

Proposed Baseline Document of Physical Media Dependent Layers
for 100Mbps – 400Mbps IEEE1394 Long Distance Links

p1394.b
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1 Alternative long distance physical media dependent layers

The alternative long distance physical layers specified by this supplement enable distance extension over 50m keeping interoperability with existing IEEE1394-1995 interface as well as in-progress interface of P1394.a at the data rate of 100Mbps, 200Mbps and 400Mbps. Each data rate is covered by following alternatives.

Physical Media Dependent Layer	Data Rate	Baud Rate
POF and HPCF links with 650nm LED	upto 200Mbps	upto 250MBaud
<u>TBD</u>	upto 400Mbps	upto 500MBaud
UTP Category 5	100Mbps	125MBaud

The remarks below apply to external cabling and interface, where extra care must be exercised for safety and EMC compliance.

1.1 Plastic Optical Fiber and Hard Polymer Clad Fiber Links with 650nm Light Emitting Diode

1.1.1 Scope

This clause specifies the physical media dependent (PMD) sublayer of Plastic Optical Fiber (POF) and Hard Polymer Clad Fiber (HPCF) links with 650nm light emitting diode (LED) for the data rate of 100Mbps and 200Mbps. This PMD provides the low cost digital baseband point-to-point interconnection among IEEE1394 equipments for the distance extension over 50m, which was specified as a requirement criteria of IEEE1394 long distance link. HPCF link provides longer distance transmission capability up to 100m, POF link supports 50m minimum transmission distance though. The PMD shall provide all of the services required to transport a suitably coded digital bit stream across the link segment.

The PMD sublayer specified in this clause has the following general characteristics:

- Provides a means of converting the IEEE1394-1995 physical layer or in-progress physical layer of P1394.a to the POF and HPCF link segment by way of the Active Interface.
- Provides a means of transmitting and receiving the optical signal between two active optical interfaces.
- Provides a common optical interface for POF and HPCF at each baud rate.

1.1.2 Cables

The POF shall be 1000 μm multimode plastic optical fiber. The HPCF shall be 225 μm multi-mode hard polymer clad fiber.

POF and HPCF shall have a minimum modal bandwidth of TBD MHz*km at 650 nm when measured in accordance with IEC 793-1-C2A or IEC 793-1-C2B. The specifications for fiber modal bandwidth include a variation in source numerical aperture and account for the effect of bandwidth degradation to ensure correct system operation.

The maximum attenuation of 50 m POF under the condition of -20 to +70 degrees C and 95% relative humidity shall be 9.1 dB. The maximum attenuation of 100 m HPCF under the condition of -20 to +70 degrees C and 95% relative humidity shall be 2.7 dB. The attenuation shall be measured in accordance with IEC 793-1-C1A or C1B using a nominal 650 nm narrow (< 5 nm FWHM) spectral width light source.

In addition, the fiber loss due to environmental conditions and launch NA is included in the attenuation of 9.1 dB for POF and 2.7 dB for HPCF. The loss increments of 3.4 dB for POF and 0.1 dB for HPCF, shown in Table 1, account for both a source center wavelength shift to 660 nm or 640 nm and the difference between the < 5 nm spectral width of the test source and 40 nm worst case source spectral width. Loss increments of 0.5 dB for POF and 0.1 dB for HPCF due to cable bends are also accounted for as shown in Table 1.

For the condition shown in Table 1, the worst case fiber attenuation for 50 m POF shall be 13 dB and the worst case fiber attenuation for 100 m HPCF shall be 2.9 dB.

Table 1 Worst case loss increments for 50 m POF cable and 100 m HPCF cable

Parameters		Unit	Min.	Max.	Loss Increment
Source center wavelength		nm	640	660	POF: 3.4 dB
Source spectral width (FWHM)		nm		40	HPCF: 0.1 dB
Cable Bend	Radius	mm	25.4		POF: 0.5 dB HPCF: 0.1 dB

1.1.3 Connectors

The optical connector should be either PN(modified F07) connector or SMI connector. The PN connector has been well established in the data network market and the industrial machine tool market. The SMI connector features smaller size than PN connector. This is suitably applied for small size consumer devices. It is to be decided which of PN connector or SMI connector you use by design concept of a target equipment.

- PN Connector

The PN receptacle and the PN plug should meet the interface standard, IEC 1754-16 and the performance standard, IEC 1753-AA. It is recommended that the network polarity (transmit and receive) be managed in accordance with ANSI/TIA/EIA-568-A.

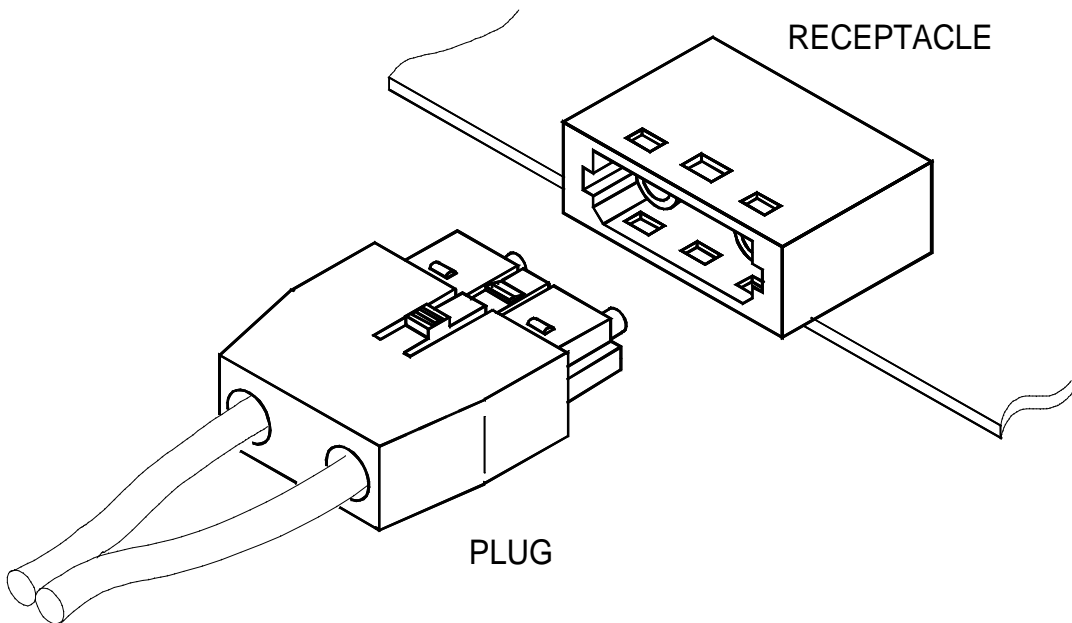
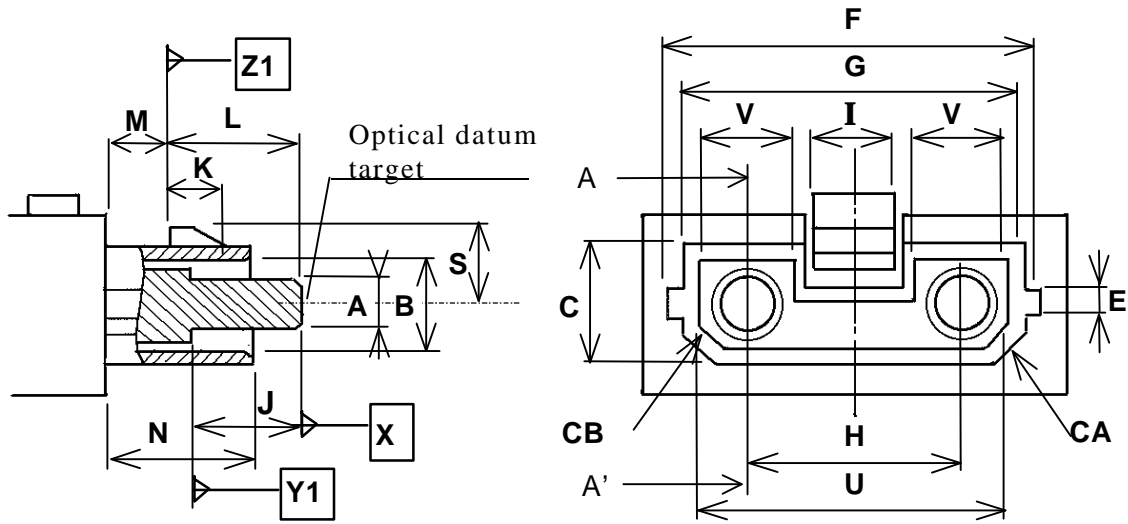


Figure 1 PN Plug and Receptacle

The parent connector for type PN connector family is a duplex plug connector which is characterized by a 10.16 mm pitch, and a 2.5 mm nominal ferrule diameter. It includes two type plugs. One (PN-I) is high precision type which has floating ferrules with springs. The other (PN-II) is low-cost type which has fixed ferrule, made by one piece body. Two plugs have mechanical compatibility to adaptor or socket.

The subsequent pages define the standard interfaces for the type PN connector family.



Cross-section A-A'

Figure 2 - Plug PN-I connector interface

Table 2 - Dimensions of the plug PN-I connector interface

Reference	Dimension		Notes
	Mm		
	Minimum	Maximum	
A	2,49	2,50	
B	4,3	4,5	
C	5,8	6,0	
E	1,49	1,595	
F	17,45	17,65	
G	15,95	16,09	
H	10,12	10,20	
I	3,8	4,299	
J	5,30	5,40	
K	-	2,5	4
L	6,8	-	3

M	2,9	3,15	
N	6,55	6,9	
S	3,6	4,5	2
U	14,4	14,8	
V	4,4	4,6	
CA	1,35	1,7	Chamfer
CB	0,8	1,15	Chamfer

NOTES

1. Plug PN-I is high precision, floating ferrule type. It is designed for plastic optical fibre and polymer clad silica fibre, specified at IEC 793-2. type A4a,A4d,A3c,A3d fiber. (A4d,A3d are NWIP)
2. Dimension S is movable to 3.0mm when insert to adaptor or socket, and lock to dimension K (figure 4,5).
3. Dimension L is given for plug endface when not mated. It is movable by a certain axial compression force. When mate with adaptor or socket, dimension L is 6.1 to 6.45mm. And then ferrule compression force shall be 4.3N to 8.1N.
4. Dimension K is given for mating with adaptor's dimension K (figure 4) or socket's dimension K (figure 5).
5. Plane Y1 is mechanical reference plane, and mate with adaptor's plane Y (figure 4) or socket's plane Y (figure 5). Plane Z1 correspond to adaptor's plane Z1 (figure 4) or socket's plane Z1 (figure 5).

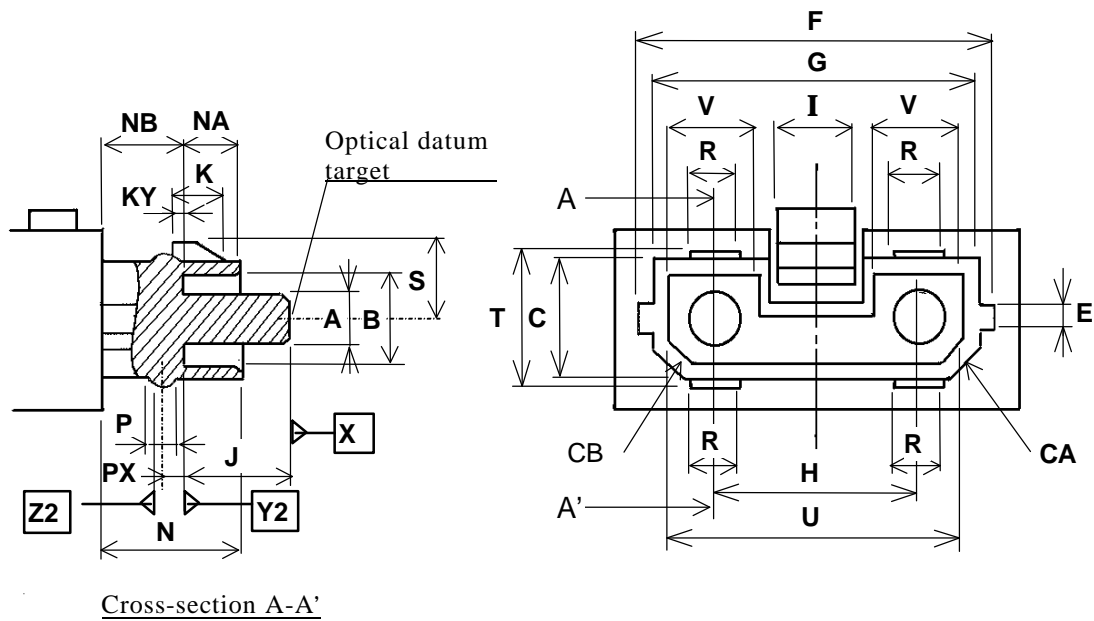


Figure 3 - Plug PN-II connector interface

Table 3 - Dimensions of the plug PN-II connector interface

Reference	Dimension		Notes
	Mm		
	Minimum	Maximum	
A	2,42	2,50	
B	4,3	4,5	
C	5,8	6,0	
E	1,49	1,595	
F	17,45	17,65	
G	15,95	16,09	
H	10,12	10,20	
I	3,8	4,299	
J	5,30	5,40	
K	-	2,5	
KY	0,7	0,8	3

N	6,55	6,9	6
NA	2,7	2,9	
NB	3,85	4,0	
P	1,75	1,91	4
PX	0,9	1,0	
R	2,7	2,9	4
S	3,6	4,5	2
T	6,35	6,45	4
U	14,4	14,8	
V	4,4	4,6	
CA	1,35	1,7	Chamfer
CB	0,8	1,15	Chamfer

NOTES

1. PN-II is one piece body type. It is designed for plastic optical fibre, specified at IEC 793-2. type A4a,A4d fiber. (A4d is NWIP)
2. Dimension S is movable to 3.0mm when insert to adaptor or socket, and lock to dimension K(figure4,5).
3. Dimension K is given for mating with adaptor or socket's (figure 4,5) dimension K.
4. Detents of dimension P-R-T deflects dimension C when insert to adaptor or socket (figure 4,5) rectangle holes of dimension P-R.
5. Plane Y2 is mate with socket (figure 5) plane Y.
Plane Z2 is correspond to adaptor or socket (figure 4,5) plane Z1.
6. Dimension N = dimension NA + dimension NB.

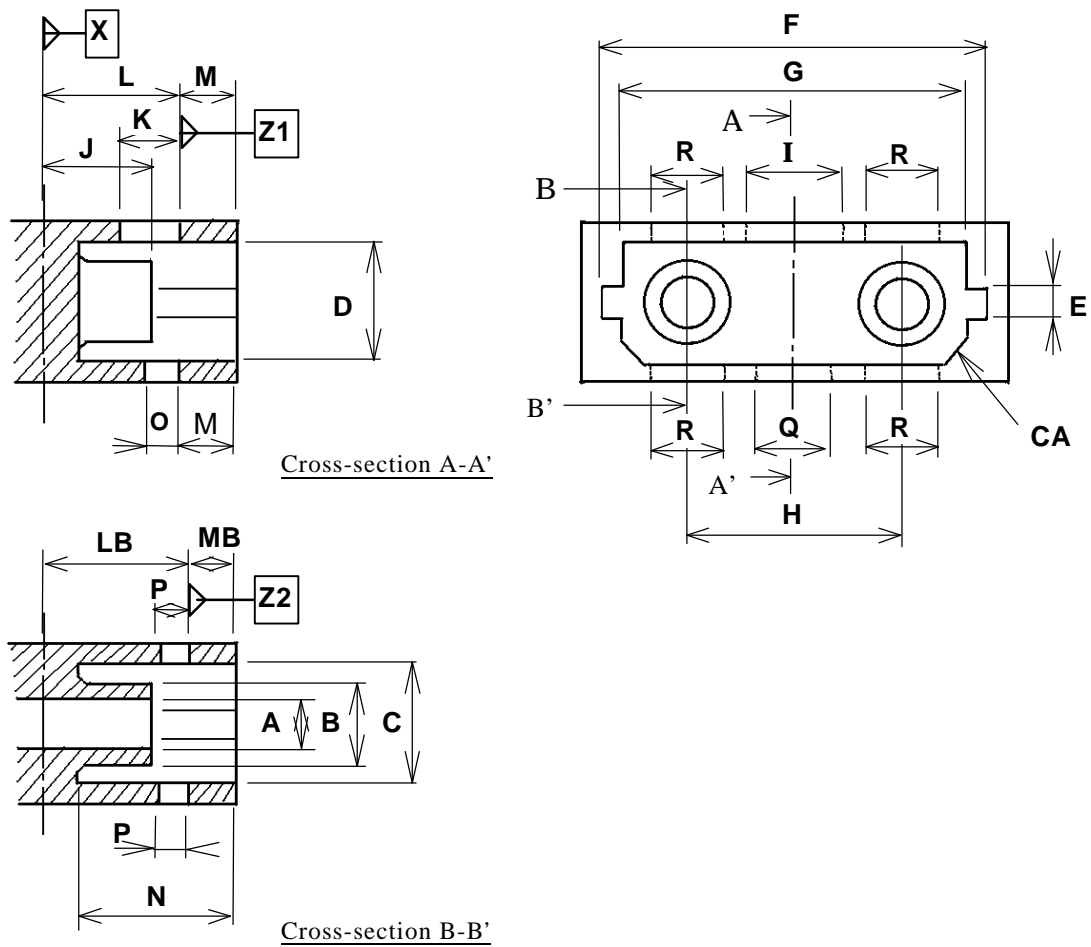


Figure 4 – Adaptor PN connector interface

Table 4 - Dimensions of adaptor PN connector interface

Reference	Dimensions		Notes
	Mm		
	Minimum	Maximum	
A	2,501	2,521	
B	3,9	4,1	
C	6,1	6,25	
D	6,05	6,25	

E	1,6	1,7	
F	18,2	18,5	
G	16,1	16,2	
H	10,12	10,20	
I	4,5	4,7	
J	5,05	5,15	
K	2,6	2,8	
L	6,25	6,45	
LB	6,65	6,75	
M	2,55	2,8	
MB	2,25	2,5	
N	6,95	-	
O	1,3	1,5	
P	1,3	1,5	1
Q	3,5	3,7	
R	3,5	3,7	1
CA	1,0	1,3	Chamfer

NOTE

1. This hole is given for mating with PN-II plug, not used for mating with PN-I plug.
When PN-II plug is inserted, dimension C is deflected, and mate with PN-II's detents (figure 3. demension P-R.)
2. Dimention L's left plane, X shows plug's ferrule end face at mated, so correspond to plug's plane X (figure 2,3). When mate with PN-I plug, plane Z1 correspond to plug's plane Z (figure 2) . When mate with PN-II plug, plane Z2 correspond to plug's plane Z (figure 3).

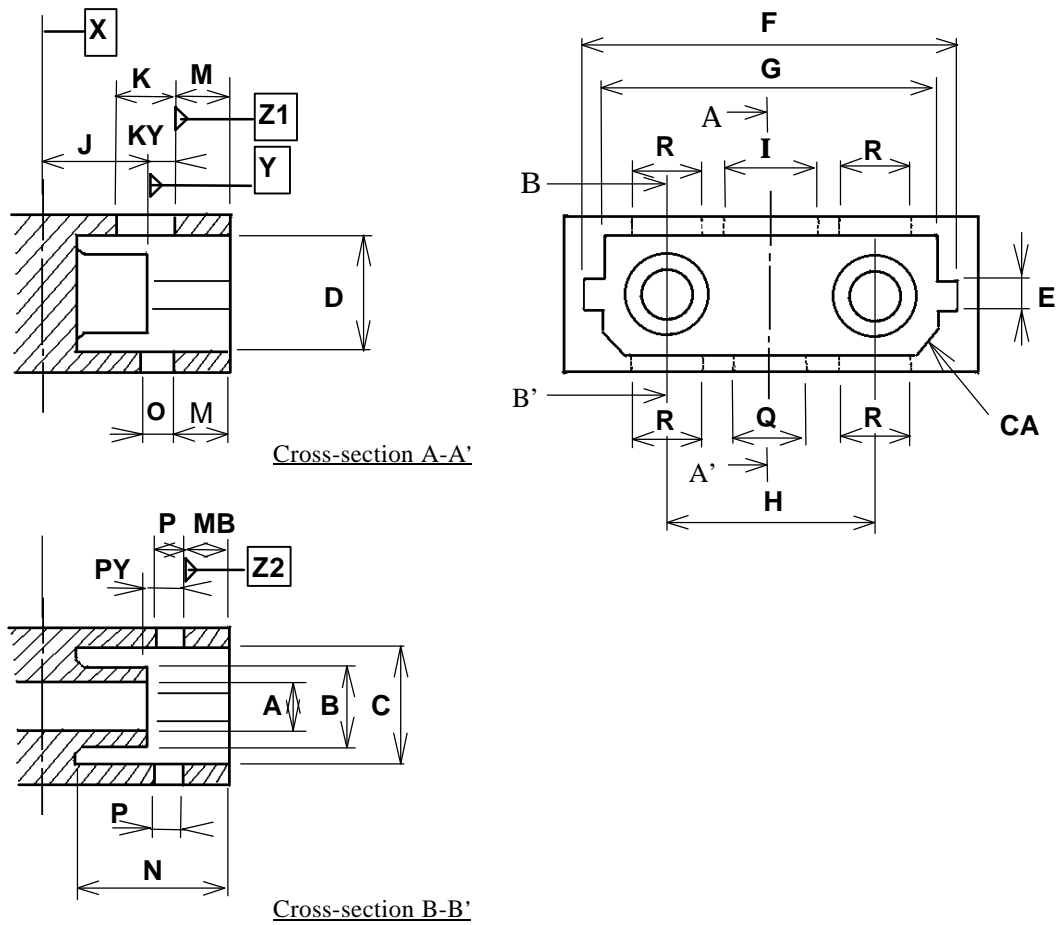


Figure 5 – Socket (Receptacle) PN connector interface

Table 5 - Dimensions of socket (receptacle) PN connector interface

Reference	Dimensions		Notes
	Mm		
	Minimum	Maximum	
A	2,501	2,551	
B	3,9	4,1	
C	6,1	6,25	
D	6,05	6,25	
E	1,6	1,7	

F	18,2	18,5	
G	16,1	16,2	
H	10,12	10,20	
I	4,5	4,7	
J	5,3	5,4	3
K	2,6	2,8	
KY	0,8	0,9	4
M	2,75	2,85	
MB	2,4	2,5	
N	6,95	7,25	
O	1,3	1,5	
P	1,3	1,5	1
PY	1,15	1,25	3
Q	3,5	3,7	
R	3,5	3,7	1
CA	1,0	1,2	Chamfer

NOTE .

1. This hole is given for mating with PN-II plug, not used for mating with PN-I plug.
When PN-II plug is inserted, dimension C is deflected, and mate with PN-II's detents (figure 3. demension P-R.)
2. When mate with PN-I plug, plane Y correspond to plug's plane Y1, and plane Z1 correspond to plug's plane Z1. When mate with PN-II plug, plane Y correspond to plug's plane Y2, and plane Z2 correspond to plug's plane Z2.
3. Dimension J's left plane, X shows plug's ferrule end face at mating.
4. Dimension KY + dimension M = dimension PY + dimension MB (= Minimum: 3,55
Maximum: 3,75)

- SMI connector

The parent connector for type SMI connector family is a duplex plug connector which is characterized by a 5.0 mm pitch, and a 2.5 mm nominal ferrule diameter. The subsequent pages define the standard interfaces for the type SMI connector family.

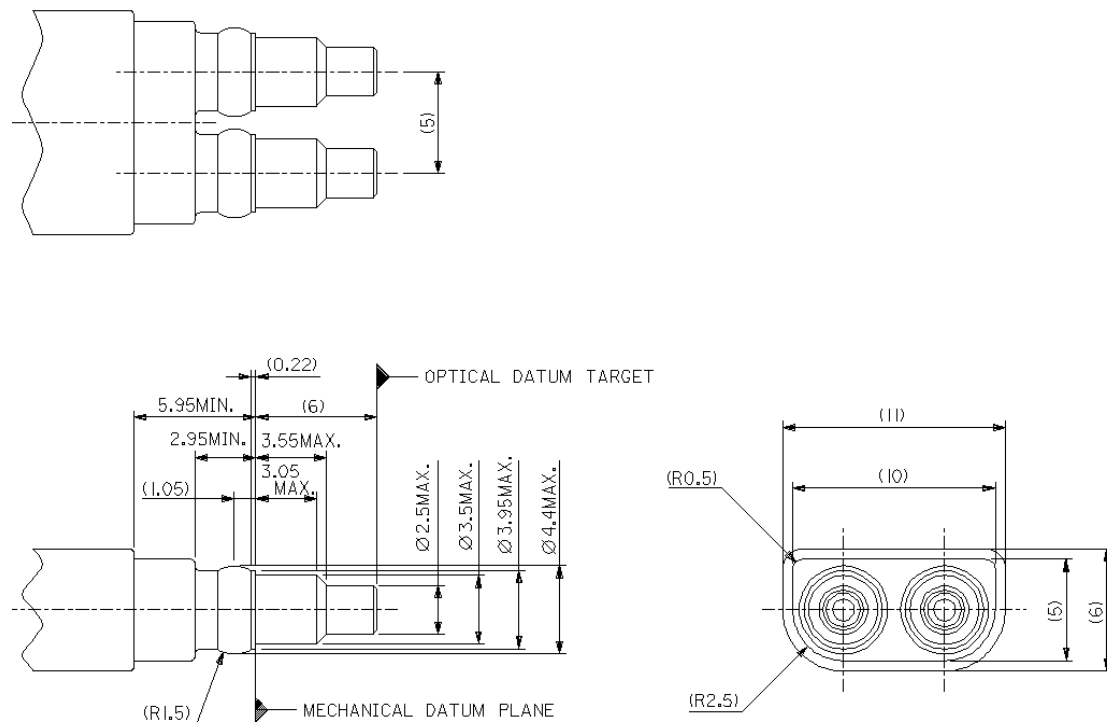


Figure 6 Plug SMI connector interface

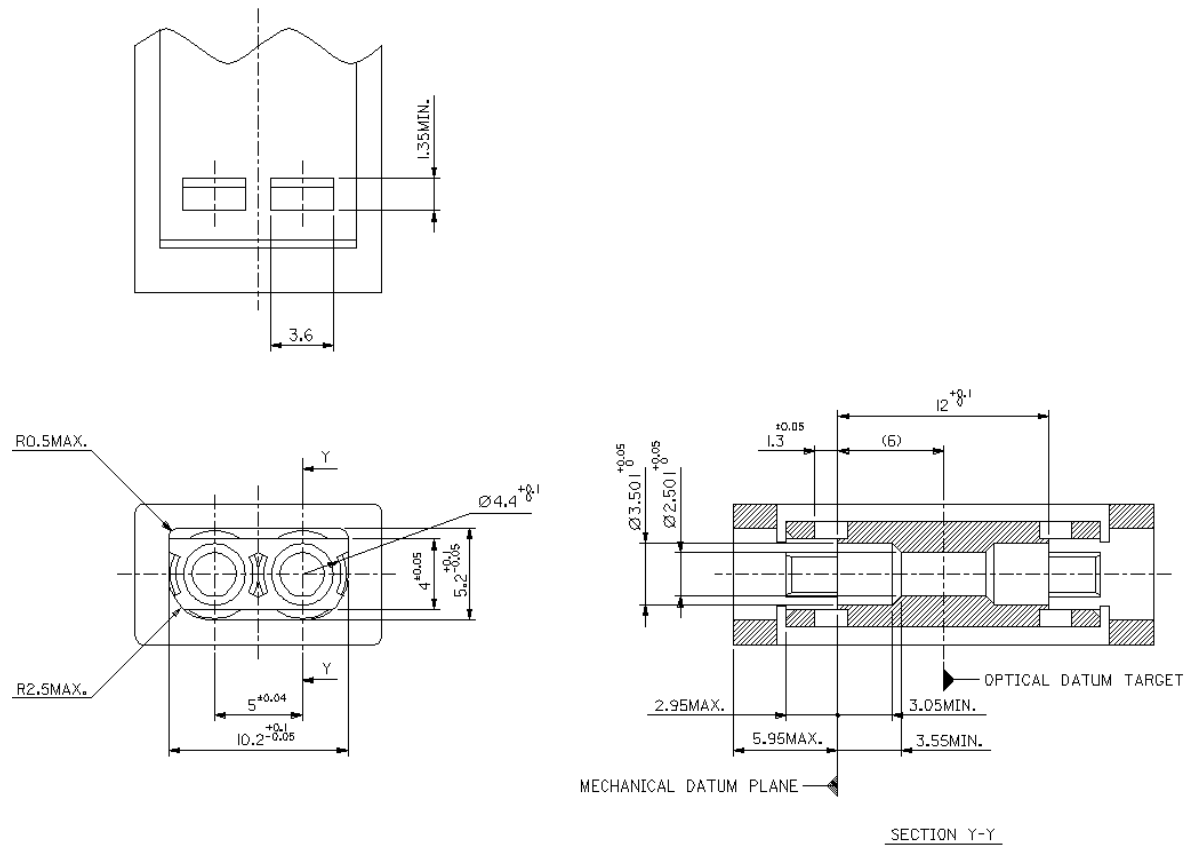


Figure 7 Adapter SMI connector interface

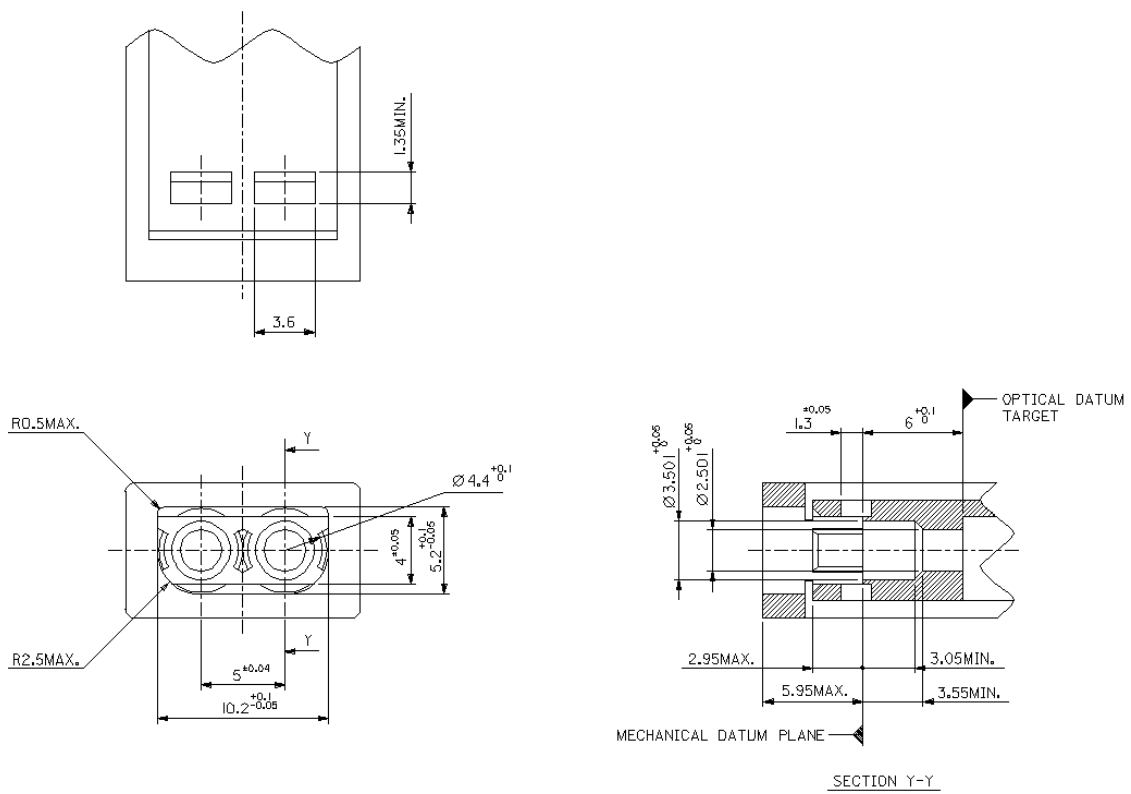


Figure 8 Socket (receptacle) SMI connector interface

1.1.4 Connector and cable assembly performance criteria

The worst case connector insertion loss, including the effect of environmental conditions, shall be less than 2.0 dB for POF and HPCF.

1.1.5 Optical Fiber Interface

This section specifies a Physical Media Dependent (PMD) sublayer over plastic optical fiber (POF) and hard polymer clad fiber (HPCF) using light emitting diodes (LEDs) operating at nominal baudrate of 125MBaud and 250MBaud. The POF interface is intended for link lengths of up to 50 m. The HPCF interface is intended for link lengths of up to 100 m.

The optical line coding is binary NRZ. Binary 1 shall be represented as a high light level condition.

An interface receiver shall operate with a bit error ratio (BER) not to exceed 10^{-12} (1 bit error in 10^{12} bits) when presented with a transmitter signal as specified in section 1.1.5.2 transmitted through a link subject to the system budget constraints specified in 1.1.5.1.

1.1.5.1 System Budget

Proper system performance is ensured by considering the attenuation and modal bandwidth of the optical path and including them as part of the link budget. In addition to these cable plant characteristics, a system power penalty is normally included in the link budget. The power penalty includes the effects of eye closure due to transmitter characteristics (finite rise and fall times, random and systematic jitter). This system power penalty is accounted for in the receiver sensitivity specification; therefore, the system budget is composed entirely of losses due to the cable plant and connectors.

The attenuation range specification for the links were defined based on the use of components meeting the requirements specified in 1.1.2 and 1.1.4 and operating up to 50 meters for POF and up to 100 meters for HPCF. The static attenuation in the optical path includes worst case loss values for the fiber media and connectors. The attenuation ranges for 125MBaud POF link and 250MBaud POF link are respectively 17dB and 13dB, of which 13 dB is allocated for 50m fiber. The attenuation ranges for 125MBaud HPCF link and 250MBaud HPCF link are respectively 6.5 dB and 3.0dB, of which 2.9 dB is allocated for 100m fiber.

1.1.5.2 Transceiver Characteristics

The values prescribed are for worst case operating conditions and end of life; they are to be met over the full range of standard operating conditions, (i.e., voltage, temperature and humidity) and include aging effects. The following parameters are specified for the transmitter and receiver.

Table 6 Optical Parameters for POF and HPCF Interfaces at 125MBaud

	POF	HPCF	Unit
Transmitter Interface Characteristics			
Center Wavelength	640 to 660	640 to 660	nm
Maximum Spectral Width (FWHM)	40	40	nm
Mean Launched Power (Note 1)	-8 to -2	-20 to -14	dBm
Source NA	0.2 to 0.3	0.2 to 0.3	
Minimum Extinction Ratio	10	10	dB
Maximum Rise (Fall) Time, (10-90%)	4.5	4.5	ns
Maximum Overshoot	25	25	%
Maximum Systematic Interface Jitter	1.6	1.6	ns
Maximum Random Interface Jitter	0.6	0.6	ns
Receiver Interface Characteristics			
Minimum Receiver Input Power (Note 2)	-25	-26.5	dBm
Minimum Overload	-2	-14	dBm
Maximum Rise (Fall) Time, (10-90%)	TBD	TBD	ns
Maximum Systematic Interface Jitter	TBD	TBD	ns
Maximum Random Interface Jitter	0.6	0.6	ns
Minimum Receiver Eye Opening (Note 3)	1.5	1.5	ns

(Editors note: This table is subjected to change after specifying the fiber characteristic.)

NOTE 1: The interface specifications for both POF and HPCF fibers are based on the use of a common optical transmitter and receiver. Differences in the optical power budget between HPCF and POF link specifications are due to the fiber core diameter and NA. The interface point for the mean launched power specification is a short length of fiber (e.g. 50 cm) located immediately after the plug of the connector attached to the transmitter receptacle. The connector at this interface point is therefore considered to be part of the equipment and not part of the cable plant.

NOTE 2: The improved minimum receiver input power for the HPCF receiver interface is due to the more efficient optical coupling from the smaller diameter HPCF into the same optical detector to achieve a minimum detected current. The interface point for the minimum receiver input power specification is located between the plug of the connector and the receptacle.

NOTE 3: The receiver eye opening represents the time interval allocated for the clock recovery function after the optical to electrical conversion at the receiver.

Table 7 Optical Parameters for POF and HPCF Interfaces at 250MBaud

	POF	HPCF	Unit
Transmitter Interface Characteristics			
Center Wavelength	640 to 660	640 to 660	nm
Maximum Spectral Width (FWHM)	40	40	nm
Mean Launched Power (Note 1)	-9 to -3	-21 to -15	dBm
Source NA	0.2 to 0.3	0.2 to 0.3	
Minimum Extinction Ratio	10	10	dB
Maximum Rise (Fall) Time, (10-90%)	3.0	3.0	ns
Maximum Overshoot	25	25	%
Maximum Systematic Interface Jitter	1.6	1.6	ns
Maximum Random Interface Jitter	0.6	0.6	ns
Receiver Interface Characteristics			
Minimum Receiver Input Power (Note 2)	-22	-24	dBm
Minimum Overload	-3	-15	dBm
Maximum Rise (Fall) Time, (10-90%)	TBD	TBD	ns
Maximum Systematic Interface Jitter	TBD	TBD	ns
Maximum Random Interface Jitter	0.6	0.6	ns
Minimum Receiver Eye Opening (Note 3)	0.8	0.8	ns

(Editors note: This table is subjected to change after specifying the fiber characteristic.)

NOTE 1: The interface specifications for both POF and HPCF fibers are based on the use of a common optical transmitter and receiver. Differences in the optical power budget between HPCF and POF link specifications are due to the fiber core diameter and NA. The interface point for the mean launched power specification is a short length of fiber (e.g. 50 cm) located

immediately after the plug of the connector attached to the transmitter receptacle. The connector at this interface point is therefore considered to be part of the equipment and not part of the cable plant.

NOTE 2: The improved minimum receiver input power for the HPCF receiver interface is due to the more efficient optical coupling from the smaller diameter HPCF into the same optical detector to achieve a minimum detected current. The interface point for the minimum receiver input power specification is located between the plug of the connector and the receptacle.

NOTE 3: The receiver eye opening represents the time interval allocated for the clock recovery function after the optical to electrical conversion at the receiver.

1.2 Unshielded Twisted Pair Cable link

TBD