

7 ANEXOS

7.1 ANEXO 1: ESPECIFICACIONES TRANSMISOR Y RECEPTOR

Para la transferencia de datos a 50Mbps sería recomendable usar los siguientes componentes de transmisión y recepción.

- **Transmisor (Tx)** fabricante: Broadcom Limited. Distribuido por la tienda DigiKey Electronics. Velocidad de transmisión 50Mbps. Referencia en la página web de DigiKey: 516-2643-ND
Referencia fabricante: AFBR-2624Z
Precio: 16,44 €/unidad



Figura 1: Transmisor fibra óptica.

- **Receptor (Rx)** fabricante: Broadcom Limited. Distribuido por la tienda DigiKey Electronics. Velocidad recuperación de datos 50Mbps. Referencia en la página web de DigiKey: 516-2642-ND
Referencia fabricante: AFBR-1624Z
Precio: 15,17 €/unidad



Figura 2: Receptor fibra óptica.

AFBR-16xxZ and AFBR-26x4Z/25x9Z
DC-50MBd Versatile Link Fiber Optic Transmitter
and Receiver for 1 mm POF and 200 μm PCS



Data Sheet



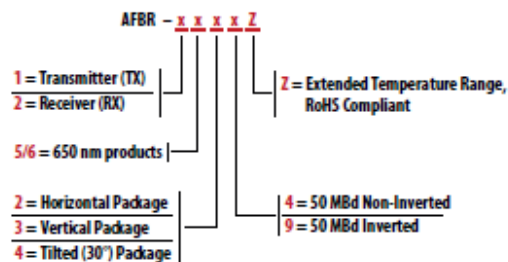
Description

The AFBR-16xxZ transmitter utilizes a 650 nm LED source with integrated optics and driver IC for efficient coupling into 1 mm Polymer Optical Fiber (POF). The AFBR-26x4Z/25x9Z receiver consists of an IC with an integrated photodiode to produce a logic compatible output. The transmitter input and receiver output are compatible with TTL logic families. The pair operates any type of signal from DC up to 50 MBd at distances up to 50 m with 1 mm POF, up to 200 m at 10 MBd and 120 m at 50 MBd with 200 μm Plastic-Clad Silica (PCS), respectively.

The transmitter is a 3-pin and the receiver is a 4-pin device, packed in Versatile Link housing. Versatile Link components can be interlocked (N-plexed together) to minimize space and to provide dual connections with the duplex connectors. Various simplex and duplex connectors, as well as POF cables are available for Versatile Link components. For details, contact Avago Technologies or visit our company website at www.avagotech.com

AFBR-xxx4Z are delivering non-inverted output signals while AFBR-xxx9Z deliver inverted output signals.

AFBR-xxxxZ - Part number selection guide



Available options

Horizontal Package	AFBR-x624Z	AFBR-1629Z	AFBR-2529Z
Vertical Package	AFBR-x634Z	AFBR-1639Z	AFBR-2539Z
Tilted (30°) package	AFBR-x644Z		

Features

- RoHS-compliant
- Data transmission at signal rates from DC up to 50 MBd
- Transmitter: integrated 650 nm LED and driver IC with TTL input logic
- Receiver: integrated PIN diode and digitalizing IC with TTL output logic
- Up to 50 m distance with 1 mm Polymer Optical Fiber (POF) over operating temperature range
- Up to 200 m (10 MBd) distance and 120 m (50 MBd) distance with 200 μm Plastic-Clad Silica (PCS) over operating temperature range
- Operating temperature range of -40 °C to +85 °C
- Compatible with Avago's Versatile Link family of connectors, for easy termination of fiber

Applications

Optical Transmitter and Receiver for 50 MBd systems and below:

- Industrial control and factory automation
- Extension of RS-232 and RS-485
- High voltage isolation
- Elimination of ground loops
- Reduces voltage transient susceptibility

Figura 3: Pagina 1 especificaciones transmisor y receptor.

Application Literature

Application Note 1035 (Versatile Link) - AV02-0730EN

Package and Handling Information

The compact Versatile Link package is made of a flame-retardant material and uses the same pad layout as a standard, eight-pin dual-in-line package. Horizontal, Vertical, and Tilted (30°) packages are available. These low profile Versatile Link packages are stackable and are enclosed to provide a dust-resistant seal. Snap action simplex, simplex latching, duplex, and duplex latching connectors are offered with simplex or duplex cables.

Package Orientation

Performance and pinouts for the horizontal, vertical, and tilted (30°) packages are identical. To provide additional attachment support for the vertical Versatile Link housing, the designer has the option of using a self-tapping screw through a printed circuit board into a mounting hole at the bottom of the package. For most applications this is not necessary.

Package Housing Color

Versatile Link components and simplex connectors are color coded to eliminate confusion when making connections. Receiver packages are black and transmitter packages are gray in color respectively.

Handling

Versatile Link components are auto-insertable. When wave soldering is performed with Versatile Link components, the optical port plug should be left in to prevent contamination of the port. Do not use reflow solder processes (i.e., infrared reflow or vapor-phase reflow). Nonhalogenated water soluble fluxes (i.e., 0% chloride), not rosin based fluxes, are recommended for use with Versatile Link components.

Versatile Link components are moisture sensitive devices and are shipped in a moisture sealed bag. If the components are exposed to air for an extended period of time, they may require a baking step before the soldering process. Refer to the special labeling on the shipping tube for details.

Recommended Chemicals for Cleaning/Degreasing

Alcohols: methyl, isopropyl, isobutyl. Aliphatics: hexane, heptane. Other: soap solution, naphtha.

Do not use partially halogenated hydrocarbons such as 1,1,1 trichloroethane, ketones such as MEK, acetone, chloroform, ethyl acetate, methylene dichloride, phenol, methylene chloride, or N-methylpyrrolidone. Also, Avago does not recommend the use of cleaners that use halogenated hydrocarbons because of their potential environmental harm.

Figura 4: Página 2 especificaciones transmisor y receptor.

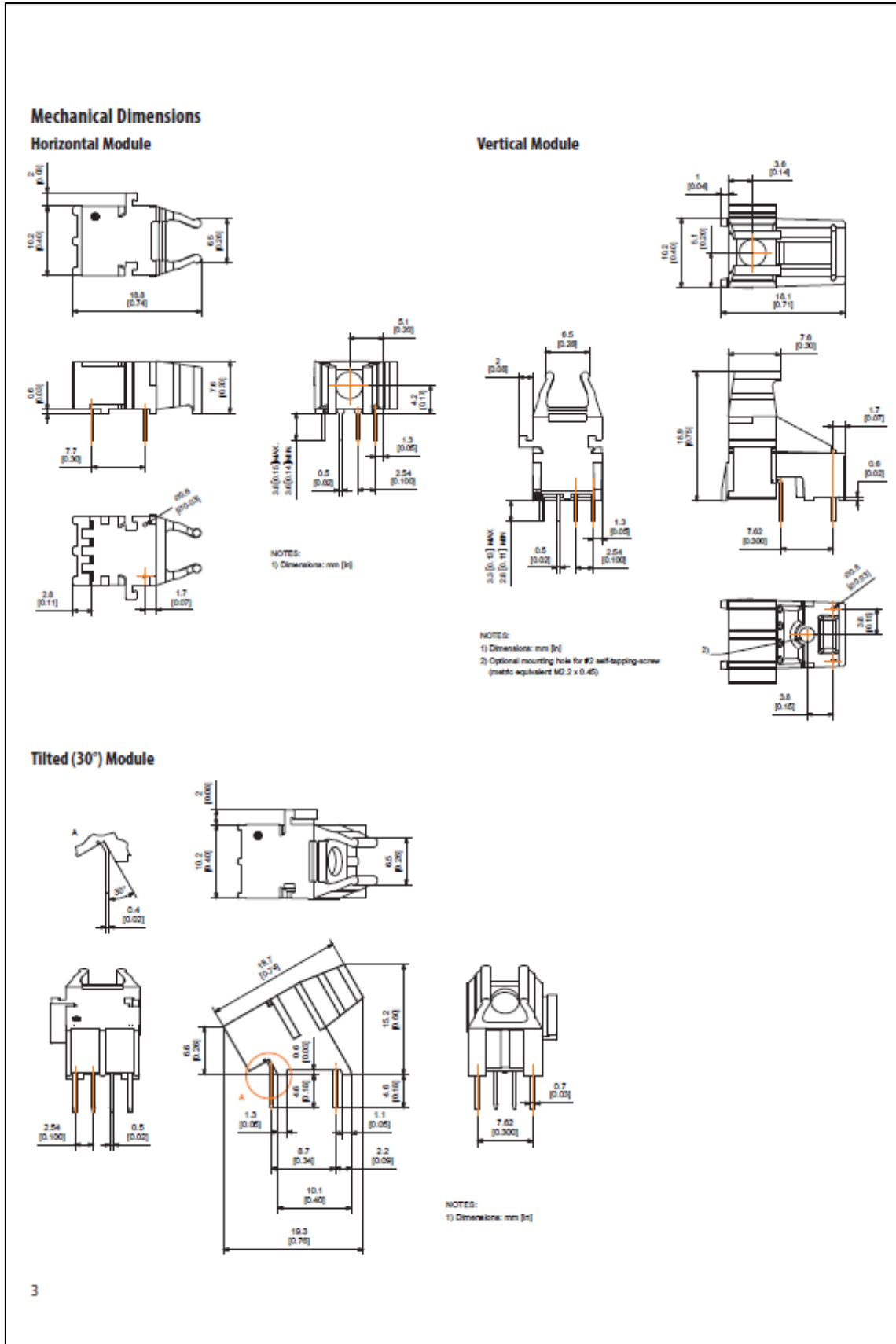


Figura 5: Pagina 3 especificaciones transmisor y receptor.

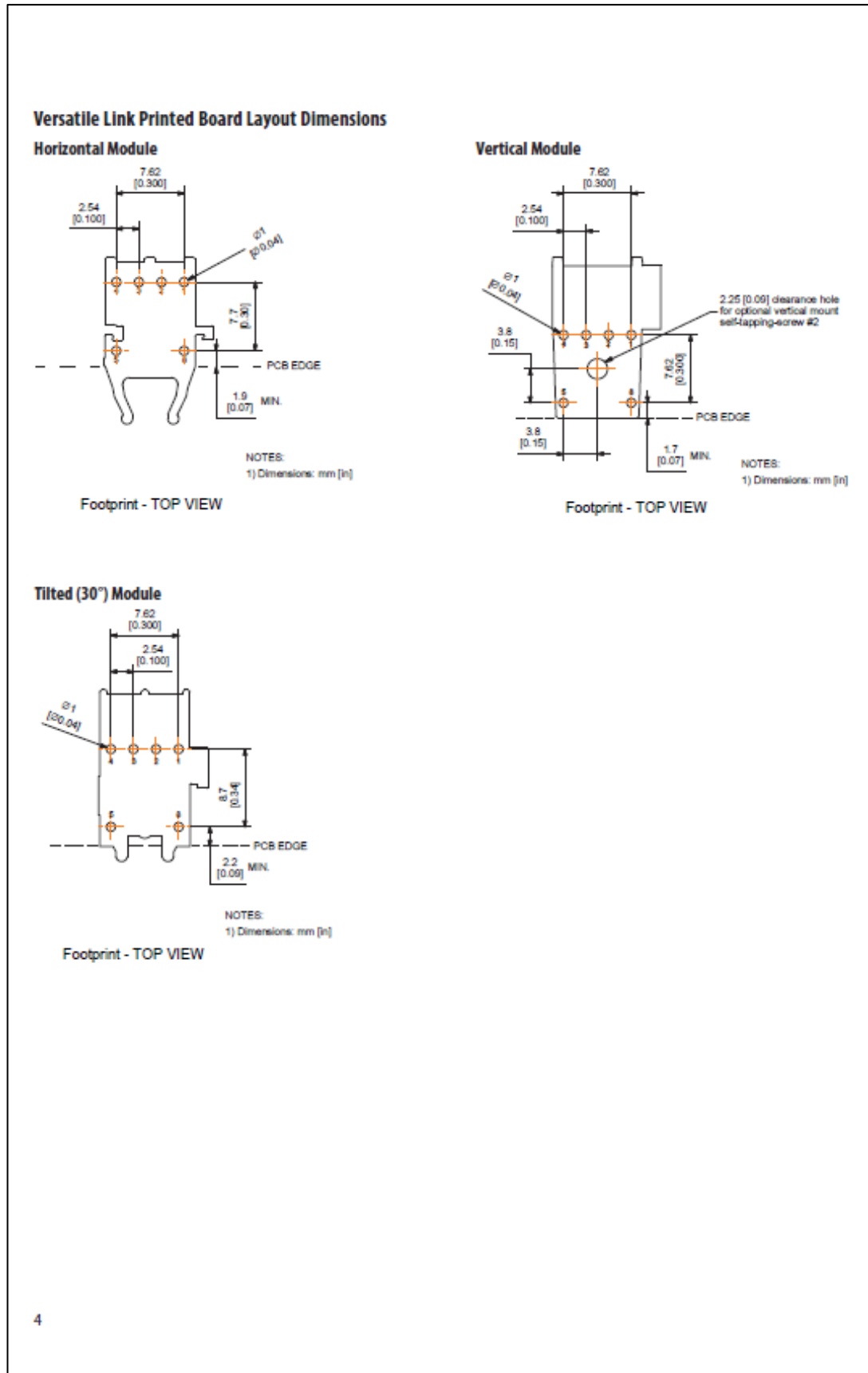


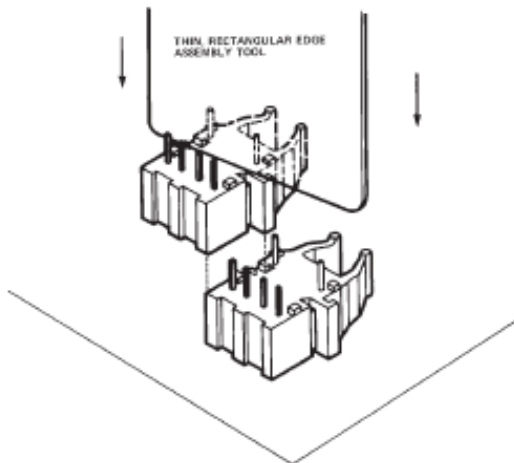
Figura 6: Pagina 4 especificaciones transmisor y receptor.

Interlocked (Stacked) Assemblies (refer to Figure 1)

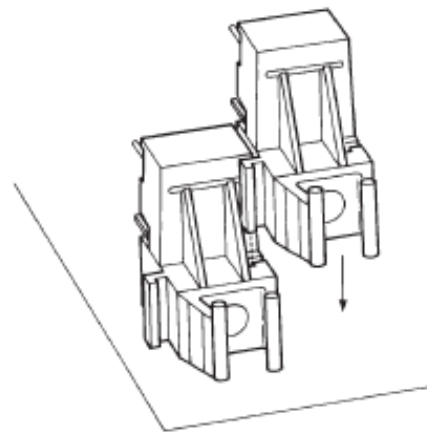
Horizontal packages may be stacked by placing units with pins facing upward. Initially engage the interlocking mechanism by sliding the L bracket body from above into the L slot body of the lower package. Use a straight edge, such as a ruler, to bring all stacked units into uniform alignment. This technique prevents potential harm that could occur to fingers and hands of assemblers from the package pins. Stacked horizontal packages can be disengaged if necessary. Repeated stacking and unstacking causes no damage to individual units.

To stack vertical packages, hold one unit in each hand, with the pins facing away and the optical ports on the bottom. Slide the L bracket unit into the L slot unit. The straight edge used for horizontal package alignment is not needed.

Stacking Horizontal Modules



Stacking Vertical Modules



Tilted (30°) Module

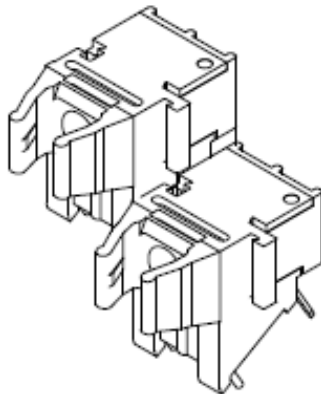


Figure 1. Interlocked (stacked) Horizontal, Vertical and Tilted (30°) packages

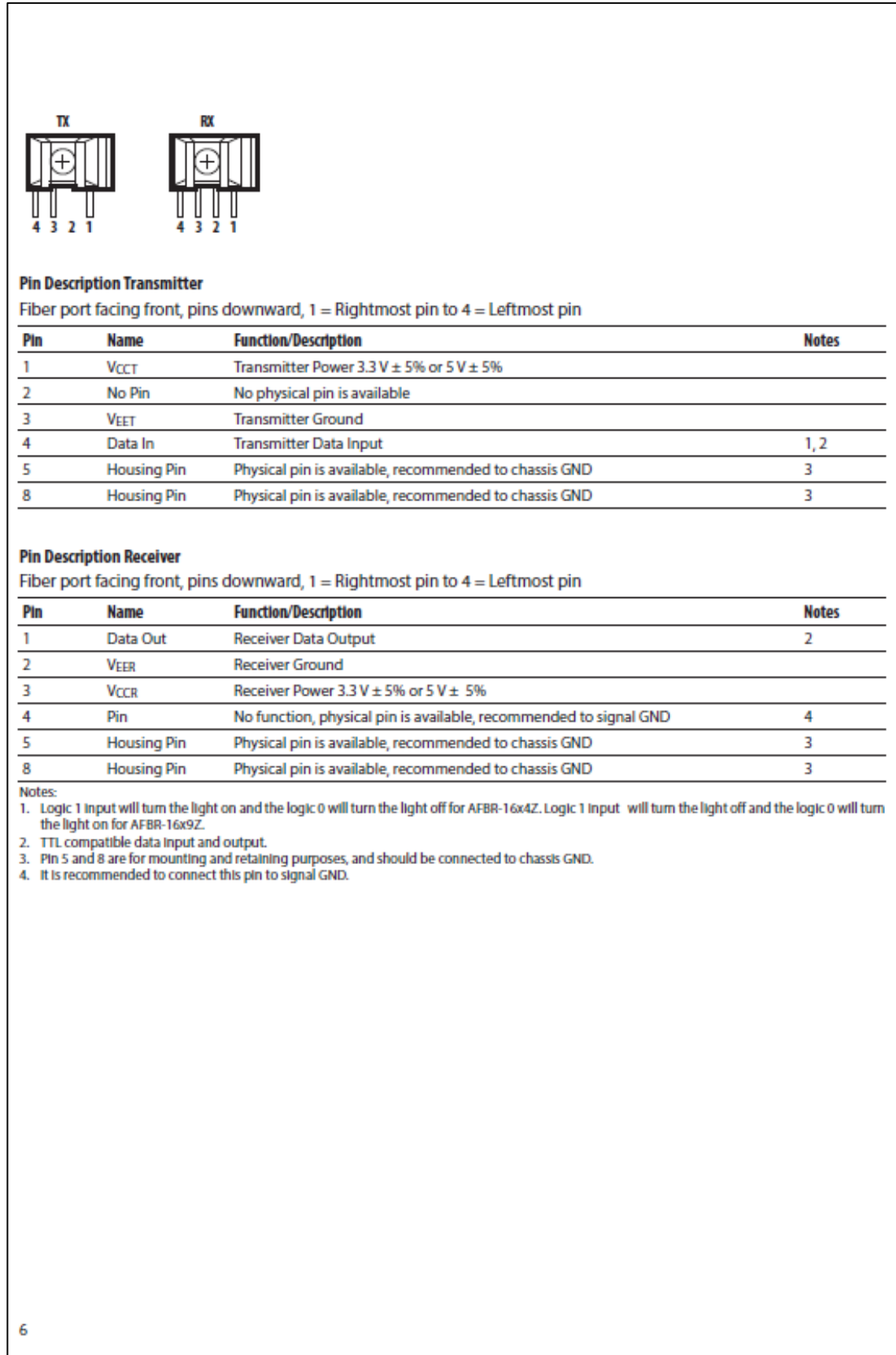


Figura 8: Pagina 6 especificaciones transmisor y receptor.

Regulatory Compliance

Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the Electrical Pins Human Body Model	MIL-STD-883 Method 3015	Min ± 2000 V
Eye Safety	IEC 60825-1, 2, Class 1	

Specified Link Performance, $T_A = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$, 50 MBd

Parameter	Min	Max	Unit	Condition	Notes
Link Distance with Standard POF cable	0.1	50	meters	$-40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$	1, 3
Link distance with 200 μm PCS (10 MBd)	0.1	200	meters	$-40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$	2, 3
Link distance with 200 μm PCS (50 MBd)	0.1	120	meters	$-40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$	2, 3

Notes:

1. HFBR-R/EXXXXX is the part number for 1 mm POF. Worst-case attenuation used (0.27 dB/m for standard loss POF cable from $-40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$ at 660 nm).
2. PCS, worst-case attenuation (12 dB/km from $-40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$ at 650 nm).
3. The optical link performance is guaranteed only with transmitters AFBR-16xxZ and receivers AFBR-26x4Z/25x9Z.

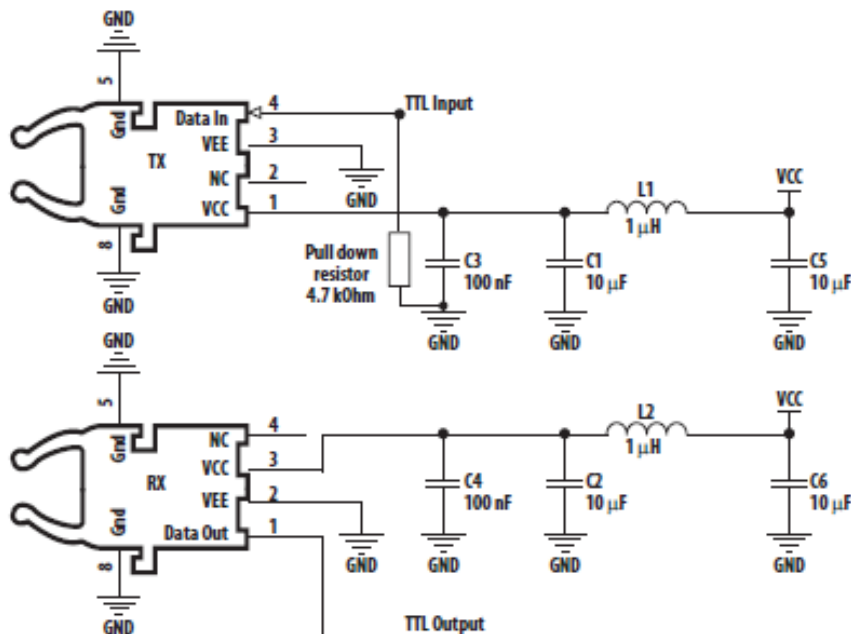


Figure 2. Recommended Transmitter and Receiver Application Circuit

Absolute Maximum Ratings						
Parameter	Symbol	Min	Typical	Max	Unit	Notes
Storage Temperature	T _s	-40		85	°C	1
Ambient Temperature	T _c	-40		85	°C	1
Relative Humidity	RH	0		85	%	1
Supply Voltage	V _{CC1} / V _{CC2}	-0.5		6	V	1
Data Input Voltage	V _{IN}	-0.5		V _{CC} +0.5	V	1
Data Output Current	I _O			10	mA	1
Data Rate		DC		50	MBd	

Notes:
1. Absolute Maximum Ratings are those values beyond which damage to the device may occur if these limits are exceeded for other than a short period of time.

Recommended Operating Conditions						
Parameter	Symbol	Min	Typical	Max	Unit	Notes
Ambient Temp	T _A	-40	25	85	°C	2
Supply Voltage	V _{CC1} / V _{CC2}	3.135	3.3	3.465	V	2
		4.75	5	5.25	V	2

Notes:
2. Recommended operating conditions are those values outside of which functional performance is not intended, device reliability is not implied, and damage to the device may occur over an extended period of time. See Reliability Data Sheet for specific reliability performance.

Process Compatibility						
Parameter	Symbol	Min	Typical	Max	Unit	Notes
Solder Environment	T _{SOLD}			260	°C	3, 5, 6
	t _{SOLD}			10	sec	4, 5, 6

Notes:
3. Maximum temperature refers to peak temperature.
4. Maximum time refers to time spent at peak temperature.
5. Solder surface to be at least 1mm below lead frame stops.
6. Product is moisture sensitive level 3.

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Figura 10: Pagina 8 especificaciones transmisor y receptor.

AFBR-16xxZ Transmitter

The AFBR-16xxZ transmitter incorporates a 650 nm LED and integrated driver IC in a light gray, nonconductive plastic Versatile Link housing. Its input data is compatible with TTL logic level. This transmitter can operate from DC to 50 MBd with any kind of data pattern using 1 mm Polymer Optical Fiber (POF). Within the specified ranges AFBR-16x4Z and AFBR-16x9Z devices will support a BER < 10E-9.

Transmitter Electrical Characteristics

($T_A = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$, $V_{CCCT} = 3.3\text{ V} \pm 5\%$ or $5\text{ V} \pm 5\%$)

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Supply Current (Optical Power ON)	I_{CCT}		21	31	mA	1
Input Voltage - Low	V_{IL}	-0.3		0.8	V	2
Input Voltage - High	V_{IH}	2.0		$V_{CC}+0.3$	V	2
Data Input Capacitance	C_{IN}			7	pF	
Data Input Resistance	R_{IN}	2			k Ω	
Propagation Delay	t_{PD}			30	ns	

Transmitter Optical Characteristics

($T_A = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$, $V_{CCCT} = 3.3\text{ V} \pm 5\%$ or $5\text{ V} \pm 5\%$)

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Output Optical Power (peak), 1 mm POF	P_N	-4.5	-2	+2	dBm	3
Output Optical Power (peak), PCS (200 μm)	P_N	-16.5	-13	-9	dBm	3
Output Optical Power (Average), OFF	P_S			-50	dBm	
Extinction Ratio	ER	10			dB	
Peak Wavelength	λ_c	630		685	nm	
Rise Time (20%–80%)	t_{RT}			5	ns	
Fall Time (20%–80%)	t_{FT}			5	ns	
Pulse Width Distortion	PWD	-3		+3	ns	4, 5
Pulse Width Distortion of first pulse	PWD	-5		+3	ns	5, 6

Notes:

1. For any type of data between DC and 50 Mbd. Typical value 21 mA for PRBS-7 pattern at 25 $^\circ\text{C}$ at 5 V and 50 Mbaud.
2. Standard TTL compatible input.
3. Measured with polished connector end face: after 1 meter 1 mm POF, NA = 0.5, or 200 μm PCS, NA = 0.37.
4. Pulse width is measured at 50% threshold using a rising edge trigger tested with PRBS-7 pattern
5. Electrical input pulse width is determined at 1.5 V and dU/dt between 1 V and 2 V shall not be less than 1 V/ns.
6. The first pulse is shorter as the LED is completely discharged. This helps to mitigate the increase of pulse width of the first pulse of the Receiver

Figura 11: Pagina 9 especificaciones transmisor y receptor.

AFBR-26x4Z/25x9Z Receiver

The AFBR-26x4Z/25x9Z receiver consists of a digitalizing IC with integrated photodiode to produce an output level that is compatible with TTL logic. The integrated photodiode and the following amplifier uses a fully differential approach with an active and a passive area for an improved EMI performance. Within the specified ranges AFBR-25x9Z and AFBR-26x4Z devices will support a BER $10E-9$.

Receiver Electrical Characteristics

($T_A = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$, $V_{CC1} = 3.3\text{ V} \pm 5\%$ or $5\text{ V} \pm 5\%$)

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Supply Current	I_{CCR}		20	30	mA	
Data Output Voltage – Low	V_{OL}	-0.3		0.4	V	1, 3
Data Output Voltage – High	V_{OH}	2.5		$V_{CC1}+0.3$	V	1, 3
Rise Time (10%–90%)	t_{RR}			5	ns	2, 3
Fall Time (10%–90%)	t_{FR}			5	ns	2, 3
Pulse Width Distortion	PWD	-4		+4	ns	3, 6, 7, 8, 11
Pulse Width Distortion 1 st to 3 rd pulse	PWD_{init}	-5		+8	ns	3, 8, 9, 11
Propagation Delay	t_{RD}			30	ns	
Max. Initiation time after Power up	T_{INT}			15	ms	12

Receiver Optical Characteristics

($T_A = -40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$, $V_{CC1} = 3.3\text{ V} \pm 5\%$ or $5\text{ V} \pm 5\%$)

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Input Optical Power (Peak), 1 mm POF	P_{IN}	-22		+2	dBm	3
Input Optical Power (Peak) Off-State, 1 mm POF	P_{IN_Off}	-40			dBm	3, 10
Input Optical Power (Peak), PCS (200 μm)	P_{IN}	-25		-1	dBm	3
Input Optical Power (Peak) Off-State, PCS (200 μm)	P_{IN_Off}	-44			dBm	3
Optical Spectrum Range	λ	630		685	nm	

Notes:

- Standard TTL output.
- Measured with $R_L = 50\text{ k}\Omega$ and $C_L = 15\text{ pF}$.
- Guaranteed only if optical input signal to the receiver is generated by AFBR-16xxZ, with ideal alignment to photo diode using 1mm POF (NA=0.5).
- Optical input signal of 50 MBd, PRBS 2⁷-1 pattern and 50% duty cycle.
- Pulse width is measured at 50% threshold using a rising edge trigger and PRBS 2⁷-1 pattern.
- If data rate is below 1MBd the pulse width distortion would be equal to the pulse width distortion of the 1st to 3rd pulses for higher data rates.
- The threshold of the 1st pulse of a data sequence is difficult to adjust and therefore the pulse width distortion up to the 3rd pulse is higher than for all other pulses (worst case for the 1st pulse). This strongly depends on the quality of the rising and falling edge of the optical input. The faster the edges the smaller the pulse width variation. Furthermore lower data rates would result in the same issue as all the pulse become 1st pulses.
- Output low for AFBR-26x4Z and Output high for AFBR-25x9Z.
- Because of optical pulse width spreading, the PWD limits have to be increased by $\pm 0.1\text{ ns}$ for each 10 m fiber length.
- Starting point is when supply voltage passes -2.8 V .

Figura 12: Página 10 especificaciones transmisor y receptor.

7.2 ANEXO 2: ESPECIFICACIONES LATIGUILLO

- **Latiguillo (POF)** fabricante Broadcom Limited. Distribuido por la tienda DigiKey Electronics.
Referencia en la página web de DigiKey: 516-2088-ND
Referencia fabricante: HFBR-RLS001Z
Precio: 4,95 €/unidad



Figura 13: Latiguillo POF.

HFBR-RXXYYYYZ Series (POF)
HFBR-EXXYYYYZ Series (POF)
 Plastic Optical Fiber Cable and Accessories
 for Versatile Link

Data Sheet

Cable Description

The HFBR-R/EXXYYYYZ series of plastic fiber optic cables are constructed of a single step-index fiber sheathed in a black polyethylene jacket. The duplex fiber consists of two simplex fibers joined with a zipcord web.

Standard (Type="R") and Extra Low Loss (Type="E") cables comply with UL VW-1 flame retardant specification (UL file # E89328).

Cables are available in unconnected or connected options. Refer to the Ordering Guide for part number information.



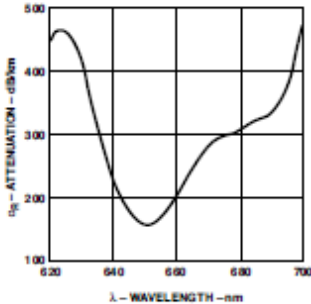



Figure 1. Typical POF attenuation vs. wavelength.



Features

- Compatible with Broadcom Versatile Link Family of connectors and fiber optic components
- 1 mm diameter Plastic Optical Fiber (POF) in 2 grades:
 - Standard POF with 0.22 dB/m typical attenuation (-40°C to 85°C)
 - High performance Extra Low Loss POF with 0.19 dB/m typical attenuation (-40°C to 85°C).

Applications

- Industrial data links for factory automation and plant control
- Intra-system links; board-to-board, rack-to-rack
- Telecommunications switching systems
- Computer-to-peripheral data links, PC bus extension
- Proprietary LANs
- Digitized video
- Medical instruments
- Reduction of lightning and voltage transient susceptibility
- High voltage isolation

Figura 14: Pagina 1 especificaciones latiguillo.

Plastic Optical Fiber Specifications: HFBR-R/EXXYYYZ							
Absolute Maximum Ratings							
Parameter		Symbol	Min.	Max.	Unit	Note	
Recommended Storage Temperature	(HFBR-R/EXXYYYZ)	T _s	-55	+85	°C		
Recommended Operating Temperature	(HFBR-R/EXXYYYZ)	T _o	-40	+85	°C		
Recommended Installation Temperature	(HFBR-R/EXXYYYZ)	T _i	-20	+70	°C	1	
Short Term Tensile Force	Single Channel	F _T		50	N	2	
	Dual Channel	F _T		100	N		
Short Term Bend Radius		r	25		mm	3,4	
Long Term Bend Radius		r	35		mm		
Long Term Tensile Load		F _T		1	N		
Flexing				1000	Cycles	4	
UL VW-1 Flame Retardant							
Mechanical/Optical Characteristics, T_A = -40 to +85°C unless otherwise specified.							
Parameter		Symbol	Min.	Typ. ^[5]	Max.	Unit	Condition
Cable Attenuation Source: 660nm LED, 0.5 NA (HFBR-15xxZ) Length:50m	Standard Cable, Type="R"	α _c	0.15	0.22	0.27	dB/m	T _A =-40°C to +85°C
	Extra Low Loss, Type="E"		0.15	0.19	0.23		T _A =-40°C to +85°C
Reference Attenuation Source: 650nm, 0.5 NA (monochrometer) Length:50m	Standard Cable, Type="R"	α _R	0.12	0.19	0.24	dB/m	T _A =-40°C to +85°C
	Extra Low Loss, Type="E"		0.12	0.16	0.19		T _A =-40°C to +85°C
Numerical Aperture		NA	0.46	0.47	0.50		>2 meters
Diameter, Core and Cladding		DC	0.94	1.00	1.06	mm	
Diameter, Jacket		DJ	2.13	2.20	2.27	mm	Simplex Cable
Propagation Delay Constant		l/v		5.0		ns/m	Note 6
Mass per Unit Length/Channel				5.3		g/m	Without Connectors
Cable Leakage Current		IL		12		nA	50 kV, l = 0.3 meters
Refractive Index	Core	n		1.492			
	Cladding			1.417			
Notes:							
1. Installation temperature is the range over which the cable can be bent and pulled without damage. Below -20°C the cable becomes brittle and should not be subjected to mechanical stress.							
2. Short Term Tensile Force is for less than 30 minutes.							
3. Short Term Bend Radius is for less than 1 hour nonoperating.							
4. 90° bend on 25 mm radius mandrel. Bend radius is the radius of the mandrel around which the cable is bent.							
5. Typical data are at 25°C.							
6. Propagation delay constant is the reciprocal of the group velocity for propagation delay of optical power. Group velocity is v=c/n where c is the velocity of light in free space (3x10 ⁸ m/s) and n is the effective core index of refraction.							
7. Note that α _R rises at the rate of about 0.0067 dB/°C, where the thermal rise refers to the LED temperature changes above 25°C. Please refer to Figure 1 which shows the typical plastic optical fiber attenuation versus wavelength at 25°C.							

Figura 15: Pagina 2 especificaciones latiguillo.

Plastic Fiber Connector Styles

Connector Description

Four connector styles are available for termination of plastic optical fiber: simplex, simplex latching, duplex and duplex latching. All connectors provide a snap-in action when mated to Versatile Link components. Simplex connectors are color coded to facilitate identification of transmitter and receiver connections. Duplex connectors are keyed so that proper orientation is ensured during insertion. If the POF cable/connector will be used at extreme operating temperatures or experience frequent and wide temperature cycling effects, the cable/connector attachment can be strengthened with an RTV adhesive (see Plastic Connectoring Instructions for more detail). The connectors are made of a flame retardant VALOX UL94 V-0 material (UL file # E121562).

SIMPLEX CONNECTOR STYLES

HFBR-4501Z/4511Z – Simplex



SIMPLEX CRIMP RING, HFBR-4501Z

The simplex connector provides a quick and stable connection for applications that require a component-to-connector retention force of 8 Newtons (1.8 lb.). These connectors are available in gray (HFBR-4501Z) or blue (HFBR-4511Z). The simplex connector is compatible with horizontal or vertical or tilted packages.

HFBR-4503Z/4513Z – Simplex Latching

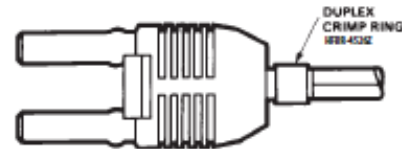


The simplex latching connector is designed for rugged applications requiring a greater retention force — 80 Newtons (18 lb.) — than provided by a simplex non-latching connector. When inserting the simplex latching connector into a module, the connector latch mechanism should be aligned with the top surface of the horizontal package, or with the tall vertical side of the vertical package or with top surface of tilted package. Misalignment of an inserted latching connector into either module will not result in a positive latch. The connector is released by depressing the rear section of the connector lever, and then pulling the connector assembly away from the module housing.

The simplex latching connector is available in gray (HFBR-4503Z) or blue (HFBR-4513Z).

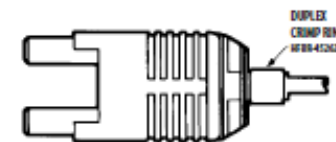
DUPLEX CONNECTOR STYLES

HFBR-4506Z – Duplex



Duplex connectors provide convenient duplex cable termination and are keyed to prevent incorrect insertion into duplex configured modules. The duplex connector is compatible with dual combinations of horizontal, vertical or tilted packages (e.g., two horizontal transmitters, two vertical receivers, a horizontal transmitter with a horizontal receiver, etc.). The duplex non-latching connector is available in parchment, off-white (HFBR-4506Z).

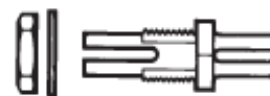
HFBR-4516Z – Duplex Latching



The duplex latching connector is designed for rugged applications requiring greater retention force than the nonlatching duplex connector. When inserting the duplex latching connector into a module, the connector latch mechanism should be aligned with the top surface of the dual combination of horizontal, vertical or tilted packages. The duplex latching connector is available in gray (HFBR-4516Z).

Feedthrough/Splice

HFBR-4505Z/4515Z Bulkhead Adapter



The HFBR-4505Z/4515Z adapter mates two simplex connectors for panel/bulkhead feedthrough of HFBR-4501Z/4511Z terminated plastic fiber cable. Maximum panel thickness is 4.1 mm (0.16 inch). This adapter can serve as a cable in-line splice using two simplex connectors. The adapters are available in gray (HFBR-4505Z) and blue (HFBR-4515Z). This adapter is not compatible with POF duplex, POF simplex latching, or HCS connectors.

Plastic Optical Fiber Connector Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Note
Storage and Operating Temperature	T_{SO}	-40	85	°C	1
Recommended Operating Temperature	T_O	-40	85	°C	1
Installation Temperature	T_I	0	70	°C	1
Nut Torque	T_N		0.7	N-m	2
HFBR-4505Z/4515Z Adapter			100	OzF-in.	

Notes:

- Storage and Operating Temperatures refer to the ranges over which the connectors can be used when not subjected to mechanical stress. Installation Temperature refers to the ranges over which connectors may be installed onto the fiber and over which connectors can be connected and disconnected from transmitter and receiver modules.
- Recommended nut torque is 0.57 N-m.

Plastic Optical Fiber Connector Mechanical/Optical Characteristics

$T_A = -40$ to $+85^\circ\text{C}$, Unless Otherwise Specified.

Parameter	Part Number	Symbol	Min.	Typ. ^[1]	Max.	Units	Temp. °C	Note	
Retention Force, Connector to Versatile Link Transmitters and Receivers	Simplex, HFBR-4501Z/4511Z	$F_{R,C}$	7	8		N	+25	2	
			3		-40 to +85				
	Simplex Latching, HFBR-4503Z/4513Z		47	80			+25		
			11				-40 to +85		
Tensile Force, Connector to Cable	Duplex, HFBR-4506Z	F_T	7	12		N	+25	3	
			4		-40 to +85				
	Duplex Latching, HFBR-4516Z		50	80			+25		
			15				-40 to +85		
Adapter Connector to Connector Loss	Simplex, HFBR-4501Z/4511Z	α_{CC}	8.5	22		dB	25	4, 5	
	Simplex Latching, HFBR-4503Z/4513Z			8.5	22				
	Duplex, HFBR-4506Z			14	35				
	Duplex Latching, HFBR-4516Z			14	35				
Retention Force Connector to Adapter	HFBR-4505Z/4515Z with HFBR-4501Z/4511Z	$F_{R,B}$	7	8		N			
Insertion Force, Connector to Versatile Link Transmitters and Receivers	Simplex, HFBR-4501Z/4511Z	F_I		8	30	N		6	
	Simplex Latching, HFBR-4503Z/4513Z				16				35
	Duplex, HFBR-4506Z				13				46
	Duplex Latching HFBR-4516Z				22				51

Notes:

- Typical data are at $+25^\circ\text{C}$.
- No perceivable reduction in retention force was observed after 2000 insertions. Retention force of non-latching connectors is lower at elevated temperatures. Latching connectors are recommended for applications where a high retention force at high temperatures is desired.
- For applications where frequent temperature cycling over temperature extremes is expected, please contact Broadcom Ltd. for alternate connecting techniques.
- Minimum and maximum limit for α_{CC} for 0°C to $+70^\circ\text{C}$ temperature range. Typical value of α_{CC} is at $+25^\circ\text{C}$.
- Factory polish or field polish per recommended procedure.
- Destructive Insertion force was typically at 178 N (40 lb.).

Figura 17: Pagina 4 especificaciones latiguillo.

Step-by-Step Plastic Cable Connectoring Instructions

The following step-by-step guide describes how to terminate plastic fiber optic cable. It is ideal for both field and factory installation. Connectors can be easily installed on cable ends with wire strippers, cutters and a crimping tool.

Finishing the cable is accomplished with the Broadcom AFBR-4594Z Polishing Kit, consisting of a Polishing Fixture, 600 grit abrasive paper and 3 μm pink lapping film (3M Company, OC3-14). The connector can be used immediately after polishing.

Materials needed for plastic fiber termination are:

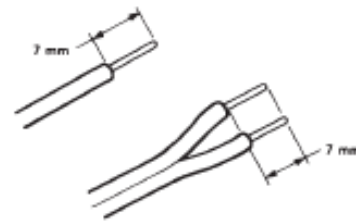
1. Broadcom Plastic Optical Fiber Cable (Example: HFBR-RUS500Z, HFBR-RUD500Z, HFBR-EUS500Z, or HFBR-EUD500Z)
2. Industrial Razor Blade or Wire Cutters
3. 16 Gauge Latching Wire Strippers (Example: Ideal Stripmaster™ type 45-092).
4. HFBR-4597Z Crimping Tool
5. AFBR-4594Z Polishing Kit
6. One of the following connectors:
 - a) HFBR-4501Z/4503Z Gray Simplex/Simplex Latching Connector and HFBR-4525Z Simplex Crimp Ring
 - b) HFBR-4511Z/4513Z Blue Simplex/Simplex Latching Connector and HFBR-4525Z Simplex Crimp Ring
 - c) HFBR-4506Z Parchment (off-white) Duplex Connector and HFBR-4526Z Duplex Crimp Ring
 - d) HFBR-4516Z Gray Latching Duplex Connector and HFBR-4526Z Duplex Crimp Ring

Step 1

The zip cord structure of the duplex cable permits easy separation of the channels. The channels should be separated a minimum of 100 mm (4 in) to a maximum of 150 mm (6 in) back from the ends to permit connectoring and polishing.

After cutting the cable to the desired length, strip off approximately 7 mm (0.3 in.) of the outer jacket with the 16 gauge wire strippers. Excess webbing on the duplex cable may have to be trimmed to allow the simplex or simplex latching connector to slide over the cable.

When using the duplex connector and duplex cable, the separated duplex cable must be stripped to equal lengths on each cable. This allows easy and proper seating of the cable into the duplex connector.



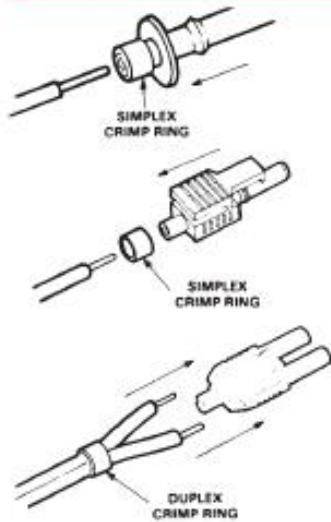
Step 2

Place the crimp ring and connector over the end of the cable; the fiber should protrude about 3 mm (0.12 in.) through the end of the connector. Carefully position the ring so that it is entirely on the connector with the rim of the crimp ring flush with the connector, leaving a small space between the crimp ring and the flange. Then crimp the ring in place with the crimping tool. One crimp tool is used for all POF connector crimping requirements.

For applications with extreme temperature operation or frequent temperature cycling, improved connector to cable attachment can be achieved with the use of an RTV (GE Company, RTV-128 or Dow Corning 3145-RTV) adhesive. The RTV is placed into the connector prior to insertion of the fiber and the fiber is crimped normally. The connector can be polished after the RTV has cured and is then ready for use.

Note: By convention, place the gray connector on the transmitter cable end and the blue connector on the receiver cable end to maintain color coding (different color connectors are mechanically identical).

Simplex connector crimp rings cannot be used with duplex connectors and duplex connector crimp rings cannot be used with simplex connectors because of size differences. The simplex crimp has a dull luster appearance; the duplex ring is glossy and has a thinner wall.



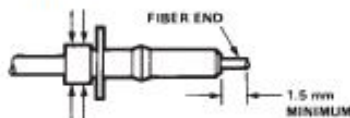
Step 3

Any excess fiber protruding from the connector end may be cut off; however, the trimmed fiber should extend at least 1.5 mm (0.06 in) from the connector end.

Insert the connector fully into the polishing fixture with the trimmed fiber protruding from the bottom of the fixture. This plastic polishing fixture can be used to polish two simplex connectors or simplex latching connectors simultaneously, or one duplex connector.

Note: The four dots on the bottom of the polishing fixture are wear indicators. Replace the polishing fixture when any dot is no longer visible. Typically, the polishing fixture can be used 10 times; 10 duplex connectors or 20 simplex connectors, two at a time.

Place the 600 grit abrasive paper on a flat smooth surface, pressing down on the connector, polish the fiber and the connector using a figure eight pattern of strokes until the connector is flush with the bottom of the polishing fixture. Wipe the connector and fixture with a clean cloth or tissue.



Step 4

Place the flush connector and polishing fixture on the dull side of the 3 μm pink lapping film and continue to polish the fiber and connector for approximately 25 strokes. The fiber end should be flat, smooth and clean.

This cable is now ready for use.

Note: Use of the pink lapping film fine polishing step results in approximately 2 dB improvement in coupling performance of either a transmitter-receiver link or a bulkhead/splice over a 600 grit polish alone. This fine polish is comparable to the Broadcom factory polish. The fine polishing step may be omitted where an extra 2 dB of optical power is not essential, as with short link lengths. Proper polishing of the tip of the fiber/connector face results in a tip diameter between 2.5 mm (0.098 in.) minimum and 3.2 mm (0.126 in.) maximum..

AFBR-4594Z Polishing Kit

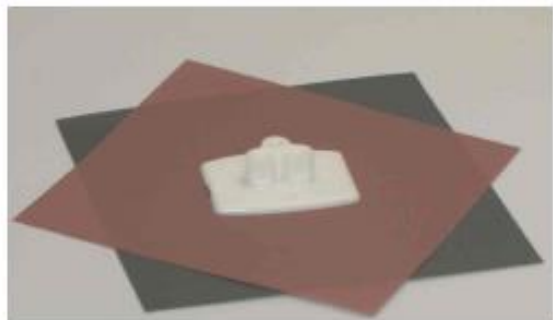


Figura 19: Pagina 6 especificaciones latiguillo.

Ordering Guide for POF Connectors and Accessories

Plastic Optical Fiber Connectors

HFBR-4501Z	Gray Simplex Connector/Crimp Ring
HFBR-4511Z	Blue Simplex Connector/Crimp Ring
HFBR-4503Z	Gray Simplex Latching Connector with Crimp Ring
HFBR-4513Z	Blue Simplex Latching Connector with Crimp Ring
HFBR-4506Z	Parchment Duplex Connector with Crimp Ring
HFBR-4516Z	Gray Duplex Latching Connector with Crimp Ring
HFBR-4505Z	Gray Adapter (Bulkhead/Feedthrough)
HFBR-4515Z	Blue Adapter (Bulkhead/Feedthrough)

Plastic Optical Fiber Accessories

HFBR-4522Z	500 HFBR-0500 Products Port Plugs
HFBR-4525Z	1000 Simplex Crimp Rings
HFBR-4526Z	500 Duplex Crimp Rings
AFBR-4594Z	Polishing Kit (one polishing tool, two pieces 600 grit abrasive paper, and two pieces 3 µm pink lapping film)
HFBR-4597Z	Plastic Fiber Crimping Tool

Ordering Guide for POF Cable

For Example:

HFBR-RUD500Z is a Standard Attenuation, Unconnected, Duplex, 500 meter cable.

HFBR-RLS001Z is a Standard Attenuation, Latching Simplex Connected, Simplex, 1 meter cable.

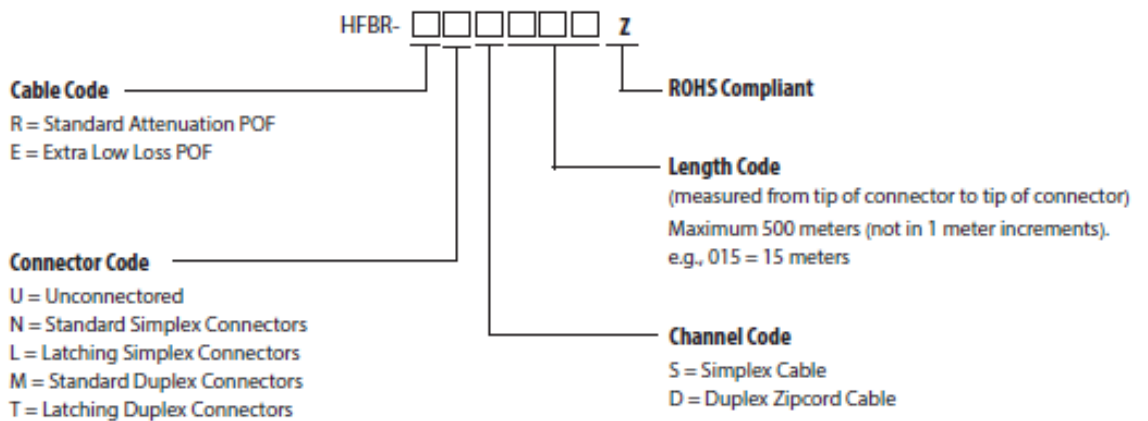
HFBR-RMD010Z is a Standard Attenuation, Standard Duplex Connected, Duplex, 10 meter cable.

HFBR-RMD100Z is a Standard Attenuation, Standard Duplex Connected, Duplex, 100 meter cable.

Cable Length Tolerances:

The plastic cable length tolerances are: +10%/-0%.

NOTE: By convention, pre-connected simplex POF cables have gray and blue colored connectors on the opposite ends of the same fiber; although oppositely colored, the connectors are mechanically identical. Duplex POF cables with duplex connectors use color-coded markings on the duplex fiber cable to differentiate between the channel.



Note: Not all possible combinations reflect available part numbers. Please contact your local Broadcom Ltd. representative for a list of current available cable part numbers.

Figura 20: Pagina 7 especificaciones latiguillo.

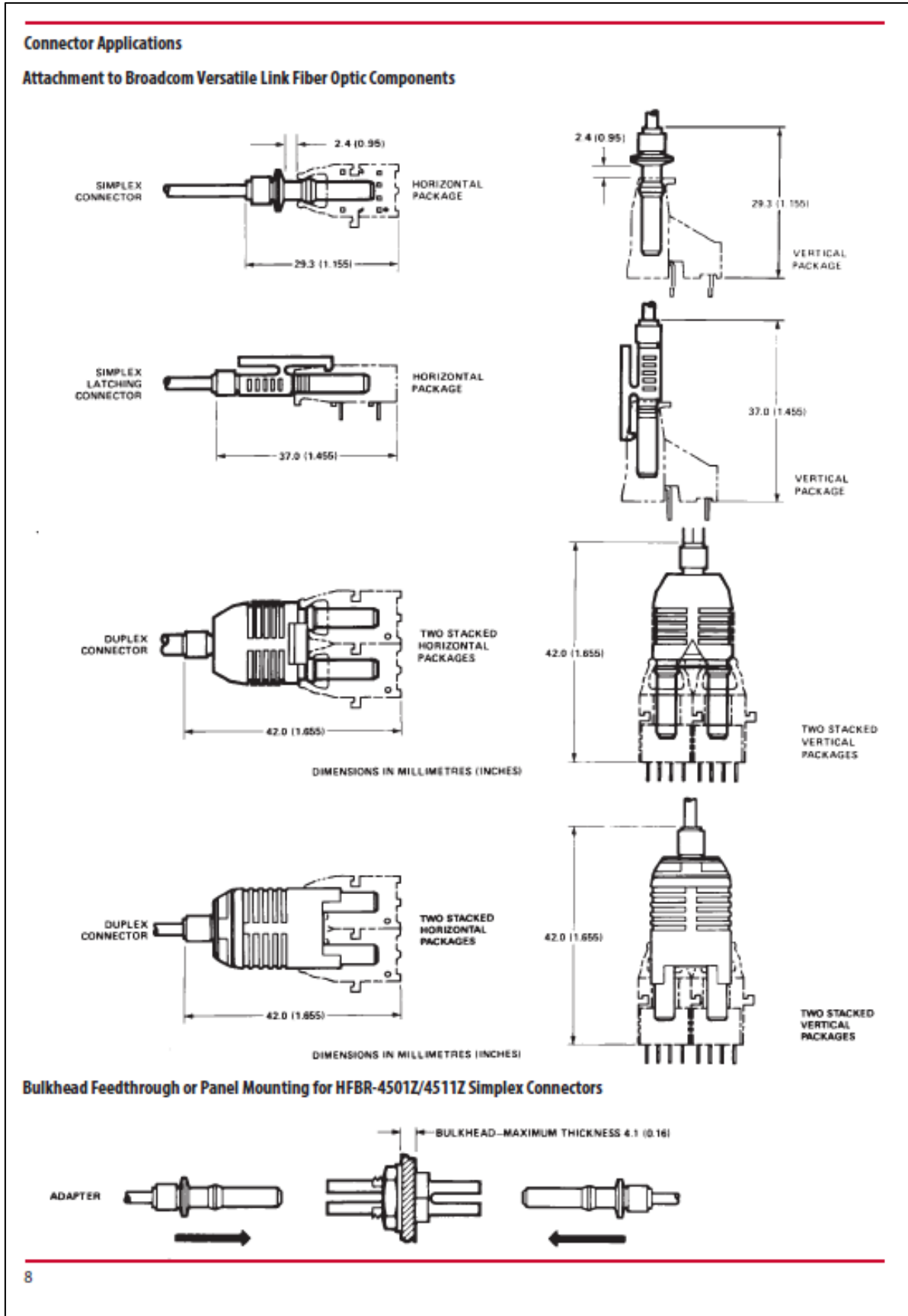


Figura 21: Pagina 8 especificaciones latiguillo.

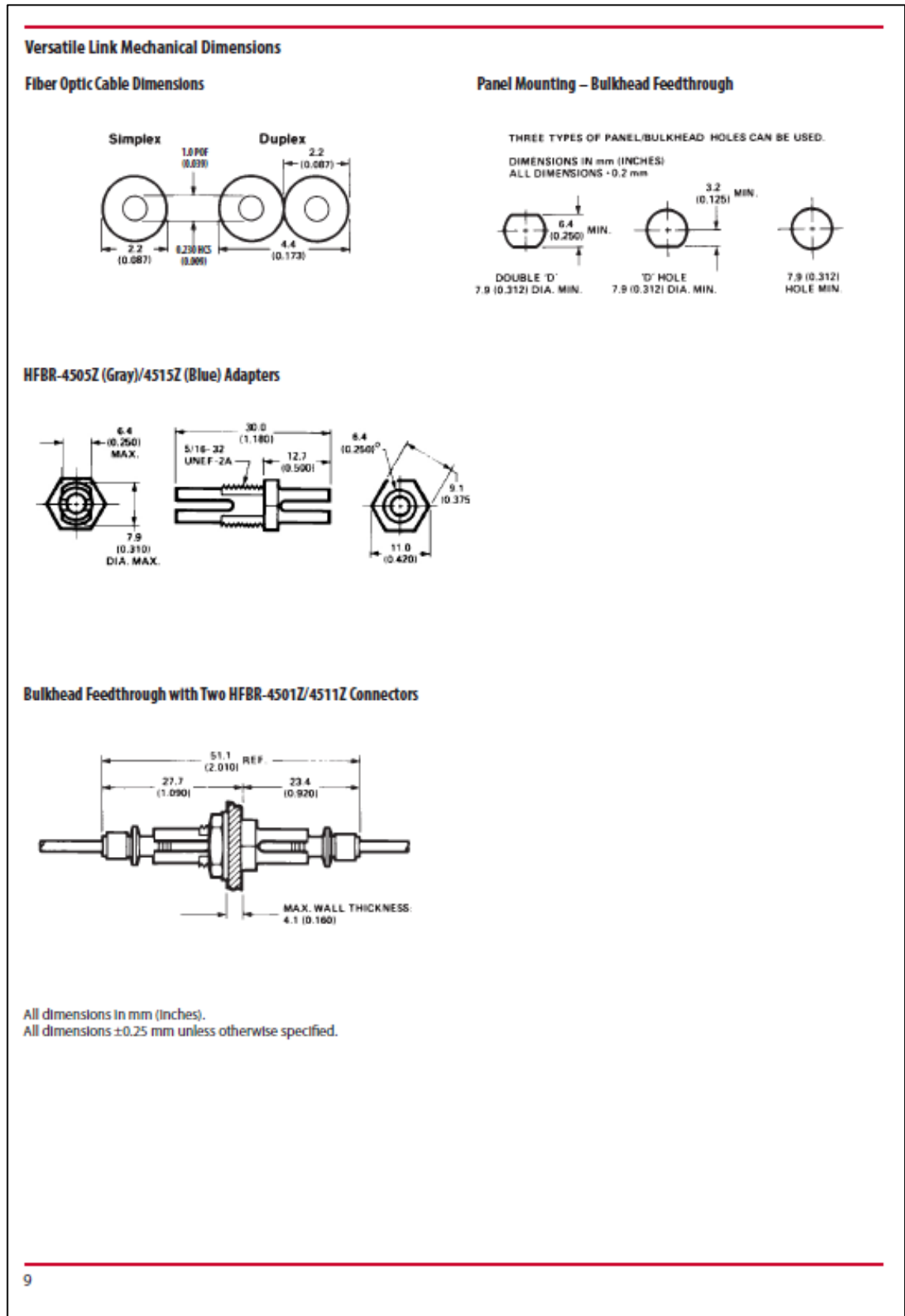
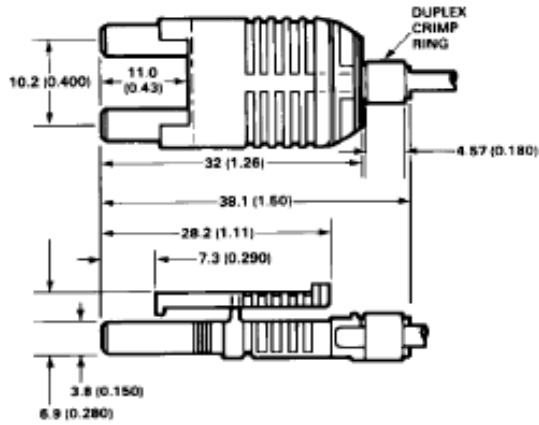


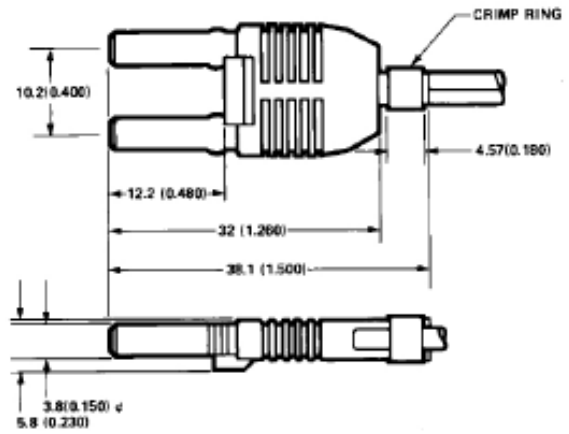
Figura 22: Pagina 9 especificaciones latiguillo.

Versatile Link Mechanical Dimensions, continued

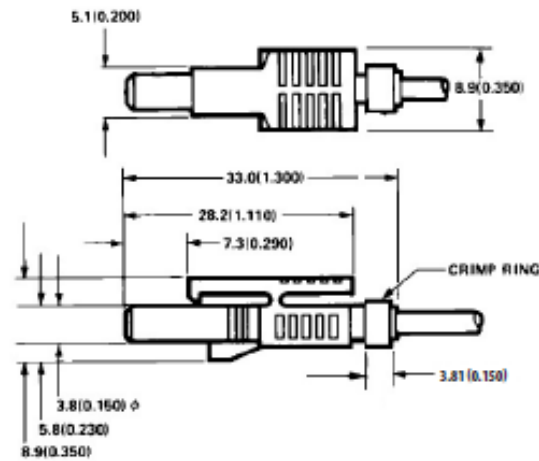
HFBR-4516Z (Parchment) Duplex Latching Connector



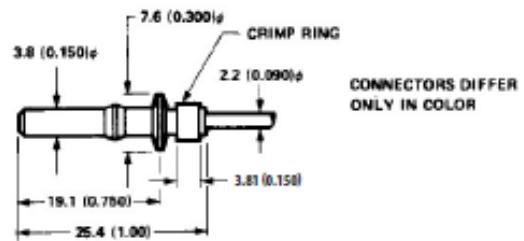
HFBR-4506Z (Parchment) Duplex Connector



HFBR-4503Z (Gray)/4513Z (Blue) Simplex Latching Connector



HFBR-4501Z (Gray)/4511Z (Blue) Simplex Connector



CONNECTORS DIFFER
ONLY IN COLOR

All dimensions in mm (Inches).
All dimensions ±0.25 mm unless otherwise specified.

Figura 23: Pagina 10 especificaciones latiguillo.



Figura 24: Página 11 especificaciones latiguillo.