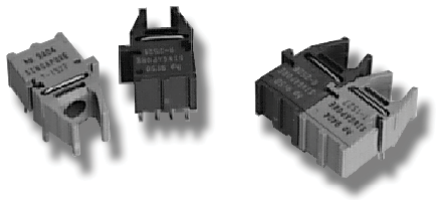
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HFBR-0507Z Series
HFBR-15X7Z Transmitters
HFBR-25X6Z Receivers

125 Megabaud Versatile Link
The Versatile Fiber Optic Connection

Data Sheet



Description

The 125 MBd Versatile Link (HFBR-0507Z Series) is the most cost-effective fiber-optic solution for transmission of 125 MBd data over 100 meters. The data link consists of a 650 nm LED transmitter, HFBR-15X7Z, and a PIN/pre-amp receiver, HFBR-25X6Z. These can be used with low-cost plastic or silica fiber. One mm diameter plastic fiber provides the lowest cost solution for distances under 25 meters. The lower attenuation of silica fiber allows data transmission over longer distance, for a small difference in cost. These components can be used for high speed data links without the problems common with copper wire solutions, at a competitive cost.

The HFBR-15X7Z transmitter is a high power 650 nm LED in a low cost plastic housing designed to efficiently couple power into 1 mm diameter plastic optical fiber and 200 µm Hard Clad Silica (HCS®) fiber. With the recommended drive circuit, the LED operates at speeds from 1-125 MBd. The HFBR-25X6Z is a high bandwidth analog receiver containing a PIN photodiode and internal transimpedance amplifier. With the recommended application circuit for 125 MBd operation, the performance of the complete data link is specified for of 0-25 meters with plastic fiber and 0-100 meters with 200 µm HCS® fiber. A wide variety of other digitizing circuits can be combined with the HFBR-0507Z Series to optimize perfor-mance and cost at higher and lower data rates.

Features

- RoHS-compliant
- Data transmission at signal rates of 1 to 125 MBd over distances of 100 meters
- Compatible with inexpensive, easily terminated plastic optical fiber, and with large core silica fiber
- High voltage isolation
- Transmitter and receiver application circuit schematics and recommended board layouts available
- Interlocking feature for single channel or duplex links, in a vertical or horizontal mount configuration

Applications

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

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HFBR-0507Z Series

125 MBd Data Link

Data link operating conditions and performance are specified for the HFBR-15X7Z transmitter and HFBR-25X6Z receiver in the recommended applications circuits shown in Figure 1. This circuit has been optimized for 125 MBd operation. The Applications Engineering Department in the Avago Optical Communication Division is available to assist in optimizing link performance for higher or lower speed operation.

Recommended Operating Conditions for the Circuits in Figures 1 and 2.

Parameter	Symbol	Min.	Max.	Unit	Reference
Ambient Temperature	T_A	0	70	°C	
Supply Voltage	V_{CC}	+4.75	+5.25	V	
Data Input Voltage – Low	V_{IL}	V_{CC}-1.89	V_{CC}-1.62	V	
Data Input Voltage – High	V_{IH}	V_{CC}-1.06	V_{CC}-0.70	V	
Data Output Load	R_L	45	55	Ω	Note 1
Signaling Rate	f_S	1	125	MBd	
Duty Cycle	D.C.	40	60	%	Note 2

Link Performance: 1-125 MBd, BER ≤ 10^{-9}, under recommended operating conditions with recommended transmit and receive application circuits.

Parameter	Symbol	Min.[3]	Typ.[4]	Max.	Unit	Condition	Reference
Optical Power Budget, 1 m POF	OPB_{POF}	11	16		dB		Note 5,6,7
Optical Power Margin, 20 m Standard POF	$OPM_{POF,20}$	3	6		dB		Note 5,6,7
Link Distance with Standard 1 mm POF	l	20	27		m		
Optical Power Margin, 25 m Low Loss POF	$OPM_{POF,25}$	3	6		dB		Note 5,6,7
Link Distance with Extra Low Loss 1 mm POF	l	25	32		m		
Optical Power Budget, 1 m HCS	OPB_{HCS}	7	12		dB		Note 5,6,7
Optical Power Margin, 100 m HCS	$OPM_{HCS,100}$	3	6		dB		Note 5,6,7
Link Distance with HCS Cable	l	100	125		m		

Notes:

1. If the output of U4C in Figure 1, page 4 is transmitted via coaxial cable, terminate with a 50 Ω resistor to V_{CC} - 2 V.
2. Run length limited code with maximum run length of 10 µs.
3. Minimum link performance is projected based on the worst case specifications of the HFBR-15X7Z transmitter, HFBR-25X6Z receiver, and POF cable, and the typical performance of other components (e.g. logic gates, transistors, resistors, capacitors, quantizer, HCS cable).
4. Typical performance is at 25°C, 125 MBd, and is measured with typical values of all circuit components.
5. Standard cable is HFBR-RXXYYYZ plastic optical fiber , with a maximum attenuation of 0.24 dB/m at 650 nm and NA = 0.5. Extra low loss cable is HFBR-EXXYYYZ plastic optical fiber, with a maximum attenuation of 0.19 dB/m at 650 nm and NA = 0.5. HCS cable is HFBR-H/VXXYYY glass optical fiber, with a maximum attenuation of 10 dB/km at 650 nm and NA = 0.37.
6. Optical Power Budget is the difference between the transmitter output power and the receiver sensitivity, measured after 1 meter of fiber. The minimum OPB is based on the limits of optical component performance over temperature, process, and recommended power supply variation.
7. The Optical Power Margin is the available OPB after including the effects of attenuation and modal dispersion for the minimum link distance: OPM = OPB - (attenuation power loss + modal dispersion power penalty). The minimum OPM is the margin available for longterm LED LOP degradation and additional fixed passive losses (such as in-line connectors) in addition to the minimum specified distance.

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Plastic Optical Fiber (1 mm POF) Transmitter Application Circuit: Performance of the HFBR-15X7Z transmitter in the recommended application circuit (Figure 1) for POF; 1-125 MBd, 25°C.

Parameter	Symbol	Typical	Unit	Condition	Note
Average Optical Power 1 mm POF	P_{avg}	-9.7	dBm	50% Duty Cycle	Note 1, Fig 3
Average Modulated Power 1 mm POF	P_{mod}	-11.3	dBm		Note 2, Fig 3
Optical Rise Time (10% to 90%)	t_r	2.1	ns	5 MHz	
Optical Fall Time (90% to 10%)	t_f	2.8	ns	5 MHz	
High Level LED Current (On)	$I_{F,H}$	19	mA		Note 3
Low Level LED Current (Off)	$I_{F,L}$	3	mA		Note 3
Optical Overshoot - 1 mm POF		45	%		
Transmitter Application Circuit Current Consumption - 1 mm POF	I_{CC}	110	mA		Figure 1

Hard Clad Silica Fiber (200 µm HCS) Transmitter Application Circuit: Performance of the HFBR-15X7Z transmitter in the recommended application circuit (Figure 1) for HCS; 1-125 MBd, 25°C.

Parameter	Symbol	Typical	Unit	Condition	Note
Average Optical Power 200 µm HCS	P_{avg}	-14.6	dBm	50% Duty Cycle	Note 1, Fig 3
Average Modulated Power 200 µm HCS	P_{mod}	-16.2	dBm		Note 2, Fig 3
Optical Rise Time (10% to 90%)	t_r	3.1	ns	5 MHz	
Optical Fall Time (90% to 10%)	t_f	3.4	ns	5 MHz	
High Level LED Current (On)	$I_{F,H}$	60	mA		Note 3
Low Level LED Current (Off)	$I_{F,L}$	6	mA		Note 3
Optical Overshoot - 200 µm HCS		30	%		
Transmitter Application Circuit Current Consumption - 200 µm HCS	I_{CC}	130	mA		Figure 1

Notes:

1. Average optical power is measured with an average power meter at 50% duty cycle, after 1 meter of fiber.
2. To allow the LED to switch at high speeds, the recommended drive circuit modulates LED light output between two non-zero power levels. The modulated (useful) power is the difference between the high and low level of light output power (transmitted) or input power (received), which can be measured with an average power meter as a function of duty cycle (see Figure 3). Average Modulated Power is defined as one half the slope of the average power versus duty cycle:

$$\text{Average Modulated Power} = \frac{[P_{avg} \text{ @ 80\% duty cycle} - P_{avg} \text{ @ 20\% duty cycle}]}{(2)\,[0.80 - 0.20]}$$

3. High and low level LED currents refer to the current through the HFBR-15X7Z LED. The low level LED "off" current, sometimes referred to as "hold-on" current, is prebias supplied to the LED during the off state to facilitate fast switching speeds.

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Plastic and Hard Clad Silica Optical Fiber Receiver Application Circuit: Performance[4] of the HFBR-25X6Z receiver in the recommended application circuit (Figure 1); 1-125 MBd, 25°C unless otherwise stated.

Parameter	Symbol	Typical	Unit	Condition	Note
Data Output Voltage - Low	V_{OL}	V_{CC} -1.7	V	R_L = 50 Ω	Note 5
Data Output Voltage - High	V_{OH}	V_{CC} -0.9	V	R_L = 50 Ω	Note 5
Receiver Sensitivity to Average Modulated Optical Power 1 mm POF	P_{min}	-27.5	dBm	50% eye opening	Note 2
Receiver Sensitivity to Average Modulated Optical Power 200 µm HCS	P_{min}	-28.5	dBm	50% eye opening	Note 2
Receiver Overdrive Level of Average Modulated Optical Power 1 mm POF	P_{max}	-7.5	dBm	50% eye opening	Note 2
Receiver Overdrive Level of Average Modulated Optical Power 200 µm HCS	P_{max}	-10.5	dBm	50% eye opening	Note 2
Receiver Application Circuit Current Consumption	I_{CC}	85	mA	$R_L = \infty$	Figure 1

Notes:

4. Performance in response to a signal from the HFBR-15X7Z transmitter driven with the recommended circuit at 1-125 MBd over 1 meter of HFBR-RZ/EXXYYYZ plastic optical fiber or 1 meter of HFBR-H/VXXYYY hard clad silica optical fiber.
5. Terminated through a 50 Ω resistor to V_{CC} - 2 V.
6. If there is no input optical power to the receiver, electrical noise can result in false triggering of the receiver. In typical applications, data encoding and error detection prevent random triggering from being interpreted as valid data. Refer to Applications Note 1066 for design guidelines.

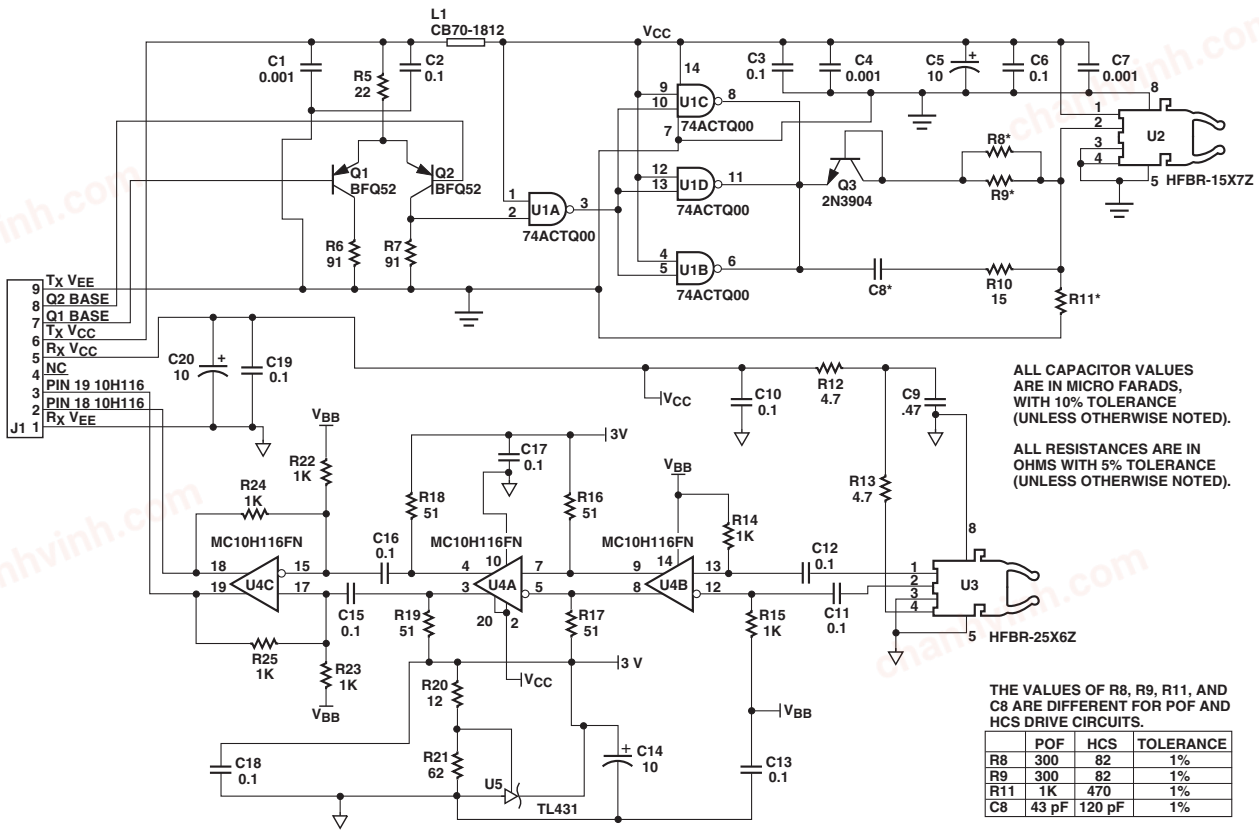


Figure 1. Transmitter and receiver application circuit with +5 V ECL inputs and outputs.

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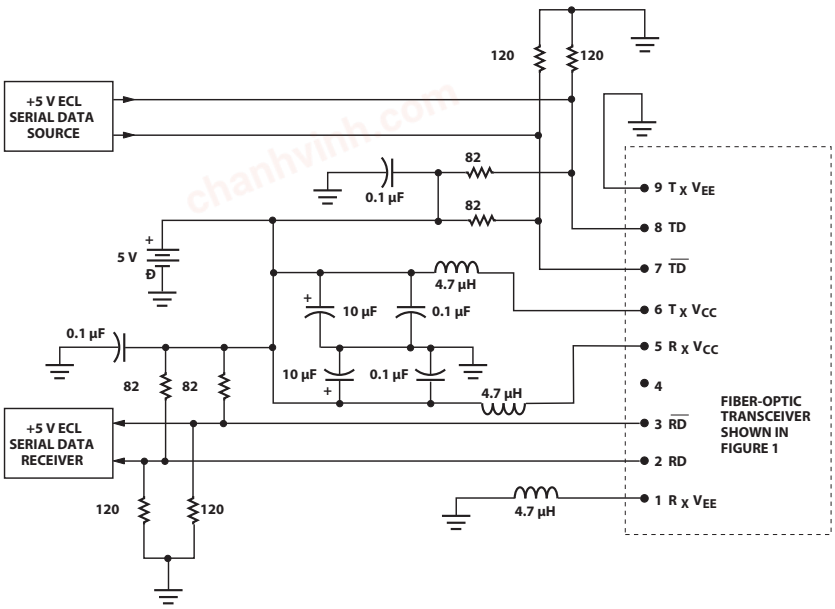


Figure 2. Recommended power supply filter and +5 V ECL signal terminations for the transmitter and receiver application circuit of Figure 1.

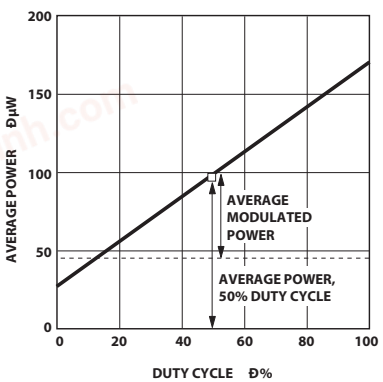


Figure 3. Average modulated power.

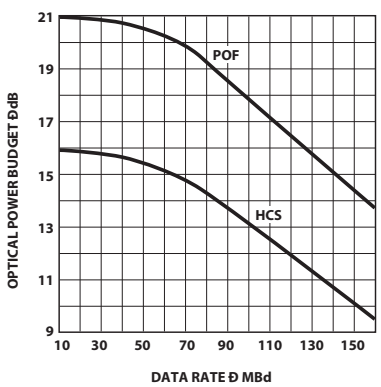


Figure 4. Typical optical power budget vs. data rate.

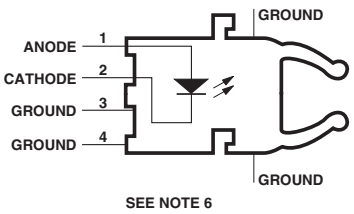
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125 Megabaud Versatile Link Transmitter

HFBR-15X7Z Series

Description

The HFBR-15X7Z transmitters incorporate a 650 nanometer LED in a horizontal (HFBR-1527Z) or vertical (HFBR-1537Z) gray housing. The HFBR-15X7Z transmitters are suitable for use with current peaking to decrease response time and can be used with HFBR-25X6Z receivers in data links operating at signal rates from 1 to 125 megabaud over 1 mm diameter plastic optical fiber or 200 µm diameter hard clad silica glass optical fiber. Refer to Application Note 1066 for details for recommended interface circuits.



Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Reference
Storage Temperature	T_S	-40	85	°C	
Operating Temperature	T_O	-40	70	°C	
Lead Soldering Temperature Cycle Time			260	°C	Note 1, 9
			10	s	
Transmitter High Level Forward Input Current	$I_{F,H}$		120	mA	50% Duty Cycle ≥ 1 MHz
Transmitter Average Forward Input Current	$I_{F,AV}$		60	mA	
Reverse Input Voltage	V_R		3	V	

CAUTION: The small junction sizes inherent to the design of this component increase the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.

WARNING: WHEN VIEWED UNDER SOME CONDITIONS, THE OPTICAL PORT MAY EXPOSE THE EYE BEYOND THE MAXIMUM PERMISSIBLE EXPOSURE RECOMMENDED IN ANSI Z136.2, 1993. UNDER MOST VIEWING CONDITIONS THERE IS NO EYE HAZARD.

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Electrical/Optical Characteristics 0 to 70°C, unless otherwise stated.

Parameter	Symbol	Min.	Typ.[2]	Max.	Unit	Condition	Note
Transmitter Output Optical Power, 1 mm POF	P_T	-9.5 -10.4	-7.0	-4.8 -4.3	dBm	$I_{F,dc}$ = 20 mA, 25°C 0-70°C	Note 3
Transmitter Output Optical Power, 1 mm POF	P_T	-6.0 -6.9	-3.0	-0.5 -0.0	dBm	$I_{F,dc}$ = 60 mA, 25°C 0-70°C	Note 3
Transmitter Output Optical Power, 200 µm HCS®	P_T	-14.6 -15.5	-13.0	-10.5 -10.0	dBm	$I_{F,dc}$ = 60 mA, 25°C 0-70°C	Note 3
Output Optical Power Temperature Coefficient	$\frac{\Delta P_T}{\Delta T}$		-0.02		dB/°C		
Peak Emission Wavelength	λ_{PK}	640	650	660	nm		
Peak Wavelength Temperature Coefficient	$\frac{\Delta \lambda}{\Delta T}$		0.12		nm/°C		
Spectral Width	FWHM		21		nm	Full Width, Half Maximum	
Forward Voltage	V_F	1.8	2.1	2.4	V	I_F = 60 mA	
Forward Voltage Temperature Coefficient	$\frac{\Delta V_F}{\Delta T}$		-1.8		mV/°C		
Transmitter Numerical Aperture	NA		0.5				
Thermal Resistance, Junction to Case	θ_{jc}		140		°C/W		Note 4
Reverse Input Breakdown Voltage	V_{BR}	3.0	13		V	$I_{F,dc}$ = -10 µA	
Diode Capacitance	C_O		60		pF	V_F = 0 V, f = 1 MHz	
Unpeaked Optical Rise Time, 10% - 90%	t_r		12		ns	I_F = 60 mA f = 100 kHz	Figure 1 Note 5
Unpeaked Optical Fall Time, 90% - 10%	t_f		9		ns	I_F = 60 mA f = 100 kHz	Figure 1 Note 5

Notes:

1. 1.6 mm below seating plane.
2. Typical data is at 25°C.
3. Optical Power measured at the end of 0.5 meter of 1 mm diameter plastic or 200 µm diameter hard clad silica optical fiber with a large area detector.
4. Typical value measured from junction to PC board solder joint for horizontal mount package, HFBR-1527Z. θ_{jc} is approximately 30°C/W higher for vertical mount package, HFBR-1537Z.
5. Optical rise and fall times can be reduced with the appropriate driver circuit; refer to Application Note 1066.
6. Pins 5 and 8 are primarily for mounting and retaining purposes, but are electrically connected; pins 3 and 4 are electrically unconnected. It is recommended that pins 3, 4, 5, and 8 all be connected to ground to reduce coupling of electrical noise.
7. Refer to the Versatile Link Family Fiber Optic Cable and Connectors Technical Data Sheet for cable connector options for 1 mm plastic optical fiber and 200 µm HCS fiber.
8. The LED current peaking necessary for high frequency circuit design contributes to electromagnetic interference (EMI). Care must be taken in circuit board layout to minimize emissions for compliance with governmental EMI emissions regulations. Refer to Application Note 1066 for design guidelines.
9. Moisture sensitivity level (MSL) is 3

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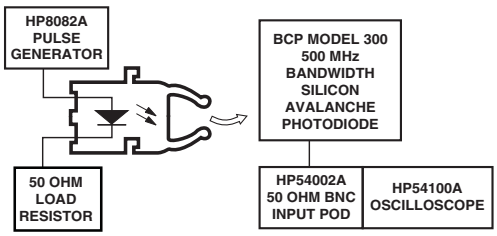


Figure 1. Test circuit for measuring unpeaked rise and fall times.

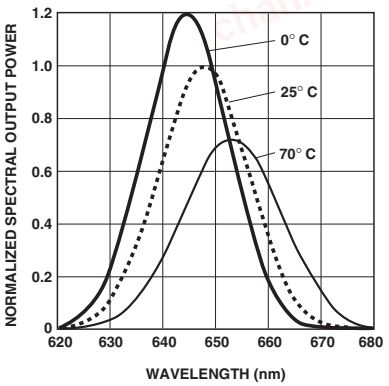


Figure 2. Typical spectra normalized to the 25°C peak.

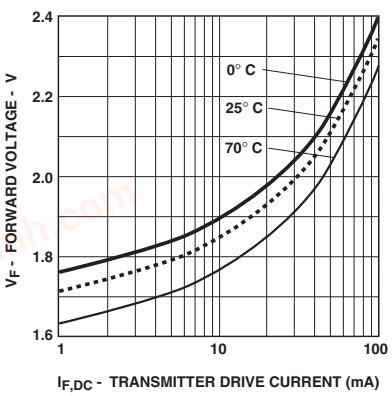


Figure 3. Typical forward voltage vs. drive current.

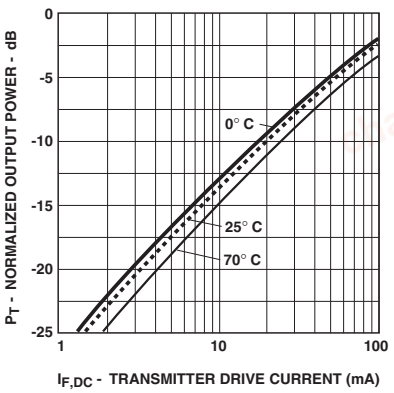


Figure 4. Typical normalized output optical power vs. drive current.

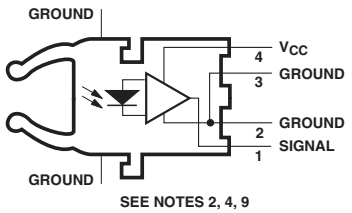
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125 Megabaud Versatile Link Receiver

HFBR-25X6Z Series

Description

The HFBR-25X6Z receivers contain a PIN photodiode and transimpedance pre-amplifier circuit in a horizontal (HFBR-2526Z) or vertical (HFBR-2536Z) blue housing, and are designed to interface to 1mm diameter plastic optical fiber or 200 µm hard clad silica glass optical fiber. The receivers convert a received optical signal to an analog output voltage. Follow-on circuitry can optimize link performance for a variety of distance and data rate requirements. Electrical bandwidth greater than 65 MHz allows design of high speed data links with plastic or hard clad silica optical fiber. Refer to Application Note 1066 for details for recommended interface circuits.



Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Reference
Storage Temperature	T_S	-40	+75	°C	
Operating Temperature	T_A	0	+70	°C	
Lead Soldering Temperature			260	°C	Note 1, 11
Cycle Time			10	s	
Signal Pin Voltage	V_O	-0.5	V_{CC}	V	
Supply Voltage	V_{CC}	-0.5	6.0	V	
Output Current	I_O		25	mA	

CAUTION: The small junction sizes inherent to the design of this component increase the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.

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Electrical/Optical Characteristics 0 to 70°C; 5.25 V ≥ V_{CC} ≥ 4.75 V; power supply must be filtered (see Figure 1, Note 2).

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition	Note
AC Responsivity 1 mm POF	$R_{P,APF}$	1.7	3.9	6.5	mV/µW	650 nm	Note 4
AC Responsivity 200 µm HCS	$R_{P,HCS}$	4.5	7.9	11.5	mV/µW		
RMS Output Noise	V_{NO}		0.46	0.69	mV_{RMS}		Note 5
Equivalent Optical Noise Input Power, RMS - 1 mm POF	$P_{N,RMS}$		- 39	-36	dBm		Note 5
Equivalent Optical Noise Input Power, RMS - 200 µm HCS	$P_{N,RMS}$		-42	-40	dBm		Note 5
Peak Input Optical Power - 1 mm POF	P_R			-5.8	dBm	5 ns PWD	Note 6
				-6.4	dBm	2 ns PWD	
Peak Input Optical Power - 200 µm HCS	P_R			-8.8	dBm	5 ns PWD	Note 6
				-9.4	dBm	2 ns PWD	
Output Impedance	Z_O		30		Ω	50 MHz	Note 4
DC Output Voltage	V_O	0.8	1.8	2.6	V	P_R = 0 µW	
Supply Current	I_{CC}		9	15	mA		
Electrical Bandwidth	BW_E	65	125		MHz	-3 dB electrical	
Bandwidth * Rise Time			0.41		Hz * s		
Electrical Rise Time, 10-90%	t_r		3.3	6.3	ns	P_R = -10 dBm peak	
Electrical Fall Time, 90-10%	t_f		3.3	6.3	ns	P_R = -10 dBm peak	
Pulse Width Distortion	PWD		0.4	1.0	ns	P_R = -10 dBm peak	Note 7
Overshoot			4		%	P_R = -10 dBm peak	Note 8

Notes:

1. 1.6 mm below seating plane.
2. The signal output is an emitter follower, which does not reject noise in the power supply. The power supply must be filtered as in Figure 1.
3. Typical data are at 25°C and V_{CC} = +5 Vdc.
4. Pin 1 should be ac coupled to a load ≥ 510 Ω with load capacitance less than 5 pF.
5. Measured with a 3 pole Bessel filter with a 75 MHz, -3dB bandwidth.
6. The maximum Peak Input Optical Power is the level at which the Pulse Width Distortion is guaranteed to be less than the PWD listed under Test Condition. $P_{R,Max}$ is given for PWD = 5 ns for designing links at ≤ 50 MBd operation, and also for PWD = 2 ns for designing links up to 125 MBd (for both POF and HCS input conditions).
7. 10 ns pulse width, 50% duty cycle, at the 50% amplitude point of the waveform.
8. Percent overshoot is defined at:

$$\frac{(V_{PK} - V_{100\%})}{V_{100\%}} \times 100\%$$

9. Pins 5 and 8 are primarily for mounting and retaining purposes, but are electrically connected. It is recommended that these pins be connected to ground to reduce coupling of electrical noise.
10. If there is no input optical power to the receiver (no transmitted signal) electrical noise can result in false triggering of the receiver. In typical applications, data encoding and error detection prevent random triggering from being interpreted as valid data. Refer to Application Note 1066 for design guidelines.
11. Moisture sensitivity level (MSL) is 4

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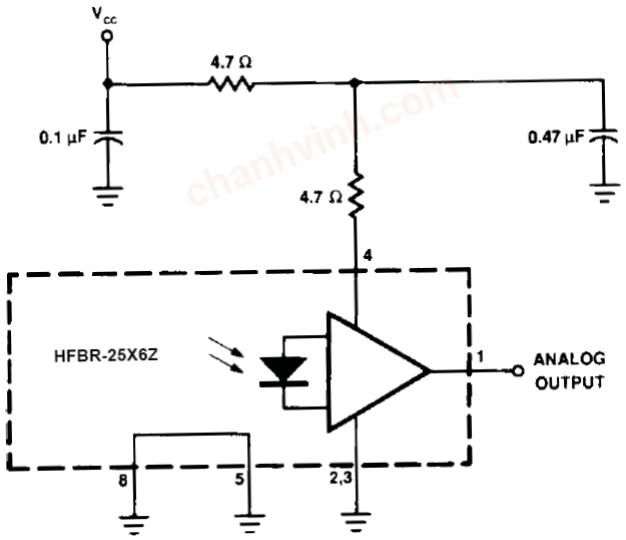


Figure 1. Recommended power supply filter circuit.

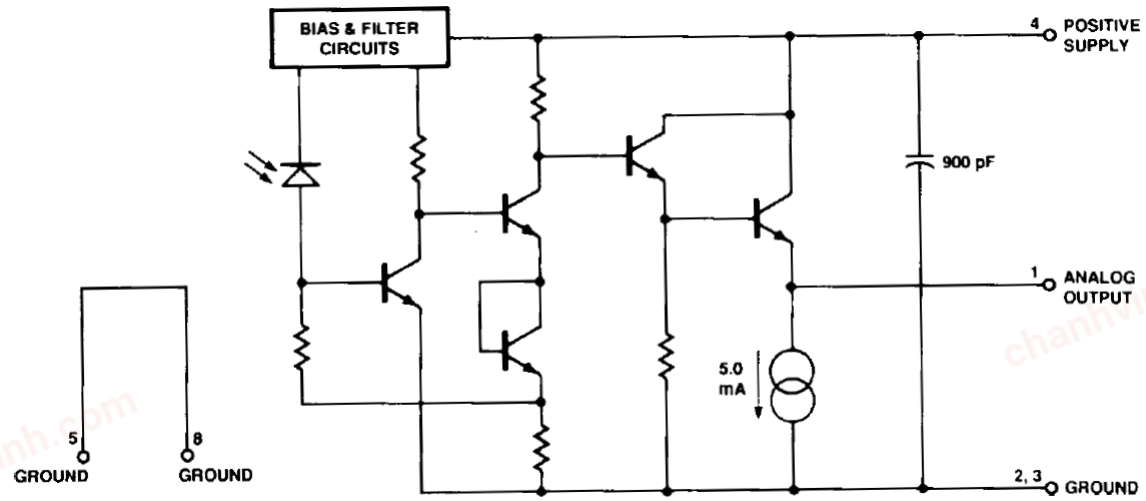


Figure 2. Simplified receiver schematic.

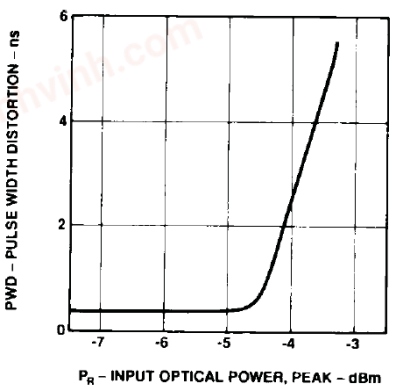


Figure 3. Typical pulse width distortion vs. peak input power.

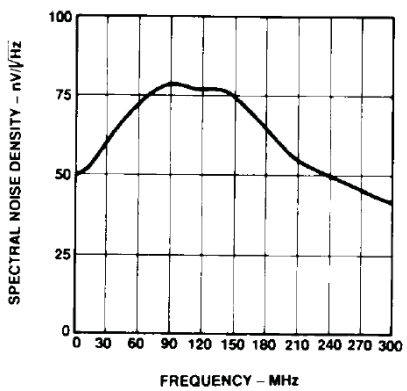


Figure 4. Typical output spectral noise density vs. frequency.

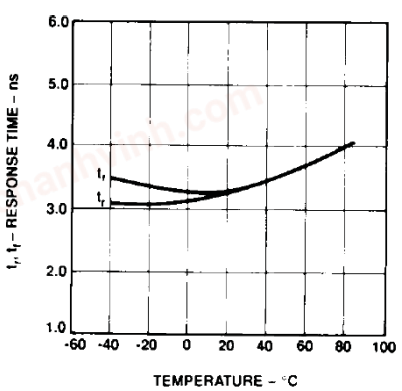
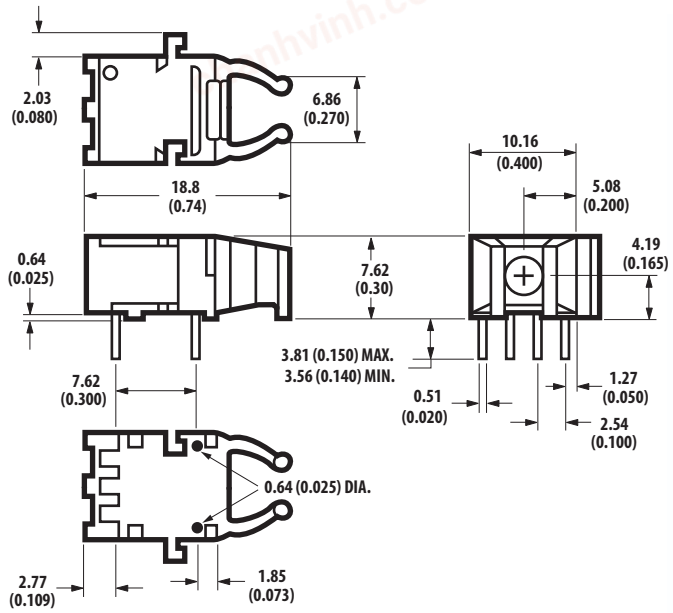


Figure 5. Typical rise and fall time vs. temperature.

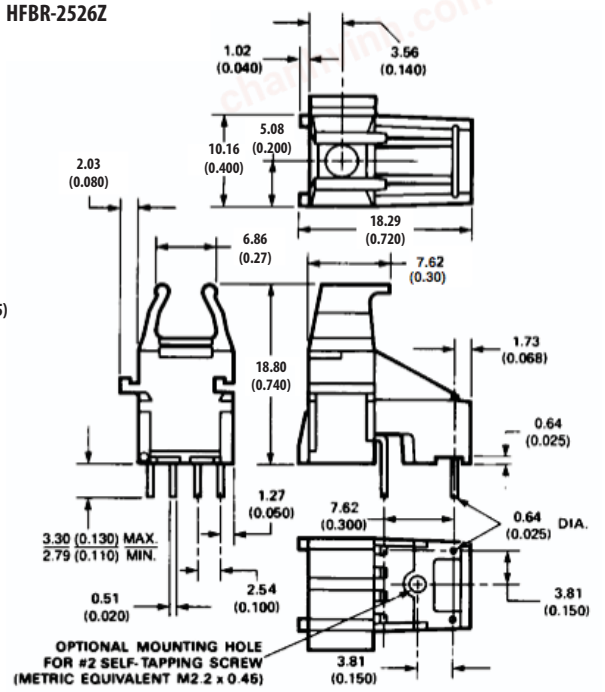
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Versatile Link Mechanical Dimensions

HORIZONTAL MODULES
HFBR-1527Z
HFBR-2526Z



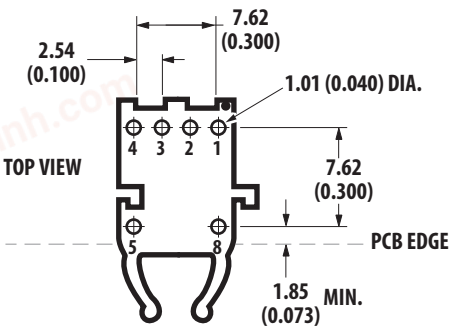
HORIZONTAL MODULES
HFBR-1537Z
HFBR-2526Z



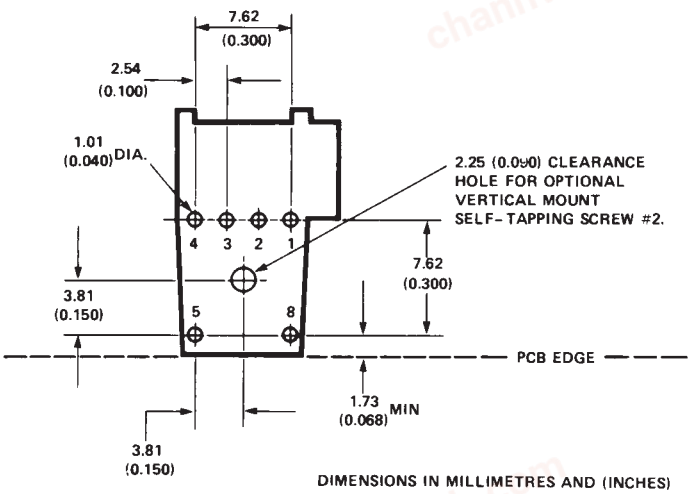
Versatile Link Printed Circuit Board Layout Dimensions

TOP VIEWS

HORIZONTAL MODULE



VERTICAL MODULE



DIMENSIONS IN MILLIMETRES AND (INCHES)

DIMENSIONS IN MILLIMETERS (INCHES).

ELECTRICAL PIN FUNCTIONS

PIN NO.	TRANSMITTERS HFBR-15x7Z	RECEIVERS HFBR-25x6Z
1	ANODE	SIGNAL
2	CATHODE	GROUND
3	GROUND*	GROUND
4	GROUND*	V_{CC} (+5 V)
5	GROUND**	GROUND**
8	GROUND**	GROUND**

*NO INTERNAL CONNECTION.
**PINS 5 AND 8 CONNECTED INTERNALLY TO EACH OTHER ONLY.

For product information and a complete list of distributors, please go to our website: **www.avagotech.com**

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