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TIA/EIA STANDARD

FOCIS 10

Fiber Optic Connector Intermateability Standard – Type LC

TIA/EIA-604-10A

(Revision of TIA/EIA-604-10)

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Representing the telecommunications industry in
association with the Electronic Industries Alliance

TIA/EIA-604-10A

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Fiber Optic Connector Intermateability Standard - Type LC

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FOCIS 10A
FIBER OPTIC CONNECTOR INTERMATEABILITY STANDARD
TYPE LC

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FOCIS 10A

FIBER OPTIC CONNECTOR INTERMATEABILITY STANDARD

1 Introduction

1.1 Scope

FOCIS 10A presents the intermateability standard for simplex and duplex connectors with the commercial designation LC, and is issued as an addendum to TIA/EIA 604, *Fiber Optic Connector Intermateability Standards*. The provisions of TIA/EIA 604 apply to this document.

1.2 Objective

Intermateability standards define the minimum physical attributes of mating connector components. Fully dimensioned components are not within the scope or intent of FOCIS 10A.

The requirements in FOCIS 10A have been selected with the objective of ensuring that any combination of plugs and adapters conforming to the requirements of FOCIS 10A will mechanically intermate, and that intermated connector assemblies will meet a common level of performance.

The common level of performance of an intermated connector assembly is the least demanding set of performance requirements in the separate performance specifications of each of the products in the assembly; see TIA/EIA 604.

1.3 Limitations

Realization of the objectives for FOCIS 10A may be limited by the following considerations:

1.3.1 Configuration Options

There are configuration options for both plugs and adapters in FOCIS 10A that impose limitations on the combinations of plugs and adapters that should be selected in a connector assembly.

- For plugs to be inserted in the adapter, the key option, k , for both plugs must be compatible with the keying option of the adapter
- Both plugs should have the same ferrule diameter option, t . An assembly with different diameter options may have a higher loss than anticipated.
- Both plugs should have the same angle of contact option, a . An increase in loss may be expected if the plugs with different options are mated, and the polish on the ferrule may be damaged.

1.3.2 Common performance

The following considerations limit the application of common performance:

- The location of the optical cores, figure 3.2.3a, and the apex offsets, clause 3.2.5, are defined, without tolerances, by their true positions. To achieve common performance, the distributions of the actual positions of these features should be centered on their respective true positions.
- Tuning of the connector plugs may improve performance when plugs are mated with plugs that have been similarly tuned. Tuning, however, offsets the cores relative to the center of the ferrule and common performance can not be expected between tuned plugs and untuned plugs. Tuned plugs are assembled so the offset of the fiber falls in a preferred location with respect to the key; see clause 3.2.8. As an alternative to tuning for fiber offset, plugs could be tuned for apex offset.
- This standard does not control the intrinsic loss that may occur between fibers in a connector assembly. Intrinsic loss between fibers must be added to the basic connector loss.

1.3.3 Resolution

Cases of combinations of plugs and adapters where mechanical intermateability or the common level of performance is not achieved should be resolved through the cooperation of the user and the connector and adapter manufacturer(s).

1.4 Drawing practices

To be in compliance with ANSI and ISO Engineering Practices, the following shall apply:

1. Where the tolerance of form is not specified, the limits of the dimensions for a feature control the form as well as the size. The combined effects of size and form variations may not exceed the envelope of perfect form at the maximum material condition (MMC).
2. Where interrelated features of size (features shown with a common axis or center plane) have no geometric tolerance of location or runout specified, the limits of the dimensions for a feature control the location tolerance as well as the size. When interrelated features are at the MMC, they shall be perfectly located relative to each other as indicated by the drawing.
3. Where perpendicular features (features shown at right angles) have no geometric tolerance of orientation or runout specified, the limits of the dimensions for a feature control the orientation tolerance as well as the size. When perpendicular features are at the MMC, they shall be perfectly oriented to each other as indicated by the drawing.
4. As the size of a feature departs from the MMC, variations in form, location and orientation are permissible.

2 Adapter Standard

2.1 Adapter designation

The designation for FOCIS 10A adapter is

FOCIS 10A-A-n-k-m

where

A	designates an adapter
n	is the number of fibers
k	defines the keying configuration
m	defines the mounting configuration

2.2 Adapter requirements

FOCIS 10A adapters shall meet the requirements of this section.

2.2.1 Adapter interface dimensions

The dimensional requirements for FOCIS 10A adapters are defined as follows:

- $n = 1$ Figure 2.2.1a, Simplex adapter interface and Figure 2.2.1b Simplex junior adapter interface
- $n = 2$ Figure 2.2.1c, Duplex adapter interface

2.2.2 Adapter sleeves

The adapter sleeve is a split (resilient), and the sleeve may be either fixed or floating within the adapter. The minimum inside diameter of the sleeve is specified by the force required to remove a gage pin from a sleeve. The force required to remove a gage pin from the sleeve in FOCIS 10A adapter shall be 1.0 N to 2.5 N. The procedures of FOTP 158 shall be used to measure the withdrawal force. The pin gauge shall be as defined in Figure 2.2.2

The maximum inside diameter of a sleeve is in effect limited by the common level of performance that the adapter is to achieve.

2.2.3 Adapter keying options

Keying refers to differences in the interface between FOCIS 10A plugs and adapters that affect the ability of plugs and adapters to be connected or that alter the performance of the resulting connector assembly.

The keying interfaces have been defined:

$k = 1$ Figure 2.2.1a, Senior Adapter Half

$k = 2$ Figure 2.2.1b. Junior Adapter Half

Adapters can be made with either, $k = 1$ and $k = 1$ adapter halves or $k = 1$ and $k = 2$ adapter halves. Adapters with $k = 1$ and $k = 2$ is mounted so the $k = 2$ half is mounted behind the panel protected from mechanical elements. Adapter with $k = 2 / k = 2$ option is not recognized as FOCIS 10A compliant.

2.2.4 Adapter mounting options

The adapter mounting options are defined in Table 2.

Table 2 - Adapter options

Adapter Mounting Option	Type of mounting
$m = 0$	Unspecified mounting
$m = 1$	Simplex Snap-in Flange Mounting
$m = 2$	Duplex Snap-in Flange Mounting
$m = 3$	Duplex Snap-in Flange Mounting compatible with FOCIS 3A $m = 3$
$m = 4$	Duplex Snap-in Flange Mounting compatible with FOCIS 3A $m = 1$ and $m = 2$

Adapters whose mounting features are not defined are identified with the option $m = 0$.

The dimensions of the surfaces of the adapter that interface with the mounting panel are defined by the cutouts in the panel on which the adapter is mounted.

FOCIS 10A adapters for $m = 1$, $m = 2$, $m = 3$, and $m = 4$ shall be capable of being mounted on panels with the dimensions in Figure 2.2.4.

3 Plug standard

3.1 Plug designation

The complete designation for FOCIS 10A connector plug is:

FOCIS 10A P-d-n-k-t-a

where

P	designates a plug
d	defines the plug design
n	is the number of fibers
k	defines the keying arrangement
t	defines the ferrule diameter
a	is the angle of contact

3.2 Plug requirements

FOCIS 10A plugs shall meet the requirements of this section.

3.2.1 Plug interface option

There are three plug interface option for FOCIS 10A plugs. The requirement for each of these interface options are:

- $d = 0$ The design requirement on the elements of the plug that control the interface with the adapter, for plugs offered under this option, is that the plugs function with all adapters that meet the requirements for FOCIS 10A adapters.
- $d = 1$ The elements of the plug that control the interface with the adapter, for plugs offered under this option, must meet the dimensional requirements of figure 3.2.3a Simplex plug interface ($d=1$).
- $d = 2$ The elements of the plug that control the interface with the adapter, for plugs offered under this option, must meet the dimensional requirements of figure 3.2.3b, Duplex plug interface ($d=2$).

3.2.2 Ferrule diameter option

Ferrule diameters for FOCIS 10A plugs are specified in Table 3.

Table 3 - Ferrule diameter

t	Minimum (mm)	Maximum (mm)	Fiber
1	1.2483	1.2495	Singlemode
2	1.2485	1.2495	Singlemode
3	1.2467	1.2495	Multimode

The ferrule tolerance $t = 1$ and $t = 2$ is typically applied to plugs with singlemode fiber.
The ferrule tolerance $t = 3$ is typically applied to plugs with multimode fiber.

3.2.3 Number of fibers option

Plugs with option $n = 1$ Figure 3.2.3a designates a simplex fiber plug.
Plugs with option $n = 2$ Figure 3.2.3b designates a duplex fiber plug.

3.2.4 Plug keying option

Plugs with option $k = 1$, designates a floating fiber plug with a spring.
Plugs with option $k = 2$, designates a fixed fiber plug without a spring.

Plugs with option $k = 1$ can be mated in adapters with either $k = 1$ or the $k = 2$ option.
Plugs with option $k = 2$ can only be mated in adapter option $k = 2$.

The dimensional requirements for these options are defined in 3.2.3a and 3.2.3b.

3.2.5 Angle of contact option

Contact angle α is the angle that the plane of contact makes to a plane perpendicular to the axis of the ferrule. The plane of contact is defined as plane A-A in Figure 3.2.5

$a = 0$, designates an angle of 0°
 $a = 8$, designates an angle of 8°

Requirements:

For $a = 0$, and $a = 8$:

The True Position for the apex is at the center of the ferrule as projected on the plane of contact in Figure 3.2.5 ($\mathcal{E} = 0$) See Clause 1.3.2.

For $a = 8$:

The orientation between the key and the plane of contact to be shown in Figure 3.2.5.

3.2.6 Ferrule extension and contact force

The travel of the ferrule relative to the body of the plug and spring force on the ferrule is defined in Figure 3.2.6. For plugs with the $k = 2$ option, only the ferrule extension shall apply as referenced on Figure 3.2.6.

3.2.7 Ferrule geometry

The geometry of the end of the ferrule for option $a = 0$ is defined in Figure 3.2.7. For option $a = 8$, the geometry of the end of the ferrule is defined in Figure 3.2.5

3.2.8 Plug tuning

It is not required that plugs be tuned; however, if a plug is tuned, the orientation of the eccentricity of the core is to be located as shown in Figure 3.2.8. Tuning of the plug is the preferential angular positioning of the ferrule relative to the key of the plug.

4 Application

The FOCIS 10A adapter requirements may be extended to hybrid adapters and receptacles.

4.1 Hybrid adapters

A hybrid adapter provides an optical connection between plugs of two different types.

A hybrid adapter between a FOCIS 10A connector and another connector would have the dimensions of Figure 2.2.1a or 2.2.1b and if a hybrid duplex Figure 2.2.1c on one side of the centerline or optical plane and the corresponding dimensions of the other type on the other side.

4.2 Receptacle designation

The designation for FOCIS 10A receptacle is

FOCIS 10A R-n-k-t

where

R	designates an receptacle
n	is the number of fibers
t	defines the sleeve diameter

4.2.1 Receptacle requirements

The dimensional requirements for FOCIS 10A receptacles are defined as follows:

$n = 1$ Figure 4.2a Simplex active device receptacle interface

$n = 2$ Figure 4.2b, Duplex active device receptacle interface

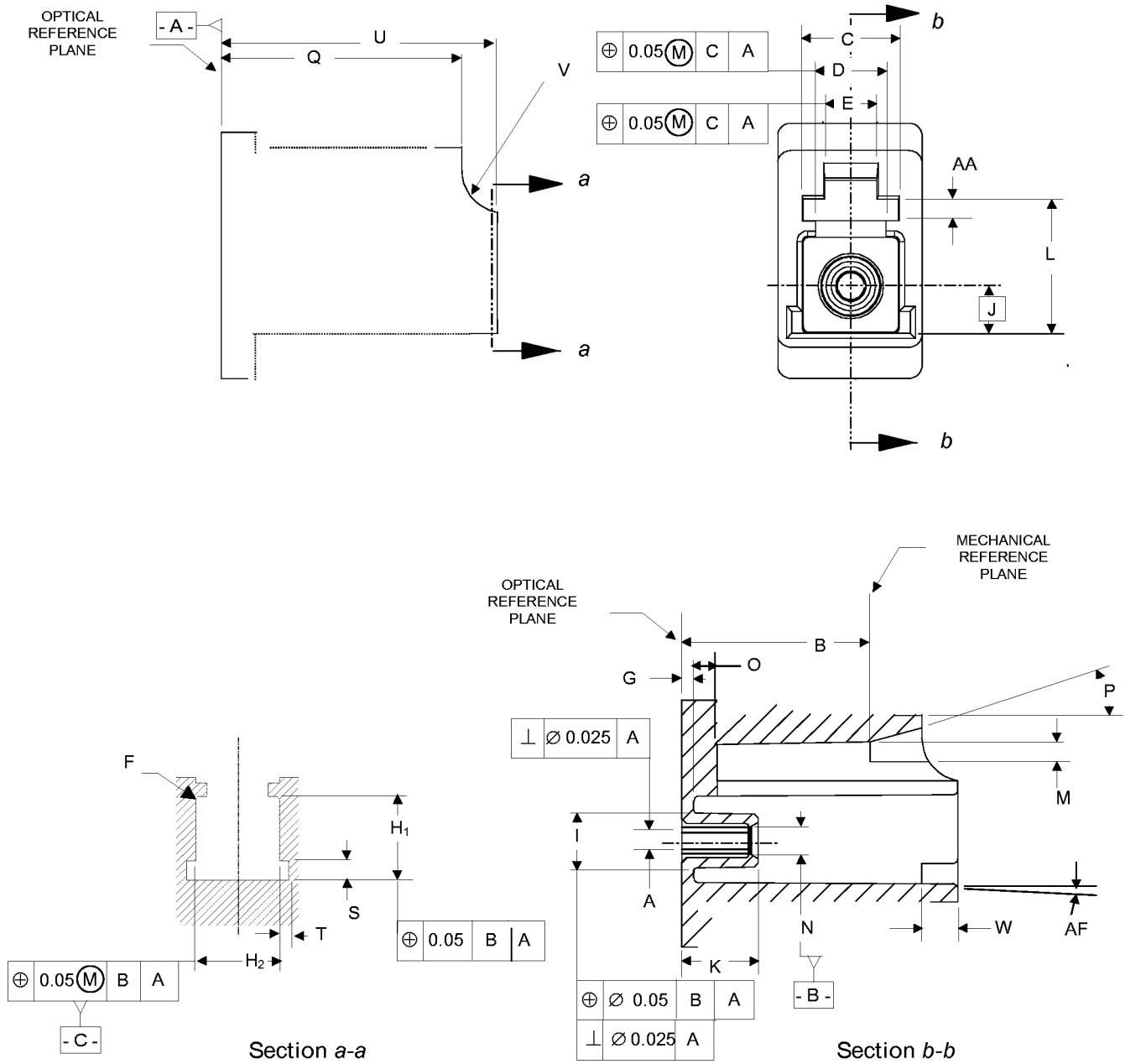
4.2.2. Receptacle Sleeves

The receptacle sleeve may be either solid or split resilient, and the sleeve, either split or solid, may be either fixed or floating

If the sleeve is solid the inside diameter is given in Figure 4.2. If the sleeve is split resilient the inside diameter is given by the requirements of Section 2.2.2

5 Polarization Maintenance

The standard for maintaining polarization through a FOCIS 10A connector, when the connector is to be mounted on either polarization maintaining (PM) or polarizing (PZ) fiber, is to align the plug key with the slow axis of the fiber as illustrated in Figure 5.

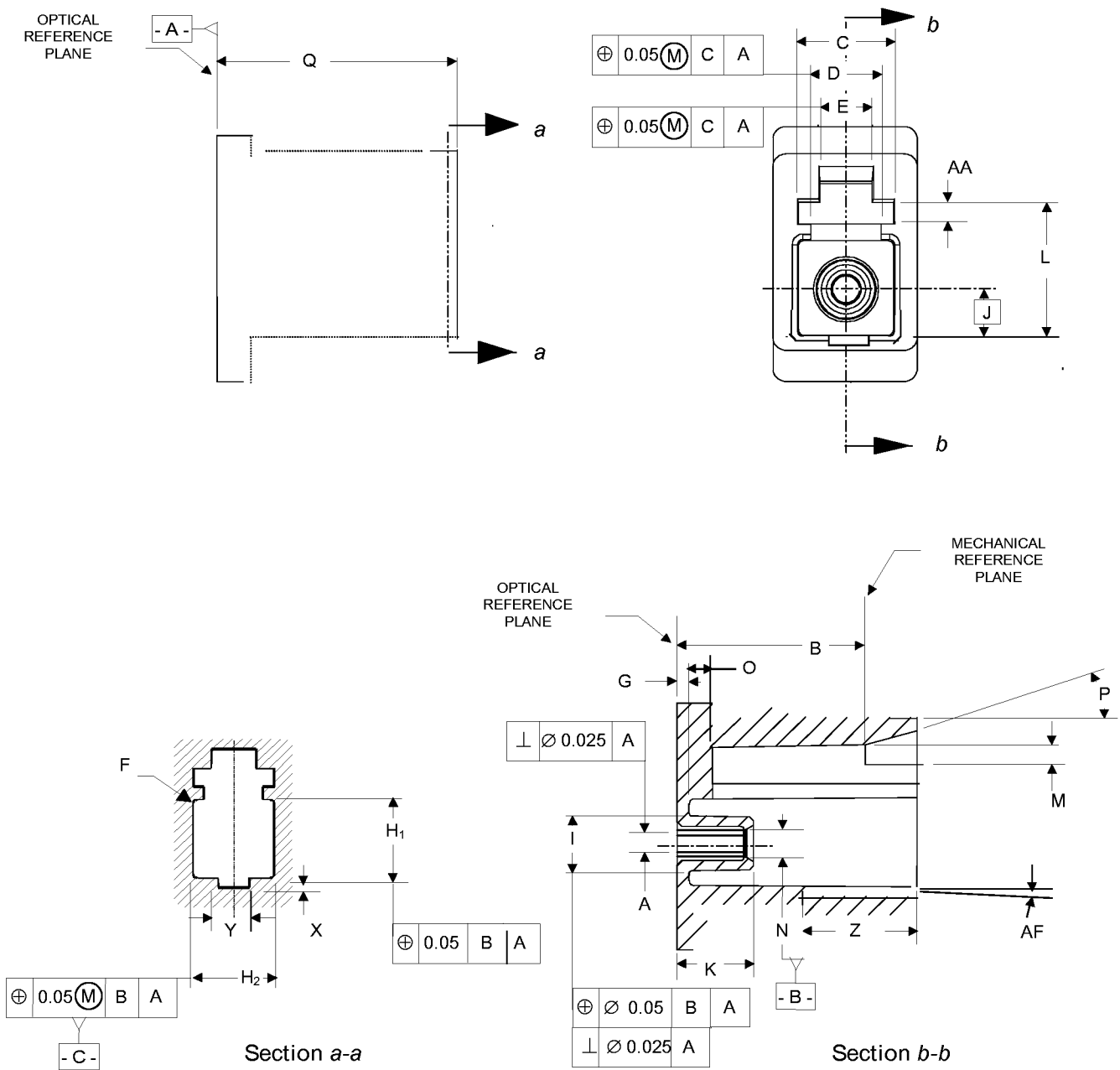
Figure 2.2.1a - Simplex senior adapter interface for $k = 1$ (Sheet 1)

Dim.	Min. (mm)	Max. (mm)	Notes
A	-	-	1,2
B	9.9	10.0	
C	4.5	-	
D	3.4	3.5	
E	2.6	2.7	
F	0.2	0.3	radius
G	0.6	0.7	
H ₁	4.60	4.75	
H ₂	4.60	4.75	
I	2.87	2.97	diameter
J	2.29		Basic Dimension
K	4.0	4.1	
L	6.6	6.8	
M	1.0	1.1	
N	1.4	1.5	diameter
O	-	1.2	
P	15		degrees, typical
Q	11.1	12.8	
R	-	-	Call-out not used
S	1.0	1.1	
T	0.5	0.6	
U	14.5	14.7	
V	2.2	2.4	radius
W	1.9	-	
X	-	-	Call-out not used
Y	-	-	Call-out not used
Z	-	-	Call-out not used
AA	1.1	1.2	
AF	-	0.2	degrees, 3

Notes:

1. See section 2.2.2 for specifications of the I.D. of the adapter sleeve.
2. A gage pin inserted in the sleeve must be capable of moving freely into a position such that it is coincident with datum *B*.
3. Taper dimension AF is applied to the surfaces associated with dimension/feature H₁ and H₂

Figure 2.2.1a - Simplex senior adapter interface for $k = 1$ (Sheet 2)

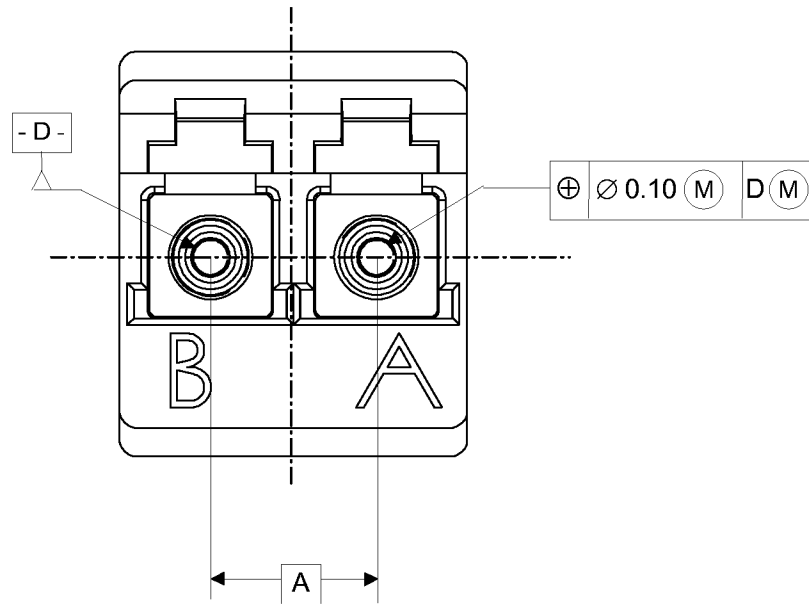
Figure 2.2.1b - Simplex junior adapter interface for $k = 2$ (Sheet 1)

Dim.	Min. (mm)	Max. (mm)	Notes
A	-	-	1,2
B	9.9	10.0	
C	4.5	-	
D	3.4	3.5	
E	2.6	2.7	
F	0.2	0.3	radius
G	0.6	0.7	
H ₁	4.60	4.75	
H ₂	4.60	4.75	
I	2.87	2.97	diameter
J	2.29		Basic Dimension
K	4.0	4.1	
L	6.6	6.8	
M	1.0	1.1	
N	1.4	1.5	diameter
O	-	1.2	
P	15		degrees, typical
Q	11.1	12.8	
R	-	-	Call-out not used
S	-	-	Call-out not used
T	-	-	Call-out not used
U	-	-	Call-out not used
V	-	-	Call-out not used
W	-	-	Call-out not used
X	0.5	0.6	
Y	1.7	1.8	
Z	5.3	5.4	
AA	1.1	1.2	
AF	-	0.2	degrees, 3

Notes:

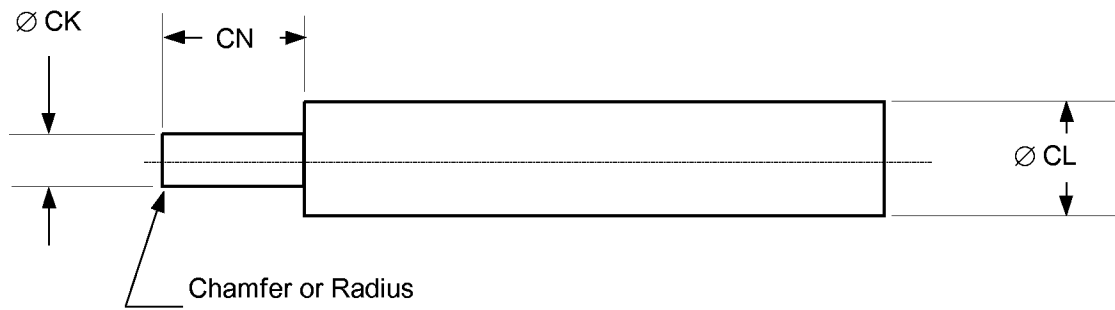
1. See section 2.2.2 for specifications of the I.D. of the adapter sleeve.
2. The sleeve may be fixed or floating. For a fixed sleeve the positional tolerance of dimension I applies to both A and I dimensions. For a floating sleeve, a gage pin inserted in the sleeve must be capable of moving freely into a position such that it is coincident with datum B.
3. Taper dimension AF is applied to the surfaces associated with dimension/feature H₁ and H₂

Figure 2.2.1b - Simplex junior adapter interface for $k = 2$ (Sheet 2)



Note: Each of the units in the duplex adapter shall comply with all of the dimensions of figure 2.2.1a or 2.2.1b.

Figure 2.2.1c - Duplex adapter interface for $k = 1$ and $k = 2$

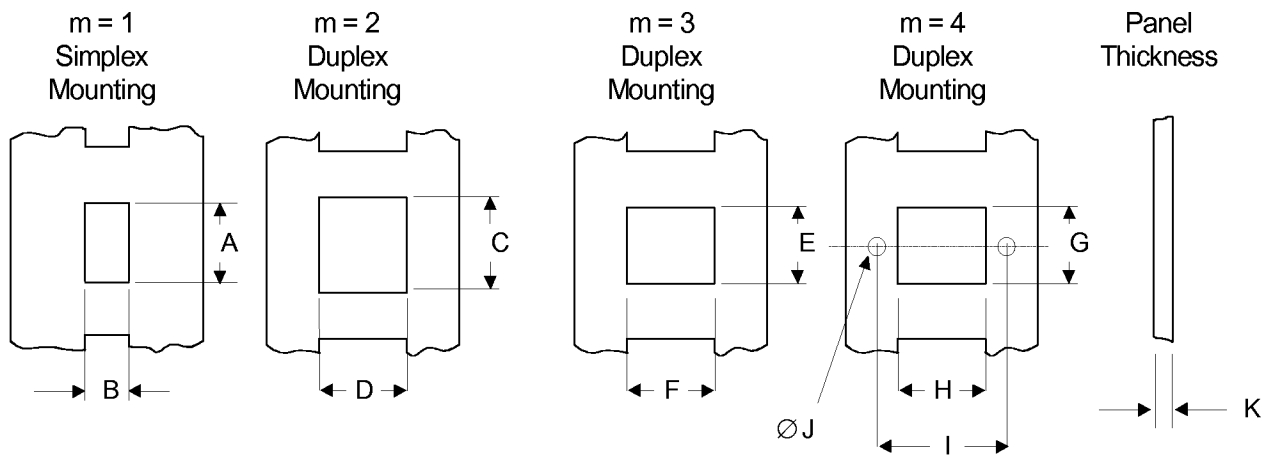


PIN GAUGE GRADE	CK		CL		CN		NOTES
	(mm)		(mm)		(mm)		
	MIN	MAX	MIN	MAX	MIN	MAX	
1.249	1.2488	1.2492	2.6	4.4	4.2	15	1

Notes:

1. Surface roughness should be $0.2 \mu\text{m}$ Ra and cylindricity is less than $0.5 \mu\text{m}$.

Figure 2.2.2 - Pin Gauge for Resilient Sleeve



Dimension	Minimum (mm)	Maximum (mm)
A	11.7	11.8
B	7.1	7.2
C	13.2	13.4
D	13.2	13.4
E	9.5	10.0
F	13.0	13.5
G	9.5	10.0
H	13.0	13.5
I	17.9	18.1
J	2.4	2.6
K	1.2	1.7

Figure 2.2.4 - Adapter mounting dimensions

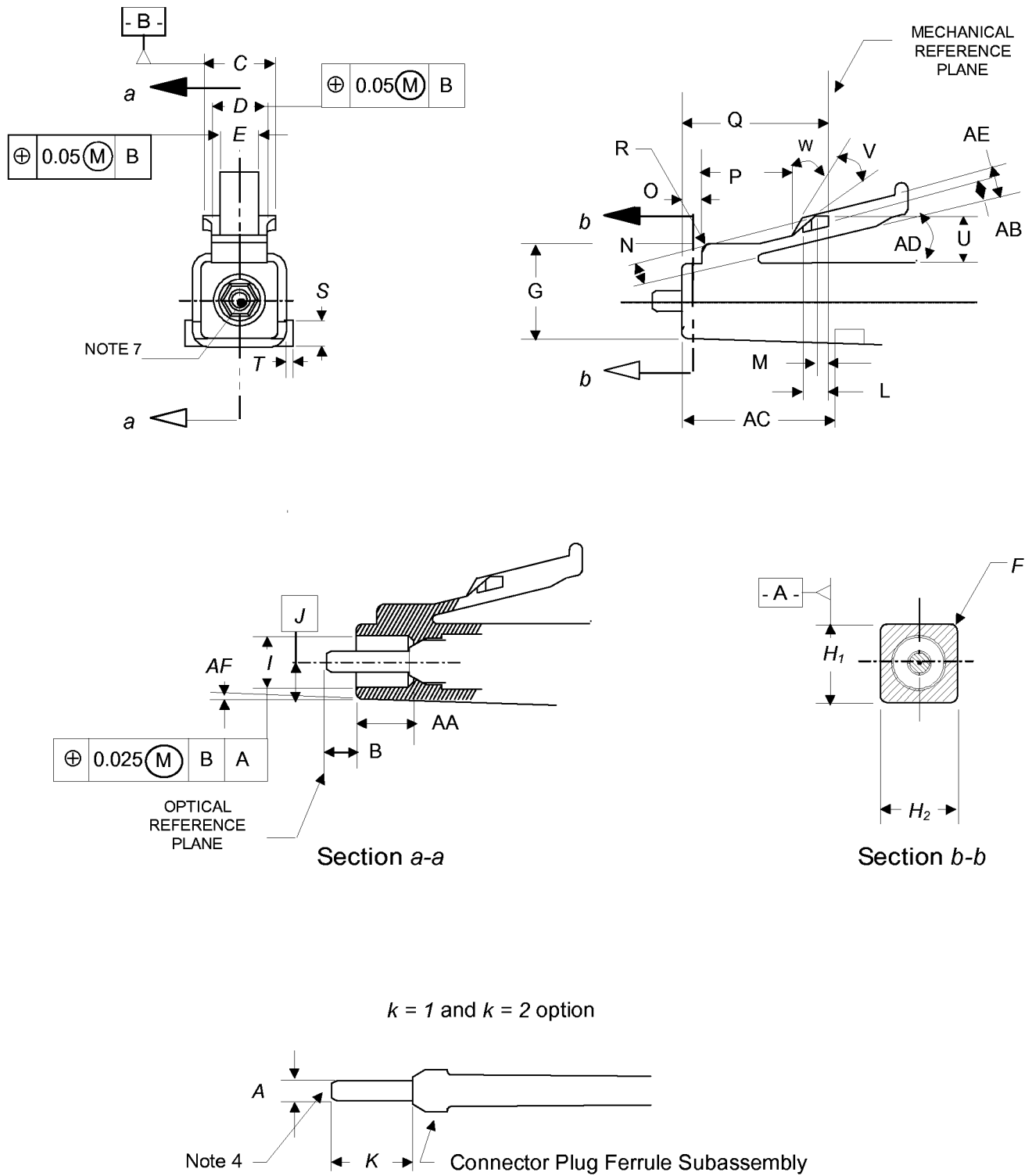


Figure 3.2.3a - Simplex plug interface, option $k = 1$, $k = 2$ and $d = 1$ (Sheet1)

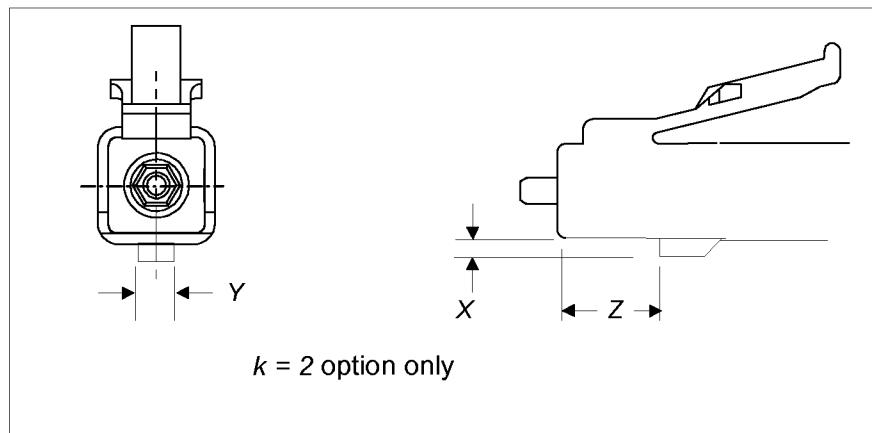


Figure 3.2.3a - Simplex plug interface, option $k = 1$, $k = 2$ and $d = 1$ (Sheet 2)

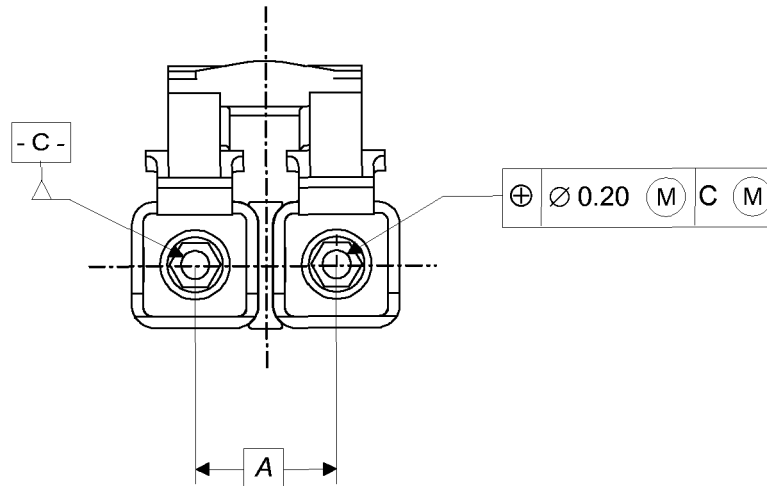
Dim.	Min. (mm)	Max. (mm)	Notes
<i>A</i>	-	-	3
<i>B</i>	-	-	6
<i>C</i>	4.2	4.4	
<i>D</i>	3.2	3.35	
<i>E</i>	2.2	2.4	
<i>F</i>	0.3	0.5	radius
<i>G</i>	5.6	5.7	
<i>H₁</i>	4.42	4.52	
<i>H₂</i>	4.42	4.52	
<i>I</i>	3.0	3.2	diameter
<i>J</i>	$H_1/2$		Basic dimension
<i>K</i>	4.88	5.00	4
<i>L</i>	1.3	1.5	
<i>M</i>	0.3	0.5	
<i>N</i>	1.2	1.4	
<i>O</i>	1.1	1.3	
<i>P</i>	5.2	5.4	
<i>Q</i>	8.5	8.7	
<i>R</i>	0.4	0.6	radius
<i>S</i>	-	1.0	
<i>T</i>	-	0.5	
<i>U</i>	2.7	2.9	
<i>V</i>	21		degrees, typical
<i>W</i>	30		degrees, typical
<i>X</i>	0.4	0.5	
<i>Y</i>	1.4	1.5	
<i>Z</i>	5.15	5.3	
<i>AA</i>	3.3	3.5	
<i>AB</i>	0.5	0.7	
<i>AC</i>	12.2	-	
<i>AD</i>	14		degrees, typical
<i>AE</i>	1.4	1.6	
<i>AF</i>	-	0.2	degrees, 8

Figure 3.2.3a - Simplex plug interface, option k = 1, k = 2 and d = 1 (Sheet 3)

Notes:

1. Dimensional call-outs in italics are comparable to the adapter figures 2.2.1a and 2.2.1.b and receptacle figures 4.2a.
2. Dimensions for intermateability are shown.
3. See Table 3 for dimension A, the diameter of the ferrule.
4. Shape of the plug tip shall be as specified in section 3.2.7.
5. Dimension B is for terminated connectors with direct contacting end-faces.
6. See Figure 3.2.6. for connector ferrule extension.
7. The True Position for the fiber at the end of the ferrule is at the center of the ferrule, see clause 1.3.2.
8. Taper dimension AF is applied to the surfaces associated with dimension/feature H_1 and H_2

Figure 3.2.3a - Simplex plug interface, option k = 1, k = 2 and d = 1 (Sheet 4)

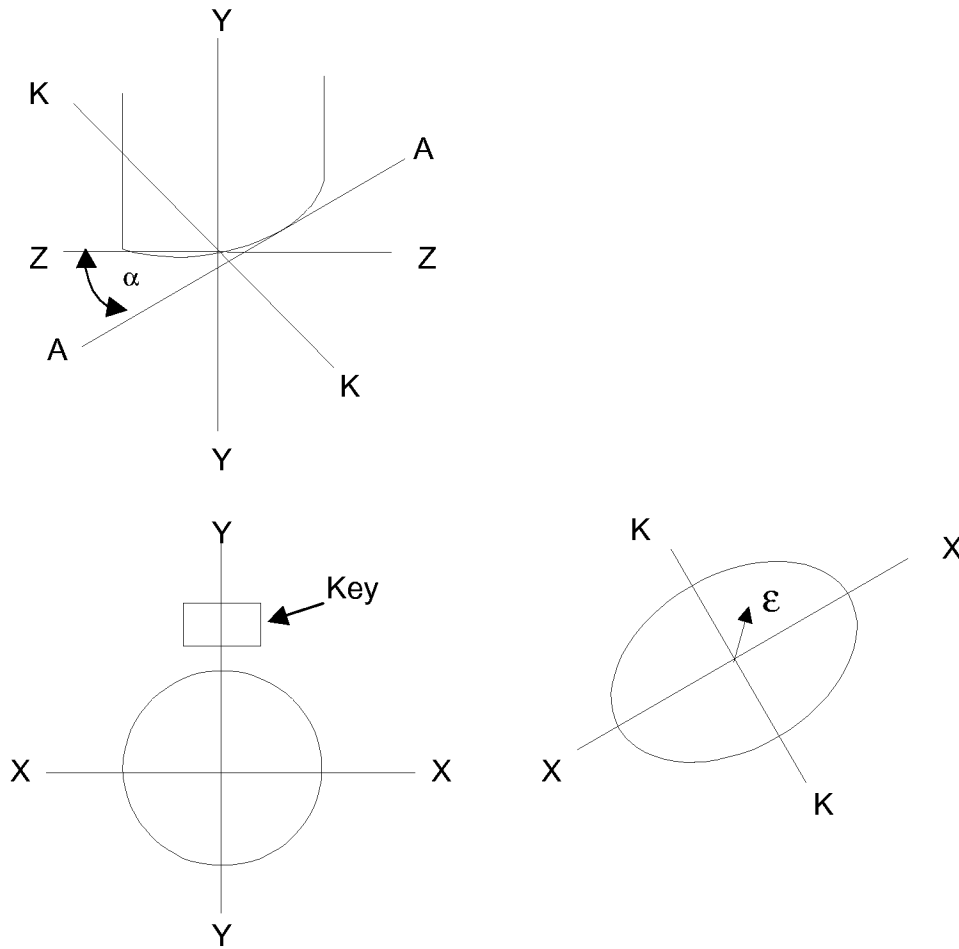


Dim.	Basic Dimension (mm)
<i>A</i>	6.25

Notes:

1. Dimensional call-outs in italics are comparable to adapter figure 2.2.1.c and receptacle Figure 4.2b.
2. Each of the units in the duplex plug shall comply with all of dimensions of figure 3.2.3a.
3. The duplex connector ferrules must be free to float to any position within the geometric tolerance.

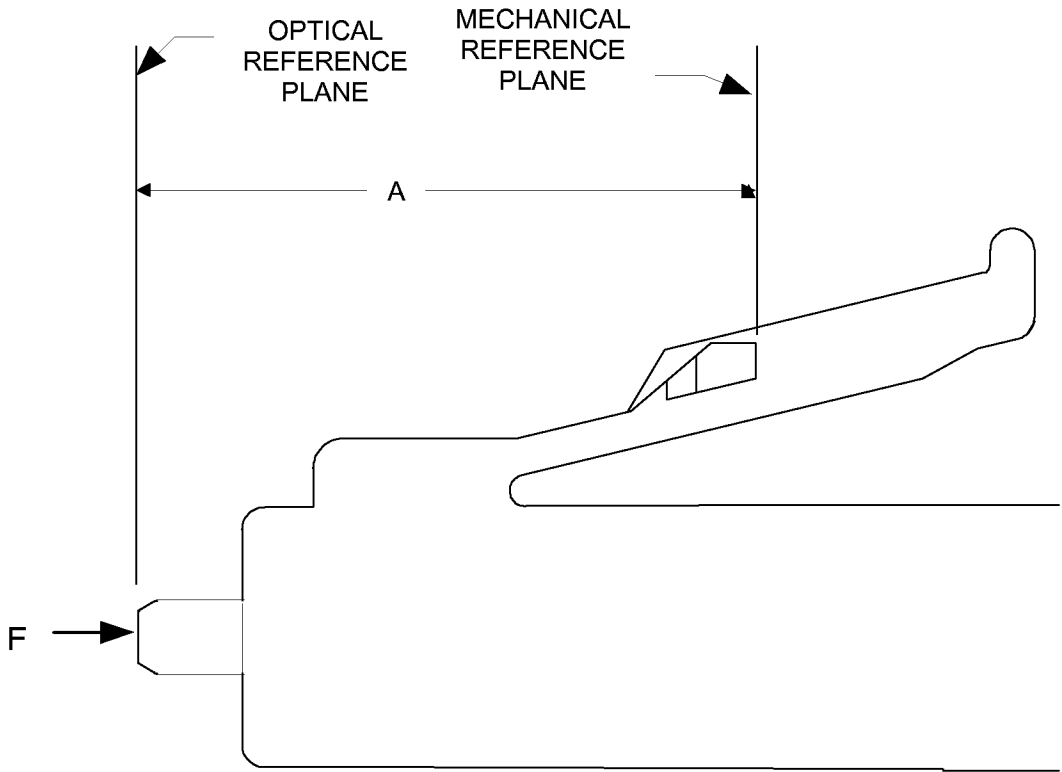
Figure 3.2.3b - Duplex plug interface, option k = 1, k = 2 and d = 1



Definitions for 3.2.5:

1. Plane Y-Y contains the centerline of the ferrule, and passes through the center of the key.
2. Plane X-X contains the centerline of the ferrule, and is perpendicular to Plane Y-Y.
3. Plane Z-Z is perpendicular to Planes X-X and Y-Y and contains the point at which the centerline of the ferrule intersects the end of the ferrule.
4. Plane A-A is inclined at an angle α to Plane Z-Z, is perpendicular to Plane X-X, and is tangent to the end of the ferrule.
5. Plane K-K is perpendicular to Planes A-A and X-X and contains the point at which the centerline of the ferrule intersects the end of the ferrule.
6. Ferrule apex is the point of tangency between Planes A-A and the end of the ferrule.
7. ϵ is the distance on Plane A-A between the apex, and the projection on Plane A-A, of the point at which the centerline of the ferrule intersects the end of the ferrule.

Figure 3.2.5 – Geometry of an Angled Ferrule.

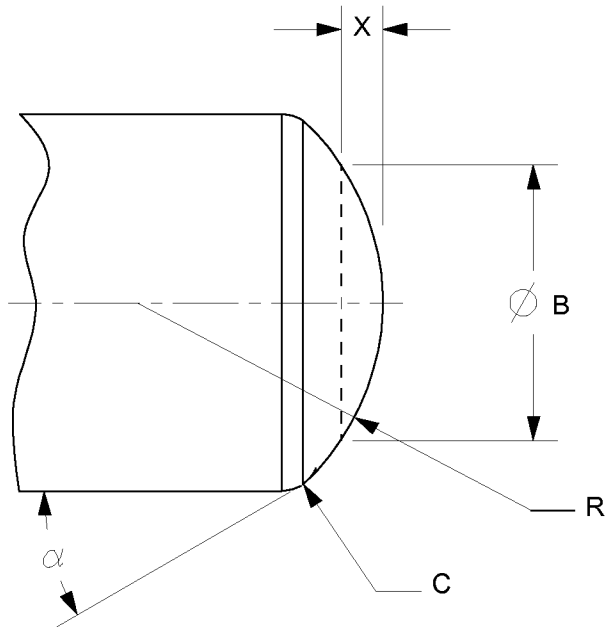


Requirements for ferrule travel and contact force option k = 1:		
	IF	THEN
1	$F = 0$	$A \geq 10.45 \text{ mm}$
2	$A \leq 10.2 \text{ mm}$	$F \geq 5.0 \text{ N (510 gf)}$
3	$A \geq 9.6 \text{ mm}$	$F \leq 6.0 \text{ N (612 gf)}$

Requirements for ferrule extension k = 2:		
	Minimum	Maximum
A	9.90	10.05

Note: Dimension A is for finished ends after all polishing has been completed.

Figure 3.2.6 - Ferrule extension and contact force



	t = 1 (Singlemode) mm	t = 2 (Multimode) mm	Notes
B	0.60 - 0.85	0.60 - 0.85	1
$X_{\max}$ ($R_{\min}$)	0.0145 (7)	0.0145 (7)	2 (3)
$X_{\min}$ ($R_{\max}$)	0.0041 (25)	0.0041 (25)	2 (3)
C	-	-	4
α	32.5 - 37.5	32.5 - 37.5	degrees

Notes:

1. B is the diameter of a circle on the surface of the ferrule that is concentric with the axis of the ferrule.
2. x is the distance that the apex of the end of the ferrule extends beyond the circle described in note 1.
3. The values of R are reference values. They are the radii of the end of the ferrule when the surface of the ferrule is spherical, and " B " is as given:

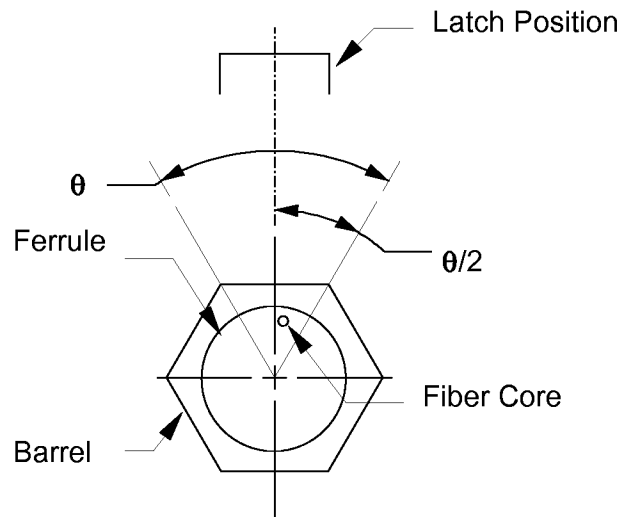
$R_{\min}$ radius when $X = X_{\max}$

$R_{\max}$ radius when $X = X_{\min}$

4. Break corner or edge " C ".

These dimensional requirements apply to the finished ferrule, after all polishing procedures have been completed.

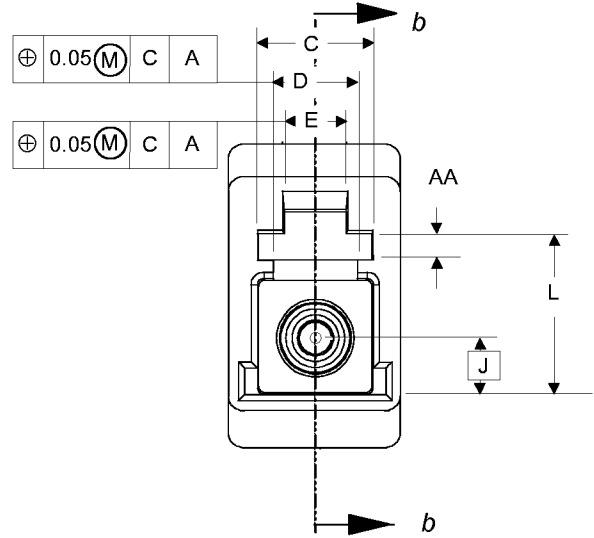
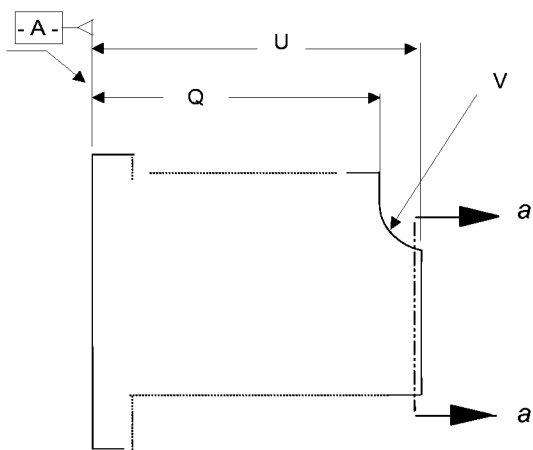
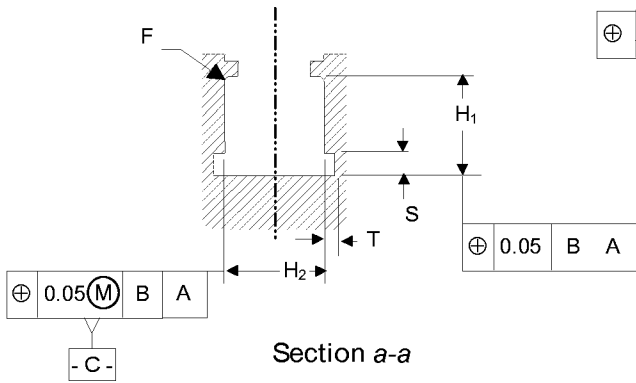
Figure 3.2.7 - Ferrule end geometry



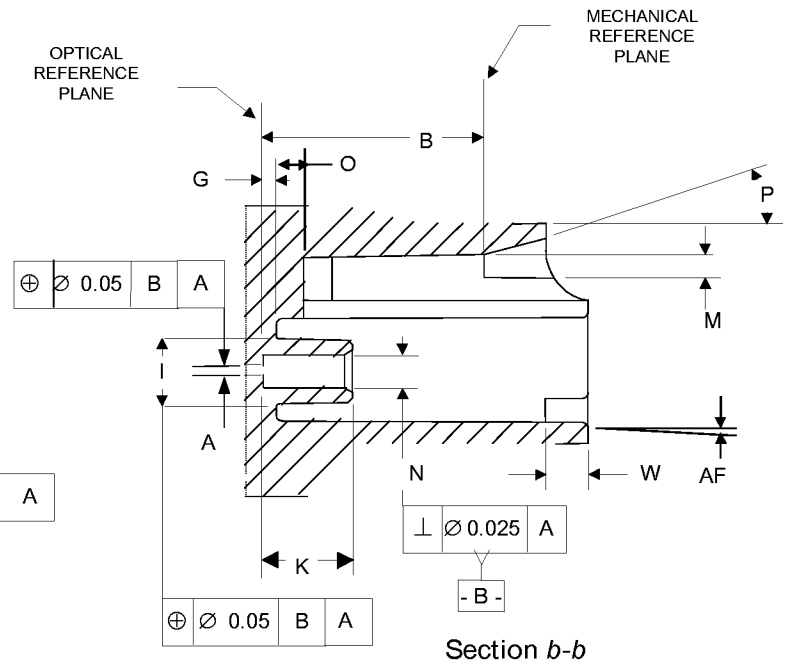
Notes:

1. If tuning is required to minimize loss, the eccentricity of the fiber core is to be located relative to the connector latch within the angle θ as shown.
2. $\theta \leq 180^\circ$

Figure 3.2.8 - Plug tuning orientation

OPTICAL
REFERENCE
PLANEOPTICAL
REFERENCE
PLANEMECHANICAL
REFERENCE
PLANE

Section a-a



Section b-b

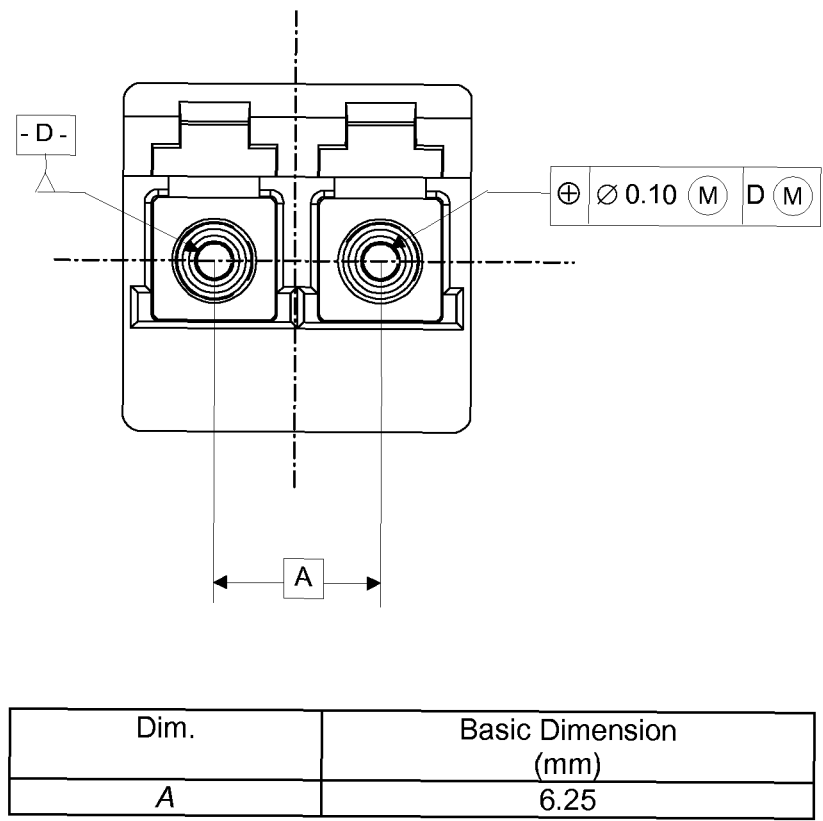
Figure 4.2a - Active Device Receptacle Interface (Sheet 1)

Dim.	Min. (mm)	Max. (mm)	Notes
A	0.5	0.8	
B	9.9	10.0	
C	4.5	-	
D	3.4	3.5	
E	2.6	2.7	
F	0.2	0.3	radius
G	0.6	0.7	
H ₁	4.60	4.75	
H ₂	4.60	4.75	
I	2.87	2.97	diameter
J	2.29		Basic Dimension
K	4.0	4.1	
L	6.6	6.8	
M	1.0	1.1	
N (t=1)	resilient sleeve		1,2,3,5,7
N (t=2)	1.251	1.252	1,2,3,6,7
N (t=3)	1.251	1.254	1,2,3,6,7
N (t=4)	1.251	1.257	1,2,3,6,7
O	-	1.2	
P	15		degrees, typical
Q	12.6	12.8	
R	-	-	Call-out not used
S	1.0	1.1	
T	0.5	0.6	
U	14.5	14.7	
V	2.2	2.4	radius
W	1.9	-	
X	-	-	Call-out not used
Y	-	-	Call-out not used
Z	-	-	Call-out not used
AA	1.1	1.2	
AF	-	0.2	degrees, 4

Notes:

1. "t" refers to the alignment sleeve grade tolerance option. Dimension N applies to the inside diameter of solid bore sleeves. The requirement for the inside diameter of a split resilient sleeve is given in Section 2.2.2.
2. For a solid sleeve the positional tolerance applies. For a floating sleeve, a gauge pin as defined in Figure 2.2.2 inserted in the sleeve must be capable to move freely into a position such that it is coincident with datum *B*.
3. Taper dimension AF is applied to the surfaces associated with dimension/feature H_1 and H_2 .
4. The connector alignment feature is an alignment sleeve. The feature must accept a pin gauge completely to the left side of dimension K with a force specified in Section 2.2.2 (1.0 N to 2.5 N). Insert the pin gauge completely, from only one side, the connector side of the active device receptacle interface. The pin gauge shall be as defined in Figure 2.2.2.
5. The connector alignment feature is a rigid bore sleeve. The dimension N shall be tested using two pin gauges. One pin gauge has the pin gauge grade number $1\text{ }\mu\text{m}$ larger than the maximum value of dimension N, the other pin gauge has the number pin gauge grade number $1\text{ }\mu\text{m}$ smaller than the minimum value of dimension N.
6. Add grade number to the interface reference number

Figure 4.2a - Active Device Receptacle Interface (Sheet 2)



Note: Each of the units in the duplex active device receptacle shall comply with all of the dimensions of Figure 4.2a.

Figure 4.2b - Duplex Active Device Receptacle Interface

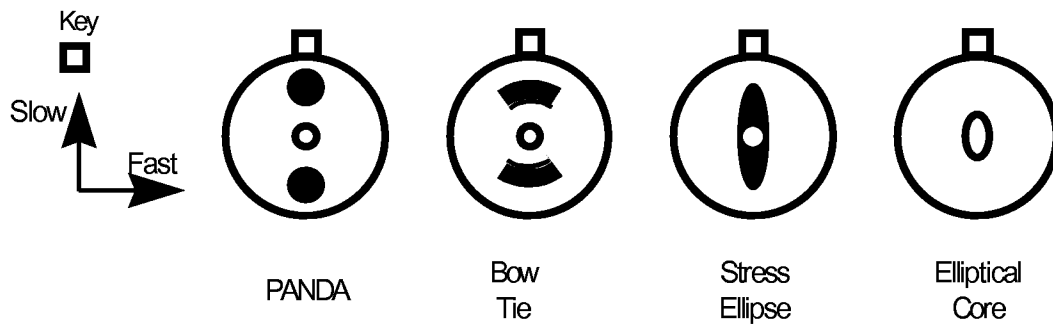


Figure 5. Polarization Maintaining Applications

