HEWLETT PACKARD

MINIATURE FIBER OPTIC LOGIC LINK

HFBR-1202
HFBR-2202
HFBR-4202

Features

- DC TO 5 MBAUD DATA RATE
- MAXIMUM LINK LENGTH
  625 Metres (Guaranteed)
  1600 Metres (Typical)
- TTL/CMOS COMPATIBLE OUTPUT
- MINIATURE, RUGGED METAL PACKAGE
- SINGLE +5V RECEIVER POWER SUPPLY
- INTERNALLY SHIELDED RECEIVER FOR EMI/RFI IMMUNITY
- PCB AND PANEL MOUNTABLE
- LOW POWER CONSUMPTION

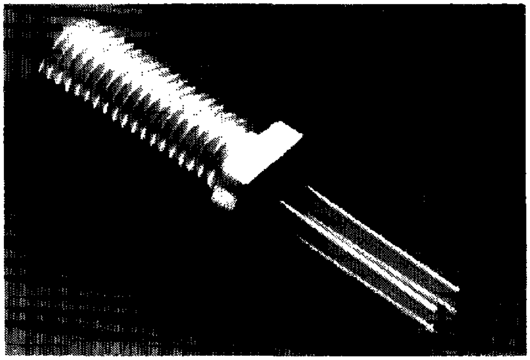
Applications

- EMC REGULATED SYSTEMS (FCC, VDE)
- EXPLOSION PROOF SYSTEMS IN OIL INDUSTRY/CHEMICAL PROCESS CONTROL INDUSTRY
- SECURE DATA COMMUNICATIONS
- WEIGHT SENSITIVE SYSTEMS (e.g. Avionics, Mobile Stations)
- HIGH VOLTAGE ISOLATION IN POWER GENERATION

Description

The HFBR-1202 Transmitter and HFBR-2202 Receiver are SMA style connector compatible fiber optic link components. Distances to 1600 metres at data rates up to 5 MBaud are achievable with these components.

The HFBR-1202 Transmitter contains a high efficiency GaAlAs emitter operating at 820 nm. Consistent coupling



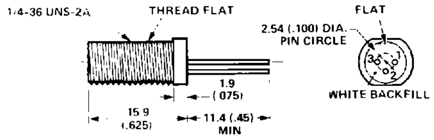
efficiency is assured by factory alignment of the LED with the optical axis of the package. Power coupled into the fiber varies less that 4 dB from part to part at a given temperature and drive current. The benefit of this is reduced dynamic range requirements on the receiver.

The HFBR-2202 Receiver incorporates a photo IC containing a photodetector and dc amplifier. An open collector Schottky transistor on the IC provides logic compatibility. The combination of an internal EMI shield, the metal package and an isolated case ground provides excellent immunity to EMI/RFI. For unusually severe EMI/ESD environments, a snap-on metal shield is available. The receiver is easily identified by the black epoxy backfill.

The HFBR-1202 Transmitter and HFBR-2202 Receiver are compatible with SMA style connectors, types A and B (see Figure 11.

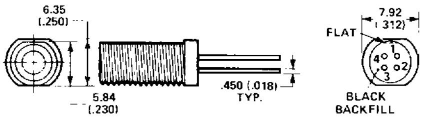
Mechanical Dimensions

HFBR-1202 TRANSMITTER



PIN	FUNCTION
1	ANODE
2	CATHODE
3	CASE

HFBR-2202 RECEIVER



PIN	FUNCTION
1	CASE
2	V_{CC}
3	DATA
4	COMMON

DIMENSIONS IN MILLIMETRES (INCHES)
UNLESS OTHERWISE SPECIFIED, THE TOLERANCES ARE:
.X ± .51 mm (.XX ± .02 IN)
.XX ± .13 mm (.XXX ± .005 IN)

System Design Considerations

The Miniature Fiber Optic Logic Link is guaranteed to work over the entire range of 0 to 625 metres at a data rate of dc -5 MBd, with arbitrary data format and typically less than 25% pulse width distortion, if the Transmitter is driven with $I_F = 40$ mA, $R_1 = 82\Omega$. If it is desired to economize on power or achieve lower pulse distortion, then a lower drive current (I_F) may be used. The following example will illustrate the technique for optimizing I_F.

EXAMPLE: Maximum distance required = 250 metres. From Figure 2 the worst case drive current = 20 mA. From the Transmitter data — $V_F = 1.8V$ (max.).

$$R_1 = \frac{V_{CC} - V_F}{I_F} = \frac{5 - 1.8V}{20 \text{ mA}} = 160\Omega$$

The optical power margin between the typical and worst case curves (Figure 2) at 250 metres is 4 dB. To calculate the worst case pulse width distortion at 250 metres, see Figure 8. The power into the Receiver is P_{RL} + 4 dB = -20 dBm. Therefore, the typical distortion is 40 ns or 20% at 5 MBd.

CABLE SELECTION

The link performance specifications on the following page are based on using cables that contain glass-clad silica fibers with a 100 μm core diameter and 140 μm cladding diameter. This fiber type is now a user accepted standard for local data communications links (RS-458, Class I, Type B). The HFBR-1202 Transmitter and HFBR-2202 Receiver are optimized for use with the 100/140 μm fiber. There is, however, no fundamental restriction against using other fiber types. Before selecting an alternate fiber type, several parameter need to be carefully evaluated. will significantly affect the optical power coupled into the fiber are as follows:

a. **Fiber Core Diameter.** As the core diameter is increased, the optical power coupled increases, leveling off at about 250 μm diameter.
b. **Numerical Aperture (NA).** As the NA is increased, the optical power coupled increases, leveling off at an NA of about 0.34.
c. **Index Profile (α).** The Index profile parameter of fibers varies from 2 (fully graded index) to infinite (step index). Some gains in coupled optical power can be achieved at the expense of bandwidth, when α is increased.

In addition to the optical parameters, the environmental performance of the selected fiber/cable must be evaluated. Finally, the ease of installing connectors on the selected fiber/cable must be considered. Given the large number of parameters that must be evaluated when using a non-standard fiber, it is recommended that the 100/140 μm fiber be used unless unusual circumstances warrant the use of an alternate fiber/cable type.

SMA STYLE CONNECTORS

The HFBR-1202/2202 is compatible with either the Type A or Type B SMA style fiber optic connector (see Figure 11). The basic difference between the two connectors is the plastic half-sleeve on the stepped ferrule tip of the Type B connector. This step provides the capability to use a full length plastic sleeve to ensure good alignment of two connectors for an inline splice. Hewlett-Packard offers connectored cable that utilizes the Type A connector system because of the inherent environmental advantages of metal-to-metal interfaces.

FIBER OPTICS

Typical Circuit Configuration

NOTE:
IT IS ESSENTIAL THAT A BYPASS CAPACITOR (0.01 μF to 0.1 μF CERAMIC) BE CONNECTED FROM PIN 2 TO PIN 4 OF THE RECEIVER. TOTAL LEAD LENGTH BETWEEN BOTH ENDS OF THE CAPACITOR AND THE PINS SHOULD NOT EXCEED 20 mm.

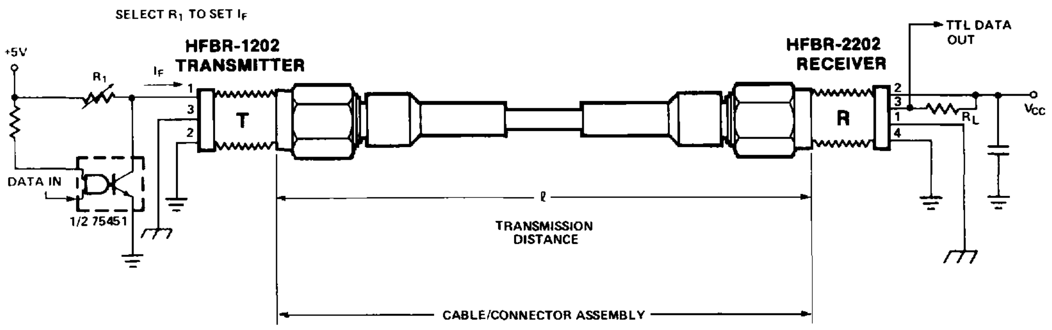


Figure 1.

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units	Reference
TRANSMITTER					
Ambient Temperature	T_A	-40	+85	°C	
Peak Forward Input Current	$I_{F\ PK}$		40	mA	Note 7
Average Forward Input Current	I_{FAV}		40	mA	Note 7
RECEIVER					
Ambient Temperature	T_A	-40	+85	°C	
Supply Voltage	V_{CC}	4.75	5.25	V	
Fan Out (TTL)	N		5		Note 3, Fig. 1
CABLE (see SMA connectored cable data sheet)					

System Performance -40° C to +85° C unless otherwise specified

Parameter	Symbol	Min.[1]	Typ.	Max.	Units	Conditions	Reference
Transmission Distance	ℓ	625	1600		Metres		Fig. 2, Note 9
Data Rate Synchronous		dc		5	MBaud		Note 10
Asynchronous		dc		2.5	MBaud		Note 10, Fig. 8
Propagation Delay LOW to HIGH	t_{PLH}		82		nsec	$T_A = 25°C$, $P_R = -21$ dBm, $I_{F\ PK} = 15$ mA, ℓ = 1 metre	Fig. 7, 8, 9
Propagation Delay HIGH to LOW	t_{PHL}		55		nsec		
System Pulse Width Distortion	t_D		27		nsec		
Bit Error Rate	BER			10^{-9}		Data Rate ≤5 MBaud, $P_R > -24$ dBm (4μW)	

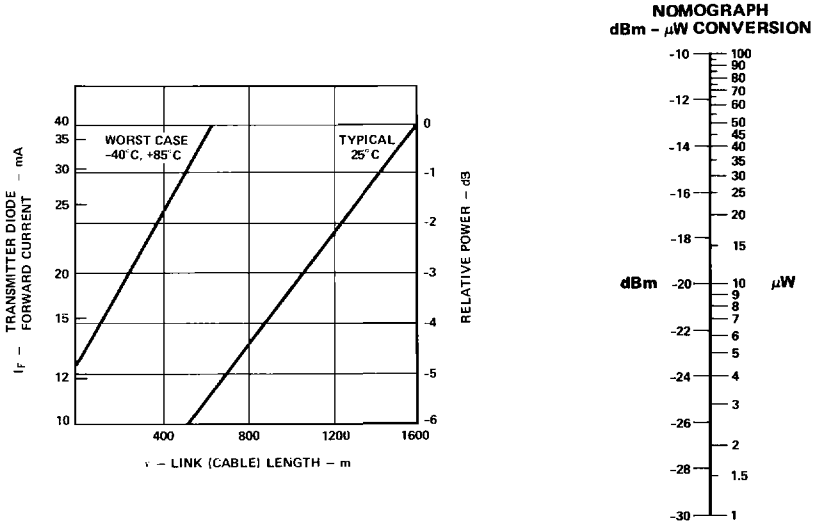
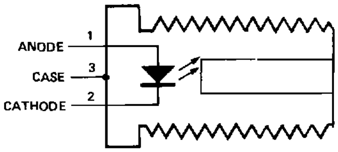
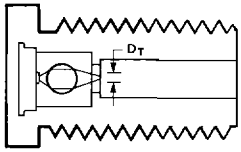


Figure 2. System Performance: HFBR-1202/HFBR-2202 with HP's 100/140 μm fiber cable

HFBR-1202 TRANSMITTER

HFBR-1202 TRANSMITTER





Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Unit	Reference
Storage Temperature		T_S	-55	+85	°C	
Operating Temperature		T_A	-40	+85	°C	Note 13
Lead Soldering Cycle	Temp.			+260	°C	Note 2
	Time			10	sec	
Forward Input Current	Peak	$I_{F\ PK}$		40	mA	Note 7
	Average	$I_{F,\ AV}$		40	mA	
Reverse Input Voltage		V_R		2.5	V	

Electrical/Optical Characteristics -40° C to +85° C unless otherwise specified

Parameter	Symbol	Min.	Typ.[1]	Max.	Units	Conditions	Reference
Forward Voltage	V_F		1.5	1.8	V	I_F = 40 mA	Figure 5
Forward Voltage Temperature Coefficient	$\Delta V_F/\Delta T$		-0.91		mV/° C	I_F = 40 mA	Figure 5
Reverse Breakdown Voltage	V_{BR}	2.5	4.0		V	I_R = 100 μA	
Numerical Aperture	NA		.34				
Optical Port Diameter	D_T		250		μm		Note 11
Peak Emission Wavelength	λ_P		820		nm		Figure 6
Peak Output Optical Power Coupled into HFBR-3000 Fiber Cable/Connector Assembly, 100/140 μm	P_T	-17	-16	-13	dBm	I_F = 40 mA	Figure 3
		20	25	50	μW	T_A = 25° C	Notes 4, 15
		-18		-12.3	dBm	I_F = 40 mA	
		15.8		59	μW	-40° C < T_A < 85° C	
Output Optical Power Coupled into 50/125 μm Fiber	P_T		-24		dBm	I_F = 40 mA	Figure 3
			4		μW	T_A = 25° C	Notes 14, 15
Output Optical Power Coupled into Siecor 100/140 μm Fiber Cable or Equivalent	P_T		-18		dBm	I_F = 40 mA T_A = 25° C	Figure 3 Notes 15, 16
Optical Power Temperature Coefficient	$\Delta P_T/\Delta T$		-.017		dB/° C		Figure 4

Dynamic Characteristics -40° C to +85° C unless otherwise specified

Parameter	Symbol	Min.	Typ.[1]	Max.	Units	Conditions	Reference
Propagation Delay LOW to HIGH	t_{PLH}		17		nsec	$I_{F\ PK}$ = 10 mA	Note 8 Figure 7
Propagation Delay HIGH to LOW	t_{PHL}		6		nsec		

Notes:

1. Typical data at T_A = 25° C, V_{CC} = 5.0V dc.
2. 2.0 mm from where leads enter case
3. 8 mA load (5 x 1.6 mA), R_L = 560Ω.
4. Measured at the end of 1.0 metre HP's 100/140 μm Fiber Optic Cable with large area detector and cladding modes stripped, terminated with the appropriate type of connector. This assembly approximates a Standard Test Fiber. The fiber NA is 0.28, measured at the end of greater than 300 metres length of fiber, the NA being defined as the sine of the half angle determined by the 10% intensity points.
5. Measured at the end of HP's 100/140 μm Fiber Optic Cable with large area detector.
6. When changing microwatts to dBm, the optical flux is referenced to one milliwatt (1000 μW).

   $$\text{Optical Flux, P (dBm)} = 10 \log \frac{P\ (\mu W)}{1000\ \mu W}$$
7. I_{FPK} should not be less than 10 mA in the "ON" state. This is to avoid the long turn-on time that occurs at low input current. I_{FAV} may be arbitrarily low, as there is no duty factor restriction.

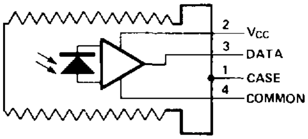
WARNING: OBSERVING THE TRANSMITTER OUTPUT POWER UNDER MAGNIFICATION MAY CAUSE INJURY TO THE EYE. When viewed with the unaided eye, the infrared output is radiologically safe; however, when viewed under magnification, precaution should be taken to avoid exceeding the limits recommended in ANSI Z136.1-1981.

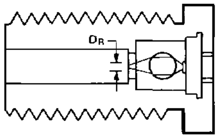
HFBR/2202 RECEIVER

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Reference
Storage Temperature		T_S	-55	+85	°C	
Operating Temperature		T_A	-40	+85	°C	
Lead Soldering Cycle	Temp			+260	°C	Note 2
	Time			10	sec	
Supply Voltage		V_{CC}	-0.5	+7.0	V	
Output Current		I_O		25	mA	
Output Voltage		V_O	-0.5	+18.0	V	
Output Collector Power Dissipation		$P_{O,AV}$		40	mW	

HFBR/2202 RECEIVER





Electrical/Optical Characteristics

−40°C to +85°C and 4.75 ≤ V_{CC} ≤ 5.25 V unless otherwise specified.

Parameter	Symbol	Min.	Typ.[11]	Max.	Units	Conditions	Reference
High Level Output Current	I_{OH}		5	250	μA	V_O = 18V P_R < -40 dBm	
Low Level Output Voltage	V_{OL}		0.4	0.5	V	I_O = 8 mA P_R > -24 dBm	
High Level Supply Current	I_{CCH}		3.5	6.3	mA	V_{CC} = 5.25 V P_R < -40 dBm	
Low Level Supply Current	I_{CCL}		6.2	10	mA	V_{CC} = 5.25 V P_R > -24 dBm	
Optical Port Diameter	D_R		700		μm		Note 12
Numerical Aperture	NA		.32				

Dynamic Characteristics

−40°C to +85°C and 4.75 ≤ V_{CC} ≤ 5.25 V unless otherwise specified.

Parameter	Symbol	Min.	Typ.[11]	Max.	Units	Conditions	Reference
Input Power Level Logic HIGH	P_{RH}			-40	dBm	λ_P = 820 nm	Note 5
				0.1	μW		
Input Power Level Logic LOW	P_{RL}	-25.4		-11.2	dBm	T_A = +25°C	Fig. 4, Note 5
		2.9		76	μW		
		-24		-12.0	dBm	-40 < T_A < 85°C	
		4.0		63	μW		
Propagation Delay LOW to HIGH	t_{PLHR}		65		nsec	T_A = 25°C, P_R = -21 dBm	Note 8, Fig. 7
Propagation Delay HIGH to LOW	t_{PHLR}		49		nsec		

Notes:

8. Propagation delay through the system is the result of several sequentially-occurring phenomena. Consequently it is a combination of data-rate-limiting effects and of transmission-time effects. Because of this, the data-rate limit of the system must be described in terms of time differentials between delays imposed on falling and rising edges.

   As the cable length is increased, the propagation delays increase at 5 ns per metre of length increase. Data rate, as limited by pulse width distortion, is not affected by increasing cable length if the optical power level at the Receiver is maintained.

9. Worst case system performance is based on worst case performance of individual components: transmitter at +85°C, receiver at -40°C and cable at -20°C.

10. Synchronous data rate limit is based on these assumptions: (a) 50% duty factor modulation, e.g. Manchester I or BiPhase (Manchester II), (b) continuous data; (c) PLL Phase Lock Loop demodulation, (d) TTL threshold.

    Asynchronous data rate limit is based on these assumptions: (a) NRZ data, (b) arbitrary timing — no duty factor restriction, (c) TTL threshold.

    The EYE pattern describes the timing range within which there is no uncertainty of the logic state relative to a specific threshold, due to either noise or intersymbol (prop delay) effects.

11. D_T is measured at the plane of the fiber face and defines a diameter where the optical power density is within 10 dB of its maximum.

12. D_R is the effective diameter of the detector image on the plane of the fiber face. The numerical value is the product of the actual detector diameter and the lens magnification.

13. *HP's 100/140 μm Fiber Cable is specified at a narrower temperature range -20°C to 85°C.*

14. Measured at the end of 1.0 metre 50/125 μm fiber with large area detector and cladding modes stripped, approximating a Standard Test Fiber. The fiber NA is 0.21 measured at the end of a 2.0 metre length, the NA being defined as the sine of the half angle determined by the 5% of peak intensity points.

15. Output Optical Power into connectored fiber cable other than HP's Fiber Optic Cable/Connector Assemblies may be different than specified because of mechanical tolerances of the connector, quality of the fiber surface and other variables.

16. Measured at the end of 1.0 metre Siecor 100/140 μm fiber cable or equivalent, with large area detector and cladding modes stripped, terminated with the appropriate type of connector. This assembly approximates a Standard Test Fiber. The fiber NA is 0.275 measured at the end of a 2.0 metre length, the NA being defined as the sine of the half angle determined by the 5% of peak intensity points.

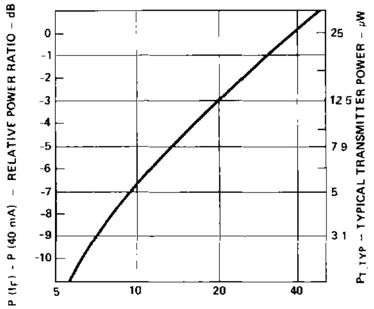


Figure 3. Normalized Transmitter Output vs. Forward Current

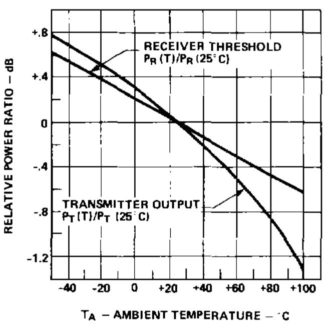


Figure 4. Normalized Thermal Effects in Transmitter Output, Receiver Threshold, and Link Performance (Relative Threshold)

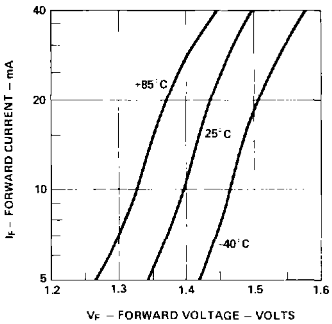


Figure 5. Forward Voltage and Current Characteristics for the Transmitter LED.

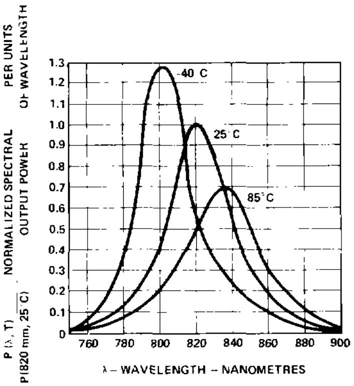


Figure 6. Transmitter Spectrum Normalized to the Peak at 25°C

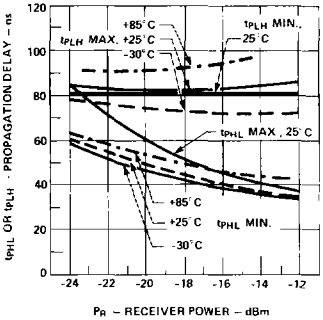


Figure 7. Propagation Delay through System with One Metre of Cable

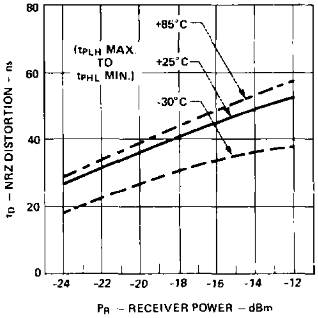


Figure 8. Worst-Case Distortion of NRZ EYE-pattern with Pseudo Random Data at 5 Mb/s. (see note 10)

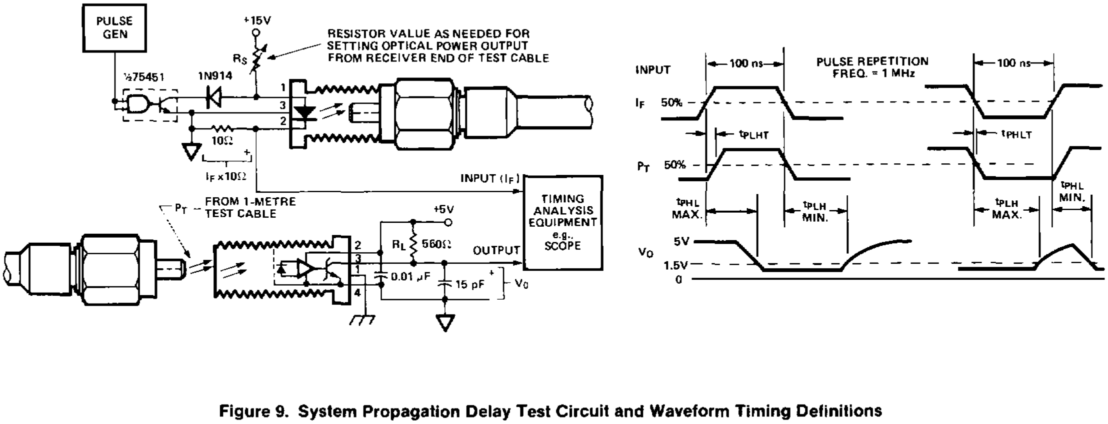
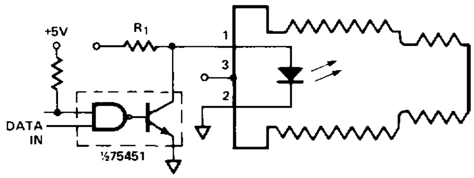
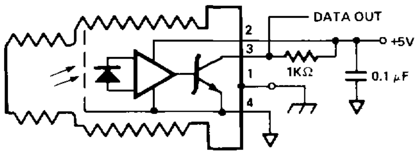


Figure 9. System Propagation Delay Test Circuit and Waveform Timing Definitions

Typical Circuit Configuration



HFBR-1201 TRANSMITTER



HFBR-2201 RECEIVER

Good system performance requires clean port optics and cable ferrules to avoid obstructing the optical path. Clean compressed air often is sufficient to remove particles of dirt; methanol or Freon™ on a cotton swab also works well.

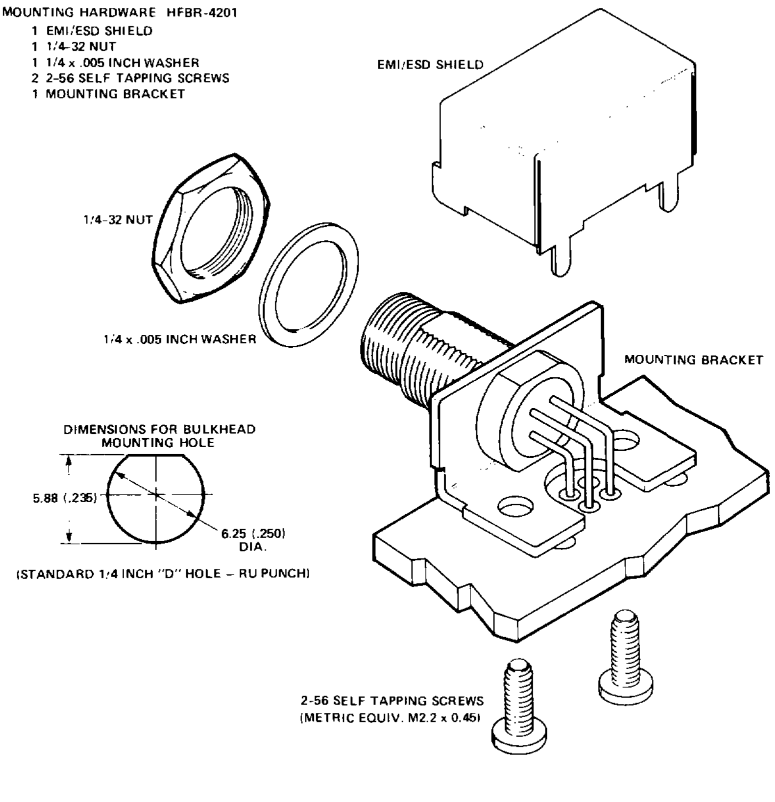
It is essential that a bypass capacitor (0.01 μF to 0.1 μF ceramic) be connected from pin 2 to pin 4 of the receiver. Total lead length between both ends of the capacitor and the pins should not exceed 20 mm.

Horizontal PCB Mounting

Mounting at the edge of a printed circuit board with the lock nut overhanging the edge is recommended.

When bending the leads, avoid sharp bends right where the lead enters the backfill. Use needle nose pliers to support the leads at the base of the package and bend the leads as desired.

When soldering, it is advisable to leave the protective cap on the unit to keep the optics clean.



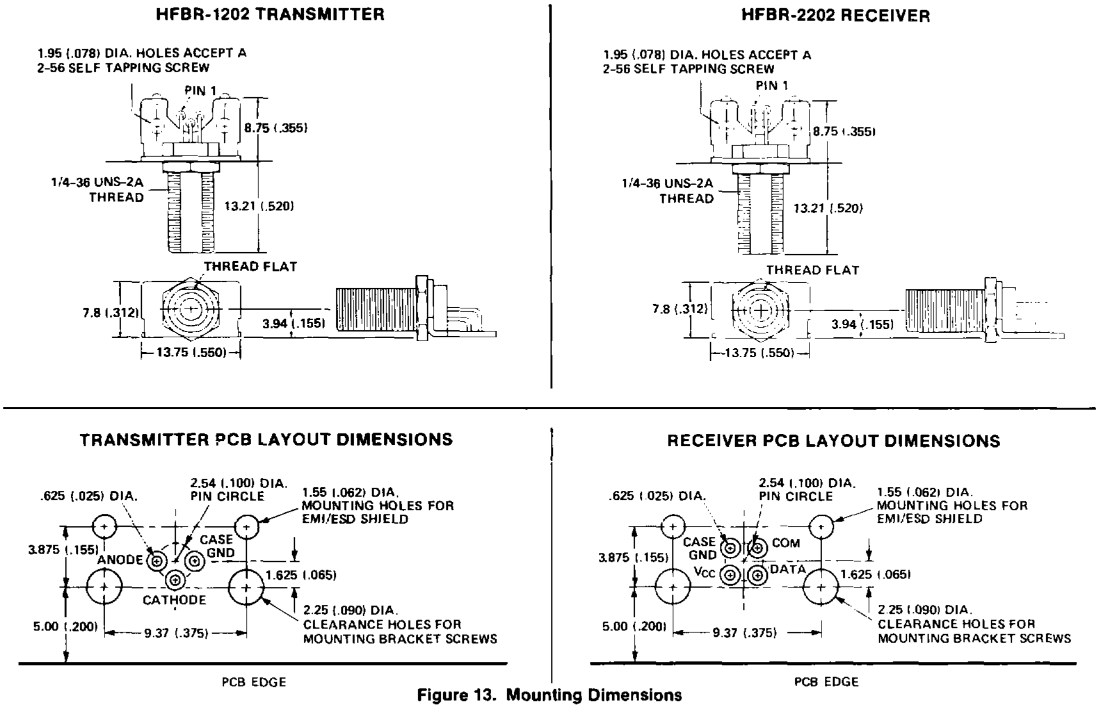


Figure 13. Mounting Dimensions
DIMENSIONS IN MILLIMETRES (INCHES).

Ordering Guide

Transmitter: HFBR-1202 (SMA Connector Compatible)

Receiver: HFBR-2202 (SMA Connector Compatible)

Mounting Hardware: HFBR-4202 (SMA Connector Compatible)