HEWLETT PACKARD

VERSATILE LINK
The Versatile Fiber Optic Connection

HFBR-0501 SERIES

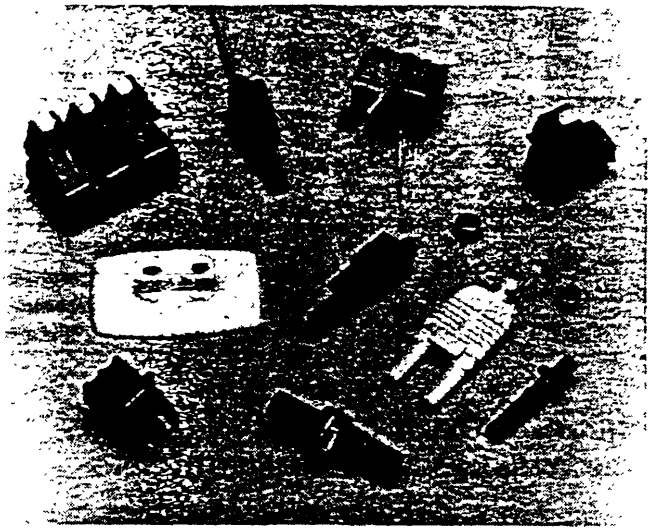
327-750 TO 890

Features

- LOW COST FIBER OPTIC COMPONENTS
- GUARANTEED LINK PERFORMANCE OVER TEMPERATURE
  High Speed Links: dc to 5 MBd
  Extended Distance Links: up to 82 m
  Low Current Link: 6 mA Peak Supply Current
  Low Cost Standard Link: dc to 1 MBd
  Photo Interrupter Link
- COMPACT, LOW PROFILE PACKAGES
  Horizontal and Vertical Mounting
  "N-plex" Stackable
  Flame Retardant
- EASY TO USE RECEIVERS
  TTL, CMOS Compatible Output Level
  High Noise Immunity
- EASY CONNECTORING
  Simplex, Duplex and Latching Connectors
  Flame Retardant Material
- LOW LOSS PLASTIC CABLE
  Selected Super Low Loss Simplex
  Simplex and Zip Cord Style Duplex
  Flame Retardant
- NO OPTICAL DESIGN REQUIRED
- AUTO-INSERTABLE AND WAVE SOLDERABLE
- DEMONSTRATED RELIABILITY @ 40°C EXCEEDS 2 MILLION HOURS MTBF

Description

The Versatile Link series is a complete family of fiber opt
link components for applications requiring a low co
solution. The HFBR-0501 series includes transmitters, r
ceivers, connectors and cable specified for easy desig
This series of components is ideal for solving problem
with voltage isolation/insulation, EMI/RFI immunity or da
security. The Link design is simplified by the logic com
patible receivers and complete specifications for ea
component. No optical design is necessary. The key optic
and electrical parameters of links configured with t
HFBR-0501 family are fully guaranteed from 0° to 70°C.
wide variety of package configurations and connecto
provide the designer with numerous mechanical solutio
to meet application requirements. The transmitter ar
receiver components have been designed for use in hig
volume/low cost assembly processes such as aut
insertion and wave soldering.



Versatile Link Applications

- Reduction of lightning/voltage transient susceptability
- Motor controller triggering
- Data communications and Local Area Networks
- Electromagnetic Compatibility (EMC) for regulated systems: FCC, VDE, CSA, etc.
- Tempest—secure data processing equipment
- Isolation in test and measurement instruments
- Error free signalling for industrial and manufacturing equipment
- Automotive communications and control networks
- Power supply control
- Communication and isolation in medical instruments
- Noise immune communication in audio and video equipment
- Remote photo interrupter for office and industrial equipment
- Robotics communication
- PC to peripheral links

FIBER OPTICS

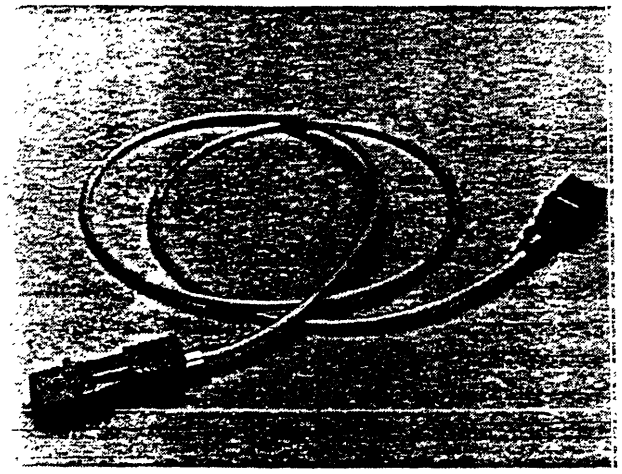
Link Selection Guide

Specific Product Numbers and Component Selection Gu de on page 23.

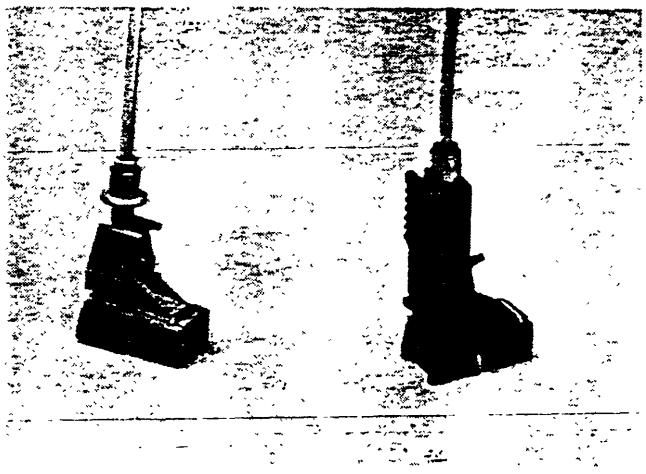
Versatile Link		Guarante d Minimum Link Length Metres				Typical Link Length Metres		Page
		0°C - 70°C		25°C		25°C		
		Standard Cable	Imp oved C ble	Standard Cable	Improved Cable	Standard Cable	Improved Cable	
High Performance	5 MBd	12	7	17	24	35	40	5-14
High Performance	1 MBd	24	4	30	41	50	65	5-14
Low Current Link	40 kBd	8	1	—	—	30	35	5-14
Extended Distance Link	40 kBd	60	2	65	90	100	125	5-14
Standard	1 MBd	5		11	15	30	40	5-14
Photo Interrupter	500 kHz	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5-20
Evaluation Kit	1 MBd (Standard)	Contents: Hor ontal transmitter, horizontal receiver packages; 5 metres of sim ex cable with simplex and simplex latching connectors install d; individual connectors: simplex, duplex, simplex latching, bulkh ad adapter; polishing tool, abrasive paper, literature.						5-34

Versatile Link Product Family

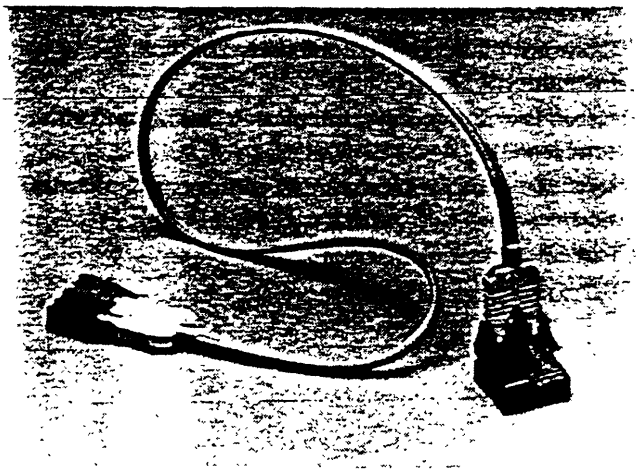
5 MBd, 1 MBd and 40 kBd FIBER OPTIC LINKS



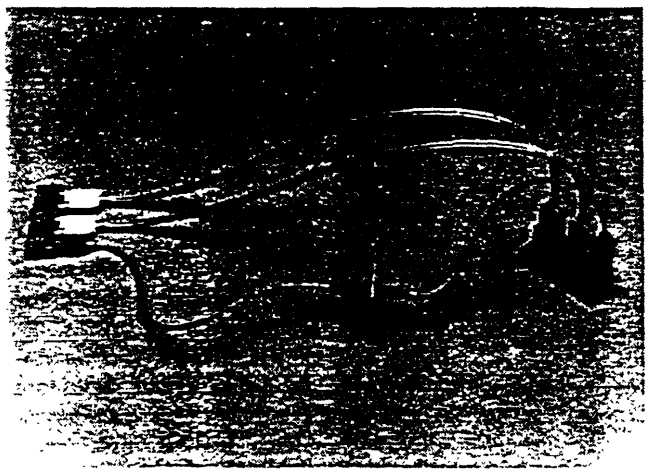
Simplex Link — Horizontal Packages



Simplex Link — Vertical Packages



Duplex Link — Combination of Horizontal & Vertical Packages



N-Plex Link — Combinations

Table of Contents

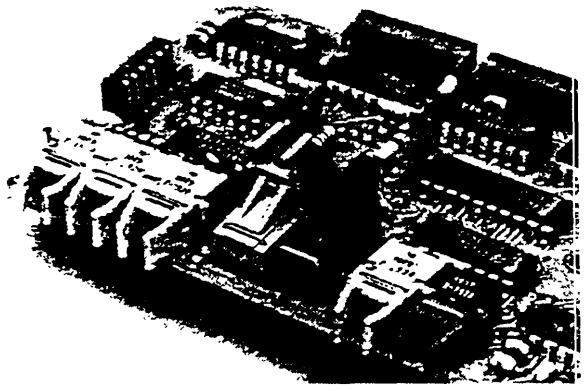
Versatile Link Product Description

Mechanical: The compact Versatile Link package is ma. e of a flame retardant material (UL V-0) in a standard, eig t pin dual-in-line package (DIP) with 7.6 millimetre (0.3 inc) pin spacing. Vertical and horizontal mountable parts a e available. These low profile Versatile Link packages a e stackable and are enclosed to provide a dust resistant se . Snap action simplex, simplex latching, duplex, and dupl c latching connectors are offered with simplex or dupl c cables.

Electrical: Transmitters incorporate a 660 nanometre lig t emitting diode (LED). Receivers include a monolithic c : coupled, digital IC receiver with open collector Schottl r output transistor. An internal pullup resistor is available r use in the HFBR-25X1/2/4 receivers. Transmitter and r - ceiver are compatible with standard TTL circuitry. A shie l has been integrated into the receiver IC to provide a - ditional, localized noise immunity.

Optical: Internal optics have been optimized for use w 1 mm diameter plastic optical fiber. Versatile Link specific tions incorporate all component interface losses. Therefo the need of optical calculations for common link applic tions is eliminated.

Optical power budget is graphically displayed to facilita electrical design for customized links.



Designing with Versatile Link

When designing with Versatile Link, the following topics should be considered:

Distance and Data Rate

Distances and data rates guaranteed with Versatile Link depend upon the Versatile Link transmitter/receiver pair chosen. See the Versatile Link guide (page 5-14).

Typically, a data rate requirement is first specified. This determines the choice of the 5 MBd, 1 MBd or 40 kBd Versatile Link components. Distances guaranteed with Versatile Link then depend upon choice of cable, specific drive condition and circuit configuration. Extended distance operation is possible with pulsed operation of the LED (see Figure 2a, 2b, 2c, 2d, 2e and 2f dotted lines.)

Drive circuits are described on page 5-17. Cable is discussed on page 5-29. Pulsed operation of the LED at larger current will result in increased pulse width distortion of the receiver output signal.

Versatile Link can also be used as a photo interrupter at frequencies up to 500 KHz. This is described on page 10.

Package Orientation

As shown in the photograph, Versatile Link is available in vertical and horizontal packages. Performance and pinouts for the two 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. The HFBR-15X1/2/4 transmitters are gray, and the HFBR-25X1/2/3/4 receivers are blue. The HFBR-15X3 transmitter is black.

All of the above transmitters and receivers are also available in black versions for special applications. These black components, combined with black fiber optic cable, form a "black link" which has superior immunity to external light. The black link is appropriate where improved housing opacity is required due to very bright ambient light or bright flashes of light. Black link components are otherwise identical to blue and gray components.

Connector Style

As shown, Versatile Link can be used with snap-in connectors: simplex, simplex latching, duplex, and duplex latching.

The simplex connector is intended for applications requiring simple, stable connection capability with a moderate retention force. The simplex latching connector provides similar convenience with a larger retention force. Connector/cable retention force can be improved by using a RTV adhesive within the connector. A suggested adhesive is 3M Company product RTV-739.

The duplex connector connects a cable containing two fibers to two similar Versatile Link components. A lockout feature ensures the connection can be made in only one orientation. The duplex connector is intended for Versatile Link components "n-plexed" together, as discussed in the next section.

N-plexing
Versatile Link components can be stacked or interlocke (n-plexed) together to minimize use of printed circuit boa space and to provide efficient, dual connections via th duplex connector. Up to eight identical package styles ca be n-plexed and inserted by hand into a printed circu board without difficulty. However, auto-insertability stacked units becomes limited when more than two pac ages are n-plexed together.

Cable
Two cable versions are available: Simplex (single channe and color coded duplex (dual channel). Each version of th cable is flame retardant (UL VW-1) and of low optical loss.

Two grades of the simplex cable are available: standa cable and improved cable. Improved cable is recommende for applications requiring longer distance needs, as reflecte in the Link Selection Guide on page 5-12. Flexible cab construction allows simple cable installation techniqu Cables are discussed in detail on page 5-29.

Accessories
A variety of accessories are available. The bulkhead fee through adapter discussed on page 5-30 can be used to mate two simplex snap-in connectors. It can be used either as a splice or a panel feedthrough for a panel thickness < 4.1 mm (0.16 inch).

Several accessories are offered to help with proper fiber/ connector polishing. These are shown on page 5-31.

Manufacturing with Versatile Link

Non-stacked Versatile Link parts require no special handling during assembly of units onto printed circuit boards. Versatile Link components are auto-insertable. When wave soldering is performed with Versatile Link components, an optical port plug is recommended to be used to prevent contamination of the port. Water soluble fluxes, not rosin based fluxes, are recommended for use with Versatile Link components.

Refer to the Connectoring Section on page 5-33 for details of connectors and cable connectoring.

Versatile Link Performance

5 MEGABITS PER SECOND (NRZ)
1 MEGABIT PER SECOND (NRZ)
40 KILOBITS PER SECOND (NRZ)

The 5 Megabaud (MBd) Versatile Link is guaranteed perform from dc to 5 Mb/s (megabits per second, NR Distances up to 17 metres are guaranteed when the tran mitter is driven with a current of 60 milliamperes. Th represents worst case performance throughout the temp ature range of 0 to 70 degrees centigrade. With the requir drive circuit of Figure 1b and at 60 milliamp drive curre the 1 Megabaud Versatile Link has guaranteed performan over 0 to 70 degrees centigrade from dc to 1 Mb/s (NR up to 34 metres.

The low current link requires only 6 mA peak supp current for the transmitter and receiver combined to achie an 11 metre link. Extended distances up to 82 metres c be achieved at a maximum transmitter drive current of 60 mA peak. The 40 kBd Versatile Link is guaranteed to perform from dc to 40 kb/s (NRZ) over 0° to 70°C up to the distances just described.

Receivers are compatible with LSTTL, TTL, CMOS logic levels and offer a choice of an internal pull-up resistor or an open collector output. Horizontal or vertical packages provide identical performance and are compatible with simplex, simplex latching, duplex, and duplex latching connectors. Refer to the connector section (page 5-30) and the cable section (page 5-29) for further information about these products. A list of specific part numbers is found below and in the Selection Guide on page 5-11.

VERSATILE LINK GUIDE

Versatile Link		Unit	Horizontal Package	Vertical Package	Cable Link Length	
					Standard Cable	Improved Cable
High Performance	5 MBd	T_X	HFBR-1521	HFBR-1531	12 metres	17 metres
		R_X	HFBR-2521	HFBR-2531		
High Performance	1 MBd	T_X	HFBR-1522	HFBR-1532	24 metres	34 metres
		R_X	HFBR-2522	HFBR-2532		
Low Current/ Extended Distance	40 kBd	T_X	HFBR-1523	HFBR-1533	8 metres/ 60 metres	11 metres/ 82 metres
		R_X	HFBR-2523	HFBR-2533		
Standard	1 MBd	T_X	HFBR-1524	HFBR-1534	5 metres	7 metres
		R_X	HFBR-2524	HFBR-2534		

RECOMMENDED OPERATING CONDITIONS

Parameter		Symbol	Min.	Max.	Units	Ref.
Ambient Temperature		T_A	0	70	°C	
Transmitter Peak Forward Current		$I_{F\,PK}$	10	750	mA	Note 1,8
Avg. Forward Current		$I_{F\,AV}$		60	mA	
Receiver Supply Voltage	HFBR-25X3	V_{CC}	4.50	5.50	V	Note 2
	HFBR-25X1/25X2/25X4		4.75	5.25		
Output Voltage	HFBR-25X3	V_O		V_{CC}	V	
	HFBR-25X1/25X2/25X4			18		
Fanout (TTL)	HFBR-25X3	N		1		
	HFBR-25X1/25X2/25X4			5		

SYSTEM PERFORMANCE Under recommended operating conditions unless otherwise specified.

	Parameter	Symbol	Min.	Typ.[5]	Max.	Units	Conditions		Ref.
High Performance 5 MBd	Data Rate		dc		5	MBd	BER ≤ 10^{-9}, PRBS: 2^7-1		
	Link Distance with Standard Cable	ℓ	12			m	I_{Fdc} = 60 mA		Fig. 2a Note 7
			17	3		m	I_{Fdc} = 60 mA, 25°C		
	Link Distance with Improved Cable	ℓ	17			m	I_{Fdc} = 60 mA		Fig. 2b Note 7
			24	4		m	I_{Fdc} = 60 mA, 25°C		
	Propagation Delay	t_{PLH}		8	140	ns	R_L = 560 Ω, C_L = 30 pF ℓ = 0.5 metre -21.6 ≤ P_R ≤ -9.5 dBm		Fig. 3, 5 Notes 3, 6
		t_{PHL}		5	140	ns			
	Pulse Width Distortion	t_D		3		ns	P_R = -15 dBm R_L = 560 Ω, C_L = 30 pF		Fig. 3, 4 Note 4
High Performance 1 MBd	Data Rate		dc		1	MBd	BER ≤ 10^{-9}, PRBS: 2^7-1		
	Link Distance with Standard Cable	ℓ	24			m	I_{Fdc} = 60 mA		Fig. 2a Notes 1, 7, 8
			30	5		m	I_{Fdc} = 60 mA, 25°C		
			30			m	I_{FPK} = 120 mA	50% Duty Factor	
			36	6		m	I_{FPK} = 120 mA, 25°C	50% Duty Factor	
	Link Distance with Improved Cable	ℓ	34			m	I_{Fdc} = 60 mA		Fig. 2b Notes 1, 7, 8
			41	6		m	I_{Fdc} = 60 mA, 25°C		
			44			m	I_{FPK} = 120 mA	50% Duty Factor	
			51	7		m	I_{FPK} = 120 mA, 25°C	50% Duty Factor	
	Propagation Delay	t_{PLH}		18	250	ns	R_L = 560 Ω, C_L = 30 pF ℓ = 0.5 metre P_R = -24 dBm		Fig. 3, 5 Notes 3, 8
		t_{PHL}		10	140	ns			
	Pulse Width Distortion	t_D		8		ns	P_R = -24 dBm R_L = 560 Ω, C_L = 30 pF		Fig. 3, 4 Notes 4, 8

FIBER OPTICS

SYSTEM PERFORMANCE Under recommended operat ıg conditions unless otherwise specified

Link	Parameter	Symbol	Min.	Typ.[	Max.	Units	Conditions		Ref.
Low Current/ Extended Distance 40 kBd	Data Rate		dc		40	kBd	BER ≤ 10^{-9}, PRBS: 2^7-1		
	Link Distance with Standard Cable	ℓ	8	30		m	I_{Fdc} = 2 mA		Fig. 2c Note 7
			60	10:		m	I_{Fdc} = 60 mA		
	Link Distance with Improved Cable	ℓ	11	35		m	I_{Fdc} = 2 mA		Fig. 2d Note 7
			82	12:		m	I_{Fdc} = 60 mA		
	Propagation Delay	t_{PLH}		4		µs	R_L = 3.3 kΩ, C_L = 30 pF = 1 metre P_R = -25 dBm		Fig. 3, 7 Note 3
		t_{PHL}		2.5		µs			
	Pulse Width Distortion	t_D			7.0	µs	-39 ≤ P_R ≤ -14 dBm R_L = 3.3 kΩ, C_L = 30 pF		Fig. 3, 6 Note 4
Standard 1 MBd	Data Rate		dc		1	MBd	BER ≤ 10^{-9}, PRBS: 2^7-1		
	Link Distance with Standard Cable	ℓ	5			m	I_{Fdc} = 60 mA		Fig. 2e Notes 1, 7, 8
			11	30		m	I_{Fdc} = 60 mA, 25°C		
			12			m	I_{FPK} = 120 mA	50% Duty Factor	
			18	40		m	I_{FPK} = 120 mA, 25°C	50% Duty Factor	
	Link Distance with Improved Cable	ℓ	7			m	I_{Fdc} = 60 mA		Fig. 2f Notes 1, 7, 8
			15	40		m	I_{Fdc} = 60 mA, 25°C		
			17			m	I_{FPK} = 120 mA	50% Duty Factor	
			25	50		m	I_{FPK} = 120 mA, 25°C	50% Duty Factor	
	Propagation Delay	t_{PLH}		18(	250	ns	R_L = 560 Ω, C_L = 30 pF ℓ = 0.5 metre P_R = -20 dBm		Fig. 3, 5 Notes 3, 8
		t_{PHL}		10(	140	ns			
	Pulse Width Distortion	t_D		8(		ns	P_R = -20 dBm R_L = 560 Ω, C_L = 30 pF		Fig. 3, 4 Notes 4, 8

Notes:

1. For I_{FPK} > 80 mA, the duty factor must be such as to keep I_{FDC} ≤ 80 mA. In addition, for I_{FPK} > 80 mA, the following rules for pulse width apply:
   I_{FPK} ≤ 160 mA: Pulse width ≤ 1 ms
   I_{FPK} ≥ 160 mA: Pulse width ≤ 1 µs, period ≥ 20 µS
2. It is essential that a bypass capacitor, 0.1 µF ceramic, be connected from pin 2 to pin 3 of the HFBR-25X1/25X2/25X4 receivers and from pin 2 to pin 4 of the HFBR-25X3 receiver. Total lead length between both ends of the capacitor and the supply pins should not exceed 20 mm.
3. The propagation delay for one metre of cable is typically 5 ns.
4. $t_D = t_{PLH} - t_{PHL}$.
5. Typical data is at 25° C. V_{CC} = 5 V.
6. Typical propagation delay is measured at P_R = -15 dBm.
7. Estimated typical link life expectancy at 40° C exceeds 10 years at 60 mA.
8. Pulsed LED operation at I_{FPK} > 80 mA will cause increased link t_{PLH} propagation delay time. This extended t_{PLH} time contributes to increased pulse width distortion of the receiver output signal.
9. Pins 5 and 8 of both the transmitter and receiver are for mounting and retaining purposes only. Do not electrically connect pin 5 and/or pin 8.

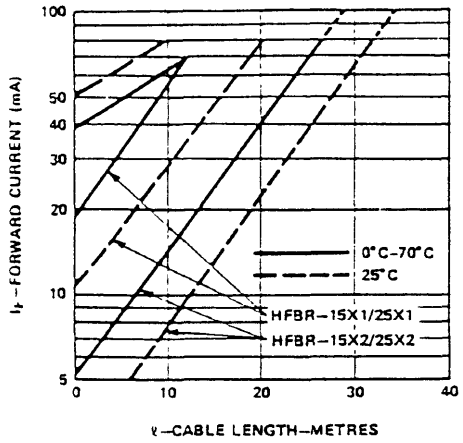


Figure 2a. Guaranteed System Performance for the HFBR-15X1/25X1 and HFBR-15X2/25X2 Links with Standard Cable

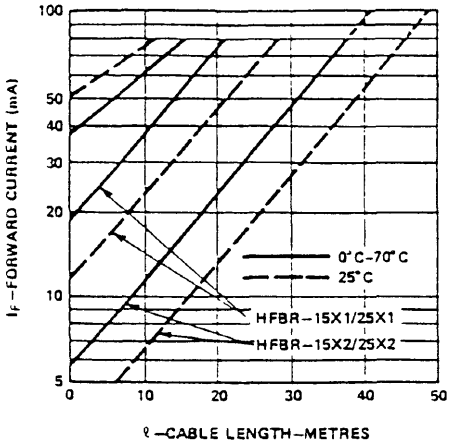


Figure 2b. Guaranteed System Performance for the HFBR-15X1/25X1 and HFBR-15X2/25X2 Links with Improved Cable

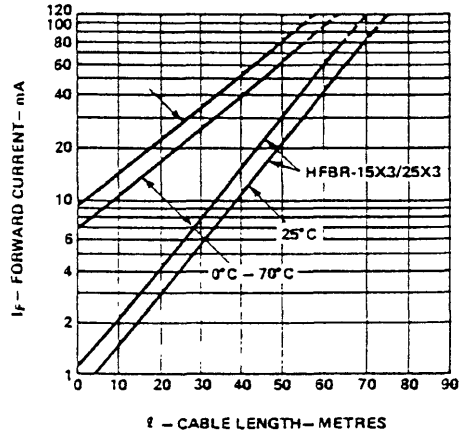


Figure 2c. Guaranteed System Performance for the HFBR-15X3/25X3 Link with Standard Cable

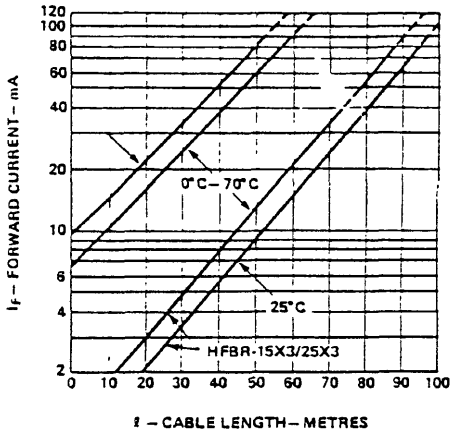


Figure 2d. Guaranteed System Performance for the HFBR-15X3/25X3 Link with Improved Cable

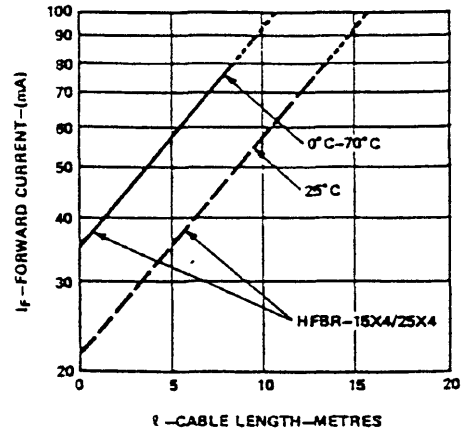


Figure 2e. Guaranteed System Performance for the HFBR-15X4/25X4 Link with Standard Cable

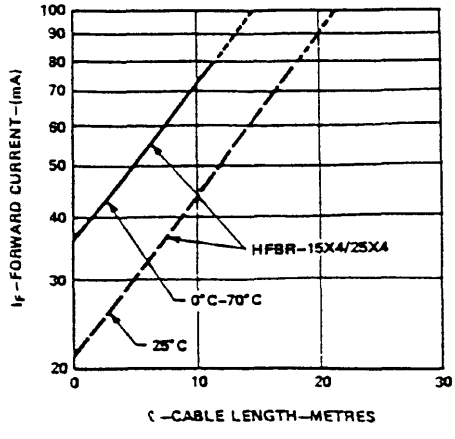


Figure 2f. Guaranteed System Performance for the HFBR-15X4/25X4 Link with Improved Cable

Versatile Link Design Considerations

Simple interface circuits for 5 MBd, 1 MBd and 40 kBd applications are shown in Figure 1. The value of transmitter drive current depends upon the desired distance. This is shown in Figures 2a through 2f. After selecting a value of transmitter drive current, I_F, the value of R1 can be determined with the aid of Figures 1a, 1b and 1d. Note that the 5 MBd and 40 kBd Versatile Links have an overdrive and underdrive limit for the chosen value of I_F while the 1 MBd Versatile Link has only an underdrive limit. Dotted lines in Figures 2a through represent pulsed operation for extended link distance requirements. For the 1 MBd interface circuit, the R1C1 time constant must be > 75 ns. Conditions described in Note 1 must be met for pulsed operation. Refer to Note 8 for performance comments when pulsed operation is used.

All specifications are guardbanded for worst case conditions between 0 to 70 degrees centigrade. All tolerances and variations (including end-of-life transmitter power, receiver sensitivity, coupling variances, connector and cable variations) are taken into account.

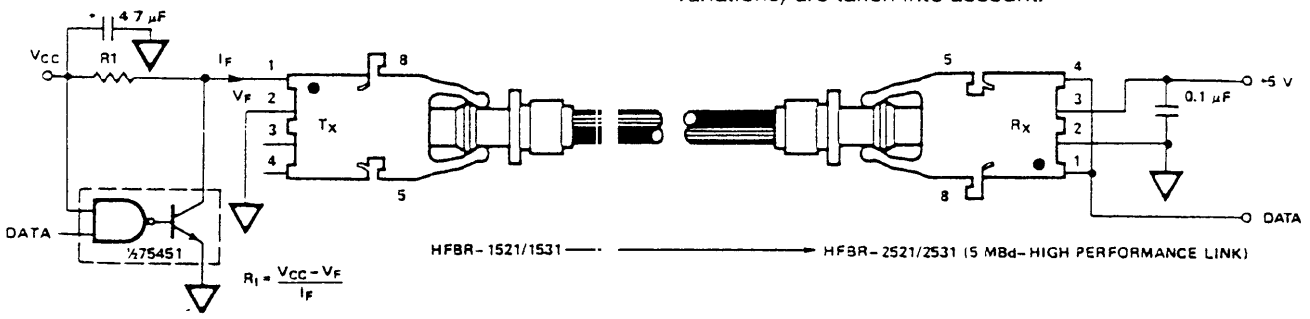
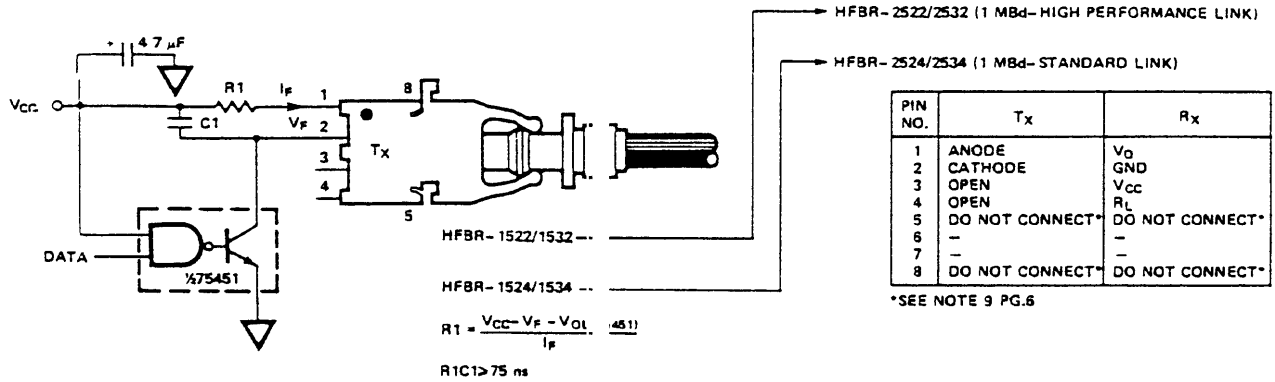


Figure 1a. Typical 5 MBd Interface Circuit;

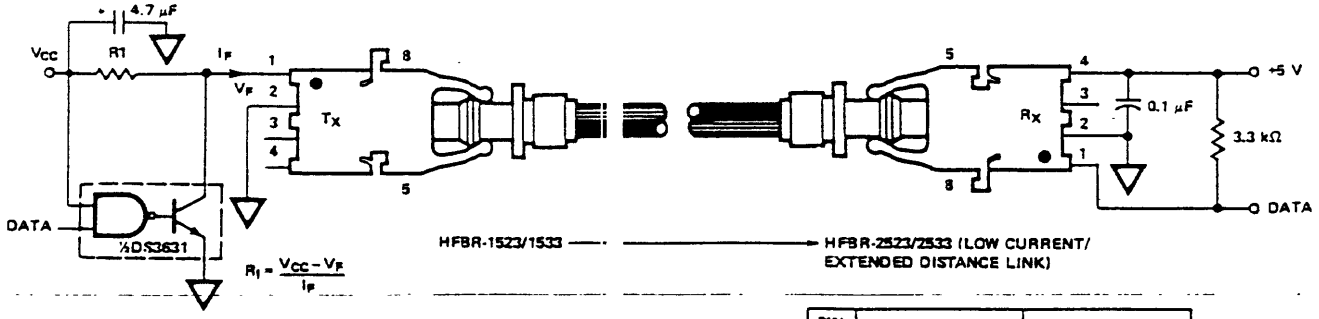


1b. Required 1 MBd Interface Circuit;

PIN NO.	Tx	Rx
1	ANODE	V_O
2	CATHODE	GND
3	OPEN	V_{CC}
4	OPEN	R_L
5	DO NOT CONNECT*	DO NOT CONNECT*
6	–	–
7	–	–
8	DO NOT CONNECT*	DO NOT CONNECT*

*SEE NOTE 9 PG.6

1c. Electrical Pin Assignments for 5 MBd and 1 MBd Transmitters and Receivers



1d. Typical 40 kBd Interface Circuit;

PIN NO.	Tx	Rx
1	ANODE	V_O
2	CATHODE	GND
3	OPEN	OPEN
4	OPEN	V_{CC}
5	DO NOT CONNECT*	DO NOT CONNECT*
6	–	–
7	–	–
8	DO NOT CONNECT*	DO NOT CONNECT*

*SEE NOTE 9 PG.6

1e. Electrical Pin Assignments for 40 kBd Transmitters and Receivers

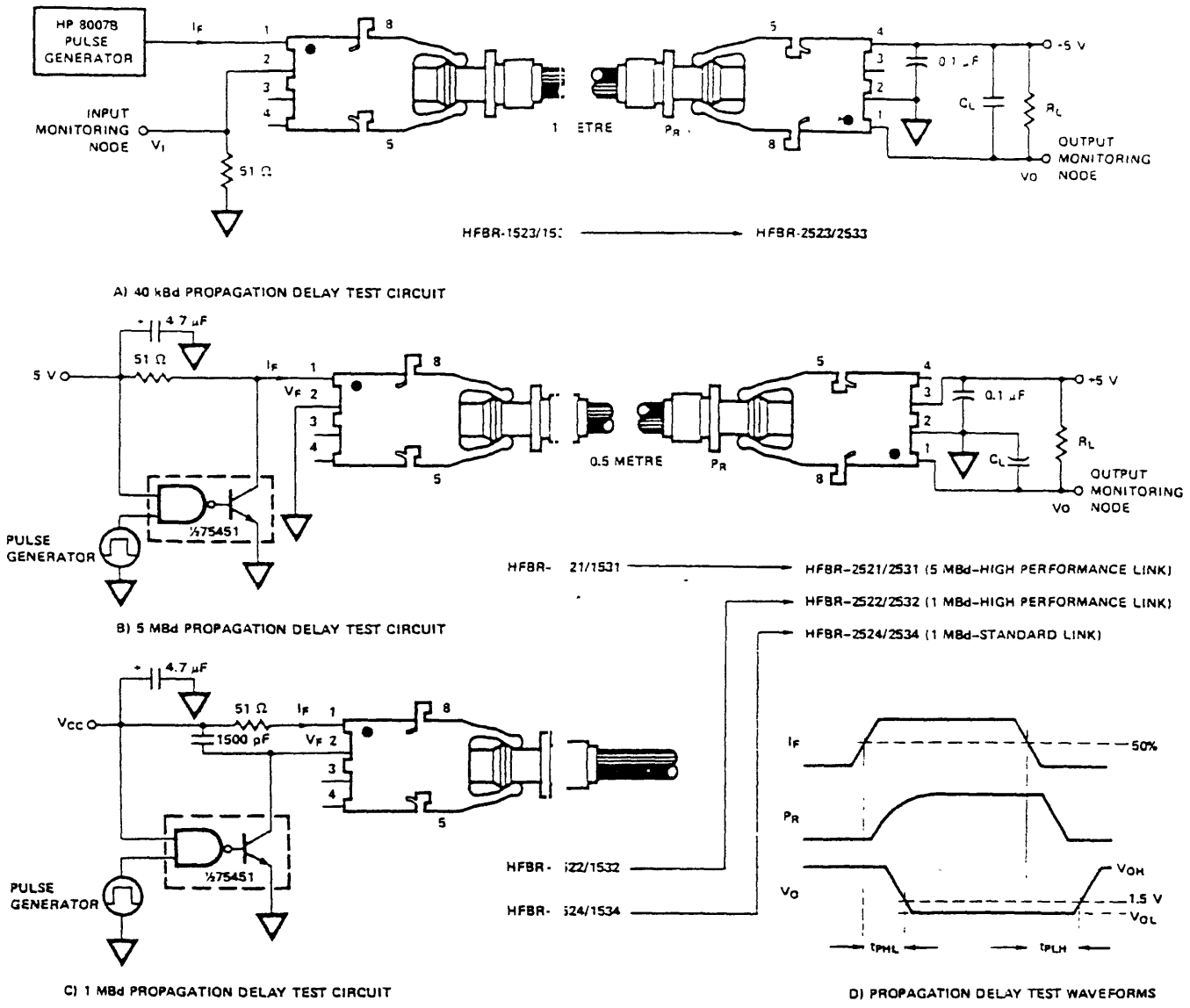


Figure 3. Propagation Delay Test Circuits and Waveforms: a) 40 Bd, b) 5 MBd, c) 1 MBd, d) Test Waveforms

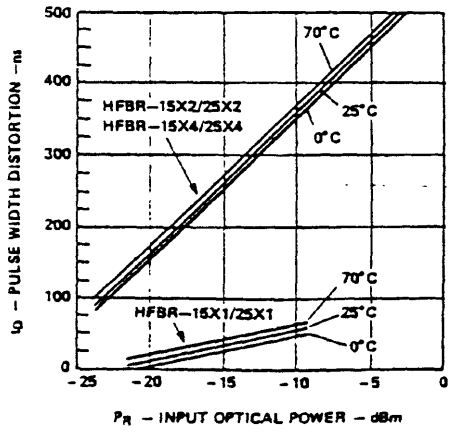


Figure 4. Typical HFBR-15X1/25X1, HFBR-15X2/25X2 and HFBR-15X4/25X4 Link Pulse Width Distortion vs. Optical Power

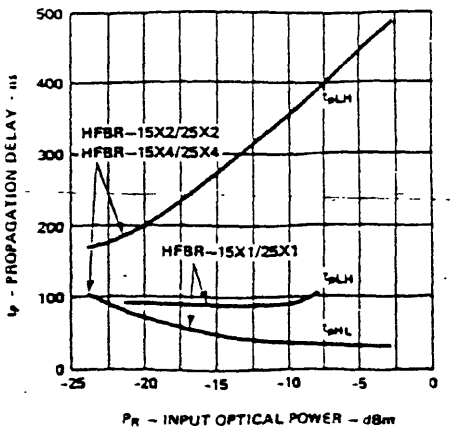


Figure 5. Typical HFBR-15X1/25X1, HFBR-15X2/25X2 and HFBR-15X4/25X4 Link Propagation Delay vs. Optical Power

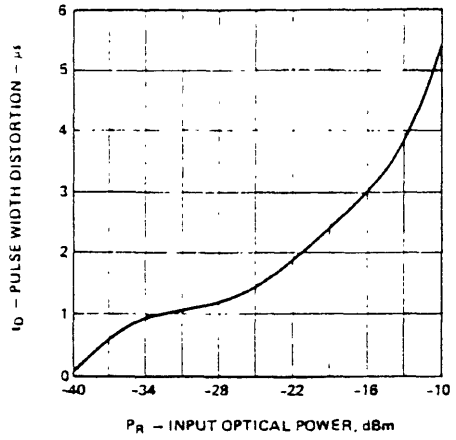


Figure 6. Typical HFBR-15X3/25X3 Link Pulse Width Distortion vs. Optical Power

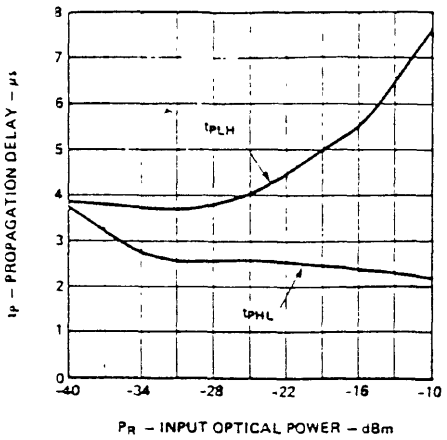


Figure 7. Typical HFBR-15X3/25X3 Link Propagation Delay vs. Optical Power

Versatile Link Photo Interrupter

20 KHz (40 kBd) LINK, 500 kHz (1 MBd) LINK

Versatile Link may be used as a photo-interrupter in optical switches, shaft position sensors, velocity sensors, position sensors, and other similar applications. This link is particularly useful where high voltage, electrical noise, or explosive environments prohibit the use of electromechanical or optoelectronic sensors. The 20 kHz (40 kBd) transmitter/receiver pair has an optical power budget of 25 dB. The 500 kHz (1 MBd) transmitter/receiver pair has an optical power budget of 10 dB. Total system losses (cable attenuation, air gap loss, etc.) must not exceed the link optical power budget.

RECOMMENDED OPERATING CONDITIONS

Recommended operating conditions are identical to those of the Low Current/Extended Distance and High Performance 1 MBd links. Refer to page 5-15.

SYSTEM PERFORMANCE

These specification apply when using Standard and Improved cable and, unless otherwise specified, under recommended operating conditions. Refer to the appropriate link data on pages 5-17 and 5-18 for additional design information.

Parameter	Min.	Typ.[1]	Max.	Units	Conditions	Ref.
HFBR-15X3/25X3						
Max. Count Frequency	dc		20	kHz		
Optical Power Budget	25.4			dB	I_{Fdc} = 60 mA, 0-70°C	Note 2
	27.8	34		dB	I_{Fdc} = 60 mA, 25°C	
HFBR-15X2/25X2						
Max. Count Frequency	dc		500	kHz		
Optical Power Budget	10.4			dB	I_{Fdc} = 60 mA, 0-70°C	Note 2
	12.8	15.6		dB	I_{Fdc} = 60 mA, 25°C	

1. Typical data is at T_A = 25°C, V_{CC} = 5 V.
2. Optical Power Budget = P_T min. = P_R (L) min. Refer to page X for additional design information.

Photo Interrupter Link Design Considerations

The fiber optic Transmitter/Receiver pair is intended fo applications where the photo interrupter must be physi cally separated from the optoelectronic emitter and detecto This separation would be useful where high voltage, elec trical noise or explosive environments prohibit the use o electronic devices. To ensure reliable long term operatio link design for this application should operate with a ample optical power margin $\alpha_M \geq 3$ dB, since the expose fiber ends are subject to environmental contamination th will increase the optical attenuation of the slot with time. graph of air gap separation versus attenuation for clea fiber ends with minimum radial error ≤ 0.127 mm (0.00 inches) and angular error (≤3.0°) is provided in Figure 8.

The following equations can be used to determine th transmitter output power, P_T, for both the overdrive and underdrive cases. Overdrive is defined as a condition where excessive optical power is delivered to the receiver. The first equation calculates, for a predetermined link length and slot attenuation, the maximum P_T in order not to overdrive the receiver. The second equation defines the minimum P_T allowed for link operation to prevent underdrive condition from occurring, where α_o is the fiber attenuation.

$$P_T(MAX) - P_R(MAX) \leq \alpha_{O\ MIN}\,\ell + \alpha_{SLOT} \qquad \text{Eq. 1}$$

$$P_T(MIN) - P_{RL}(MIN) \geq \alpha_{O\ MAX}\,\ell + \alpha_{SLOT} + \alpha_M \qquad \text{Eq. 2}$$

Once P_T (MIN) has been determined in the second equation for a specific link length (ℓ), slot attenuation (α_{SLOT}) and margin (α_M). Figure 9 can then be used to find I_F.

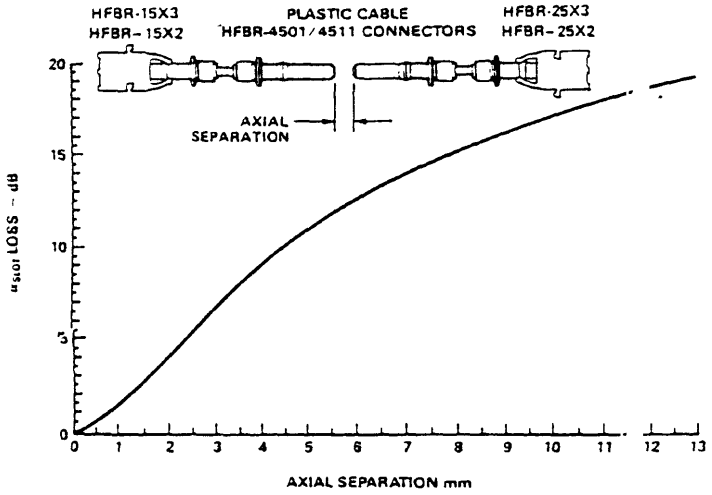


Figure 8. Typical Loss vs. Axial Separation.

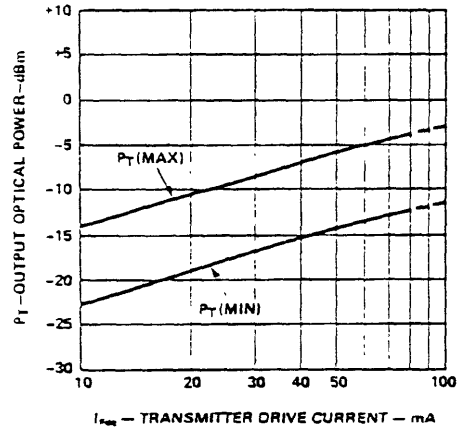


Figure 9. Typical HFBR-15X3/15X2 Optical Power vs. Transmitter I_F (0-70°C)

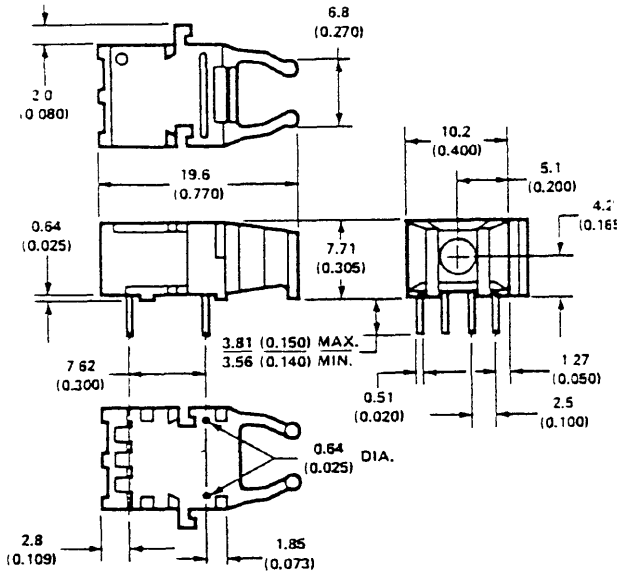
FIBER OPTICS

Versatile Link Mechanical Dimensions

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

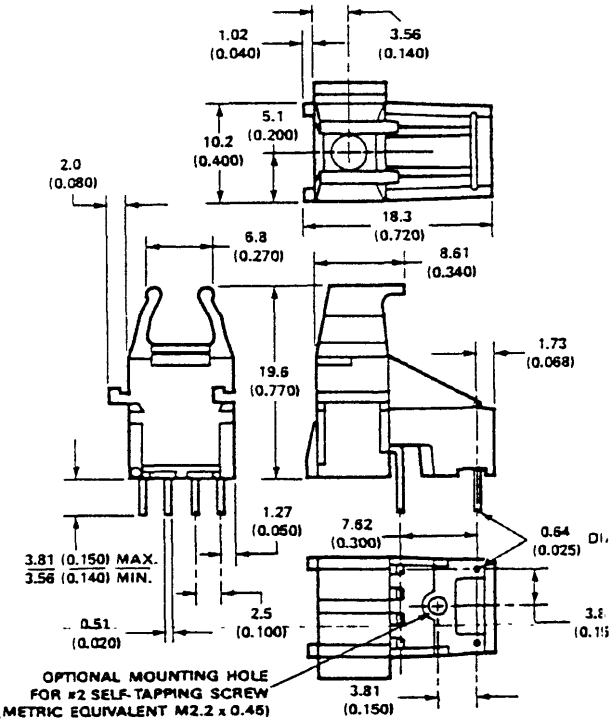
HORIZONTAL MODULES

HFBR-1521/1522/1524 (GRAY), HFBR-1523 (BLACK)
HFBR-2521/2522/2523/2524 (BLUE)

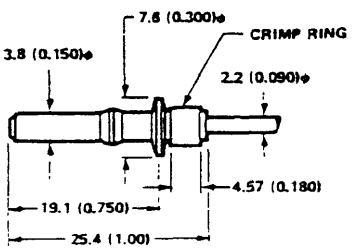


VERTICAL MODULES

HFBR-1531/1532/1534 (GRAY, HFBR-1533 (BLACK)
HFBR-2531/2532/2533/2534 (BLUE)

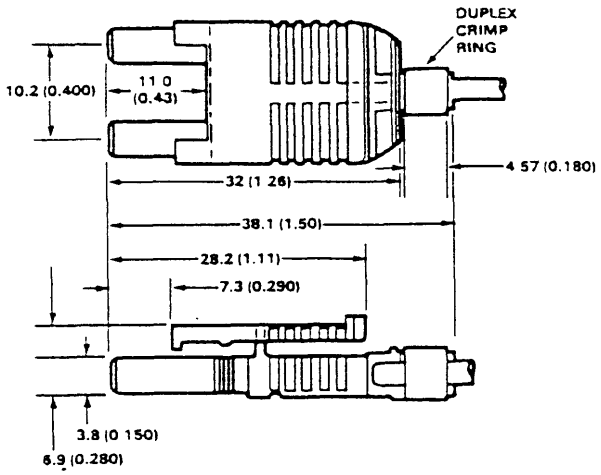


HFBR-4501 (GRAY)/4511 (BLUE) SIMPLEX CONNECTOR

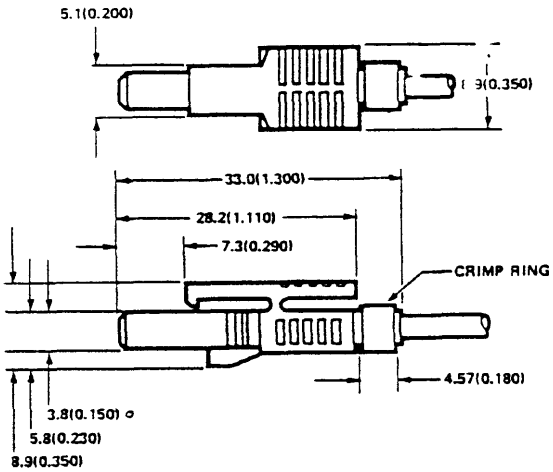


CONNECTORS DIFFER ONLY IN COLOR

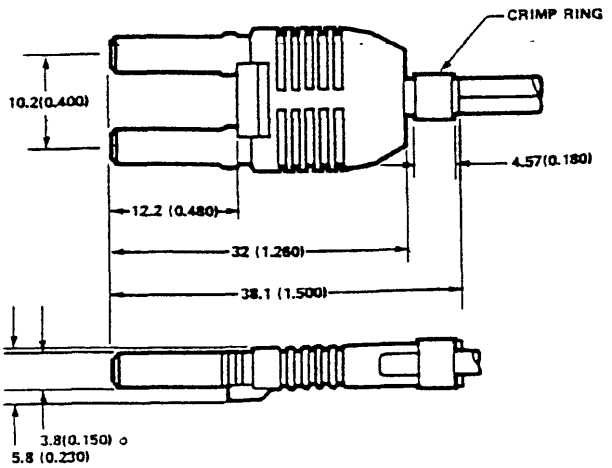
HFBR-4516 (PARCHMENT) DUPLEX LATCHING CONNECTOR



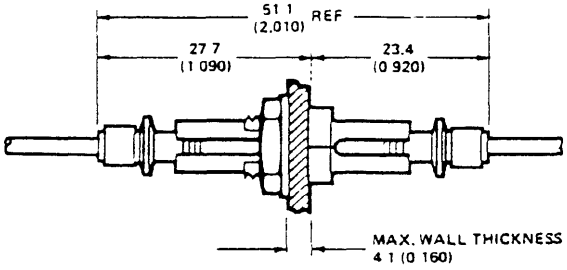
HFBR-4503 (GRAY)/4513 (BLUE) SIMPLEX LATCHING CONNECTOR



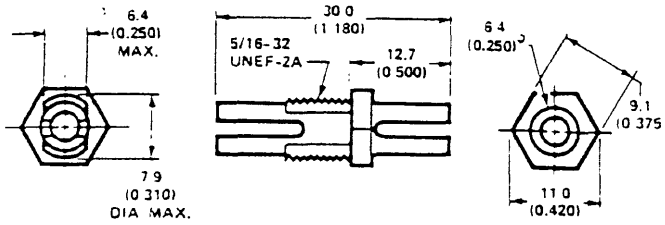
HFBR-4506 (PARCHMENT) DUPLEX CONNECTOR



BULKHEAD FEEDTHROUGH WITH TWO HFBR-4501/4511 CONNECTORS



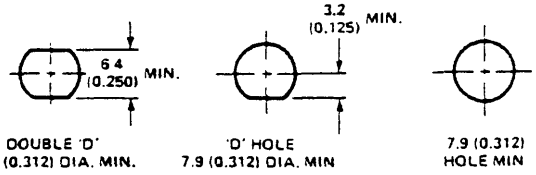
HFBR-4505 (GRAY)/4515 (BLUE) ADAPTERS



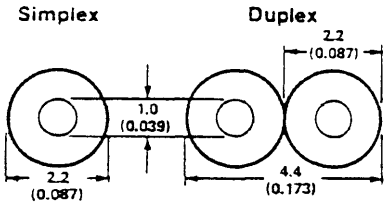
PANEL MOUNTING — BULKHEAD FEEDTHROUGH

THREE TYPES OF PANEL/BULKHEAD HOLES CAN BE USED.

DIMENSIONS IN mm (INCHES)
ALL DIMENSIONS ±0.2 mm



FIBER OPTIC CABLE DIMENSIONS

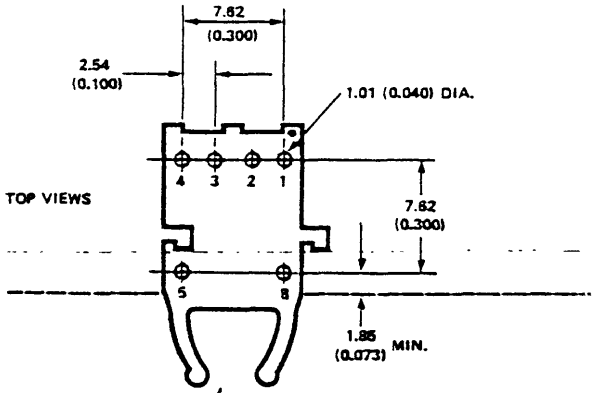


DIMENSIONS IN MILLIMETRES AND (INCHES)

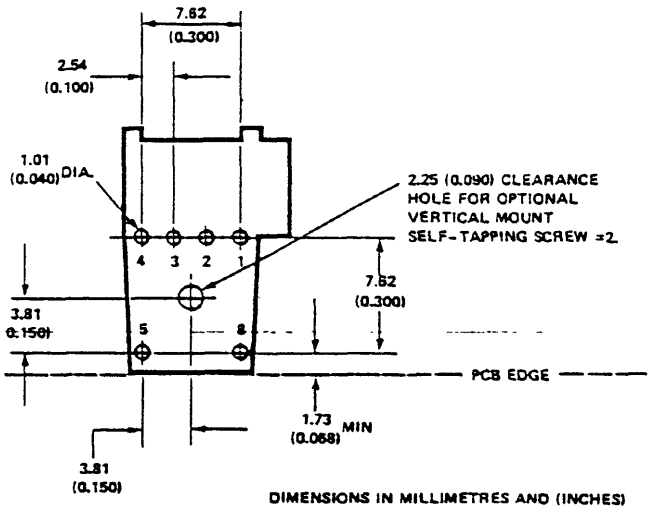
Versatile Link Printed Circuit Board Layout Dimensions

TOP VIEW

HORIZONTAL MODULE



VERTICAL MODULE



DIMENSIONS IN MILLIMETRES AND (INCHES)

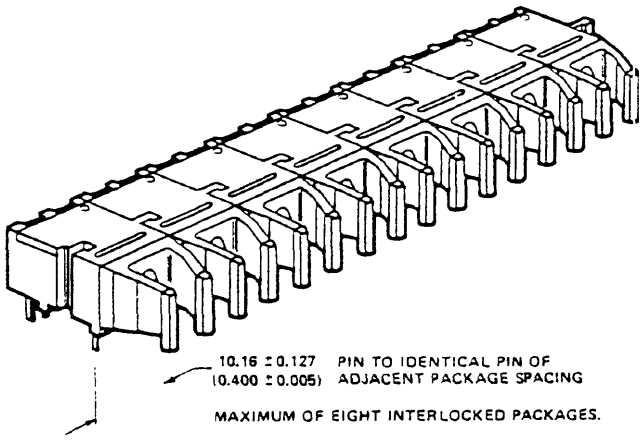
ELECTRICAL PIN FUNCTIONS

PIN NO.	TRANSMITTERS HFBR-15XX	RECEIVERS INCLUDING HFBR-25X3	RECEIVER HFBR-25X3
1	ANODE		V_O
2	CATHODE	GROUND	GROUND
3	OPEN		OPEN
4	OPEN		V_{CC}
5	DO NOT CONNECT	DO NOT CONNECT	DO NOT CONNECT
8	DO NOT CONNECT	DO NOT CONNECT	DO NOT CONNECT

FIBER OPTICS

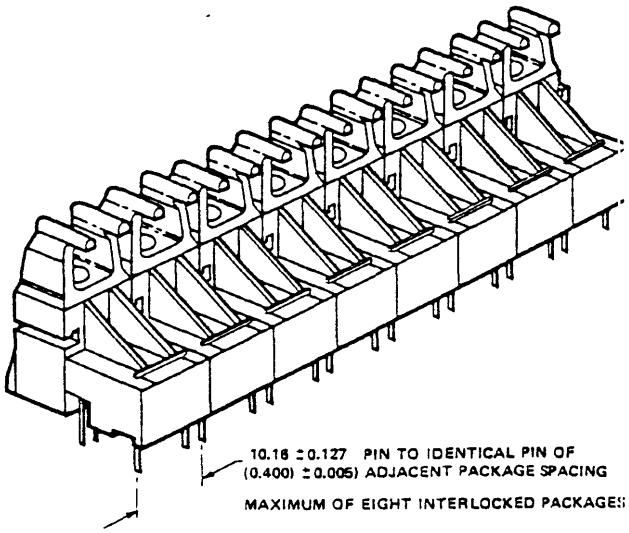
Interlocked (Stacked) Assemblies

STACKING HORIZONTAL MODULES

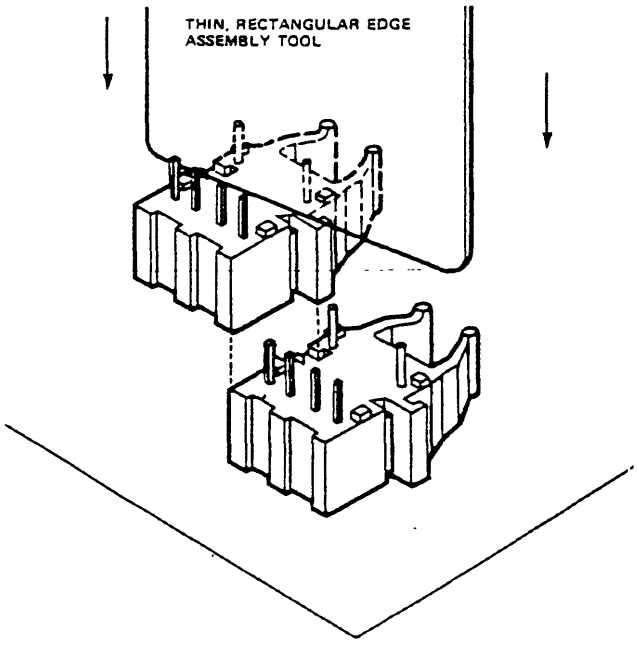


Recommended stacking assembly of horizontal packages is easily accomplished by placing units upside down with pins facing upward. Initially engage the interlocking mechanism by sliding the L bracket body from above into the L slot body of the lower package. Lay the partially interlocked units on a flat surface and push down with a thin, rigid, rectangular edged object 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. Refer to Figure 1 below that illustrates this assembly. Stacked horizontal packages can be disengaged should there be a need to do so. Repeated stacking and unstacking causes no damage to individual units.

STACKING VERTICAL MODULES



Recommended stacking of vertical packages is to hold two vertical units, one in each hand, with the pins facing away from the assembler and the optical ports located in the bottom front of each unit. Engage completely, the L bracket unit from above into the lower L slot unit. Package to package alignment is easily insured by laying the full, flat, bottom side of the assembled units onto a flat surface pushing with a finger the two packages into complete, parallel alignment. The thin rectangular edged tool, used for horizontal package alignment, is not needed with the vertical packages. Stacked vertical packages can be disengaged should there be a need to do so. Repeated stacking and unstacking causes no damage to individual units.



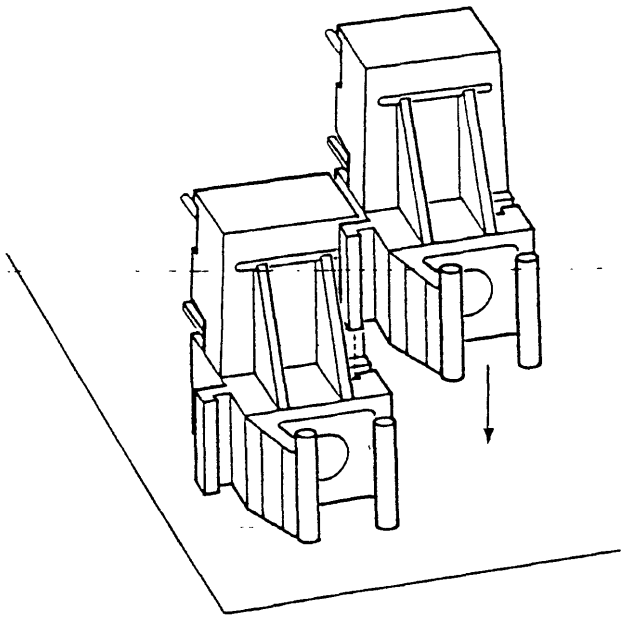
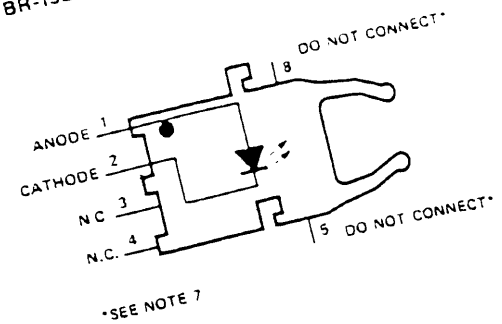


Figure 11. Interlocked (Stacked) Horizontal or Vertical Packages.

Versatile Link Transmitters

HFBR-1521/1531 (5 MBd - High Performance)
HFBR-1522/1532 (1 MBd - High Performance)
HFBR-1523/1533 (40 kBd - Low Current/Extended Distance)
HFBR-1524/1534 (1 MBd - Standard)

Versatile Link transmitters incorporate a 660 nanom re LED in a horizontal or vertical housing. The HFBR- X3 transmitter housing is black. HFBR-15X1/2/4 sta ard housings are gray, but black versions are available The transmitters can be easily interfaced to standard T L or CMOS logic. The optical output power of the FBR-152X/153X series is specified at the end of 0.5 m c cable. The mechanical and electrical pin spacing and cor ections are identical for both the horizontal and vertical pa kages.



*SEE NOTE 7

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Ref.
Storage Temperature		T_S	-40	+75	°C	
Operating Temperature		T_A	0	+70	°C	
Lead Soldering Cycle	Temp.			260	°C	Note 1
	Time			10	sec.	Note 2
Peak Forward Input Current		I_{FPK}		1000	mA	
DC Forward Input Current		I_{FDC}		80	mA	
Reverse Input Voltage		V_R		5	V	

Electrical/Optical Characteristics 0°C to -70°C Unless Otherwise Specified

Parameter		Symbol	Min.	Typ.[5]	Max.	Units	Conditions	Ref.
Transmitter Output Optical Power	HFBR-15X1	P_T	-16.5		-7.6	dBm	I_{Fdc} = 60 mA, 0-70°C	Fig. 2
			-14.3		-8.0	dBm	I_{Fdc} = 60 mA, 25°C	Notes 3, 4
	HFBR-15X2 and HFBR-15X3	P_T	-13.6		-4.5	dBm	I_{Fdc} = 60 mA, 0-70°C	
			-11.2		-5.1	dBm	I_{Fdc} = 60 mA, 25°C	
	HFBR-15X3	P_T	-35.5			dBm	I_{Fdc} = 2 mA, 0-70°C	
	HFBR-15X4	P_T	-17.8		-4.5	dBm	I_{Fdc} = 60 mA, 0-70°C	
			-15.5		-5.1	dBm	I_{Fdc} = 60 mA, 25°C	
Output Optical Power Temperature Coefficient		$\frac{\Delta P_T}{\Delta T}$		-0.85		%/°C		
Peak Emission Wavelength		λ_{PK}		660		nm		
Forward Voltage		V_F	1.45	1.67	2.02	V	I_{Fdc} = 60 mA	
Forward Voltage Temperature Coefficient		$\frac{\Delta V_F}{\Delta T}$		-1.37		mV/°C		Fig. 1
Effective Diameter		D_T		1		mm		
Numerical Aperture		N.A.		0.5				
Reverse Input Breakdown Voltage		V_{BR}	5.0	11.0		V	I_{Fdc} = 10 μA, T_A = 25°C	
Diode Capacitance		C_O		86		pF	V_F = 0, f = 1 MHz	
Rise Time		t_r		80		ns	10% to 90%, I_F = 60 mA	Note 6
Fall Time		t_f		40		ns		

Notes:

1. 1.6 mm below seating plane.
2. 1 μs pulse. 20 μs period.
3. Measured at the end of 0.5 m Standard Fiber Optic Cable with large area detector.
4. Optical power, P (dBm) = 10 Log [P (μW)/1000 μW]
5. Typical data is at 25°C.
6. Rise and fall times are measured with a voltage pulse driving the transmitter and a series connected 50 ohm load. A wide bandwidth optical to electrical waveform analyzer (transducer), terminated to a 50 ohm input of a wide bandwidth oscilloscope, is used for this response time measurement.
7. Pins 5 and 8 of the transmitter are for mounting and retaining purposes only. Do not electrically connect pin 5 and/or pin 8.

WARNING: When viewed under some conditions, the optical port of the Transmitter may expose the eye beyond the Maximum Permissible Exposure recommended in ANSI Z-136-1, 1981. Under most viewing conditions there is no eye hazard.

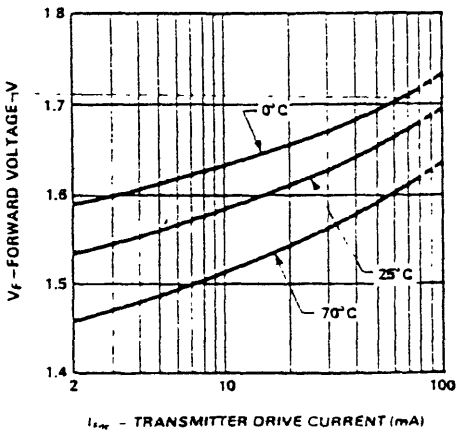


Figure 12. Typical Forward Voltage vs. Drive current for HFBR-152X/153X Series Transmitters.

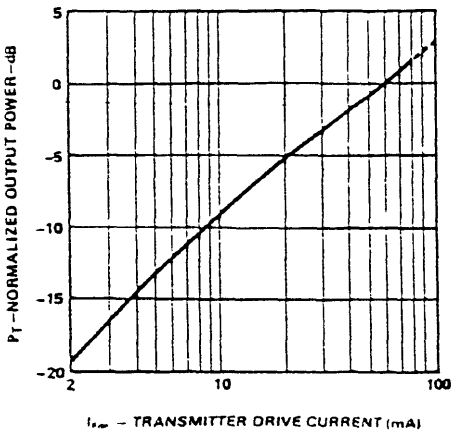


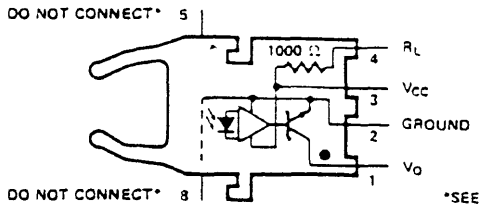
Figure 13. Normalized HFBR-152X/153X Series Transmitter Typical Output Optical Power vs. Drive Current.

atile Link Receivers

2521/2531 (5 MBd - High Performance)
-2522/2532 (1 MBd - High Performance)
-2524/2534 (1 MBd - Standard)

Versatile Link receivers feature a shielded, integrated photodetector and a wide bandwidth dc amplifier with high noise immunity. A Schottky clamped open-collector output transistor allows interfacing to common logic families and enables "wired-OR" circuit designs. The open collector output is specified up to 18 V. An integrated 1000 ohm resistor internally connected to V_{CC} may be externally connected to provide a pull-up for ease of use with +5 V logic. Under

HFBR-25X1/25X2/25X4 RECEIVER



pulsed LED current operation (I_F > 80 mA), the combination of a high optical power level and the optical falling edge of the LED transmitter will result in increased pulse width distortion of the receiver output signal. The standard receiver housings are blue; black versions are available.

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Ref.
Storage Temperature		T_S	-40	+75	°C	
Operating Temperature		T_A	0	+70	°C	
Lead Soldering Cycle	Temp.			260	°C	Note 1
	Time			10	sec.	
Supply Voltage		V_{CC}	-0.5	7	V	Note 6
Output Collector Current		I_O		25	mA	
Output Collector Power Dissipation		P_{OD}		40	mW	
Output Voltage		V_O	-0.5	18	V	
Pullup Voltage		V_{RL}	-0.5	V_{CC}	V	

Electrical/Optical Characteristics 0°C to +70°C, 4.75 V ≤ V_{CC} ≤ 5.25 V Unless Otherwise Specified

Parameter		Symbol	Min.	Typ.[5]	Max.	Units	Conditions	Ref.
Receiver Input Optical Power Level for Logic "0"	HFBR-2521 and HFBR-2531	$P_{R(L)}$	-21.6		-9.5	dBm	V_{OL} = 0.5 V, I_{OL} = 8 mA	Notes 2, 3, 8
			-21.6		-8.7	dBm	25°C, V_{OL} = 0.5 V, I_{OL} = 8 mA	
	HFBR-2522 and HFBR-2532	$P_{R(L)}$	-24			dBm	V_{OL} = 0.5 V, I_{OL} = 8 mA	Notes 2, 3, 8, 9
			-24			dBm	25°C, V_{OL} = 0.5 V, I_{OL} = 8 mA	
	HFBR-2524 and HFBR-2534	$P_{R(L)}$	-20			dBm	V_{OL} = 0.5 V, I_{OL} = 8 mA	Notes 2, 3, 8, 9
			-20			dBm	25°C, V_{OL} = 0.5 V, I_{OL} = 8 mA	
Input Optical Power Level for Logic "1"		$P_{R(H)}$			-43	dBm	V_{OH} = 5.25 V, I_{OH} ≤ 250 µA	Note 2
High Level Output Current		I_{OH}		5	250	µA	V_O = 18 V, P_R = 0	Note 4
Low Level Output Voltage		V_{OL}		0.4	0.5	V	I_{OL} = 8 mA, P_R = $P_{R(L)MIN}$	Note 4
High Level Supply Current		I_{CCH}		3.5	6.3	mA	V_{CC} = 5.25 V, P_R = 0 µW	Note 4
Low Level Supply Current		I_{CCL}		6.2	10	mA	V_{CC} = 5.25 V, P_R = -12.5 dBm	Note 4
Effective Diameter		D_R		1		mm		
Numerical Aperture		N.A.		0.5				
Internal Pull-Up Resistor		R_L	680	1000	1700	Ohms		

FIBER OPTICS

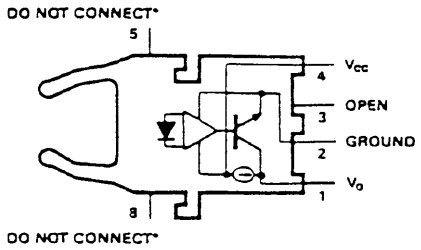
Notes:
1. 1.6 mm below seating plan
2. Optical flux P (dBm) = 10 Log (P (μW)/1000 μW)
3. Measured at the end of Fiber Optic Cable with large area detector.
4. R_L is open
5. Typical data is at 25°C. V_{CC} = 5 V.
6. It is essential that a bypass capacitor 0.01 μF be connected from pin 2 to pin 3 of the receiver. Total lead length between both ends of the capacitor and the pins should not exceed 20 mm
7. Pins 5 and 8 of both the transmitter and receiver are for mounting and retaining purposes only. Do not electrically connect pin 5 and/or pin 8
8. Pulsed LED operation at I_F > 80 mA will cause increased link t_{PLH} propagation delay time. This extended t_{PLH} time contributes to increased pulse width distortion of the receiver output signal.
9. The LED driver circuit of Figure 1b (Link Design Considerations) is required for 1 MBd operation of the HFBR-2522/2532/2524/2534

High Sensitivity Receiver

HFBR-25X3

The blue plastic HFBR-25X3 Receiver module has a sensitivity of -39 dBm. It features an integrated photodetector and dc amplifier with high EMI immunity. The output is an open collector with a 150 μA internal current source pull up and is compatible with TTL/LSTTL and most CMOS logic families. For minimum rise time add an external pull up resistor of at least 3.3K ohms. V_{CC} must be greater than or equal to the supply voltage for the pull-up resistor.

HFBR-25X3 RECEIVER



*SEE NOTE 8

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Ref.
Storage Temperature		T_S	−40	+75	°C	
Operating Temperature		T_A	0	+70	°C	
Lead Soldering Cycle	Temp			260	°C	Note 1
	Time			10	sec	
Supply Voltage		V_{CC}	−0.5	7	V	Note 7
Output Collector Current (Average)		I_O	−1	5	mA	
Output Collector Power Dissipation		P_{OD}		25	mW	
Output Voltage		V_O	−0.5	V_{CC}	V	

Electrical/Optical Characteristics 0° C to +70° C, 4.5 ≤ V_{CC} ≤ 5.5 Unless Otherwise Specified

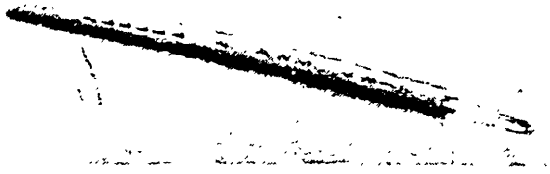
Parameter		Symbol	Min.	Typ. (5)	Max.	Units	Conditions	Ref.
Receiver Input Optical Power Level for Logic "0"	HFBR-2523 and HFBR-2533	$P_{R(L)}$	−39		−13.7	dBm	$V_O = V_{OL}$, I_{OL} = 3.2 mA	Note 2, 3, 4
			−39		−13.3	dBm	25° C, $V_O = V_{OL}$, I_{OL} = 3.2 mA	
Input Optical Power Level for Logic "1"		$P_{R(H)}$			−53	dBm	V_{OH} = 5.5V, $I_{OH} \leq 40$ μA	Note 2
High Level Output Voltage		V_{OH}	2.4			V	$I_{OH} = -40$ μA, $P_R = 0$ μW	
Low Level Output Voltage		V_{OL}			0.4	V	I_{OL} = 3.2 mA, $P_R = P_{RL\ MIN}$	Note 6
High Level Supply Current		I_{CCH}		1.2	1.9	mA	V_{CC} = 5.5V, $P_R = 0$ μW	
Low Level Supply Current		I_{CCL}		2.9	3.7	mA	V_{CC} = 5.5V, $P_R \geq P_{RL}$ (MIN)	Note 6
Effective Diameter		D_R		1		mm		
Numerical Aperture		N.A.		0.5				

Notes:
1. 1.6 mm below seating plan.
2. Optical flux, P (dBm) = 10 Log P (μW)/1000 μW.
3. Measured at the end of Fiber Optic Cable with large area detector.
4. Because of the very high sensitivity of the HFBR-25X3, the digital output may switch in response to ambient light levels when a cable is not occupying the receiver optical port. The designer should take care to filter out signals from this source if they pose a hazard to the system.
5. Typical data is at 25° C, V_{CC} = 5 V.
6. Including current in 3.3 K pull-up resistor.
7. It is recommended that a bypass capacitor 0.01 μF to 0.1 μF ceramic be connected from pin 2 to pin 4 of the receiver.
8. Pins 5 and 8 are for mounting and retaining purposes only. Do not electrically connect pin 5 and/or pin 8.

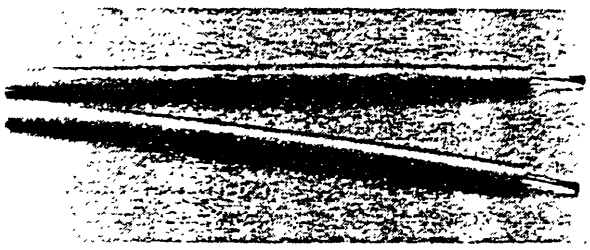
Plastic Fiber Optic Cable

Simplex Fiber Optic Cable is constructed of a single ste index plastic fiber sheathed in a plastic jacket. Duplex Fibe Optic Cable has two plastic fibers, each in a cable c construction similar to the Simplex Cable, joined with web. The individual channels are identified by a markin on one channel of the cable. The Improved Fiber Opti Cable is identical to the Standard Cable except that th attenuation is lower.

These cables are UL recognized components and pass U VW-1 flame retardancy specification. Safe cable propertie in flammable environments, along with non-conductive ele trical characteristics of the cable may make the use c conduit unnecessary. Plastic cable is available unconne tored or connectored. Refer to page 5-34 for part number numbers.



SIMPLEX CABLE



DUPLEX CABLE

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Ref.
Storage Temperature		T_S	-40	+75	°C	
Installation Temperature		T_I	-20	+70	°C	
Short Term Tensile Force	Single Channel	F_T		50	N	Note 1
	Dual Channel	F_T		100	N	
Short Term Bend Radius		r	10		mm	Note 2
Long Term Bend Radius		r	35		mm	
Long Term Tensile Load		F_T		1	N	
Flexing				1000	Cycles	Note 3
Impact		m		0.5	kg	Note 4
		h		150	mm	

Electrical/Optical Characteristics 0°C to +70°C Unless Otherwise Specified

Parameter		Symbol	Min.	Typ.[5]	Max.	Units	Conditions	Ref.
Cable Attenuation	Standard Cable	α_o	0.19	0.31	0.43	dB/m	Source is HFBR-152X/153X (660 nm), ℓ = 20 m	Note 7
	Improved Cable		0.19	0.25	0.31			
Numerical Aperture		N.A.		0.5			$\ell > 2$ m	
Diameter, Core		D_C		1.0		mm		
Diameter, Jacket		D_J		2.2		mm	Simplex Cable	
Travel Time Constant		ℓ/v		5.0		nsec/m		Note 6
Mass per Unit Length/Channel		m/ℓ		4.6		g/m	Without Connectors	
Cable Leakage Current		I_L		12		nA	50 kV, ℓ = 0.3 m	

Notes:

1. Less than 30 minutes.
2. Less than 1 hour, non-operating.
3. 90° bend on 10 mm radius mandrel. Bend radius is the radiu of the mandrel around which the cable is bent.
4. Tested at 1 impact according to MIL-STD-1678, Method 203(Procedure 1.
5. Typical data is at 25°C.
6. Travel time constant is the reciprocal of the group velocity for propa gation of optical power. Group velocity is v = c/n, where c is th velocity of light in space (3×10^8 m/s) and n equals effective core index of refraction. Unit length of cable is ℓ.
7. In addition to standard Hewlett-Packard 100% product testing, HP provides additional margin to ensure link performance. Under certain conditions, cable installation and improper connectoring may reduce performance. Contact Hewlett-Packard for recommendations.
8. Improved cable is available in 500 metre spools and in factory-connectored lengths less than 100 metres.

FIBER OPTICS

Versatile Link Fiber Optic Connectors

CONNECTORS FEEDTHROUGH/SPLICE POLISHING TOOLS

Versatile Link transmitters and receivers are compatib with three connector styles; simplex, simplex latching, an duplex. All connectors provide a snap-action when mate to Versatile Link components. Simplex connectors are colo coded to match with transmitter and receiver color codin Duplex connectors are keyed so that proper orientation ensured. When removing a connector from a module, pu at the connector body. Do not pull on the cable alone. Th same, quick and simple connectoring technique is used wit all connectors and cable. This technique is described on pag 18. Note that simplex and duplex crimp rings are different.

Simplex Connector Styles

HFBR-4501/4511 — Simplex

The simplex connector provides a quick and stabl connection for applications that require a component t provide retention force of 8 newtons (1.8 lb). These con nectors are available in colors of gray (HFBR-4501) o blue (HFBR-4511).

HFBR-4503/4513 — Simplex Latching

The simplex latching connector is designed for rugge applications requiring greater retention force, 80 N (18 lbs) than that provided by a simplex connector. When insertin the simplex latching connector into a module, the connecto latch mechanism should be aligned with the top surface o the horizontal module, or with the tall vertical side of th vertical module. Misorientation of an inserted latching con nector into either module housing will not result in a positive latch. The connector is released by depressing th rear section of the connector lever, and then pulling th connector assembly away from the module housing.

If the cable/connector will be used at elevated operatin temperatures or experience frequent and wide temperatur cycling effects, the cable/connector attachment can b strengthened by applying a RTV adhesive within the con nector. A recommended adhesive is GE Company RTV 128. In most applications, use of RTV is unnecessary. Th simplex latching connector is available in gray (HFBR 4503) or blue (HFBR-4513).

Duplex Connector HFBR-4506 — Duplex

Duplex connectors provide convenient duplex cable term nation and are keyed to prevent incorrect connection. Th duplex connector is compatible with dual combinations o identical Versatile Link components (e.g., two horizonta transmitters, two vertical receivers, a horizontal transmitte and a horizontal receiver, etc.). A duplex connector canno connect to two different packages simultaneously. Th duplex connector is an off-white color.

Feedthrough/Splice HFBR-4505/4515 — Adapter

The HFBR-4505/4515 adapter mates two simplex connec tors for panel/bulkhead feedthrough of plastic fiber cable Maximum panel thickness is 4.1 mm (0.16 inch). This adapte can serve as a cable in-line splice using two simplex connectors. The colors of the adapters are gray (HFBR 4505) and blue (HFBR-4515). The adapter is not compatibl with the duplex or simplex latching connectors.

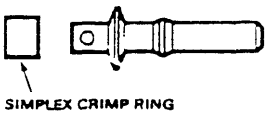
Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units	Notes
Storage Temperature	T_S	-40	+75	°C	
Operating Temperature	T_A	0	+70	°C	
Nut Torque HFBR-4505/4515	T_N		0.7	N-m	1
			100	OzF-in	

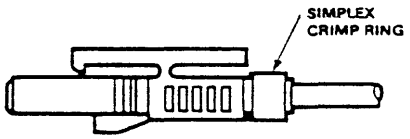
Notes:

1 Recommended nut torque is 0.57 N-m (80 OzF-in)

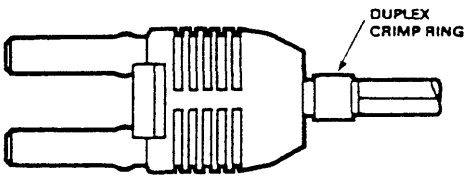
HFBR-4501 (GRAY)/4511 (BLUE) SIMPLEX CONNECTOR



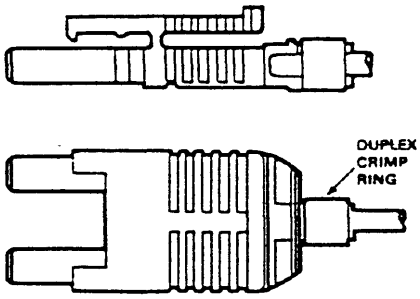
HFBR-4503 (GRAY)/4513 (BLUE) SIMPLEX LATCHING CONNECTOR



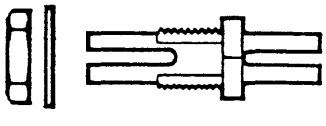
HFBR-4506 (PARCHMENT) DUPLEX CONNECTOR



HFBR-4516 (PARCHMENT) DUPLEX LATCHING CONNECTOR



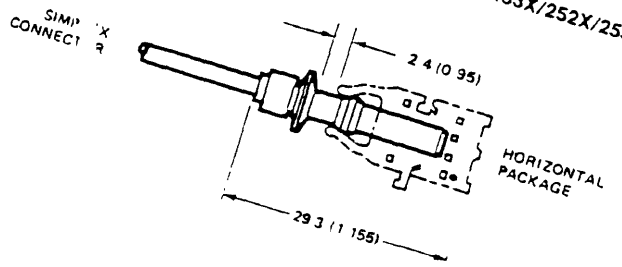
HFBR-4505 (GRAY)/4515 (BLUE) ADAPTER

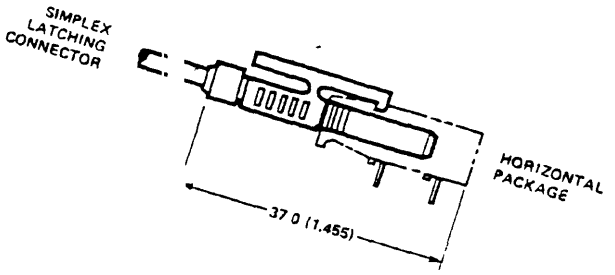


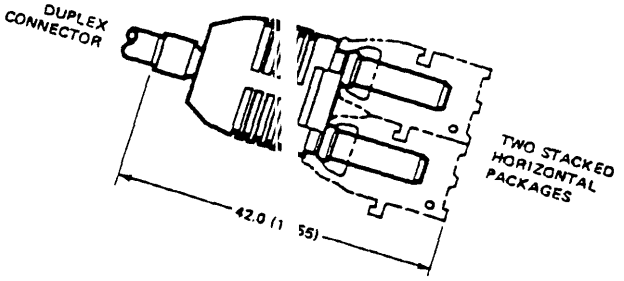
(USE WITH SIMPLEX CONNECTORS ONLY)

Connector Applications

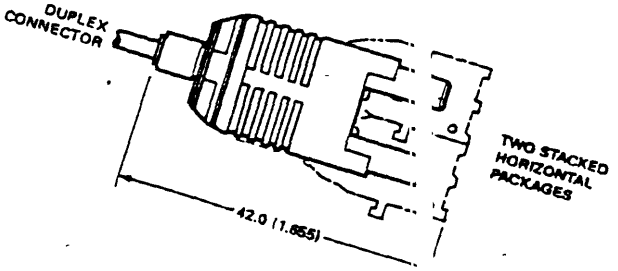
ATTACHMENT TO HEWLETT-PACKARD HFBR-152X/153X/252X/253X VERSATILE LINK FIBER C





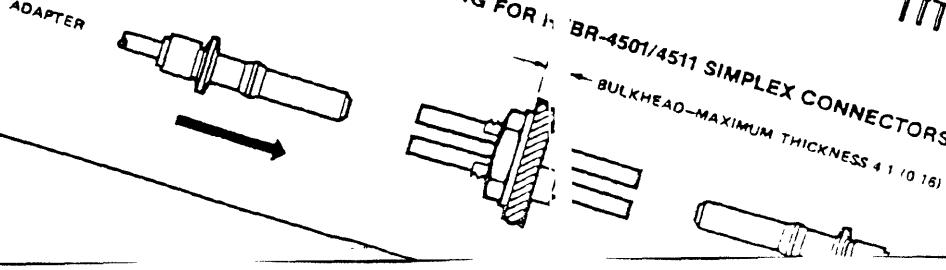


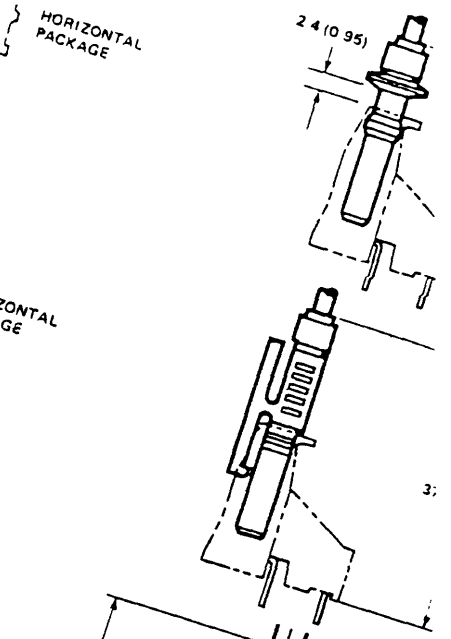
DIMENSIONS IN MILLIMETRES (INCHES)

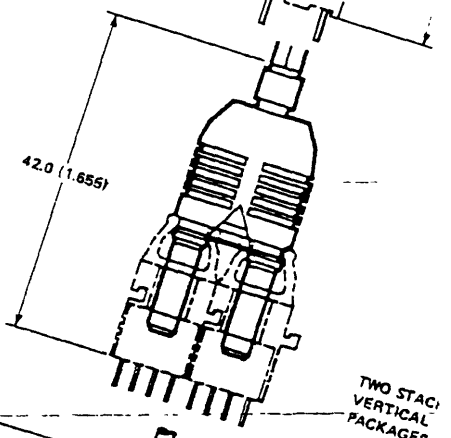


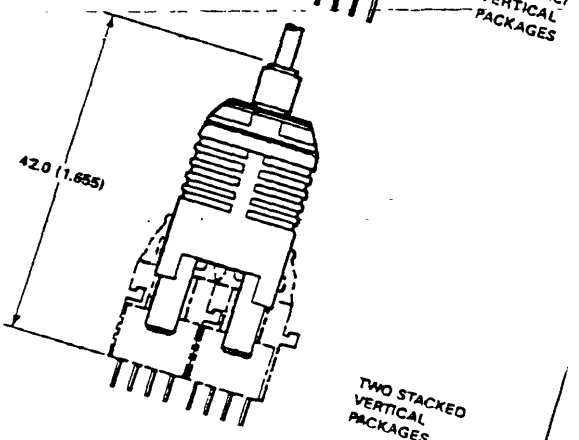
DIMENSIONS IN MILLIMETRES (INCHES)

BULKHEAD FEEDTHROUGH OR PANEL MOUNTING FOR HFBR-4501/4511 SIMPLEX CONNECTORS

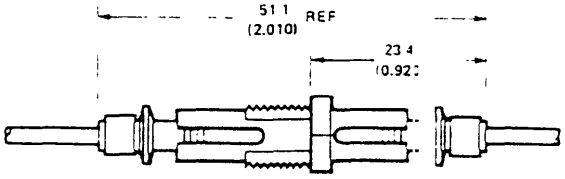








IN-LINE SPLICE FOR HFBR-35XX/36XX FIBER OPTIC CABLE WITH HFBR-4501/4511 SIMPLEX CONNECTORS



DIMENSIONS IN MILLIMETRES (INCHES)

Connector Mechanical/Optical Characteristics 25°C Unless Otherwise Specified.

Parameter	Part Number			Sym.	Min.	Typ.	Max.	Units	Ref.
Retention Force Connector to HFBR-152X 153X/ 252X/253X Modules	Simplex	HFBR-4	1/4511	F_{R-C}	7	8		N	Note 4
	Simplex Latching	HFBR-4	3/4513		47	80			
	Duplex	HFBR-4	6		7	12			
	Duplex Latching	HFBR-4	6		50	80			
Tensile Force Connector to Cable	Simplex	HFBR-4	1/4511	F_T	8.5	22		N	Notes 3, 4
	Simplex Latching	HFBR-4	3/4513		8.5	22			
	Duplex	HFBR-4	6		14	35			
	Duplex Latching	HFBR-4	6		14	35			
Adapter Connector to Connector Loss	HFBR-4505/4515 with HFBR-4		1/4511	α_{CC}	0.7	1.5	2.8	dB	Notes 1, 5
Retention Force Connector to Adapter	HFBR-4505/4515 with HFBR-4		1/4511	F_{R-B}	7	8		N	Note 4
Insertion Force Connector to HFBR-152X/153X/ 252X/253X Modules	Simplex	HFBR-4	1/4511	F_I		8	12	N	Notes 2, 4
	Simplex Latching	HFBR-4	3/4513			16	35		
	Duplex	HFBR-4	6			13	46		
	Duplex Latching	HFBR-4	6			22	51		

Notes:

1. Factory polish or field polish per recommended procedure.
2. No perceivable reduction in insertion force was observed fter 2000 insertions. Destructive insertion force was typically at 178 N (40 lbs).
3. For applications where frequent temperature cycling ove emperature extremes is expected please contact Hewlett-Packard fo alternate connectoring techniques.
4. All mechanical forces were measured after units were store at 70°C for 168 hours and returned to 25°C for one hour.
5. Minimum and maximum limits of α_{CC} are for 0°C to 70°C te perature range. Typical value of α_{CC} is at 25°C.

Connectoring

The following easy procedure describes how to make cab terminations. It is ideal for both field and factory installatio If a high volume connectoring technique is required plea contact your Hewlett-Packard sales engineer for the reco mended procedure and equipment.

Connectoring the cable is accomplished with the Hewle Packard HFBR-4593 Polishing Kit consisting of a Polishi Fixture, 600 grit abrasive paper and 3-μm pink lapping fi (3M Company, OC3-14). No adhesive material is needed secure the cable in the connector, and the connector c be used immediately after polishing. Improved connect to cable attachment can be achieved with the use of a R (GE Company, RTV-128) adhesive for frequent, extre temperature cycling environments or for elevated temper ture operation.

Connectors may be easily installed on the cable ends with readily available tools. Materials needed for the terminating procedure are:

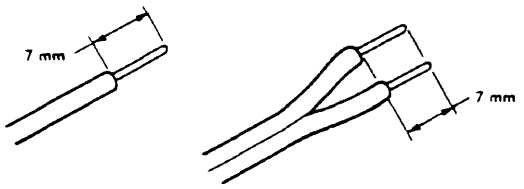
1) Hewlett-Packard Plastic Fiber Optic Cable
2) HFBR-4593 Polishing Kit
3) HFBR-4501/4503 Gray Simplex/Simplex Latching Connector and Silver Color Crimp Ring
4) HFBR-4511/4513 Blue Simplex/Simplex Latching Connector and Silver Color Crimp Ring
5) HFBR-4506 Parchment Duplex Connector and Duplex Crimp Ring
6) Industrial Razor Blade or Wire Cutters
7) 16 Gauge Latching Wire Strippers
8) Crimp Tool, HFBR-4597

Step 1

The zip cord structure of the duplex cable permits easy separation of the channels. The channels should be separated approximately 50 mm (2.0 in.) back from the ends to permit connectoring and polishing.

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

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

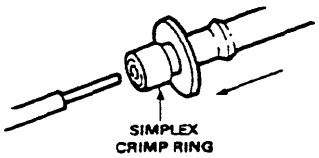


Step 2

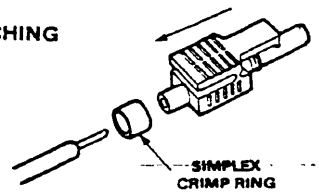
Place the crimp ring and connector over the end of the cable; the fiber should protrude about 3 mm (0.12 in.) through the end of the connector. Carefully position the ring so that it is entirely on the connector with the rim of the crimp ring flush with the connector, leaving a small space between the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

Note: *Place the gray connector on the cable end to be connected to the transmitter and the blue connector on the cable end to be connected to the receiver to maintain the color coding (both connectors are the same mechanically). For duplex connector and duplex cable application, align the color coded side of the cable with the appropriate ferrule of the duplex connector in order to match connections to the respective optical ports. The simplex connector crimp ring cannot be used with the duplex connector. The duplex connector crimp ring cannot be used with the simplex or simplex latching connectors. The simplex crimp has a dull lustre; the duplex ring is shiny and has a thinner wall.*

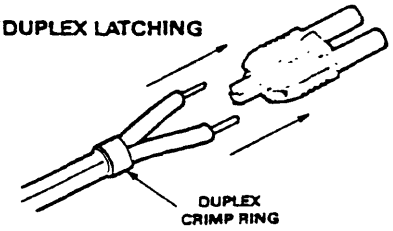
SIMPLEX



SIMPLEX LATCHING



DUPLEX/DUPLEX LATCHING



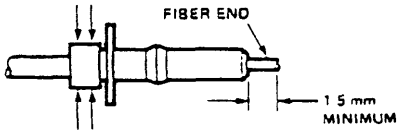
Step 3

Any excess fiber protuding 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 two 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.*

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.

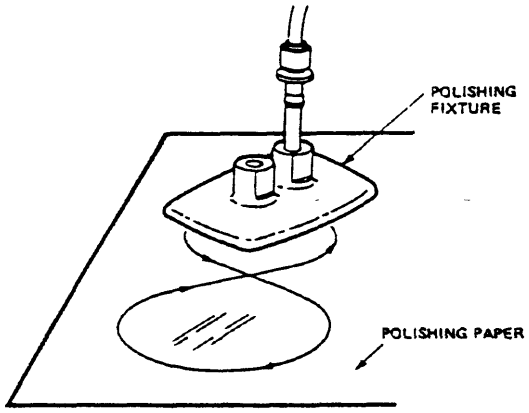


Step 4

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

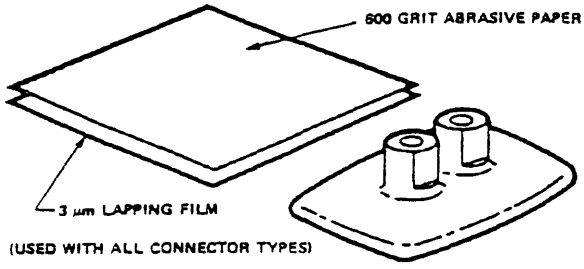
The cable is now ready for use.

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 600 grit polish alone. This fine polish is comparable to Hewlett-Packard 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 2.8 mm (0.110 in.) minimum and 3.2 mm (0.125 in.) maximum.*



For simultaneous multiple connector polishing techniques please contact Hewlett-Packard.

HFBR-4593 POLISHING KIT



Ordering Guide

TRANSMITTERS (T_X)/RECEIVERS (R_X) Pages 5-24 5-27

Versatile Link	Unit	Horizontal Modules	Vertical Modules	
5 MBd High Performance	T_X	HFBR-2521	HFBR-2	31
1 MBd High Performance	T_X	HFBR-2522	HFBR-2	32
40 kBd Low Current/ Extended Distance	T_X	HFBR-2523	HFBR-2	33
1 MBd Standard	T_X	HFBR-2524	HFBR-2	34
5 MBd High Performance	R_X	HFBR-1521	HFBR-1	31
1 MBd High Performance	R_X	HFBR-1522	HFBR-1	32
40 kBd Low Current/ Extended Distance	R_X	HFBR-1523	HFBR-1	33
1 MBd Standard	R_X	HFBR-1524	HFBR-1	34

CONNECTORS Page 5-30

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

EVALUATION KIT, HFBR-0501 CONTENTS:

HFBR-1524	Transmitter
HFBR-2524	Receiver
HFBR-4501	Gray Simplex Connector with Crimp Ring
HFBR-4506	Duplex Connector with Crimp Ring
—	5 metres of Connectored Simplex Cable with Blue Simplex and Gray Simplex Latching Connectors
HFBR-4513	Blue Simplex Latching Connector with Crimp Ring
HFBR-4505	Gray Adapter
—	Polishing Tool and 600 grit paper
HFBR-0501	Data Sheet and Brochure

ACCESSORIES

HFBR-4522	500 Port Plugs
HFBR-4525	1000 Simplex Crimp Rings
HFBR-4526	500 Duplex Crimp Rings
HFBR-4593	Polishing Kit (one polishing tool, two pieces 600 grit abrasive paper, and two pieces 3-μm lapping film).
HFBR-4597	Crimping Tool

A Note About Ordering Cable

Four steps are required to determine the proper part number for a desired cable.

Step 1 Select Standard or Improved Cable.

As explained on page 5-29, two levels of attenuation are available: Standard and Improved.

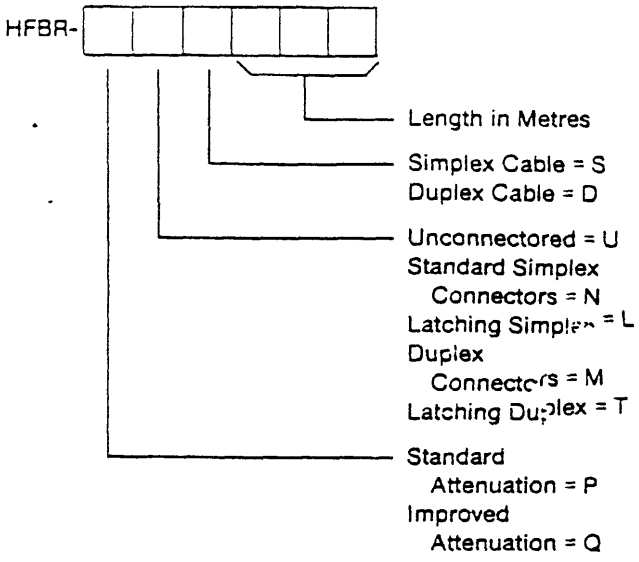
Step 2 Select the connector style.

Connector styles are described on page 5-30.

Step 3 Select Simplex or Duplex.

Step 4 Determine the cable length.

To determine the appropriate part number, select the letter corresponding to your selection and fill in the following:



For example:

HFBR-PUD500 is a Standard Attenuation, Unconnectored, Duplex, 500 metre cable.

HFBR-QLS001 is an Improved Attenuation, Latching Simplex Connectored, Simplex, 1 metre cable.

HFBR-PMD010 is a Standard Attenuation, Standard Duplex Connectored, Duplex, 10 metre cable.

HFBR-PND100 is a Standard Attenuation, Standard Simplex Connectored, Duplex, 100 metre cable.

Note: 0.1 metre Standard Attenuation Simplex lengths are available; 0.5 metre Standard Attenuation Simplex and Duplex lengths are also available. The lengths are ordered as HFBR-xxx1DM or HFBR-xxx5DM.

ATTENTION: Pre-connectored simplex cables have oppositely colored (GRAY vs. BLUE) connectors at the opposite ends of the same fiber; although oppositely colored, the connectors are mechanically identical. For duplex cables with simplex connectors, the same rule applies to each fiber; also, the side-by-side fibers at each end of the cable have oppositely colored connectors. For duplex cables with duplex connectors similar rules apply, so the connectors at opposite ends are oppositely keyed relative to the marked fiber in a duplex cable.