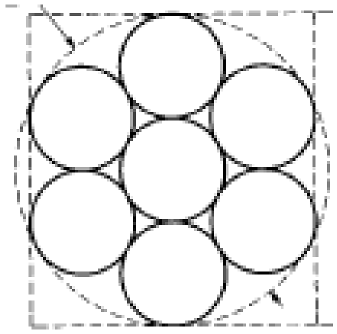
V diameter



Microduct outside diameter M mm	**The maximum theoretical space required** mm (with 4 microduct connector bundle)
	Diameter V mm
3	22
4	34
5	36
6	
7	42
8	48
10	58
12	60
14	70
15	80
16	77

Table C.3 – Typical ABF closure minimum internal diameters, containing 7 blown fibre microduct connectors

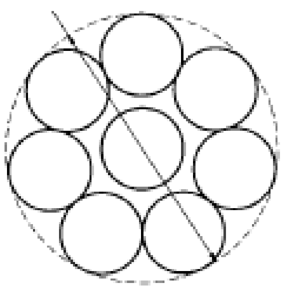
V diameter

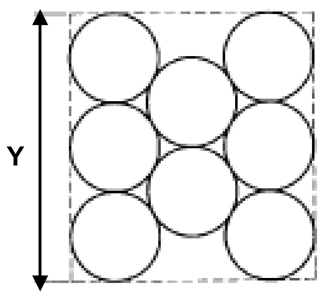


<table>
<tr><th rowspan="2">Microduct outside diameter M
mm</th><th>The maximum theoretical space required
mm
(with 7 microduct connector bundle)</th></tr>
<tr><th>Diameter V
mm</th></tr>
<tr><td>3</td><td>7</td></tr>
<tr><td>4</td><td>42</td></tr>
<tr><td>5</td><td rowspan="2">45</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td><td>52</td></tr>
<tr><td>8</td><td>60</td></tr>
<tr><td>10</td><td>72</td></tr>
<tr><td>12</td><td>75</td></tr>
<tr><td>14</td><td>88</td></tr>
<tr><td>15</td><td>99</td></tr>
<tr><td>16</td><td>96</td></tr>
</table>

Table C.4 – Typical ABF closure minimum internal diameters, containing 8 blown fibre microduct connectors

V diameter

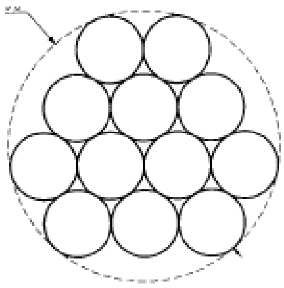




<table>
<tr><th rowspan="2">Microduct outside diameter M
mm</th><th colspan="2">The maximum theoretical space required
mm
(with 8 microduct connector bundle)</th></tr>
<tr><th>Circular shape
V</th><th>Square shape
Y</th></tr>
<tr><td>3</td><td>30</td><td>27</td></tr>
<tr><td>4</td><td>46</td><td>42</td></tr>
<tr><td>5</td><td rowspan="2">50</td><td rowspan="2">45</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td><td>57</td><td>52</td></tr>
<tr><td>8</td><td>66</td><td>60</td></tr>
<tr><td>10</td><td>79</td><td>72</td></tr>
<tr><td>12</td><td>83</td><td>75</td></tr>
<tr><td>14</td><td>96</td><td>88</td></tr>
<tr><td>15</td><td>109</td><td>99</td></tr>
<tr><td>16</td><td>105</td><td>96</td></tr>
</table>

Table C.5 – Typical ABF closure minimum internal diameters, containing 9 blown fibre microduct connectors

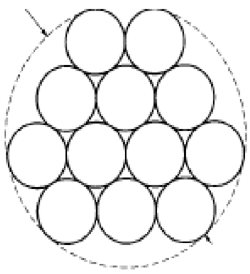
Y



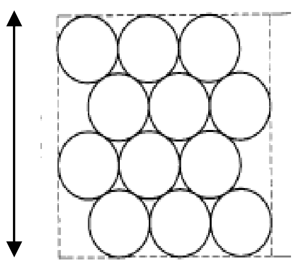
Microduct outside diameter M mm	**The maximum theoretical space required** mm (9 microduct connector bundle)	
	Circular shape V	**Square shape Y**
3	35	27
4	54	42
5	57	46
6		
7	69	62
8	80	76
10	92	72
12	96	75
14	111	87
15	126	99
16	122	96

Table C.6 – Typical ABF closure minimum internal diameters, containing 12 blown fibre microduct connectors

V diameter

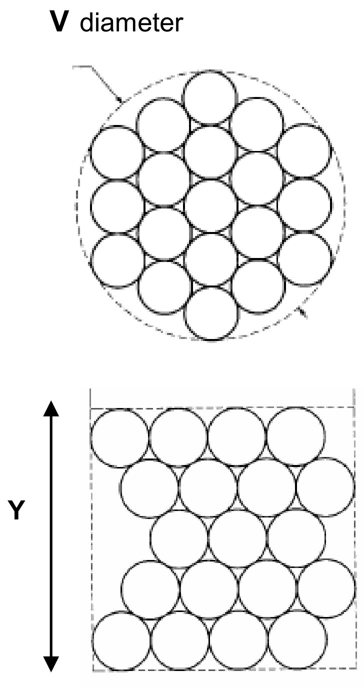


Y



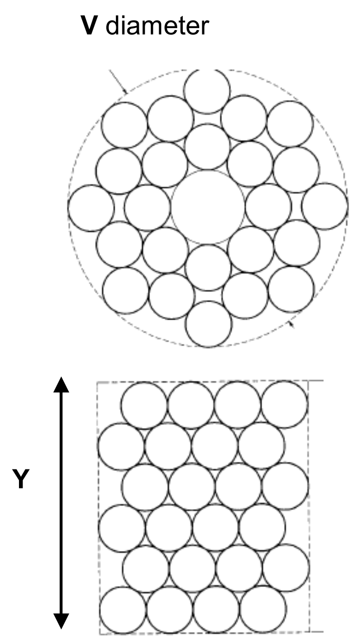
Microduct outside diameter M mm	**The maximum theoretical space required** mm (12 microduct connector bundle)	
	Circular shape V	**Square shape Y**
3	37	37
4	57	50
5	61	54
6		
7	71	63
8	81	72
10	97	86
12	101	90
14	117	104
15	134	119
16	129	115

Table C.7 – Typical ABF closure minimum internal diameters, containing 19 blown fibre microduct connectors



Microduct outside diameter M mm	The maximum theoretical space required mm (19 microduct connector bundle)	
	Circular shape V	**Square shape Y**
3	45	41
4	70	63
5	75	66
6		
7	96	84
8	100	90
10	120	108
12	125	113
15	165	149
16	160	144

Table C.8 – Typical ABF closure minimum internal diameters, containing 24 blown fibre microduct connectors



Microduct outside diameter M mm	The maximum theoretical space required mm (24 microduct connector bundle)	
	Circular shape V	**Square shape Y**
3	54	48
4	85	75
5	91	50
6		
7	106	79
8	121	107
10	145	128
12	151	133
14	175	155
15	199	176
16	194	171

Annex D
(informative)

Typical buried blown fibre microduct cable outside diameters

Table D.1 – Number of microducts per protected microduct – Direct bury

Microduct outside diameter mm	**Number of microducts per protected microduct (direct bury)**						
	Protected microduct – Maximum – Nominal outside diameter mm						
	1	2	4	7	12	19	24
3 mm	10,2	13,2	14,4	16,2	19,4	21,8	25,2
4 mm	11,2	15,2	16,9	19,2	23,5	27,3	31,8
5 mm	10,5	16,6	22,3	23,5	29,5	33,8	39,1
6 mm	6,2						
7 mm	7,2	14,2	25,3	30,5	38,0		53,9
8 mm	15,2	23,2	27,1	31,8	40,4	47,8	56,2
10 mm	18,5	27,2	31,9	37,8	49,5	57,5	NA
12 mm	19,1	31,1	37,5	44,6	57,4	70	NA
14 mm	22,9		40,0				

Table D.2 – Number of microducts per protected microduct – Direct bury reinforced

Microduct outside diameter mm	**Number of microducts per protected microduct (direct bury reinforced)**						
	Protected microduct – Maximum – Nominal outside diameter mm						
	1	2	4	7	12	19	24
3 mm	11,2		16,0	18,0	21,2	23,6	27,0
4 mm	12,4		18,1	20,4	25,2	29,0	33,5
5 mm	14		21,1	24,0	29,9		39,5
7 mm	14,2	16,6	27,9	33,2	40,8	46,0	55,7
8 mm	15,2		28,3	33,5	42,1	49,5	57,9
10 mm			33,6	39,5	51,2		
12 mm			38,5	45,5	59,1		
14 mm	24,2						

NOTE 1 Outside diameter information in Table D.1 is used to calculate dimension W in Annex C (closure capacity).

NOTE 2 For duct-installed protected microduct applications, the protected microduct is within these sizes in Table D.1.

Annex E
(informative)

Microduct connector definitions and sketches

E.1 Straight microduct connectors

Microduct connectors are used to connect two microducts together. This connector has a means of microduct attachment and sealing on both sides and is typically unsupported (floating inside the closure).

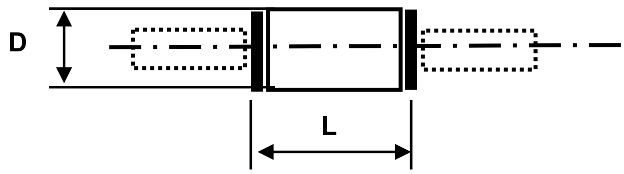


Figure E.1 – Straight microduct connectors

E.2 Straight bulkhead microduct connectors

Microduct connectors are used to connect two microducts together. This connector has a means of microduct attachment and sealing on both sides and is typically supported on a bulkhead attached by a suitable fixing system (i.e., nut or clip)

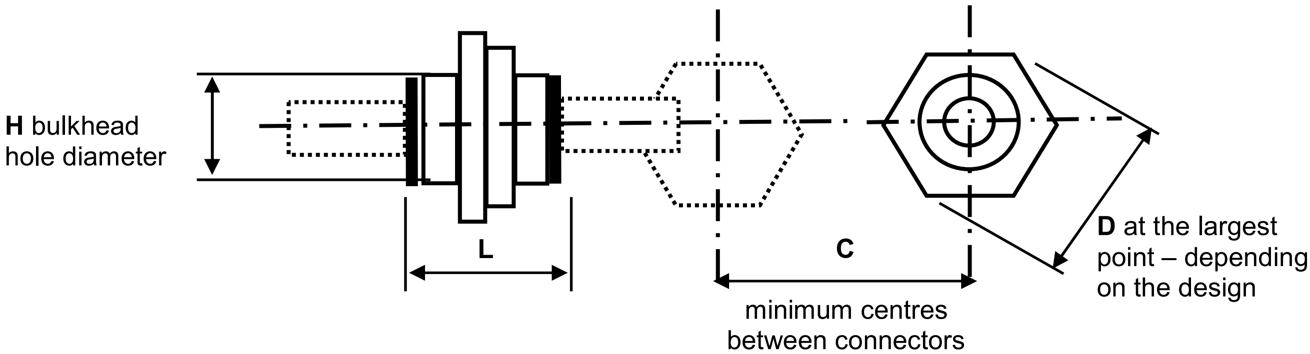


Figure E.2 – Straight bulkhead microduct connectors

E.3 ID/OD/ID and OD reducer/enlarger stem microduct connectors

A stem connector which connects two microducts with the same OD but different ID, including a smooth internal transition to prevent fibre 'hang ups', typically they have microduct attachment and sealing at one end of the connector, and a 'stem' on the other end to facilitate attachment to a 'straight connector'

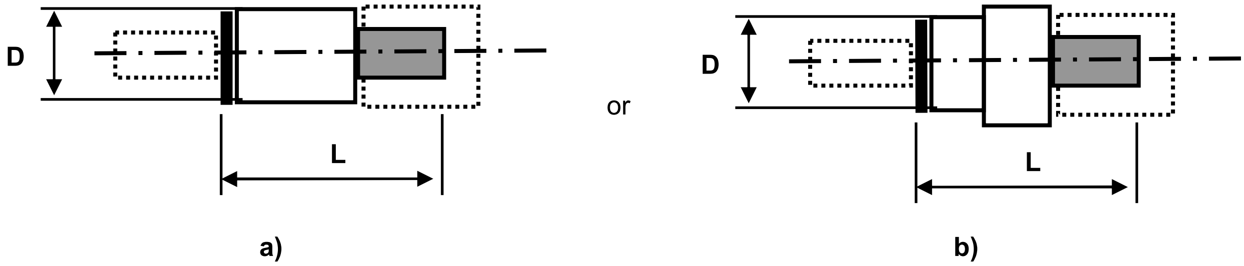


Figure E.3 – ID/OD/ID and OD reducer/enlarger stem microduct connectors

E.4 'ID/OD/ID and OD reducer/enlarger' microduct connectors

A connector which connects two microducts with the same OD but different ID, including a smooth internal transition to prevent fibre 'hang ups' typically they are to connect a heavy walled to a thinner wall MD.

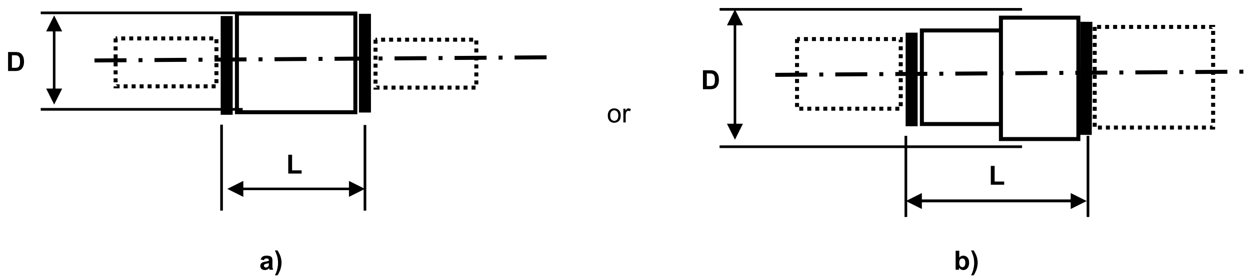


Figure E.4 – 'ID/OD/ID and OD reducer/enlarger' microduct connectors

E.5 Close down microduct connectors

Microduct connectors that are used for fibre access for blowing head equipment for cascade blowing, allowing a microduct to be opened and resealed after blowing, without detriment to the fibre in situ.

Flexible, slide-able and detachable central tube member

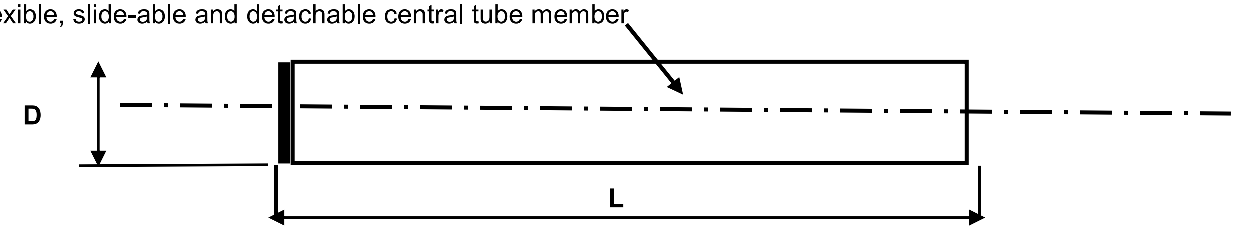


Figure E.5 – Close down microduct connectors

E.6 Liquid block microduct connectors

Microduct connectors that are used at a transition point to stop liquids from flowing between the connected microducts to avoid; liquid and contaminant ingress and, liquid damage to other equipment.

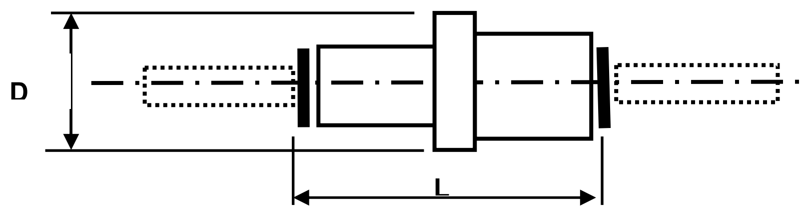


Figure E.6 – Liquid block microduct connectors

E.7 Liquid block with a barb end

Similar to a liquid block connector, however it may not necessarily meet the requirements of this specification, at the barb end. The barb end is designed to interface with the non-microduct (transport tubing), which protects the fibre at a "fibre management system" closure.

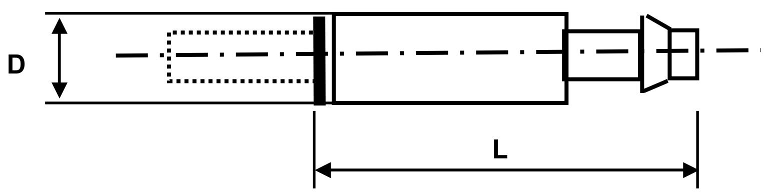


Figure E.7 – Liquid block with a barb end

E.8 End stop microduct connectors

Microduct connectors that are used for sealing open ended microduct, avoiding air leakage, water or foreign material ingress and safety reasons.

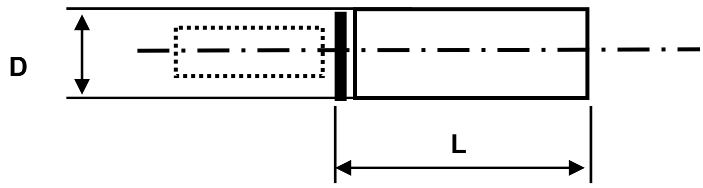


Figure E.8 – End stop microduct connectors

Annex F
(informative)

Microduct minimum bend radius

F.1 Object

This annex sets out to provide a practical recommendation for the minimum bend radius for various nominal microduct diameters.

F.2 Factors that can affect the minimum bend radius

Microducts with fitted connectors can be installed into closures at various bend radii. The following factors can affect the minimum recommended bend radius, reducing microduct kinking, and resistance to blowing:

- microduct internal diameter size (resistance to fibre and air flow);
- microduct internal surface coefficient of friction (bore material selection);
- microduct material rigidity, (wall thickness and low temperature);
- blowing equipment (pressure and airflow settings);
- microduct supplied condition (ovality, eccentricity and sizing tolerance control);
- interface between the connector internal geometry, and the fitted microducts;
- fibre unit coating material and unit number of fibres (4 or 12 fibres).

F.3 Industry guidelines on the minimum 'Protected microduct' bend radius

Experience of installation company's air blowing optical fibre through microducts has resulted in these companies setting practical guidelines for the minimum microduct radius during the blowing process. Many companies use their own differing standards. The following table provides a compilation of these company standards, to arrive at an industry standard.

Table F.1 – Compilation of company standards, to arrive to an industry standard

Microduct nominal outside diameter mm	**Cable type**	**Protected microducts bend radius – Minimum** mm (based on the number of microducts in the protected microduct)						
		1	2	4	7	12	19	24
3 mm	Outdoor only	150	150	200	230	270	330	375
5 mm		190	190	300	380	430	550	650
8 mm		230	230	400	540	700	900	1 000
10 mm		100	300	300	400			
12 mm								

NOTE 1 Outdoor protected microduct cable tends to be the larger direct buried cable with a thicker sheath sometimes re-enforced, and the indoor protected microduct cable is the ducted cable. With a thinner sheathed.

NOTE 2 Table F.1 assumes a typical blowing pressure of 10 bars.

NOTE 3 A 12 fibre unit has a minimum bend radius of 80 mm.

Bibliography

EN 60529 Degrees of protection provided by enclosures (IP Code) (IEC 60529)

EN 60793-2-50 Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres (IEC 60793-2-50)

EN 61756-1 Fibre optic interconnecting devices and passive components – Interface standard for fibre management systems – Part 1: General and guidance (IEC 61756-1)

EN 61758-1 Fibre optic interconnecting devices and passive components – Interface standard for closures – Part 1: General and guidance (IEC 61758-1)

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