

**HFBR-0507ETZ Series**  
**HFBR-1527ETZ Transmitters**  
**HFBR-2526ETZ Receivers**  
125 Megabaud Versatile Link  
The Versatile Fiber Optic Connection



## Data Sheet



### Description

The 125 MBd Versatile Link (HFBR-0507ETZ Series) is the most cost-effective fiber-optic solution for transmission of 125 MBd data over 100 m. The data link consists of a 650 nm LED transmitter, HFBR-1527ETZ, and a PIN/preamp receiver, HFBR-2526ETZ. 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 m. 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-1527ETZ 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  $\mu$ m Hard Clad Silica (HCS<sup>®</sup>) fiber. With the recommended drive circuit, the LED operates at speeds from 1-125 MBd. The HFBR-2526ETZ 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 m with plastic fiber and 0-100 m with 200  $\mu$ m HCS<sup>®</sup> fiber. A wide variety of other digitizing circuits can be combined with the HFBR-0507ETZ Series to optimize performance and cost at higher and lower data rates.

### Features

- -40° to +85°C operating temperature range
- RoHS-compliant
- Data transmission at signal rates of 1 to 125 MBd over distances of 100 m
- 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
- Renewable energies
- Medical instruments
- Reduction of lightning and voltage transient susceptibility

HCS<sup>®</sup> is a registered trademark of OFS Corporation.

## HFBR-0507ETZ Series

### 125 MBd Data Link

Data link operating conditions and performance are specified for the HFBR-1527ETZ transmitter and HFBR-2526ETZ receiver in the recommended applications circuits shown in Figure 1. This circuit has been optimized for 125 MBd operation. For other data rate application, please refer to application notes: AN1121, AN1122 and AN1123.

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

Parameter	Symbol	Min.	Max.	Unit	Reference
Ambient Temperature	T <sub>A</sub>	-40	85	°C	
Supply Voltage	V <sub>CC</sub>	+4.75	+5.25	V	
Data Input Voltage – Low	V <sub>IL</sub>	V <sub>CC</sub> -1.89	V <sub>CC</sub> -1.62	V	
Data Input Voltage – High	V <sub>IH</sub>	V <sub>CC</sub> -1.06	V <sub>CC</sub> -0.70	V	
Data Output Load	R <sub>L</sub>	45	55	Ω	Note 1
Signaling Rate	f <sub>S</sub>	1	125	MBd	
Duty Cycle	D.C.	40	60	%	Note 2

### Link Performance

1-125 MBd, BER ≤ 10<sup>-9</sup>, under recommended operating conditions with recommended transmit and receive application circuits.

Parameter	Symbol	Min. <sup>[3]</sup>	Typ. <sup>[4]</sup>	Max.	Unit	Condition	Reference
Optical Power Budget, 1 m POF	OPB <sub>POF</sub>	11	16		dB		Note 5,6,7
Optical Power Margin, 20 m Standard POF	OPM <sub>POF,20</sub>	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 <sub>POF,25</sub>	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 <sub>HCS</sub>	7	12		dB		Note 5,6,7
Optical Power Margin, 100 m HCS	OPM <sub>HCS,100</sub>	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<sub>CC</sub> - 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-1527ETZ transmitter, HFBR-2526ETZ 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-RXXYYZ plastic optical fiber, with a maximum attenuation of 0.24 dB/m at 650 nm and NA = 0.5.  
Extra low loss cable is plastic optical fiber, with a maximum attenuation of 0.19 dB/m at 650 nm and NA = 0.5.  
HCS cable is 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 m 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: OPB = OPB - (attenuation power loss + modal dispersion power penalty). The minimum OPM is the margin available for long term LED LOP degradation and additional fixed passive losses (such as in-line connectors) in addition to the minimum specified distance.

### Plastic Optical Fiber (1 mm POF) Transmitter Application Circuit

Performance of the HFBR-1527ETZ 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 <sub>avg</sub>	-9.7	dBm	50% Duty Cycle	Note 1, Fig 3
Average Modulated Power 1 mm POF	P <sub>mod</sub>	-11.3	dBm		Note 2, Fig 3
Optical Rise Time (10% to 90%)	t <sub>r</sub>	2.1	ns	5 MHz	
Optical Fall Time (90% to 10%)	t <sub>f</sub>	2.8	ns	5 MHz	
High Level LED Current (On)	I <sub>F,H</sub>	19	mA		Note 3
Low Level LED Current (Off)	I <sub>F,L</sub>	3	mA		Note 3
Optical Overshoot – 1 mm POF		45	%		
Transmitter Application Circuit Current Consumption – 1 mm POF	I <sub>CC</sub>	110	mA		Figure 1

### Hard Clad Silica Fiber (200 μm HCS) Transmitter Application Circuit

Performance of the HFBR-1527ETZ 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 <sub>avg</sub>	-14.6	dBm	50% Duty Cycle	Note 1, Fig 3
Average Modulated Power 200 μm HCS	P <sub>mod</sub>	-16.2	dBm		Note 2, Fig 3
Optical Rise Time (10% to 90%)	t <sub>r</sub>	3.1	ns	5 MHz	
Optical Fall Time (90% to 10%)	t <sub>f</sub>	3.4	ns	5 MHz	
High Level LED Current (On)	I <sub>F,H</sub>	60	mA		Note 3
Low Level LED Current (Off)	I <sub>F,L</sub>	6	mA		Note 3
Optical Overshoot – 200 μm HCS		30	%		
Transmitter Application Circuit Current Consumption – 200 μm HCS	I <sub>CC</sub>	130	mA		Figure 1

Notes:

1. Average optical power is measured with an average power meter at 50% duty cycle, after 1 m 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:

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

3. High and low level LED currents refer to the current through the HFBR-1527ETZ 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.

## Plastic and Hard Clad Silica Optical Fiber Receiver Application Circuit

Performance<sup>[4]</sup> of the HFBR-2526ETZ 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	$R_L = 50 \Omega$	Note 5
Data Output Voltage – High	$V_{OH}$	$V_{CC} - 0.9$	V	$R_L = 50 \Omega$	Note 5
Receiver Sensitivity to Average Modulated Optical Power 1 mm POF	$P_{m_{in}}$	-27.5	dBm	50% eye opening	Note 2
Receiver Sensitivity to Average Modulated Optical Power 200 $\mu$ m 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 $\mu$ m HCS	$P_{max}$	-10.5	dBm	50% eye opening	Note 2
Receiver Application Circuit Current Consumption	$I_{CC}$	TBA	mA	$R_L = \infty$	Figure 1

Notes:

- Performance in response to a signal from the HFBR-1527ETZ transmitter driven with the recommended circuit at 1-125 MBd over 1 m of HFBR-RZ/EXXYYZ plastic optical fiber or 1 m of hard clad silica optical fiber.
- Terminated through a 50  $\Omega$  resistor to  $V_{CC} - 2$  V.
- 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.

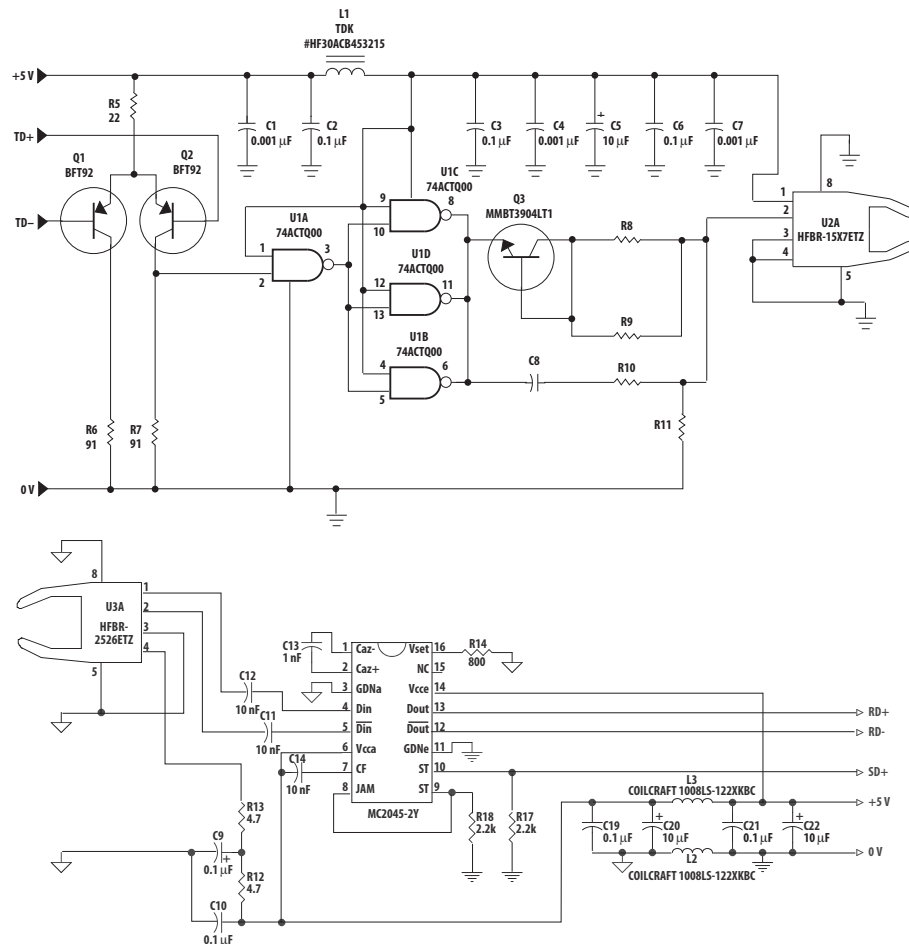


Figure 1. Transmitter and receiver application circuit with +5 V ECL inputs and outputs.

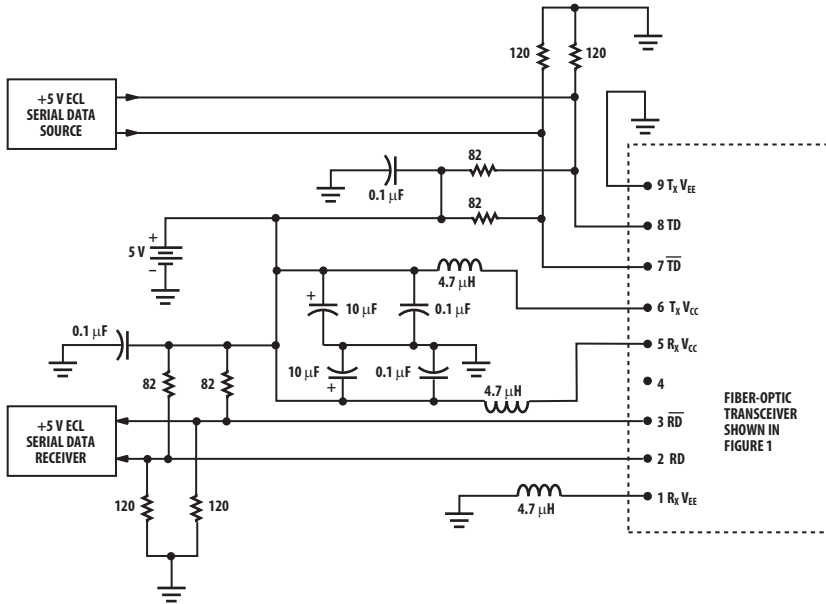


Figure 2. Recommended power supply filter and +5 V ECL signal terminations for the transmitter and receiver application circuit of Figure 1

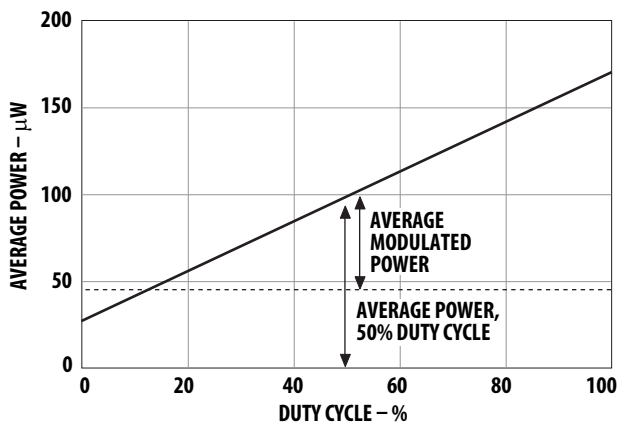


Figure 3. Average modulated power

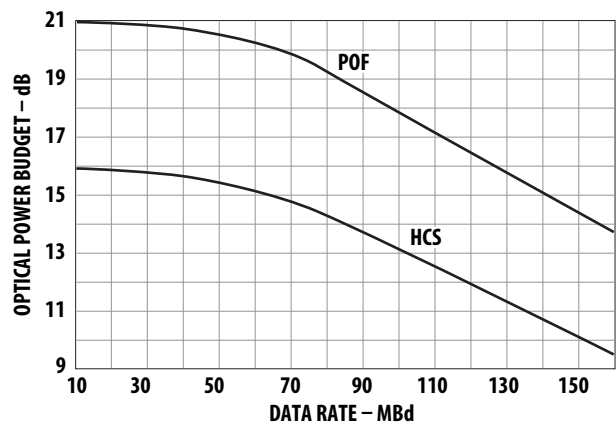


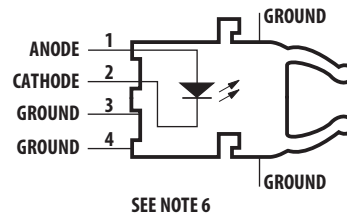
Figure 4. Typical optical power budget vs. data rate

# 125 Megabaud Versatile Link Transmitter

## HFBR-1527ETZ Series

### Description

The HFBR-1527ETZ transmitters incorporate a 650 nanometer LED in a horizontal (HFBR-1527ETZ) gray housing. The HFBR-1527ETZ transmitters are suitable for use with current peaking to decrease response time and can be used with HFBR-2526ETZ receivers in data links operating at signal rates from 1 to 125 megabaud over 1 mm diameter plastic optical fiber or 200  $\mu\text{m}$  diameter hard clad silica glass optical fiber.



### Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Reference
Storage Temperature	$T_S$	-40	85	$^{\circ}\text{C}$	
Operating Temperature	$T_O$	-40	85	$^{\circ}\text{C}$	
Lead Soldering Temperature Cycle Time			260 10	$^{\circ}\text{C}$ s	Note 1, 9
Transmitter High Level Forward Input Current	$I_{F,H}$		120	mA	50% Duty Cycle $\geq 1$ 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.

**Electrical/Optical Characteristics -40 to 85° C**, unless otherwise stated.

Parameter	Symbol	Min.	Typ. <sup>[2]</sup>	Max.	Unit	Condition	Note
Transmitter Output Peak Optical Power, 1 mm POF	$P_T$	-9.5 -10.4	-7.0	-4.8 -3.5	dBm	$I_{F,dc} = 20 \text{ mA}$ , 25° C -40 - 85° C	Note 3 NA=0.5
Transmitter Output Peak Optical Power, 1 mm POF	$P_T$	-6.0 -6.9	-3.0	-0.5 0.8	dBm	$I_{F,dc} = 60 \text{ mA}$ , 25° C -40 - 85° C	Note 3 NA=0.5
Transmitter Output Peak Optical Power, 200 $\mu\text{m}$ HCS <sup>®</sup>	$P_T$	-14.6 -16.0	-13.0	-10.5 -9.2	dBm	$I_{F,dc} = 60 \text{ mA}$ , 25° C -40 - 85° C	Note 3 NA=0.x
Output Optical Power Temperature Coefficient	$\frac{\Delta P_T}{\Delta T}$		-0.02		dB/° C		
Peak Emission Wavelength	$\lambda_{PK}$	635	650	662	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	2.65	V	$I_F = 60 \text{ mA}$	
Forward Voltage Temperature Coefficient	$\frac{\Delta V_F}{\Delta T}$		-1.8		mV/°C		
Thermal Resistance, Junction to Case	$\theta_{jc}$		140		°C/W		Note 4
Reverse Input Breakdown Voltage	$V_{BR}$	3.0	13		V	$I_{F,dc} = -10 \mu\text{A}$	
Diode Capacitance	$C_O$		60		pF	$V_F = 0 \text{ V}$ , $f = 1 \text{ MHz}$	
Unpeaked Optical Rise Time, 10% – 90%	$t_r$		10		ns	$I_F = 60 \text{ mA}$ $f = 100 \text{ kHz}$	Figure 1 Note 5
Unpeaked Optical Fall Time, 90% – 10%	$t_f$		11		ns	$I_F = 60 \text{ mA}$ $f = 100 \text{ kHz}$	Figure 1 Note 5

Notes:

- 1.6 mm below seating plane.
- Typical data is at 25° C.
- Optical power measured at the end of either 0.5m of 1mm diameter POF (NA=0.5) or 5m of 200 um diameter HCS (NA=0.37) with a large area detector.
- Typical value measured from junction to PC board solder joint for horizontal mount package, HFBR-1527ETZ.
- Optical rise and fall times can be reduced with the appropriate driver circuit.
- 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.
- Refer to the Versatile Link Family Fiber Optic Cable and Connectors Technical Data Sheet for cable connector options for 1 mm plastic optical fiber.
- 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.
- Moisture sensitivity level is MSL-4

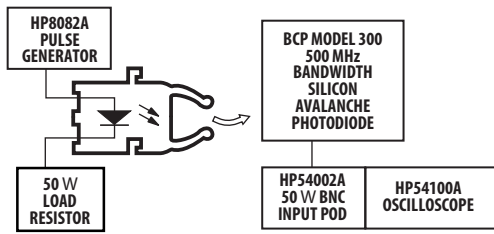


Figure 5. Test circuit for measuring unpeaked rise and fall times

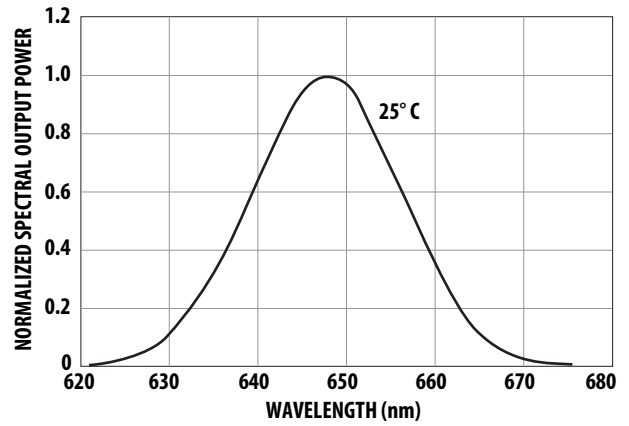


Figure 6. Typical spectra at 25°C

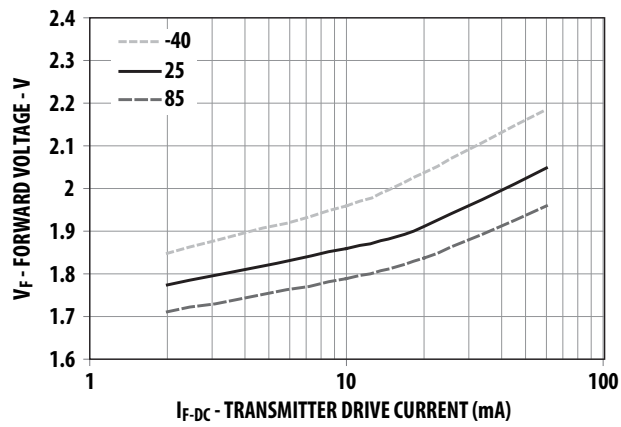


Figure 7. Typical forward voltage vs. drive current

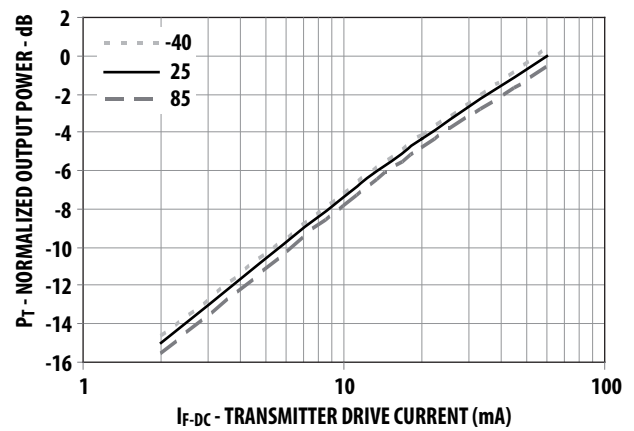


Figure 8. Typical normalized output optical power vs. drive current

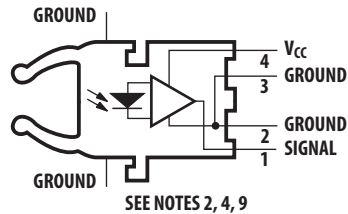


# 125 Megabaud Versatile Link Receiver

## HFBR-2526ETZ Series

### Description

The HFBR-2526ETZ receivers contain a PIN photodiode and transimpedance pre-amplifier circuit in a horizontal (HFBR-2526ETZ) blue housing, and are designed to interface to 1 mm diameter plastic optical fiber or 200  $\mu\text{m}$  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.



### Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Reference
Storage Temperature	$T_S$	-40	85	$^{\circ}\text{C}$	
Operating Temperature	$T_A$	-40	85	$^{\circ}\text{C}$	
Lead Soldering Temperature Cycle Time			260 10	$^{\circ}\text{C}$ s	Note 1, 11
Signal Pin Voltage	$V_O$	-0.5	$V_{CC}$	V	
Supply Voltage	$V_{CC}$	-0.5	60	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.

**Electrical/Optical Characteristics** -40 to 85° C; 5.25 V ≥ V<sub>CC</sub> ≥ 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 <sub>P,APF</sub>	1.7	3.9	6.5	mV/μW	650 nm	Note 4
AC Responsivity 200 μm HCS	R <sub>P,HCS</sub>	4.5	7.9	11.5	mV/μW		
RMS Output Noise	V <sub>NO</sub>		0.46	0.69	mVRMS		Note 5
Equivalent Optical Noise Input Power, RMS – 1 mm POF	P <sub>N,RMS</sub>		-39	-36	dBm		Note 5
Equivalent Optical Noise Input Power, RMS – 200 μm HCS	P <sub>N,RMS</sub>		-42	-40	dBm		Note 5
Peak Input Optical Power – 1 mm POF	P <sub>R</sub>			-5.8 -6.4	dBm dBm	5 ns PWD 2 ns PWD	Note 6
Peak Input Optical Power – 200 μm HCS	P <sub>R</sub>			-8.8 -9.4	dBm dBm	5 ns PWD 2 ns PWD	Note 6
Output Impedance	Z <sub>O</sub>		30		Ω	50 MHz	Note 4
DC Output Voltage	V <sub>O</sub>	0.8	1.8	2.6	V	PR = 0 μW	
Supply Current	I <sub>CC</sub>		9	15	mA		
Electrical Bandwidth	BW <sub>E</sub>	65	125		MHz	-3 dB electrical	
Bandwidth * Rise Time			0.41		Hz * s		
Electrical Rise Time, 10–90%	t <sub>r</sub>		3.3	6.3	ns	PR = -10 dBm peak	
Electrical Fall Time, 90–10%	t <sub>f</sub>		3.3	6.3	ns	PR = -10 dBm peak	
Pulse Width Distortion	PWD		0.4	1.0	ns	PR = -10 dBm peak	Note 7
Overshoot			4		%	PR = -10 dBm peak	Note 8

Notes:

- 1.6 mm below seating plane.
- 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.
- Typical data are at 25° C and V<sub>CC</sub> = +5 Vdc.
- Pin 1 should be ac coupled to a load ≥ 510 Ω with load capacitance less than 5 pF.
- Measured with a 3 pole Bessel filter with a 75 MHz, -3dB bandwidth.
- 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<sub>R,Max</sub> 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).
- 10 ns pulse width, 50% duty cycle, at the 50% amplitude point of the waveform.
- Percent overshoot is defined at:

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

- 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.
- 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.
- Moisture sensitivity level is MSL-4

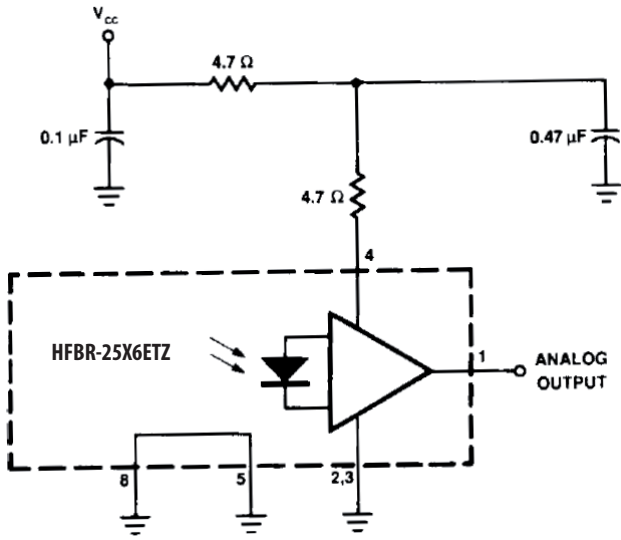


Figure 9. Recommended power supply filter circuit

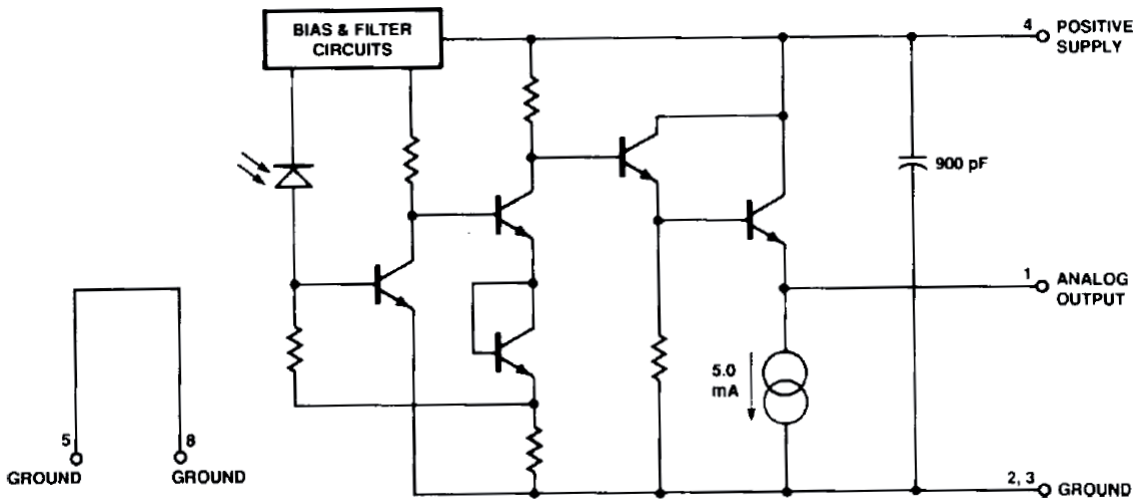


Figure 10. Simplified receiver schematic

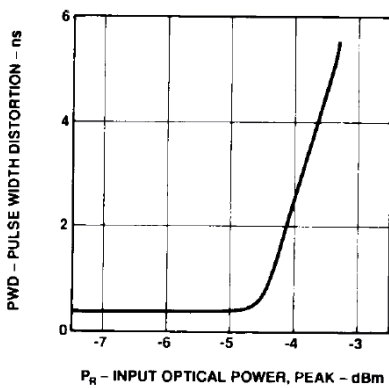


Figure 11. Typical pulse width distortion vs. peak input power

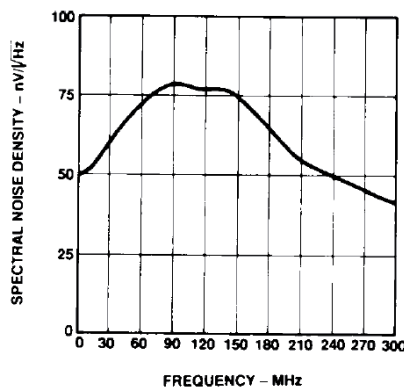


Figure 12. Typical output spectral noise density vs. frequency

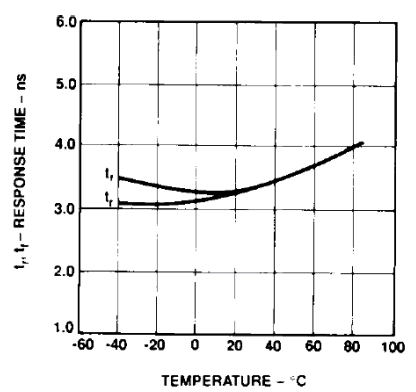


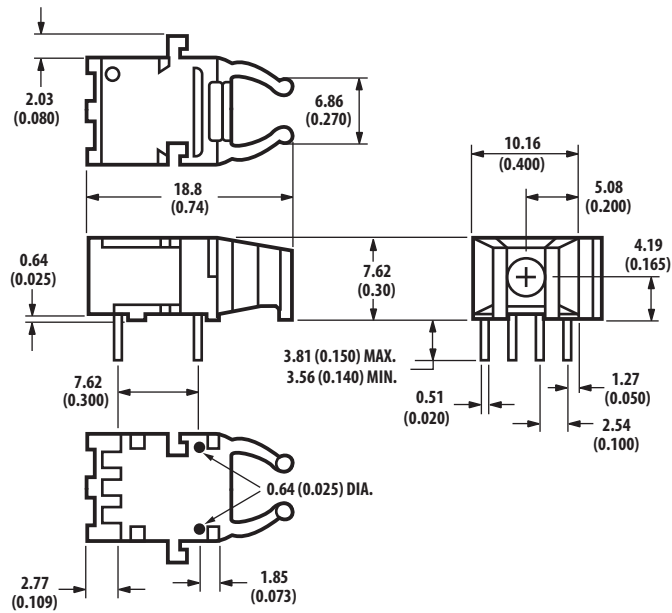
Figure 13. Typical rise and fall time vs. temperature

## Versatile Link Mechanical Dimensions

### HORIZONTAL MODULES

HFBR-1527ETZ

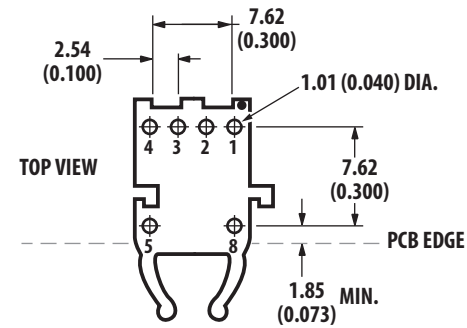
HFBR-2526ETZ



## Versatile Link Printed Circuit Board Layout Dimensions

### TOP VIEWS

#### HORIZONTAL MODULE



DIMENSIONS IN MILLIMETERS (INCHES).

### ELECTRICAL PIN FUNCTIONS

Pin No.	Transmitters HFBR-1527ETZ	Receivers HFBR-2526ETZ
1	ANODE	SIGNAL
2	CATHODE	GROUND
3	GROUND*	GROUND
4	GROUND*	VCC (+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 web site: [www.avagotech.com](http://www.avagotech.com)

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AV02-2590EN - December 16, 2010

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